Construction and demolition waste in the region of Porto - Portugal: management and survey.

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CONSTRUCTION AND DEMOLITION WASTE IN THE REGION OF PORTO - PORTUGAL: MANAGEMENT AND SURVEY

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Abstract
Management of Construction and Demolition Waste (CDW) in Portugal is not yet a primary issue. Different methods have been used by the various entities involved to assess amounts of CDW thus leading to different published results.
A wide range research programme is being carried out on CDW and in particular, a study to characterize CDW in the Porto urban region.
In this paper, after a short presentation of the Porto urban area, the waste policy, including situation of CDW practices and the possible estimation of quantities in the region are presented. Finally some examples of three recent case studies are discussed.

KeyWords: Construction, Demolition, Waste, Porto urban area

1. INTRODUCTION
Portugal in the last twenty five years reached an important degree of modernization. The efforts concerned pushed the construction activity in the country to an important level related with the need of construction and refurbishment of buildings for housing and other uses. The construction of civil engineering infrastructures has also been intensive. Today the activity is beginning to slow down and a special concern with conservation and rehabilitation of existing buildings and infrastructures is on the way.
Until now there has been no special concern with management of construction and demolition waste. Although a few laws lead to deposition of waste materials in licensed sites, in reality the destination of CDW has been controlled only in a few cases. The owners of the works, public or private are, normally, more concerned with costs and ignore environmental concerns.
It is still easy to find illegal areas where CDW can be placed and it is difficult for the authorities to find the offenders of these acts. In practice this means that there is still not enough real pressure to reduce CDW production, to deposit CDW in legal landfills or even try to find alternatives with interesting applications for this type of waste. Also the environmental costs have not yet been accurately assessed and the cost of coarse and fine aggregate extracted from stone quarries is not very different from the cost of recycled aggregates.
A research program focused on CDW of the Porto Urban area has been carried out at the Porto (FEUP) and Lisbon (IST) Faculties of Engineering.
2 THE PORTO URBAN AREA

2.1 Characterization of the urban area

Porto is the second most important urban area in Portugal after the Lisbon metropolitan area. This urban area around Porto city presently includes nine city districts near the Douro river and the shore. Seven city districts are located on the north margin and only two on the south side (fig.1).

![Location Map of Porto Urban Area](image.png)

Fig. 1: Location and constitution of the Porto Urban area

The population of the urban area is growing and represents, according to the most recent census, almost 12% of the Portuguese population (fig. 2)[1]. The city of Porto lost the leading place in number of residents to Vila Nova de Gaia, the city on the south side of the river.

![Population Chart](image.png)

Fig. 2: Population of the urban area
2.2 Construction activity in the urban area

Construction activity in the Porto urban area has some particularities compared with all the country. In recent years the majority of new buildings that have been built are residential (91.2%) and multifamily buildings are predominant [2]. The suburban city districts around Porto are the most dynamic in construction of new buildings. In what concerns restoration of buildings the cities with old centres like Porto and Vila do Conde are the ones where this effort has been more relevant in the last years. Other construction activities with expression are mainly roads and railways including construction of the underground.

3. THE PORTO URBAN AREA WASTE POLICY

In the urban area there are several entities that have responsibilities related with waste management:

- Ministry of the Cities, Planning and Environment
  - CCDRN - North Commission of Coordination and Regional Development;
  - INR - National Institute of Residues
- Ministry of Internal Administration
  - SEPNA - Special Police Service for Nature and Environment Protection;
- City Councils
  - Environment Services

The majority of the nine city districts of the Porto urban area have an integrated policy related with solid urban waste and an intermunicipal enterprise for this management has been created. This enterprise, called LIPOR, covers nine of the eight city districts.

LIPOR is the intermunicipal service of waste management, responsible for the administration, treatment and upgrading of the solid urban waste produced by eight municipal city districts in the Porto urban area. It excludes Vila Nova de Gaia where waste is managed by another enterprise called SULDOURO. To understand the dimension and main activities of LIPOR, some data are presented [3]:

- Number of inhabitants served – almost 1 million;
- Solid urban waste - 480 000 ton/year
- Multiple forms of pick up of selective waste – door to door, ecocentres and ecopoints;
- Pick up of undifferentiated waste;
- Power station from waste – capacity 25 MWh
- Sanitary landfills;
- Market for waste reuse;
- Landscape recovery;
- Support and involvement in national and international research projects waste-related including CDW.

4. CDW SITUATION IN THE URBAN AREA

Deposing CDW in ecocenters managed by LIPOR is authorized for small amounts and general waste resulting from domestic construction and demolition works. This deposition can be made with or without costs, depending on the City Council where the ecocenter is located and also of the quantity of waste. Normally the cost is higher as the quantity increases (each City Council pays LIPOR 40€/m³).

Some City Councils have special facilities for its citizens concerning small works. For example the Porto City Council collects up to 2 m³ of CDW waste charging a certain fee.
When needed, Gondomar City Council places, and later picks up, CDW containers for its citizens. The City Councils of the Porto Urban area collect illegal dumped CDW and transfer them to various legal locations, supporting costs. There are many places, normally out of site, used for CDW dumping, for example, near roads, forests, fields and old quarries (fig. 3).

In the process of approval of construction projects some City Councils demand an estimation of CDW quantities and indication of the chosen landfill as conditions to deliver the permissions for construction.

