CONSTRUCTION AND DEMOLITION WASTE

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1. OVERVIEW

For many years the generation of waste has been rampant in all fields because people did not care about his generation and much less for their proper management, and we can add the fact that there was a lack of normative to regulate their generation.

Because of the serious environmental problems that we have nowadays there emerged the need to plan better the activities performed for the control of waste generation and to comply with the laws that have appeared recently.

The growing development of the construction industry increased production of solid material waste from the activities in this sector. The volume of waste generated causes some concern and a correct management is more and more important due to serious pollution problems. Every day there are more interested people in providing adequate environmental management of the wastes produced in the construction sector.

Previously, construction companies were only concerned to make faster their activities to deliver as soon as possible their projects regardless of the environmental impact caused by the treatment given to the waste. The construction companies simply removed the material and placed it works without any control in landfills, these landfills were filling faster due to the amount of debris generated. Nowadays, aware of the situation have begun to take simple measures which allow a proper management of the debris in both the construction site and outside. This has been shown that the fact of providing a better management of the waste generated in the construction generates many benefits for companies, enhances and improves the operations from the construction companies to society, customers and to certain environmental organizations. Furthermore, it has been shown that the management of waste from construction provides other benefits such as reducing disposal costs, the construction company paid twice a material, once when the material arrives to the work site and again for the disposal of material. Good management of waste would also allow builders to achieve distinction in the market, which would facilitate sales.

2. THE ORIGIN OF WASTE FROM CONSTRUCTION AND DEMOLITION

The origin of waste from construction and demolition, as the name suggests comes from the construction and demolition of buildings and infrastructure. However its composition varies based on the type of infrastructure in question.
These are divided into:

- Sector of the residential building and commercial buildings, including the construction, maintenance and restoration of buildings.
- Infrastructure sector, which includes the construction of roads, bridges, tunnels and other infrastructure.

The composition of construction and demolition waste consists mainly on the type and quantity of raw materials used. This composition may vary depending on the constructive typology or the country in construction, in addition, also varies depending on when the building was built.

Below is a table with the average composition of construction and demolition waste in a building in the Spanish state according to the Plan of Construction and Demolition Waste.

Material	**% by weight**
Debris	75
Bricks, tiles and other ceramic	54
Concrete	12
Stone	5
Sand, gravel and other arid	4
Rest	25
Wood	4
Glass	0,5
Plastic	1,5
Metals	2,5
Asphalt	5
Gypsum	0,2
Paper	0,3
Trash	7
Others	4

3. CLASSIFICATION OF CONSTRUCTION AND DEMOLITION WASTE

For a proper management of waste from construction and demolition we must know their classification according to different factors.

According to their nature are classified as:

- Inert waste: waste that not present any risk of contamination of water, soil and air, generally could assimilate the stony materials.

- Non-hazardous or special waste: waste which by its nature can be treated or stored on the same premises as household waste. The characteristic of non-hazardous is what defines their recyclability, this kind of waste can be recycled in industrial plants with other wastes.

- Hazardous waste: waste formed by materials having certain harmful characteristics to health or to environment. This type of waste is detailed in section 3.1.

According to their source of generation and their origin are classified as:

- Land clearing materials: formed by branches, trees and topsoil.

- Materials of excavation: it is usually considered as an inert, natural or artificial residue. In some cases is presented with contaminants when does not correspond to a virgin soil.

- Waste of road infrastructure operations: composed by asphalt waste, pieces of concrete slabs and crushed pavement of asphalt of roads and bridges.

- Waste resulting from demolition: are the building materials and products which emerge as a result of disassembly, dismantling and demolition of buildings and installations.

- Wastes from repair, expansion or new construction: these wastes are generated in the process of execution of materials. Its origin is diverse, one part comes from the actions of building and other part from the products used in construction. The characteristics are varied and depend on the stage and type of construction.

3.1. HAZARDOUS WASTE FROM CONSTRUCTION AND DEMOLITION

A high percentage of waste from construction or demolition of buildings is inert. However, a small proportion of them contains hazardous waste. Taking into account the main characteristics and the dangerous contaminants which may contain, we can mention the properties about hazardous waste from construction and demolition. Therefore, waste must be considered hazardous if it exhibits any of the following characteristics:

- Flammability: flammable waste set fires under certain conditions or are spontaneously combustible and have a melting point less than 60 ° C inflammation.

- Corrosively: corrosive wastes are acids or bases capable of attacking metal containers as storage tanks, drums or barrels.

- Reactivity: reactive wastes are unstable under normal conditions. They can cause explosions, toxic fumes, gases, or vapors when are mixed with water.

- Toxicity: toxic wastes are harmful or fatal when are ingested or absorbed. When toxic waste is disposed of on land, the contaminated liquid can leak and contaminate groundwater. In the construction and demolition waste are some residues with these characteristics, for example, asphalts or lead pipes.

Main pollutants in waste from construction and demolition

The main pollutants found in waste from construction and demolition are:

- Aluminum: because of its mechanical strength, light weight and corrosion resistance are found in a lot quantities in the materials of construction. This pollutant can harm humans by exposure to aluminum dust.

- Arsenic: this element has been used to protect wood used in construction, has now ceased to be used. But because of his long life arsenic will remain being part of the construction and demolition waste for many more years.

- Asphalt: this material can be found as a protective element in coatings, pipes or installations.

- Mercury: is found in various elements of constructions such as fluorescent lamps, smoke detectors, thermostats, etc.

- Lead: was used for years in buildings, now can be found on discards of pipes, tubes and lead-based paints. On the actuality lead is not allowed because of its toxicity.

4. LIFECYCLE OF SOLID WASTE FROM CONSTRUCTION AND DEMOLITION

Like the rest of solid waste, construction and demolition waste have a life cycle that includes the following steps: collection, separation, storage, management, transportation and disposal.

Collection

Process to plan the actions to be performed by workers to collect and transfer the waste generated in the construction process to a site designed for this purpose. Is necessary to specify the methodology, frequency, responsible and is necessary towork under strict safety standards.

The methodology will vary according to the technology available in the project and the complexity and magnitude of it, quantity, volume and size of the waste and the availability of space in the workplace.

This is the initial process so it is necessary to consider some aspects such as information and training of the work.

Separation

It is the process that describes the actions or proceedings for classifying certain components or materials. Materials classified as hazardous or special waste must be handled in a special way.

Specific to separate or classify and separate different materials those who need special attention as for example the waste paints, solvents or other toxic substances that need more care in management.

At this stage the decision of the future of the material is taken, for example if the material is recyclable or reusable, or if you can use the material on the same process of the project.

To make this process is recommended to allocate staff specifically to comply this responsibility.

Storage

The storage of waste should be made based on the principle of securing the conditions for environmental protection and human health as well as compliance with the provisions of the legislation. This activity is performed if it is possible at the site of generation.

The characteristics of the storage are in function of the activity performed in the particular area. The characteristics of the site depend on the type of material to be stored and the size and volume of these.

In some cases the materials may be stored or stacked classifying them as material for recycle, materials to take to the landfill, or materials to be used again.

Management

Keep in mind that the waste management can be different from one country to another, it depends on the regulations of each country. And the type of treatment will depend on the type and characteristics of the waste material.

However, it can be generalized into three simple actions for a proper waste management:

- Learn to discard: from the point of view of efficiency and responsibility we should look at which materials are discarded and in what quantities, because this can tell us much about the ratability of equipment and workers.

- Investigate local conditions and options: is necessary and priority to establish a link between the construction companies of the city to find an appropriate, efficient and economical management of construction waste to conserve natural resources and the landfill capacity.

