# USE AND RECYCLING OF CONSTRUCTION AND DEMOLITION WASTE IN SPAIN (CONCRETE AND MASONRY DEBRIS)

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## INTRODUCTION

Spain is the fifth country in Europe generating construction and demolition waste (CDW) and unfortunately, it is one which does the least to recuperate it, as stated in the Symonds & Ass report. This report indicates that 95% of the 13 million tons of yearly generated waste materials end up in the dump.
In our country the management of CDW belongs to the Autonomous Regions with the exception of the waste originated from minor house works. Trying to solve this problem the Autonomous Regions are defining their management plans according to the hierarchy principle, stated in the title 1.1 of the Law 10/1998 referring to waste products. This principle establishes as a top priority the prevention --whenever possible-- the reutilization and recycling through a thorough selection on site, in order to further treatment, both of the mixed recycled materials as well as the ones used in treatment plants and to clearly assess all that cannot be reused o recycled. The final deposit in the dump is the last option, and the least satisfactory one.

A main aspect to be considered when dealing with construction-demolition waste recuperation and recycling is that economic and environmental interests are also part of this issue. The challenge for the future is to make the human economic development compatible with the environment preservation supporting it; that is *sustainable growth*. Therefore, regarding this, all the recuperating and recycling activities are of great importance.

## CONSTRUCTION AND DEMOLITION WASTE CDW

The demolition waste has a well-known reuse potential. This reuse has, nevertheless, certain limitations due to technical reasons, market reasons and basically due to the lack of regulations as well as ridiculous costs of disposal. The construction waste (debris) that can be reused is mainly produced during the phases of demolition, collapse, transformation or building enlargement, as well as in those civil works such as roads, airports, driveways or other traffic surfaces.

Due to its heterogeneity, the waste derived from construction presents more difficulty, because the compound construction materials make the recuperation more complex. This type of waste is considered an inert material, that is, they do not experiment physical, chemical or biological significant transformations. The inert waste is neither soluble nor combustible, and does not react physically nor chemically or in any other way. The construction waste is not biodegradable, and does not affect any material in

contact with it, nor does it produce any contamination that can harm the environment or the human health.

The total lixiavility, the contaminating content of the waste and the ecotoxicity of the lixiviate should be insignificant, and should not imply any risk for the superficial or underground waters. The construction and demolition waste is classified into: level I waste, generated by the development of great ground movements for big local or supramunicipal infrastructure works. Level II includes waste originated from the different construction and demolition works as well as the waste caused by the small repairing house works or the installation of services.

The European Catalogue classifies Edwin nine groups:

- Mixture of concrete, bricks, tiles and ceramic materials.
- Wood, glass and plastic.
- Bituminous mixtures, tarmacadam and other coal tar products.
- Metals ( including their alloys).
- Earth (included the one excavated in contaminated areas), stones and draining mud.
- Insulating materials and construction materials containing asbestos
- Construction materials with a gypsum base.
- Other refuse products from construction or demolition.

Even more, in each of the groups certain waste products appear as dangerous, in accordance with the EEC Directive 91/689/CEE on dangerous materials. Therefore this waste is subject to these dispositions unless section 5, of article 1 of this Directive applies.

## ENVIRONMENTAL CONSIDERATIONS ABOUT THE REUSE AND RECYCLING OF THE CDW

When assessing the CDW, environmental factors have to be considered when deciding whether to recycle or to eliminate it. The following factors should be underlined:
The need of waste transportation since it produces: air pollution, noise and vibrations and obviously it consumes energy.
The disposal of the waste can be positive if it is done as a controlled dump allowing for the recuperation of degraded areas or using the waste as material for dump coverings. Nevertheless, it can also be negative if it is developed in an uncontrolled way, forming black spots or modifying high ecologic value areas, creating even geological instability problems through time.
Finally, the recuperation of CDW can be positive in the sense that it extends the useful life of dumps, it implies a saving in material consumption, and it reinforces the preservation of Natural Spaces as well as the reduction of quarries. But, as drawbacks we can mention that it generates dust, noise, vibrations and in some occasions, residual water or other distortions of the socioeconomic environment or even by recuperating certain dangerous products (asbestos), it can cause harmful effects on the health.

## RECYCLING OF CONSTRUCTION AND DEMOLITION WASTE

From the CDW generated in Spain approximately 60% corresponds to masonry waste (masonry debris) and 20% corresponds to concrete waste. Therefore, this paper will deal with these two types of waste

**Concrete waste:**
Concrete waste is that of crushed concrete: made of cement manufactured with Portland clinker, according to RC-97 instruction; and natural aggregates (rolled or crushed) from crystallized slag or a combination of both.
This waste originated from structure demolition has very variable sizes, depending on the demolition method used.
It normally has impurities and pollutants such as: metals, glass, tar, organic material or sulphates, etc.
The recycling of this waste becomes new aggregate. In Spain there are presently six aggregate recycling plants: three in Barcelona, two in the Basque Country and one in Madrid

So as to obtain a quality aggregate it is necessary to carefully select the materials before the demolition and obtain a more homogeneous waste without impurities. Therefore, the selective separation prior to the demolition is essential. The waste coming from new constructions can be selected on the production site. In this case, the selection into the different categories results much easier, as opposed to the more complex, laborious and expensive selection process of waste coming from demolition. Before and during the demolition, a separation of materials should be carried out in order to prevent the mixture and contamination of the different recyclable materials. Nevertheless, greater saving are achieved if we consider the higher quality of recycled aggregates, eliminating the need to a later selection at the recycling plant, as well as the lack of transportation costs to the dump or the suppression of the dumping tax.

