1.3.4. REPORT ON END-OF-LIFE ALTERNATIVES FOR CONSTRUCTION MATERIALS IN PORTUGAL

OERCO2

ONLINE EDUCATIONAL RESOURCE FOR INNOVATIVE STUDY OF CONSTRUCTION MATERIALS LIFE CYCLE

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1. Introduction

This report contains a summarized review of studies related to the end of live alternatives regarding construction materials in the Portuguese context. The goal is to present the different possibilities and methodologies for recycling and/or reuse of the construction and demolition waste (CDW), giving them a new purpose by replacing raw materials in the production phase or reincorporating them into new similar materials, promoting strategies of circular economy and industrial symbioses.

Sustainable construction materials consider several environmental aspects throughout their lifecycle, from raw materials and production technologies to the applied construction method, disassembly and final destination. This last phase has a lot of potential as many alternatives are available to transform waste into reusable materials. If on one hand, the consumption of natural resources has largely increased due to an exponentially growth of the society, at a rate of 250,000 people per day, in constant technological development and where the standards of comfort are more demanding, on the other hand, the available quantity of resources presents an inverse behaviour (Mateus, 2004). The construction sector is responsible for a very significant part of the waste produced in the European Union, with a total production of approximately 800 million tons of CDW per year. Thus, it becomes even more important to study, develop and apply different reuse and recycling methodologies for waste materials.

2. Legislation

In this framework, through the publication of Decree-Law (DL) no. 46/2008, of March 12, which establishes the regime of the CDW management operations, including its prevention and reuse and its operations of collection, transport, storage, treatment, recovery and disposal, the first of a series of legislative and regulatory measures has been launched to fill knowledge gaps and to promote the application of the waste hierarchy. This diploma results from a national initiative since the European Union did not issue specific legislation for the CDW (unlike other waste streams).

One of the main aims of this Decree-Law is to promote the recycling of CDWs, a project reinforced by the publication of DL 73/2011, of June 17, which amended the general waste management regime and transposed Directive 2008/98/EC, of the European Parliament and of the Council of 19 November on waste, which establishes very ambitious recycling targets for CDWs: by 2020, 70% of CDW produced in Member States will have to be recycled.

Sorting and recycling are key steps in CDW valorisation. The sorting phase allows the separation of CDW according to their nature (paper, wood, metals, plastics, etc.). In the terms of article 8 of DL 46/2008 of March 12, CDW must be screened on site or licensed management operator, and no CDW may be deposited in a landfill without having passed through this phase. The most common case of CDW recycling concerns the transformation of concrete and masonry into aggregates for later use as recycled aggregates in uncontaminated layers of pavements (LNEC E473) or as recycled coarse aggregates for concrete (LNEC E471). Also, the recycling of hot bituminous mixtures at the plant (LNEC E472) and the use of recycled materials from construction and demolition waste in the landfill and bed layer of transport infrastructures (LNEC E474) are very common options for the end of life of the CDW, being all this end-of-life options standardized.

3. End-of-life alternatives for construction materials

Knowledge on the potential for reuse and recycling of a material is very important in the rational management of the resources and products of a building whose objectives are to reduce the impact of buildings on the natural environment and whenever possible seek to renovate, restore and improve the environment. In order to achieve these objectives, the selection of materials should prioritize those with greater potential for re-use to those with some potential for recycling, as direct reuse consumes less energy, although both avoid the discharge of products/residues into the environment (Mateus, 2004).

According to Coelho & Brito (2011), the CDW distribution in Portugal is characterized mainly by two types of residues, with concrete, brick and masonry residues representing 73.6% of the total volume of generated waste, followed by residues of bituminous mixtures (13.5%), wood (3.2%), metals (2.2%), plastics (0.1%) and other wastes (7.4%).

Of all the waste, CDW in Portugal are receiving less attention from authorities and public opinion, due to the physical, chemical and biological interaction with the environment (Estanqueiro, 2012). Thus, it has been neglected over the past few years, with no real data on the amounts of generated waste. The existing data refers only to estimates, based on different assumptions, which created a variety of results. Consequently, this situation leads to an almost unnoticed deposition with approximately only 5% of Portugal's CDW being recycled (BIO Intelligence Service, 2011). Considering its high volume, when waste is put into landfills, its lifespan decreases, therefore it is necessary to find other solutions about landfill, to discourage illegal dumping.

To overcome the complications above, Estanqueiro (2012) performed a life cycle assessment (LCA) to analyse the production of recycled aggregates. Three scenarios were considered: the use of natural aggregates or the use of recycled aggregates in the production of concrete, using a fixed or mobile recycling plant. The results showed that the introduction of recycled aggregates in the production of concrete have significantly lower carbon emissions compared to the introduction of natural aggregates, especially with a mobile recycling plant (- 5.79 kg of CO_2 eq per ton of aggregates produced, in the Global Warming category according to CML baseline 2000 method).

Matias and colleagues (2014) studied the possibility of incorporating ceramic waste in lime mortars, concluding that when introduced in mortars as fine particles (dust), waste may play the role of at least slightly pozzolanic materials, and so they can help to reduce the amount of binder needed for the mixtures. Therefore, it is possible to significantly reduce the use and production of binders, which have many positive advantages for the environment. Not only fewer raw materials need be extracted, but energy consumption and CO_2 emissions also decrease.

Torgal studied in 2007 the reuse of sludge from mine sludge in alkaline activated binders and concluded that its reuse allows to reduce the environmental impact of its deposition, reduce the consumption of non-renewable resources and simultaneously reduce the level of CO2 emissions responsible for the increase of the greenhouse effect, currently associated with the Portland cement binders.

Although most of the studies and techniques developed focus on the most generated types of CDW (concrete, brick and masonry residues), other CDW generated in a smaller volume should not be overlooked, since in some cases they have a greater potential for reuse and recycling than the CDW generated in larger volumes, as is the case of metal. Sorting this material, removing contaminants and other wastes, increases its value and quality as a raw material. When it is not possible to reuse the steel as it is collected, it can be recycled to produce new metal. Mateus (2004) reports that recycled steel has an energy consumption of 2.77 kWh/kg instead of the 8.89 kWh kg required to produce "virgin steel", a difference that is also reflected in the CO_2 emissions.

There are also end-of-life studies on insulation materials, such as Silvestre et al. (2012), where it studies the possibility of recycling and reuse of 3 types of insulators: Extruded polystyrene (XPS), expanded polystyrene (EPS) and polyurethane/polyisocyanurate (PUR/PIR). The results showed that the recycling of the materials avoids environmental impacts that would exist due to the deposition/incineration of the same, with values such as 48.1 kg CO_2 eq avoided per m^3 EPS.

This report focuses mainly on studies that report the carbon emissions of sustainable end-of-life alternatives for construction materials. Although this indicator is very important, consideration should be given to reducing the consumption of raw materials and the production and deposition of waste in the landfill. In the review of these studies, it becomes evident that it is also necessary to consider and aim for the reduction of other emissions produced by, for example, transport trucks in the recycling alternatives (e.g. NOx emissions), among others, when searching for more sustainable options for the end-of-life of construction materials.

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