- Follow the principle of the three Rs: this is based on three actions: Reduce, Reuse and Recycle. This principle is detailed at section 5.1.

Transport

Transport to the disposal site must be done under the strictest safety standards and respectful with the environment.

The discarded waste will be transported from the construction site to the landfill. To the landfill should only be transported the material considered as useless.

The transport depends on the policies of the construction company, in most cases the companies have trucks or contract carriers that are responsible for this function. It is important to ensure that the waste arrive at the right place.

Final disposal

This is the last stage. The final disposal of the materials considered as useless should be controlled and environmentally safe. The final disposition can take many forms, it usually has the following alternatives:

- Sanitary Landfill: this is the place for health and environmentally safe disposal of solid waste. This is done on the surface or underground, based on the principles and methods of health and environmental engineering. This technique of final disposal of solid waste on the floor have to do not generate danger to public health and do not harm the environment. Only the waste which can not receive a treatment of recovery, reuse or recycling will be sent to the sanitary landfill.

- Municipal landfills: provincial or local landfills destined for final disposal of waste. These facilities like sanitary landfills must have the environmental, health and safety protection. As in sanitary landfills, to these places only must be sent the type of waste that is considered trash that can not be used to another benefit.

5. MANAGEMENT OF CONSTRUCTION AND DEMOLITION WASTE

In this section will be defined the most efficient way to manage waste generated in the construction and demolition. This way is always applying when it is possible the principle of the three Rs, this principle is detailed below.

5.1 THE PRINCIPLE OF THE THREE Rs

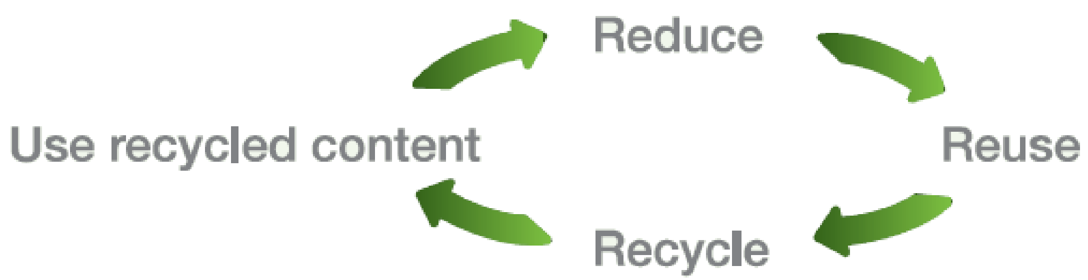
The three Rs are concerned with better resource efficiency in accordance with the following principles:

- Reduce: eliminating the generation of waste, where possible by stopping it coming on to site in the first place.

- Reuse: making use of materials in their original state on the same site or at other sites.

- Recycle: turning materials into new products for other purposes.

The final stage in this process, which completes the three Rs loop, is the specification and use of materials with higher recycled content on future projects to further reduce the demand on natural resources.



Reduce

Eliminating the generation of waste.

The first and most important step in is reduce the amount of waste you eventually send to landfill is reducing the quantity that you actually produce in the first place. There are a number of ways in which you can design out waste just by reviewing how your works are designed and installed. By planning work properly at the outset of a project, you can greatly reduce the amount of materials that end up in the skip at the end of it.

There are some kinds of actions to reduce de waste:

- Get involved in the design process:
  Early involvement of the supply chain in the design process is the most effective way of eliminating the amount of waste produced on a project. By considering the layout, materials and sequencing with the contractor and other sub-contractors, you can help to predict the exact quantities required for the project and remove the need for the safety net of over-ordering materials.

- Do not over-order materials
  There is a double cost to over-ordering: firstly when you pay for materials that are not used, and secondly when you pay to dispose of them. Materials are over-ordered to avoid expensive delays occurring during a project; however, more integrated working would provide visibility into the exact quantities required to do away with this safety net.

- Consider off-site manufacture
  Off-site manufacture can cut waste radically depending on the types of systems used. Off-site production line processes have been proved to decrease waste by optimizing cutting patterns and schedules. Materials can also be delivered directly to the production line eliminating packaging, and products stored under cover reducing weather damage.

- Look at your specifications
  Designing the job to make use of standardized components wherever possible within the design will eliminate some waste. An alternative where this is not possible is working with manufacturers to produce components that are made to fit the design; in other words, procuring size-specific items which do not require cutting to size.

- Improve logistics
  The cost of waste relates not only to materials but also losses in productivity caused by inefficiency and poor logistics. A technique known as lean construction focuses on getting rid of activities that do not add value to minimize wastage on all aspects of a project. Improving your logistics to reduce, for example, the number of times that materials are handled has the potential to minimize waste in all its forms.

- Review your storage arrangements
  If you can eliminate the need to store materials on site, you reduce the risk of them being damaged, for example by the weather, and having to be thrown away. By ordering materials just before they are needed and then storing them in a secure place, you will decrease wastage. If materials are routinely damaged during transportation, it is advisable to review the distribution methods.

- Eliminate packaging
  Ask yourself whether packaging is essential or an excuse to avoid taking responsibility. By educating your workforce to handle items properly you may be able to send products unwrapped, thereby getting rid of excessive packaging waste. Alternatively consider different types of packaging such as heavy duty or permanent packaging which can be reused, you will have to specify to your suppliers that they implement reusable packaging systems such as returnable pallets and crates.

Reuse

Making use of materials in their original state.

In today's industry, it is simply no longer justifiable to throw away perfectly good materials. As part of managing your waste, you should consider how you can make use of common surplus materials arising from a projects such as bricks and timber offcuts either on the same site or at other sites. Where this is not possible, you should liaise with your suppliers about returning the materials to them.

Some examples of reusing common types of waste materials from construction and demolition are:

- Bricks and tiles
  Bricks and tiles in good condition can be reused on site for construction, even the old bricks and tiles can be used on new builds to add aesthetic appeal and character to buildings. Bricks that do not meet the regulations can be used in applications such as landscaping where structured load-bearing is not a requirement.

- Inert materials
  Inert materials such as concrete, brick, asphalt, soils and stones can be reused on site or for backfill at other excavation sites. Topsoil can be reused for landscaping or as part of compost when a necessary tests have been carried out.

- Timber off-cuts
  Timber can be reclaimed from numerous sources on site including floorboards, rafters, doors, window frames and fencing. Temporary formwork can typically be reused four times before disposal. If reusing wood on site, you should always check it first to ensure it is of suitable quality and fit for purpose for the intended use. You should also provide a dry area for it to be stacked and stored.

- Plasterboard
  You should always try to make use of leftover plasterboard sheets and off-cuts on other projects. Where this is not possible, contact the manufacturer or supplier to see whether you can return any unused sheets to them.
  Any plasterboard which you are saving for reuse should be stored in a dry place away from activities that could damage it.

- Packaging
  The easiest way of ensuring that your packaging waste is reused is by returning it to your supplier. Transport pallets should always be reused rather than thrown away, as disposing of them in skips will result in large void spaces, which will significantly increase your costs. Many pallet firms will actually pay you for slightly damaged or irregular-sized pallets.

Recycle

Turning materials into new products.

With the potential to turn 100% of non-hazardous construction waste into new products or energy, recycling is crucial in diverting tones of valuable material from landfill.

The key to successful recycling is to make it as easy as possible for everyone to segregate their waste. As a minimum, this requires assigning containers for different waste materials with clear signage explaining what can and cannot be disposed of in each one. Having provided the facilities, all site workers then need to be equipped and motivated to make the system work.