The generation process of these aggregates includes a previous crushing of debris with a maximum of 1200 mm in size if crushing is done in fix plants and 400-700 mm in movable plants. After that, debris is taken to the main plant where mechanic impact grinding (conical grinder and tooth grinder) is used to proceed with the elimination of contaminant elements (basically steel remains). Finally the aggregates are stored according to sizes (coarse (65-80%) and fine).

The chemical properties of these aggregates depend on the composition of the aggregate used in the production.(75% concrete), being the other components the result of cement hydration , silicates, and calcium aluminates hydrated or calcium hydro-oxides. In addition, the aggregates have components due to the cement hydration (approx. 30% in aggregates of 16-32 mm and a 60% in the 4-8 fraction).

The recycled aggregate is more irregular and has a rougher and porous appearance, although the size coefficient is similar to that of a limestone. Its density is a little lower than that of natural aggregate (approx 5-10%).
Water absorption by the recycled aggregate is high; this is the reason these aggregates should normally be used in saturation conditions. Aggregate storages should be provided with water sprays to maintain this moisture conditions.

The recycled product is a mixture of coarse (65-80%) and fine aggregate.
The coarse fraction has an adequate granulometry for all applications.
The use of recycled fine aggregate implies an increase in water consumption, a reduction of both mechanical strength and workability. Therefore, it is not recommended to use sizes smaller than 4mm to produce new concrete.

Presently in Spain, the recycled aggregates are used for applications not demanding high quality; normally they are used as fillings, packings or sub-bases for road construction: aggregates for new concrete (the substitution of 30% does not alter concrete, if it is 100% the R.C. diminishes 10-20%); aggregates in new asphalt; fine aggregate: cement mortars.
Nevertheless, the increasing technological development allows improving studies on other possible uses. In this way, the research carried out by the ITYEC and the Council for Waste from the Catalonian Autonomous Government, prove that the sound materials fulfilling the specifications of granulometry, volumetric stability and maintenance of the bearing capacity can be used with great results for grounds and packings, as well as for foundations in light constructions like detached houses, garages etc. In addition, the fine fractions obtained in concrete recycling can be used for improving soil granulometry, draining systems and for neutralizing acid soils.

**Masonry debris**
The origin of 60% of this type of waste comes from masonry debris, and the other 40% from factory refused bricks.

The properties of this waste vary according to the origin; brick, silica-limestone brick or concrete, and has a smaller density than natural aggregate as well as a greater water absorption.

The process for manufacturing aggregates originated by masonry debris starts with a classification of the waste in two sizes, with a difference of 40-50 mm. The waste pieces smaller than this size are refused because they have a great number of impurities. Once this first classification is done, the crushing by hammer crusher or impact crushers starts. A second crushing operation is followed and the elimination of impurities by the dry method, humid method and finally by the thermal method take place.

Presently, the aggregates recycled from masonry debris are used as: fine aggregates in mortars and concrete, aggregate for new concrete, foundations, structures of mass and reinforced concrete (lower strength than that of normal concrete unless 20% more cement is added). In any case, the substitution of natural aggregate by this type of aggregates is not recommended in aggressive environments.

**CONCLUSIONS:**
As a final conclusion we would like to point out that construction and demolition waste recycling offers many possibilities to reduce the level of refuse. A great amount of waste can be recycled and substitute other expensive raw materials. There are, nevertheless, certain drawbacks like tradition, but they have to be overcome to open the new uses of recycled materials.

Although from an ecological point of view reusing these materials is basic, the economic aspects have also to be considered. In order to achieve the stated objectives, great capital investments are necessary to carry out the required measures. That is, it should be economically viable. New markets to generate profits with competitive prices should be created pursuing the best quality at the lowest price.

In spite of the society's awareness on the need to protect the environment and the need to recycle, and in spite of the different initiatives promoting these principles, Spain is still in the initial stages of recycling development. The construction and demolition waste finishes very frequently in the dump, and as the dumping taxes are still very low it will be an on-going practice. This is clearly a non-sustainable practice, as can be seen in the uncontrolled and increasing volume of the dumps, and the antagonistic disappearance of the natural resources. A rigorous application of the norms on waste dumping and a considerable increase in the dumping taxes, together with the encouragement of the use of recycled aggregates, are one of the most acclaimed directives to solve the deep contaminating effect produced by the construction and demolition waste.

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