The more used place for CDW deposition is the legal Solusel landfill located in Vila Nova de Gaia where the fee is supported by the builder. Previously this place was a stone quarry.

Analyzing several works it may be stated that there is no relation between the dimension of the works and the strategies in terms of CDW. Good and bad examples exist independently of the dimension of the work and the dimension of the intervening building company.

The lack of environmental awareness concerning many construction agents and also the fact that presently the construction activity involves, usually, a chain of subcontractors and therefore many intervening parties, leads to a situation where it is very difficult to prove environmental crimes related with illegal dumping.

In the Porto Urban area there are some companies operating in CDW management:
- Management of aggregates and CDW with local landfill - 1 company – Solusel;
- Pick up, temporary storage and selecting several types of waste - 9 companies;
- Pick up, temporary storage and dismantling of air-conditioning equipment - 1 company.

It is possible to try to access amounts of CDW produced in the Porto Urban area. The total amount is the sum of the quantities collected in the LIPORE cocentres, the quantities collected directly by the services of the City Councils and the material transported by builders to the Solusel licensed landfill. The amounts are presented in Table 1.

Table 1: Evaluation of CDW amounts produced in the Porto urban area in 2002

<table>
<thead>
<tr>
<th>LIPORE Ecocentres</th>
<th>Direct Collection City Councils</th>
<th>Solusel CDW including soils</th>
<th>Solusel CDW excluding soils</th>
<th>Total (ton/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>22 194</td>
<td>30 079</td>
<td>43 200</td>
<td>144 000</td>
<td>239 473</td>
</tr>
</tbody>
</table>
Considering that the population of the 8 City Councils associated to LIPOR is almost 1 million, the region presents the following rates:

- CDW per person without soils – 100 kg/pers/year;
- CDW per person with soils – 190 kg/pers/year.

CDW production referred to Portugal by the European Union, including soils is 325 kg/pers/year [4].

5. DEMOLITION AND CONSTRUCTION CASE-STUDIES

A few CDW case-studies are briefly presented and the information is based on visits to construction and demolition sites in the Porto district region. These case-studies are designated as:

- Case Study A- BFC Football Stadium demolition;
- Case Study B- Yeast Factory demolition.
- Case Study C- FCP Football Stadium demolition.

When possible the CDW technologies, the selective techniques and the equipments used and final destination are mentioned.

5.1 Brief description

5.1.1 Case study A - “BFC” Football Stadium Demolition

This demolition site, the “BCF” stadium, is located in the metropolitan area of Porto (3km from the shore) and consisted of demolishing part of the south platform (fig.4) of the stadium and construction of a new platform. The platform to be demolished was relatively recent and consisted of reinforced concrete elements such as beams, columns and slabs (concrete class - C25/30).

![Fig.4: Partial view of south “BCF” stadium platform to be demolished](image)

5.1.2 Case Study B - Yeast Factory Demolition

This demolition site is located in Matosinhos (100 m from the shore). The work consisted in the demolition of a yeast factory built in 1948. The construction area was approximately 30,000 m² and during the demolition phase was being used as a temporary deposition and treatment zone for concrete waste produced during demolition (fig.5). After treatment (sieving and grading), the resulting aggregates could be used in several applications such as landfills for roads.
Fig. 5: Partial view of the demolition site also used as a temporary deposition and treatment zone for concrete waste

After completion of the demolition works a residential complex is to be built.

5.1.3 Case Study C - FCP Football Stadium Demolition

This demolition site is located in the east area of the Porto city. The work consisted in the demolition of the old FCP Stadium. The stadium was inaugurated in 1952. The area is approximately 28,500 m² (Fig. 6). The main structure is composed of structural elements such as beams, columns and slabs with filling masonry.

Fig. 6: View of the old FCP stadium

The main materials are reinforced concrete, ceramic brick and others, topped by the plastic chairs (fig. 6). The construction area will be subjected to future urban replanning involving the construction of a great residential and commercial complex, equipments and road system.

5.2 Technologies used in demolition works

The main techniques used in CDW case-studies were:
- Use of hydraulic-mechanical equipment (scissors and hammers integrated in a rotating machine);
- Phased demolition, beginning in inferior and ending in higher levels to demolish;
- To accomplish the demolition of general structures, including higher roof slabs, modified equipment with extended mechanical arms was used. A temporary work platform was also built with soil and waste materials from the demolition itself (fig. 7).
5.3 Selective demolition techniques used

The demolition works presented are mainly of reinforced concrete. After a separation of accessories, finishing materials and non-metallic waste like plastic and timber, the demolition of reinforced concrete began.

The main selective techniques used in the CDW case-studies were:
- On-site separation and conditioning of steel from reinforced concrete and from general CDW;
- Use of containers for conditioning non-metallic waste like plastic and timber.

5.4 Equipments used on demolition works

The main equipment used in CDW case-studies were:
- Demolition equipment machines with hydraulic-mechanic accessories, like scissors and hammers for cutting and crushing materials, and expandable mechanical arms for demolition in higher places (Fig. 8 and 9).
Fig. 9: Examples of a pneumatic hammer and hydraulic scissors

- Crushing and separation equipment: machine that crushes CDW and separates magnetically steel from waste (fig. 10);

Fig. 10: Machine that crushes CDW and separates steel
(Case study B)

- Transport and conditioning equipment: Machines for transportation and conditioning of CDW at the construction site (fig. 11);

Fig. 11: Machines for transportation and conditioning of CDW at the construction site