Where segregating your waste on site for recycling is not viable, you are encouraged to identify a local waste transfer station that will collect and sort your mixed-waste skips for you.

6. MAIN MATERIALS FROM CONSTRUCTION AND DEMOLITION WASTE

6.1. MATERIAL: CONCRETE

6.1.1 GENERAL OVERVIEW

Applications in the construction sector: buildings, roads, infrastructure.
Production in the EU: about 1.350 Mt.
Waste generation in the EU: estimated average: 320-380 Mt.

Barriers to re-use and recycling of the waste:

- High availability and low cost of raw material.
- Uncertainty on the supply of secondary material.
- Misconception of the quality of recycled products compared to new materials.

Existing and potential drivers to re-use and recycling of the waste:

- High demand for aggregates in road construction, coupled with a higher quality of recycled concrete aggregates compared to virgin aggregates.
- Design for deconstruction to drive to re-use of concrete blocks.
- Sorting at source to increase the quality.
- Landfill taxes or landfill bans to promote alternatives.
- Inclusion of requirements for the use of re-use or recycled materials into building standards.
- Quality certification for recycled materials.

Treatment options

- Landfill:
  Potential absorb of waste: 0%.
  Environmental impacts: Land-use, transportation.
- Recycling into aggregates for road construction or backfilling:
  Potential absorb of waste: 75%
  Environmental impacts: Low to medium net benefits.
- Recycling into aggregates for concrete production:
  Potential absorb of waste: 40-50%
  Environmental impacts: Low to medium net benefits.
- Re-use of precast elements (concrete blocks):
  Potential absorb of waste: N/A
  Environmental impacts: High potential net benefits.

6.1.2 PRODUCT DESCRIPTION AND APPLICATIONS

Concrete is a man-made construction material that is widely used around the world for any type of building or infrastructure due to its physical and aesthetic properties.

Concrete is made from coarse aggregates (gravel or crushed stone), fine aggregates (sand), water, cement and admixtures. Cement is a hydraulic binder that hardens when water is added and represents between 6 and 15% of the concrete mix depending on the application while aggregates represent 80% in mass and water 8%.

Structural concrete takes almost completely the form of reinforced concrete which is a composite material consisting of concrete and steel. While concrete provides the material's compressive strength, steel provides its tensile strength in the form of embodied reinforcing bars and mesh.
Steel reinforcement plays a key role in reinforced concrete structures as it ensures ductile behavior in earthquakes for example. Reinforcing bars are usually formed from ridged carbon steel, the ridges giving frictional adhesion to the concrete.

Steel reinforced concrete can be used for any type of structure (bridges, highways, and runways) and buildings but it is generally used for applications carrying heavy loads such as footings, foundation walls and columns.

Applications

Buildings and civil engineering infrastructures are the two main applications of concrete.

Buildings:

Concrete is a well-established construction material that is widely used across Europe for all types of buildings: residential (individual, apartment) and nonresidential (public, commercial, industrial and agricultural).
The most common uses of concrete in the building construction sector are:

- Foundations.
- Floors for ground or upper floor levels.
- Structural frames.
- External and internal walls.
- Roof tiles.
- Garden paving.

Two types of concrete are distinguished:

- Dense concrete, which is invariably used in the construction of industrial and commercial buildings and all infrastructural projects, is strong and durable, resists fire, and has good sound insulation, vibration absorption and thermal properties.

- Lightweight concrete, in the form of concrete masonry blocks, is used mainly in the construction of individual dwelling. Because of their inherent properties, concrete blocks used as partition walls typically do not require additional sound or fire protection.

Civil engineering:

Concrete is well suited for civil engineering construction since it is able to resist moisture and weather variations, mechanical constraints, and high temperatures. Concrete also absorbs sound, reduces temperature swings and provides protection against different types of radiation and rising sea levels.

Its inherent durability and strength make it especially suitable for the construction of dams; other concrete applications for infrastructures also include:

- Roads.
- Power plants.
- Other common industrial applications such as silos, storage tanks, etc.

6.1.3. WASTE GENERATION

Concrete waste can arise from different sources: returned concrete which is fresh (wet) from ready-mix trucks, production waste at a pre-cast production facility and construction and demolition waste, which is the most significant source.

The concrete is estimated fluctuating between 20 and 80% of the total of construction and demolition waste. Differences in building traditions and other factors can explain the width of this range.

6.1.4. RECOVERY TECHNIQUES

Existing options

Although an important fraction of concrete waste is still landfilled within the EU, this practice is being increasingly discouraged. The main options for re-use, recycling and other material recovery of concrete waste are described below.

Re-use:

Concrete can be re-used in various ways in its original form. An example is to leave the concrete structure in place while modernising the inside space or façade/curtain wall of the building.

Another option is the re-use of specific concrete elements with little processing: prefabricated elements and concrete blocks are cut in smaller elements and cleaned of mortar. This requires the careful and therefore time-consuming dismantling of the building to avoid damaging the elements and the transportation to the other construction site.

Recycling and other material recovery:

Concrete can be reprocessed into coarse or fine aggregates.
Coarse aggregates can be used for road base, sub-base and civil engineering applications. Finnish research has found that recycled concrete specified to an agreed quality and composition in the sub-base and base layers can allow the thickness of these layers to be reduced due to the good bearing properties of the material. Indeed, for such an application the unbound cementations material present in recycled aggregates has proved superior behavior than virgin aggregates such that the strength is improved providing a very good construction base for new pavements.
Coarse aggregates can also be used as a filling material in quarries, referred to as backfilling.
Fine aggregates can also be obtained from concrete waste and used in place of natural sand in mortars. However, the use of recycled concrete fine aggregates could affect directly the mortar content and therefore its workability, strength and can cause shrinkage due to high water absorption.

Emerging techniques

Although not commercially feasible at present, some emerging technologies include:

- To replace the fossil fuel reliance of the recycling into aggregates process: closed-cycle construction using mechanical and thermal energy. The University of Delft, together with TNO, is working on a novel closed-cycle construction concept whereby concrete waste and masonry debris are separated back into coarse and fine aggregates and cement stone using mechanical and thermal energy supplied by the combustible fraction of construction and demolition waste. This technique is assumed to encourage the recycling into aggregates while moving away from fossil fuels reliance and the associated environmental impacts.

- To improve the efficiency of the crushing process for the recycling into aggregates option: electrical decomposition of concrete. To break down concrete, high shear stress is needed by way of a shock wave. Conventional technology uses mechanical force. Alternatively heat or electrical energy can be used. Electrical energy can be used to create pulsed power. At the present time, high initial outlay costs are a barrier to use. The environmental impacts of using electricity also need to be considered. This technique is expected to encourage recycling into aggregates through possible costs reductions.

6.1.5. ENVIRONMENTAL AND ECONOMIC IMPACTS

Environmental impacts

Impacts and benefits of the recycling and recovery options of concrete are described below.

Landfill:

Direct impacts:

- Transportation of waste to the landfill.
- No significant release of pollutants to water.
- Use of land space.

Avoided impacts:

None.

Recycling as aggregates for direct re-use:

Direct impacts:

- Transportation of waste concrete.
- Processing of waste concrete into aggregates: dust production and noise during crushing and sieving steps.
- Transportation of recycled aggregates.

Avoided impacts:

- Extraction of raw materials.
- Transportation of raw materials.
- Use of resources.
- Processing of raw materials into aggregates: dust production and noise.
- Transportation of aggregates.

Recycling as aggregates for structural concrete:

Direct impacts:

- Transportation of waste concrete.
- Processing of waste concrete into aggregates: dust production and noise.
- Transportation of recycled aggregates.
- Production of cement.
- Transportation of cement.
- Concrete production.

Avoided impacts:

- Extraction of raw materials.
- Transportation of raw materials.
- Use of resources.
- Processing of raw materials into aggregates: dust production and noise.
- Transportation of aggregates.
- Production of cement.
- Transportation of cement.
- Concrete production.

Re-use of concrete blocks:

Direct impacts:

- Transportation of waste concrete.
- Processing of concrete blocks: energy for cleaning and decontamination.
- Transportation of concrete to the new construction site.

Avoided impacts:

- Extraction of raw materials.
- Transportation of raw materials.
- Processing of raw materials into aggregates: dust production and noise.
- Production of cement.
- Transportation of cement.
- Concrete production.
- Transportation of concrete.

The best option is to re-use the concrete because avoids the production of concrete, and therefore the associated impacts of cement production. The re-use of concrete blocks can have significant environmental benefits.

Economic impacts

Despite the environmental benefits of recycling concrete, its limited production costs do not encourage re-use and recycling. Nevertheless, using recycled concrete can also show economic advantages.

Recycled concrete aggregates in Europe can sell for 3 to 12 € per tonne with a production cost of 2.5 to 10 € per tonne. The higher selling prices are obtained on sites where all C&D waste is reclaimed and maximum sorting is achieved, there is strong consumer demand, lack of natural alternatives and supportive regulatory regimes.

6.2. MATERIAL: BRICKS, TILES AND CERAMIC

6.2.1. GENERAL OVERVIEW

Applications in the construction sector:
- Brick: masonry construction.
- Tile: covering roofs, floors and walls.

Production in the EU: 6.8 billion Euros sales in 2003.
Waste generation in the EU: N/A.

Barriers to re-use and recycling of the waste:
- Reduced cost of bricks, tiles and ceramic produced from raw materials.

Existing and potential drivers to re-use and recycling of the waste:
- Design for the end-of-life.
- Increase the life span of buildings (>100 years) to reduce the amounts of waste.
- Landfill taxes or landfill bans to promote alternatives.

Treatment options

- Landfill:
  Environmental impacts: Land-use, transportation.

- Recycling:
  Environmental impacts: Few significant net benefits when crushing is need or some net benefits when crushing is not necessary.

- Re-use:
  Environmental impacts: High potential net benefits.

6.2.2. PRODUCT DESCRIPTION AND APPLICATIONS

A ceramic material is an inorganic, non-metallic solid prepared by the action of heat and subsequent cooling. Ceramic materials may have a crystalline or partly crystalline structure, or may be amorphous. Because most common ceramics are crystalline, its definition is often restricted to inorganic crystalline materials. Ceramics are used in buildings as structural products including blocks but also used for external and internal walls, for external wall cladding, as pavers, water/sewage pipes, floors and roof tiles.

Facing bricks and blocks are ceramic materials that are usually laid using mortar or glues. In many European MS including France, Germany, the UK, bricks have been used in construction for centuries as a part of the architectural heritage.

A tile is a manufactured piece of hard-wearing material such as ceramic with a hard glaze finish used for covering roofs, floors and walls. Most ceramic construction products are traditionally made from locally available materials such as clay.

The advantage of clay construction products is to be found in the energy saving during the use phase. Indeed, their density leads to lower variation in temperature and moisture, i.e. cooler in summer and warmer in winter.

6.2.3. WASTE GENERATION

Despite the potential long life of ceramic-based products that can easily exceed 100 years, clay brick buildings are most of the time demolished well before the end of their useful life. Bricks and tiles being highly durable materials, they can be re-used after a building has been demolished. Nevertheless, deconstruction allowing for the re-use of this type of materials is not common on EU.

6.2.4. RECOVERY TECHNIQUES

Existing options

Recycling:

A high proportion of ceramic form construction and demolition waste is well suited to being crushed and recycled as a substitute for newly quarried (primary) aggregates in certain lower grade applications.
Using bricks, tiles and ceramics waste from demolition sites raises however some issues. Indeed, if the technical criteria for the use of granulated ceramic material are few, it needs to be absolutely free of contaminating elements such as mineral wool, concrete, heavy metals and PAHs (Polycyclic Aromatic Hydrocarbons) that may leach and cause ground water pollution. This often mixed and contaminated fraction needs therefore to go through cleaning, crushing and sieving processes before further recycling.

The different recycling options promoted by the European Tiles and Bricks Association are described below:

- To fill and stabilise minor roads, especially in wet areas such as woods and fields. The practice is common in countries that lack adequate stone supplies such as Denmark. The material is generally used uncrushed.

- Crushed clay bricks, roof tiles and other masonry can be used on larger road building projects, especially as unbound base material. It is used to build roads in countries such as Germany, Denmark, the Netherlands, Switzerland and UK. In Germany, the maximum brick content for such use is 30%, due to quality requirements for frost attacks and impact resistance. The material replaces natural materials, such as sand and gravel, which are normally used in large amounts for this purpose.

- Aggregates for in-situ. Crushed clay bricks and other masonry can also be used to level and fill pipe trenches. The fine crushed material will replace natural materials such as sand.

- Crushed clay bricks, tiles and other masonry can also be used as aggregate in concrete. The crushed material replaces other raw materials such as sand. This is commonly practiced in Austria, Denmark, Switzerland and especially the Netherlands.

- Tennis sand produced by crushing red bricks and roof tiles. The fine surface layer is laid over courser-grained layers that can comprise crushed clay brick matter. The process is most efficient when it occurs at brick or tile factories where there is an abundance of scrap material.

- Crushed bricks and tiles can also be used as plant substrates. The material may be mixed with composted organic materials and is especially suited for green roofs: the porosity of the material allowing retaining water plants can rely on during dry periods.

Re-use:

Extracting roof tiles and storing them for re-use is not difficult and bricks that are left over from building projects can also be diverted to other uses among which the incorporation into new buildings. To do that, building deconstruction is imperatively required.

However, these materials are often contaminated which raises several issues:

- Cleaning bricks is time consuming, difficult and dusty work that, if mechanised, is apparently rarely successful.

- Cement rich mortars are difficult to remove.

- Excess mortar dust can inhibit the adhesion between mortar and bricks and lead to weaker masonry, depending on the mortar composition.

- Bricks may vary in quality. It is therefore difficult to assess the strength and load-bearing capacity of masonry made from recycled bricks. European and national standards are very strict and it is extremely difficult to be sure that re-used bricks used in new structures will be durable.

- Due to the difficult nature and high labor costs associated with the process, the use of re-used bricks may be more expensive than the use of new bricks.

Emerging techniques

An increasing amount of scientific research is carried out to improve the techniques to separate and clean bricks from other mixed construction and demolition waste and especially from contaminants but at the present time, no emerging techniques have been identified.

6.2.5. ENVIRONMENTAL AND ECONOMIC IMPACTS

Environmental impacts

Impacts and benefits of management options for bricks, tiles and ceramics are described below.

Landfill:

<u>Direct impacts:</u>

- Transportation of waste to the landfill.
- No significant release of pollutants to water.
- Use of land space.

<u>Avoided impacts:</u>

None.

Recycling in minor road works with no further processing:

<u>Direct impacts:</u>

- Transportation of bricks, tiles and ceramics waste.
- Transportation of recycled material.
- Use of recycled aggregates: dust production when loading, unloading the trucks and spreading the material on the roads.

<u>Avoided impacts:</u>

- Extraction of raw materials: land-use for quarries, production of dust, use of natural resources.
- Transportation of raw materials.
- Biodiversity impacts.
- Use of resources.
- Production of aggregates from virgin materials: dust production and noise during crushing, sieving steps.
- Transportation of aggregates.
- Use of virgin aggregates: dust production.

Recycling in heavy roads works with further processing:

Direct impacts:

- Transportation of bricks, tiles and ceramics waste.
- Production of aggregates from bricks, tiles and ceramics form construction and demolition waste: dust production and noise during crushing and sieving steps.
- Transportation of recycled material.
- Use of recycled aggregates: dust production when loading, unloading the trucks and spreading the material on the roads.

Avoided impacts:

- Extraction of raw materials: land-use for quarries, production of dust, use of natural resources.
- Transportation of raw materials.
- Biodiversity impacts.
- Use of resources.
- Transportation of aggregates.
- Use of virgin aggregates: dust production.

Re-use of bricks, tiles and ceramics from construction and demolition waste:

Direct impacts:

- Transportation of bricks, tiles and ceramics waste.
- Processing of bricks, tiles and ceramics waste.
- Transportation of bricks, tiles and ceramics to the new construction site.

Avoided impacts:

- Extraction of raw materials: land-use for quarries, use of natural resources.
- Biodiversity.
- Transportation of raw materials.
- Bricks, tiles and ceramic production.
- Transportation of bricks, tiles and ceramics to the construction site.

The best option is to re-use the ceramic materials because the re-use avoids the manufacturing processes, the associated energy consumption and gaseous emissions. As an example, the specific energy consumption for the brick and roof-tile industry varied in 2001 between 1.4 and 2.42 GJ per tonne which represents between 80 and 138 CO_2 equivalents per tonne.

The re-use of bricks and roof tiles also allows avoiding gaseous emissions to the atmosphere that normally occur during the manufacturing process. They are mainly of three kinds:

- Emissions coming from ceramic conversion of the raw material in the kiln.
- Exhaust gas emissions from combustion processes.
- Emissions of VOC’s (Volatile Organic Compounds.

Economic impacts

The harnessed extraction of clay and the development of new manufacturing techniques maintain clay bricks and tiles as competitive building materials that have good quality, long life, minimal maintenance requirements and provide efficient energy during the use phase.

The reduced costs of bricks, tiles and ceramics produced from raw materials are therefore not encouraging the development of recycling. The low economic cost of production from raw materials makes it very difficult to make an economic benefit reusing or recycling the ceramic material.

6.3. MATERIAL: ASPHALT

6.3.1. GENERAL OVERVIEW

Applications in the construction sector: pavement for road construction and maintenance.
Production in the EU: almost 300 Mt/year.
Waste generation in the EU: 47 Mt/year of reclaimed asphalt.

Barriers to re-use and recycling of the waste:

- Availability and cost of raw material.
- The actual scientific knowledge for the improvement of the manufacturing process.

Existing and potential drivers to re-use and recycling of the waste:

- Increase virgin materials costs to create a new demand for reclaimed asphalt.
- Landfilling ban to encourage recycling practices.
- Improve the communication to show the economic benefit that would be associated with recycling practices.

Treatment options

Landfill:

- Potential absorb of waste: 0%.
- Environmental impacts: Potential emissions of PAH, land use, transportation.

Recycling in a stationary plant:

- Potential absorb of waste: 30%.
- Environmental impacts: Positive potential net benefits.

In-situ recycling:

- Potential absorb of waste: almost 100%.
- Environmental impacts: Positive potential net benefits.

Material recovery:

- Potential absorb of waste: N/A
- Environmental impacts: Positive potential net benefits.

6.3.2. PRODUCT DESCRIPTION AND APPLICATIONS

Asphalt is a black viscous and elastic material made of bitumen acting as a binder composted of a mixture of aggregates, sand, filler and occasionally a number of additives.

Three major types of asphalt are distinguished depending on the production temperature: hot, warm and cold mix asphalt. The other asphalt materials are cutback, mastic and natural asphalt but they represent a minority.

To produce asphalt, a large panel of mix types exist depending on the asphalt position in the road structure (base, binder or surface course), on its particular function, on climatic conditions and on the nature of raw materials locally available.

The primary use of asphalt is in road infrastructure construction and in airports for runways and therefore referred as asphalt pavement. Over 90% of the total road network in Europe is made of asphalt.

6.3.3. WASTE GENERATION

Asphalt waste is generated during the demolition of existing infrastructures, when the existing asphalt layer is removed. Asphalt waste generated through these steps is referred as reclaimed asphalt and can be 100% recycled depending on the recycling technique.

6.3.4. RECOVERY TECHNIQUES

Existing options

Landfilling and energy recovery not being recognised as interesting options by the Asphalt Industry because of the associated costs and the loss of a “secondary raw material”, the recovery and recycling of reclaimed asphalt have become more widespread in the last decades. If reclaimed asphalt is free of contamination, it can be guaranteed that the total amount of this reclaimed asphalt can be recovered or recycled as a construction material.

A distinction is made in the following subsection between recycling, where the reclaimed asphalt is reprocessed into new mixes, and other forms of material recovery.

Recycling:

Recycling means adding the reclaimed asphalt to new asphalt mixes, with the aggregates and the old bitumen performing the same function as in their original application. Therefore, reclaimed asphalt replaces virgin aggregates and part of the binder. If asphalt is known as 100% recyclable material, the recycling rate depends on the applied technique.

The recycling processes can be divided into two major methods: hot or cold mix recycling techniques. These can be further sub-divided into stationary plant or in-situ recycling. Stationary plant recycling consists in removing the material from the site to a plant located elsewhere which recycles the reclaimed asphalt in order to re-introduce it either on the original project or on other projects. In-situ recycling allows the reclaimed material to be incorporated directly back into the new asphalt pavement under construction or maintenance.

Within both the cold and hot recycling process, screening and crushing of the reclaimed asphalt could be needed and special storage facilities at the mixing plant may be necessary. Modern plants are engineered to facilitate the addition of reclaimed material.

The maximum amount of recycled material that can be incorporated in the new mix is determined by the mixing equipment but also by some parameters related to the old asphalt like consistency of material, moisture content, etc. To achieve the highest levels of recycling it is necessary to either confirm the lack of variability in the feedstock or to have precise data on its range of properties.

Other forms of material recovery:

Material recovery refers to the utilization of reclaimed asphalt as road base course material, with the recovered aggregate and bitumen performing a lesser function than in the original application.

Emerging techniques

Further research to develop new techniques or to improve the efficiency of the existing processes by using for example less energy and reducing the operating costs could contribute to increasing recycling rates.

For instance, some current internationally coordinated research projects are aiming for further improvement of the technology cold mixing in-situ recycling.

6.3.5. ENVIRONMENTAL AND ECONOMIC IMPACTS

Environmental impacts

Impacts and benefits of the recycling and recovery options of asphalt are described below.

Landfill:

Direct impacts:

- Transportation of waste to the landfill.
- Potential PAH releases to water.
- Use of land space.

Avoided impacts:

None.

Recycling in a stationary plant to make new asphalt:

Direct impacts:

- Transportation of waste asphalt.
- Processing of waste asphalt into aggregates: particles generation and noise during crushing and screening steps.
- Production of new asphalt from reclaimed asphalt: fuel consumption for heating.
- Transportation of recycled asphalt.

Avoided impacts:

- Extraction of raw materials: land-use for quarries, production of dust, use of natural resources, biodiversity.
- Transportation of raw materials.
- Processing of raw materials into aggregates: dust production and noise.
- Production of asphalt from raw materials: fuel consumption for heating and bitumen production.
- Transportation of asphalt made from virgin materials.

In-situ recycling to make new asphalt:

Direct impacts:

- Processing of waste asphalt into aggregates: particles generation and noise during crushing and screening steps.
- Production of new asphalt from reclaimed asphalt: fuel consumption for heating.
- Use of binders for fluxed asphalt in cold recycling processes.

Avoided impacts:

- Extraction of raw materials: land-use for quarries, production of dust, use of natural resources, biodiversity.
- Transportation of raw materials.
- Processing of raw materials into aggregates: dust production and noise.
- Production of asphalt from raw materials: fuel consumption for heating.
- Transportation of asphalt made from virgin materials.

Recovery of reclaimed asphalt as a road base course in the form of aggregates:

Direct impacts:

- Transportation of reclaimed asphalt.
- Processing of waste asphalt into aggregates: dust production and noise during crushing and sieving steps.
- Transportation of recycled aggregates.

Avoided impacts:

- Extraction of raw materials: land-use for quarries, production of dust, use of natural resources, biodiversity.
- Transportation of raw materials.
- Processing of raw materials into aggregates: dust production and noise.
- Transportation of virgin aggregates.

Recycling of reclaimed asphalt allows saving natural resources that would have been extracted in quarries and limiting the transportation when they are located in remote places. Bitumen being also re-used, unnecessary bitumen production is also avoided.

This reduces the fuel and energy consumption related to the extraction step and the production of bitumen.

The net benefits for in-situ recycling could be assumed higher than for a stationary plant or recovery as transportation to the recycling plant and to the construction site are avoided.

Economic impacts

The processes for the preparation of reclaimed aggregates (crushing, sieving) being the same as virgin materials, the production costs are estimated to be identical. On the other hand, the availability of virgin aggregates explains why the supply costs for these materials are limited which therefore does not encourage asphalt producers to turn to reclaimed asphalt as a substitution.

However, landfilling and incineration for energy recovery are not considered as viable asphalt management options according to the industry as asphalt is an added-value material that is easily recycled thanks to the existing techniques.

7. CASE OF STUDY OF MANAGEMENT OF CONSTRUCTION AND DEMOLITION WASTE

This study shows an example of how would be a study of management of construction and demolition waste in every respect, the data are only examples of how could be a construction of an entire building.

For this study has used a residential building consisting of four habitable floors, one ground floor dedicated to commercial spaces and a basement floor dedicated 70% for parking and 30% for storage.

The constructed area of the building is divided in:

- 2.800 m^2 of homes.
- 420 m^2 of parking.
- 180 m^2 of storage rooms.
- 600 m^2 of commercial spaces.

Has been estimated to be generated the following amounts of waste:

- 0,25m height of waste per m^2 of homes.
- 0,30m height of waste per m^2 of parking.
- 0.20m height of waste per m^2 of storage rooms.
- 0.25m height of waste per m^2 of commercial space.

Has been estimated in the project the amount of 8.100 tonnes of earth and stone form the excavation.

Has been estimated in the project a budget of material execution (BME) of 1.500.000 €.

7.1. PURPOSE OF THE STUDY

Waste management means the collection, storage, transport, recovery and removal of them, including monitoring of these activities and places of deposit or the discharge of the waste.

Consequently, waste management study is structured according to the following stages and objectives:

- First, the agents in the process are defined, both those responsible for work on waste management and external managers involved in recycling operations.
- Then, have to identify the materials present on site and the nature of the waste generated on each stage of the work. This classification is taken under the European Waste List published by Order MAM / 304/2002. For each specific type of waste generated is made an estimate of the amount becomes.
- Finally, landing operations required for each type of waste generated are defined, depending on its origin, danger and possible management.

These operations mainly include the following steps: selective collection of waste generated, reducing waste, and segregation and separation operations at the construction site, storage, delivery and transportation to authorized agent.

The contents of this study must be supplemented by an estimate or measurement of the cost of planned management.

Definitively, the aim of this study is to answer questions like: what waste is generated? Who is responsible for them? What is done with the waste generated? All of this having considered the management principle of the three Rs: Reduce, Reuse, Recycle.

7.2. REGULATION AND APPLICABLE LEGISLATION

For the preparation of the study has considered the following regulation and legislation:

- Article 45 of the Spanish Constitution.
- Law 10/1998 of 21 April, of waste.
- National Plan of construction and demolition waste from 2001-2006, approved by resolution of Council of Ministers, June 1, 2001.
- Law 34/2007 of 15 November, about air quality and protection of the atmosphere.
- Royal Decree 105/2008 of February 1, by which the production and management of construction and demolition waste is regulated.
- Order MAM / 304/2002 of February 8, by which the operations of recovery and disposal of waste and the European Waste List are published.

7.3. INTERVINING AGENTS

Identification of the agents

Waste producer

Promoter

The producer of construction and demolition waste is the individual or legal person, or public or private entity who is the owner of the building, is who has the decision to build or demolish the building.

Holder of waste

Constructor

The holder of construction and demolition waste is the individual or legal person, or public or private entity who owns the construction and demolition waste.

This person or entity does not have the function of waste management. He performs the work and has the physical control of the waste generated in the construction.

Waste manager

The waste manager is the individual or legal person, or public or private entity who performs any of the following operations: collection, storage, transport, recovery and disposal of waste, including the supervision of such operations and monitoring of landfills. It also includes the restoration of waste and the environmental management of waste.

This person or entity will be designated by the waste producer (promoter) before the start of works.

Obligations of the agents

Waste producer

He must include in the execution project of the construction a study of management of construction and demolition waste.

The promoter is required to provide documentation attesting that the waste produced in construction and demolition have been managed.

Holder of waste

The builder is required to submit a plan showing how operations management of construction and demolition waste were made.

The holder of waste from construction and demolition will be required to pay the costs of management.

Waste manager

The manager of construction and demolition waste should make a record with the amount of managed waste, waste type, the identification of the waste, the identification of the holder of waste and the owner of the construction.

The manager should make available to the State Administration the aforementioned record.

7.4. IDENTIFICATION OF CONSTRUCTION AND DEMOLITION WASTE

All possible construction and demolition waste generated in the work are encoded considering the MAM 304/2002 Order of February 8, in which are published the valuation operations and the waste elimination operations, according to the European Waste Catalogue (EWC) adopted by Decision 2005/532 / EC, resulting in the following detailed groups:

Material according to MAM/304/2002	**Code EWC**
Construction and demolition waste of level I	
Earth and stone from the excavation	
Other earth and stones than mentioned in the code 17 05 03.	17 05 04
Construction and demolition waste of level II	
No stony construction and demolition waste	
Asphalt	
Bituminous mixtures specified in the code 17 03 01	17 03 02
Wood	
Wood	17 02 01
Metals (including alloys)	
Metal containers	15 01 04
Copper, bronze, brass	17 04 01
Iron and steel	17 04 05
Mixed metals	17 04 07
Other cables than mentioned in 17 04 10	17 04 11
Paper and paperboard	
Containers of paper and paperboard	15 01 01
Plastic	
Plastic	17 02 03
Glass	
Glass	17 02 02
Gypsum	
Construction materials from gypsum other than those mentioned in 17 08 01	17 08 02

Stony construction and demolition waste	
Sand, gravel and other arid	
Waste gravel and crushed rocks other than those mentioned in 01 05 07	01 04 08
Waste sand and clays	01 04 09
Concrete	
Concrete	17 01 01
Bricks, tiles and ceramic materials	
Bricks	17 01 02
Tiles and ceramic materials	17 01 03
Mixtures of concrete, bricks, tiles and ceramic materials specified in the code 17 01 06	17 01 07
Hazardous construction and demolition waste	
Garbage	
Street cleaning residues	20 03 03
Others	
Waste paint and varnish containing organic solvents or other dangerous substances	08 01 11
Insulating materials other than mentioned in 17 06 01 and 17 06 03	17 06 04
Mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03	17 09 04

7.5. AMOUNT OF CONSTRUCTION AND DEMOLITION WASTE THAT WILL BE GENERATED IN THE WORK

For the construction of our building we obtain the following volumes and tons of waste, which represents the construction and demolition waste of level I.

Uses	Floor area (m^2)	Waste height (m)	Waste volume (m^3)	Type density (tn/m^3)	Weight of waste (tn)
Homes	2800	0,25	700	1,5	1050
Parking	420	0,3	126	1	126
Storage rooms	180	0,2	36	0,95	34,2
Commercial spaces	600	0,25	150	1,5	225
				Total	1435,2

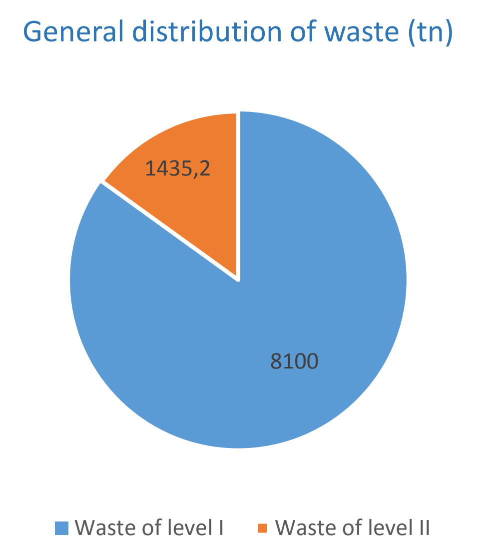
The weight of waste by type is obtained by data from studies in Spain of the composition by weight of construction and demolition waste going to landfill (National Plan of construction and demolition waste 2001-2006).

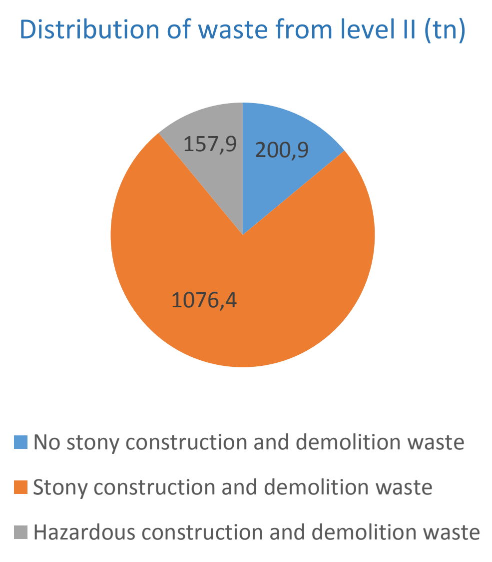
Material according to MAM/304/2002	**Code EWC**	**% by weight**	**Weight (tn)**	**Type density (tn/m^3)**	**Waste Volume (m^3)**
Construction and demolition waste of level I					
Land and stony from the excavation		100,000	8.100,000		
Other earth and stones than mentiond in the code 17 05 03.	17 05 04	100,000	8.100,000	1,620	5.000,000
Construction and demolition waste of level II					
No stony construction and demolition waste		14,000	200,928		
Asphalt		5,000	71,760		
Bituminous mixtures specified in the code 17 03 01	17 03 02	5,000	71,760	1,000	71,760
Wood		4,000	57,408		
Wood	17 02 01	4,000	57,408	1,100	52,189

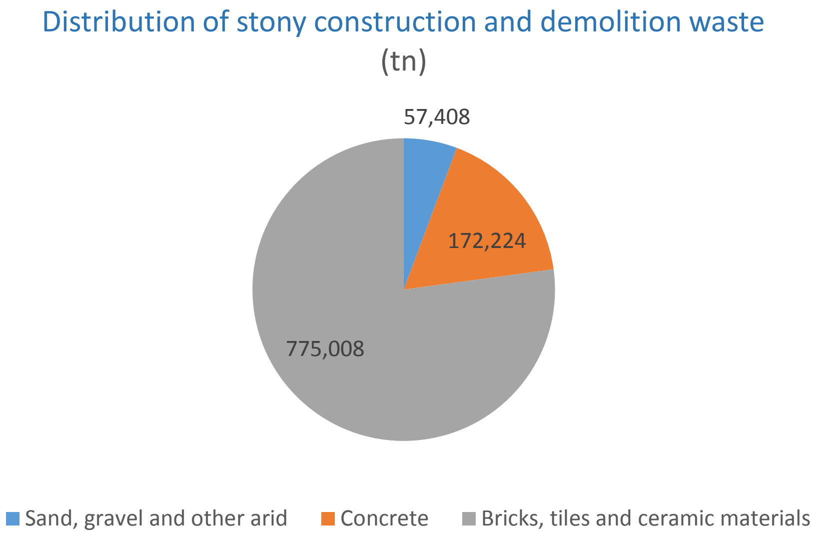
Metals (including alloys)		2,500	35,880		
Metal containers	15 01 04	0,100	1,435	0,600	2,392
Copper, bronze, brass	17 04 01	0,050	0,718	1,500	0,478
Iron and steel	17 04 05	2,100	30,139	2,100	14,352
Mixed metals	17 04 07	0,150	2,153	1,500	1,435
Other cables than mentioned in 17 04 10	17 04 11	0,100	1,435	1,500	0,957
Paper and paperboard		0,300	4,306		
Containers of paper and paperboard	15 01 01	0,300	4,306	0,750	5,741
Plastic		1,500	21,528		
Plastic	17 02 03	1,500	21,528	0,600	35,880
Glass		0,500	7,176		
Glass	17 02 02	0,500	7,176	1,000	7,176
Gypsum		0,200	2,870		
Construction materials from gypsum other than those mentioned in 17 08 01	17 08 02	0,200	2,870	1,000	2,870
Stony construction and demolition waste		75,000	1.076,400		
Sand, gravel and other arid		4,000	57,408		
Waste gravel and crushed rocks other than those mentioned in 01 05 07	01 04 08	3,000	43,056	1,510	28,514
Waste sand and clays	01 04 09	1,000	14,352	1,600	8,970
Concrete		12,000	172,224		
Concrete	17 01 01	12,000	172,224	1,500	114,816
Bricks, tiles and ceramic materials		54,000	775,008		
Bricks	17 01 02	42,000	602,784	1,250	482,227
Tiles and ceramic materials	17 01 03	8,000	114,816	1,250	91,853
Mixtures of concrete, bricks, tiles and ceramic materials specified in the code 17 01 06	17 01 07	4,000	57,408	1,250	45,926

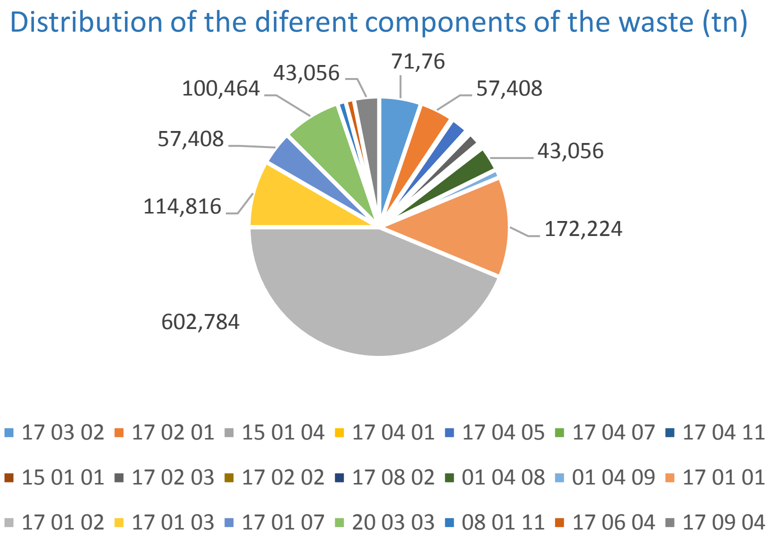
Hazardous construction and demolition waste		11,000	157,872		
Garbage		7,000	100,464		
Street cleaning residues	20 03 03	7,000	100,464	1,500	66,976
Others		4,000	57,408		
Waste paint and varnish containing organic solvents or other dangerous substances	08 01 11	1,000	14,352	0,900	15,947
Insulating materials other than mentioned in 17 06 01 and 17 06 03	17 06 04	1,000	14,352	0,600	23,920
Mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03	17 09 04	3,000	43,056	1,500	28,704

7.5.1 DISTRIBUTION OF THE AMOUNT OF CONSTRUCTIONS AND DEMOLITION WASTE






Distribution of stony construction and demolition waste (tn)
57,408
172,224
775,008
Sand, gravel and other arid
Concrete
Bricks, tiles and ceramic materials


Distribution of the diferent components of the waste (tn)
71,76
57,408
43,056
172,224
602,784
114,816
57,408
100,464
43,056
17 03 02
17 02 01
15 01 04
17 04 01
17 04 05
17 04 07
17 04 11
15 01 01
17 02 03
17 02 02
17 08 02
01 04 08
01 04 09
17 01 01
17 01 02
17 01 03
17 01 07
20 03 03
08 01 11
17 06 04
17 09 04

7.6. OPERATIONS OF REUSE, RECOVERY OR DISPOSAL FOR THE CONSTRUCTION AND DEMOLITION WASTE GENERATED

Development activities of reuse, recovery or disposal of waste in construction and demolition will require prior authorization of the competent organ in environmental matters in the Autonomous Community concerned, under the terms established by Law 10/1998 of 21 April.

The authorization shall be granted after an inspection of the facilities where the activity will be implemented and after a verification of the qualification of the technicians responsible.

The following table lists the characteristics, amount, type of treatment and the destiny of non-reusable and valuable ''in situ'' wastes.

Material according to MAM/304/2002	Code EWC	Weight (tn)	Treatment	Destination
Construction and demolition waste of level I				
Land and stony from the excavation		8.100,000		
Other earth and stones than mentiond in the code 17 05 03.	17 05 04	8.100,000	Whitout specific treatment	Restoration/landfill
Construction and demolition waste of level II				
No stony construction and demolition waste		200,928		
Asphalt		71,760		
Bituminous mixtures specified in the code 17 03 01	17 03 02	71,760	Recycled	Recycling plant of construction and demolition waste
Wood		57,408		
Wood	17 02 01	57,408	Recycled	Authorized agent of non-hazardous waste

Metals (including alloys)		35,880		
Metal containers	15 01 04	1,435	Deposit/treatment	Authorized agent of hazardous waste
Copper, bronze, brass	17 04 01	0,718	Recycled	Authorized agent of non-hazardous waste
Iron and steel	17 04 05	30,139	Recycled	Authorized agent of non-hazardous waste
Mixed metals	17 04 07	2,153	Recycled	Authorized agent of non-hazardous waste
Other cables than mentioned in 17 04 10	17 04 11	1,435	Recycled	Authorized agent of non-hazardous waste
Paper and paperboard		4,306		
Containers of paper and paperboard	15 01 01	4,306	Deposit/treatment	Authorized agent of hazardous waste
Plastic		21,528		
Plastic	17 02 03	21,528	Recycled	Authorized agent of non-hazardous waste
Glass		7,176		
Glass	17 02 02	7,176	Recycled	Authorized agent of non-hazardous waste
Gypsum		2,870		
Construction materials from gypsum other than those mentioned in 17 08 01	17 08 02	2,870	Recycled	Authorized agent of non-hazardous waste

Stony construction and demolition waste		1.076,400		
Sand, gravel and other arid		57,408		
Waste gravel and crushed rocks other than those mentioned in 01 05 07	01 04 08	43,036	Recycled	Recycling plant of construction and demolition waste
Waste sand and clays	01 04 09	14,352	Recycled	Recycling plant of construction and demolition waste
Concrete		172,224		
Concrete	17 01 01	172,224	Recycled/landfill	Recycling plant of construction and demolition waste
Bricks, tiles and ceramic materials		775,008		
Bricks	17 01 02	602,784	Recycled	Recycling plant of construction and demolition waste
Tiles and ceramic materials	17 01 03	114,816	Recycled	Recycling plant of construction and demolition waste
Mixtures of concrete, bricks, tiles and ceramic materials specified in the code 17 01 06	17 01 07	57,408	Recycled/landfill	Recycling plant of construction and demolition waste
Hazardous construction and demolition waste		157,872		
Garbage		100,464		
Street cleaning residues	20 03 03	100,464	Recycled/landfill	Recycling plant of solid municipal waste

Others		57,408		
Waste paint and varnish containing organic solvents or other dangerous substances	08 01 11	14,352	Deposit/treatment	Authorized agent of hazardous waste
Insulating materials other than mentioned in 17 06 01 and 17 06 03	17 06 04	14,352	Recycled	Authorized agent of hazardous waste
Mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03	17 09 04	43,056	Recycled	Recycling plant of construction and demolition waste

7.7. MEASURES FOR THE SEPARATION OF CONSTRUCTION AND DEMOLITION WASTE ON SITE

The construction and demolition waste is separated into the following fractions when the expected amount of generation for the whole work exceed the following amounts:

- Concrete: 80 tn.
- Bricks, tiles and ceramic materials: 40 tn.
- Metals: 1 tn.
- Glass: 1tn
- Plastic: 0.5 tn.
- Paper and paperboard: 0.5 tn.

In the following table are indicated the total weight of the different types of waste generated on site and the requirement or not to their separation in situ.

Type of waste	Total waste of construction (tn)	Maximun according to regulations (tn)	Separation "in situ"
Concrete	172,224	80	Required
Bricks, tiles and ceramic materials	775,008	40	Required
Wood	57,408	2	Required
Metals	35,88	1	Required
Glass	7,176	1	Required
Plastic	21,528	0,5	Required
Paper and paperboard	4,306	0,5	Required

The separation into fractions will be made by the possessor of waste from construction and demolition inside the construction area.

7.8. VALORATION OF THE ESTIMATED COST OF THE MANAGEMENT OF WASTE FROM CONSTRUCTION AND DEMOLITION

In order to observe the viability of the study of waste management of construction and demolition are performed the following table, showing the amount necessary to conduct the study. Showing also the % about the budget of material execution (BME) of 1.500.000 €.

A: Estimation of the cost of construction and demolition waste				
Typology	Weight (tn)	Management cost (€/tn)	Amount (€)	% about the BME
A.1. Construction and demolition waste of level I				
Earth and stone from the excavation	8.100,000	4,000	32.400,000	2,160
Total level I			32.400,000	2,160
A.2. Construction and demolition waste of level II				
No stony construction and demolition waste	200,928	10,000	2.009,280	0,134
Stony construction and demolition waste	1.076,400	10,000	10.764,000	0,718
Hazardous construction and demolition waste	157,872	12,000	1.894,464	0,126
Total level II			14.667,744	0,978
B: Other management costs				
Management costs, rents, etc			3.500,000	0,233

Total	50.567,744	3,371

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