Overview of deconstruction activities in Portugal

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ABSTRACT: Deconstruction emphasizes promotion of "reuse" of building materials and components (and even whole buildings) as a way to "close the loop" of materials, and avoid the loss of matter and energy through construction and demolition waste. In Portugal, although there are various efforts to promote sustainability in the field of reuse and recycling of building materials and components, these are not yet united under the conceptual framework of Deconstruction. This paper presents an overview of these activities (selective demolition, building and component reuse), alongside a description of construction and design trends in an attempt to define a possible framework for deconstruction. This paper is part of an ongoing PhD research that aims to assess the possibilities of implementation of Deconstruction, from an architectural point of view, within the specific characteristics of Portuguese building design and construction industry.

1 INTRODUCTION

A vast amount of resources and energy is lost in building demolition and transformation, usually with associated negative environmental impacts due to considerable waste volumes produced. Building deconstruction allows a reduction of the negative impacts mentioned, by promoting the reuse of whole buildings, components or materials, both existing and future, thus increasing the efficiency of resources (material and energetic) in building construction.

The increase in environmental efficiency of the usage of resources is the ultimate aim in all sustainability efforts (UN-GASS, 1997), and recent studies have shown dissociation between GDP growth and Direct Material Inputs in several EU economies, in effect demonstrating that welfare can increase without resource consumption increase (Niza, 2001).

No report exists on Deconstruction activities in Portugal, as this subject has only recently became the object of scientific studies. This document follows the template for national reports used in CIB publication 300 *Deconstruction and Materials Reuse - An International Overview* (Chini, 2005), allowing easy cross-referencing with the various national reports.

1.1 *Waste statistics: overall production of C&D*

Construction and Demolition Waste (CDW) is still an undefined problem in Portugal, although awareness and need for research into its processing are rising. Presently, the most visible aspect of CDW is illegal roadside dumps, common along secondary roads or desert grounds. They are due to a variety of reasons including lack of appropriate dumps, insufficient inspection by authorities and particularly due to a general lack of awareness by parties involved (figure 1).

There are no quantified data on the type, origin and constitution of CDW in Portugal, other than local or incomplete studies. Data are difficult to obtain since there is a general lack of record keeping, while illegal dumping is rather commonplace.

Estimation of values ranges from 7.691 ton/year (Carvalho, 2001) to a 3 Mton/year production mentioned in the 1999 Symonds Report (Symonds, 1999), while more recent estimates provide a figure of 4,4 Mton/year (Farinha, 2007). Since there are no systematic and complete records, accurate trends are impossible to ascertain, but these last two values would represent a 150% increase in CDW production in less than ten years, and an average 400 kg/capita/year production.

Figure 1. Illegal Construction and demolition dump in abandoned factory in Lisbon

1.2 *Waste statistics: percentages of C&D waste reused, recycled or land filled.*

The Symonds report (Symonds, 1999) also indicated that, in 1999, less than 5% of all CDW in Portugal was reused or recycled, then one of the lowest values in the EU. The situation has changed little since then, although further CDW processing units have been created in the meantime. There are currently 31 licensed operators to receive and process CDW waste (INR, 2007), 67% of which act as basic landfill / separation units, while 13% act as valorization units for glass and ceramics. This amounts to an average of one unit per 2800 sq. km., a low value comparing to Germany's average of one unit per 223 sq. km. (Chini, 2005).

2 DEMOLITION AND DECONSTRUCTION TECHNIQUES, MACHINERY AND TOOLS

Before the second half of the XX century, buildings in Portugal were made essentially with load bearing walls, either of stonework or more often of a poorer mix of small stones, bricks and lime mortar. Raised floors were built of wooden elements, as well as interior walls (plastered over). Roofs were built using wooden structures with clay tiles. Exterior finishes invariably included mortar renders, painted or with lime washes. In the northern parts of the country the percentage of use of stone was higher, including load bearing walls in solid stone or stone slate roofs. In the southern areas, earth rammed construction was very common. The beginning of the XX century saw the introduction of reinforced concrete in building construction, although this only became generally widespread by the 1950's. Typical mid-century residential and office buildings comprise reinforced concrete frame, single or cavity wall of ceramic bricks, finished in mortar renders with scarce stone facings. Dividing walls are also in ceramic brick, with embedded infrastructures. Window frames are either in wood or first-generation aluminum, while roofs are composed of clay roof tiles over concrete structure or slab. The probable candidates for demolition or deconstruction are therefore extremely monolithic constructions, in which almost all elements are interconnected by chemical bonds, and where the possibility of disassembly and material harvesting is very low.

In April 2007 there are 42 registered demolition companies, ranging from family owned businesses to more professional multi-firm corporations, largely concentrated around Lisbon (13 firms) and Porto (9). The range of techniques used in demolition / deconstruction is thus quite limited, varying only due to the size and height of the building and the conditions of the location. Usually the first step is the removal of the more characteristic or valuable features (depending on the age of the building) whose form of fixing, size or value allows removal. Demolition work will take a top-down approach, using pneumatic hammers or hydraulic claws, handheld or as machine extensions, steadily demolishing the building on site. Demolition by controlled explosions is quite rare due to the fact that urban centers with older buildings are very dense areas, and explosive demolitions are liable to cause damage to adjacent buildings by blast or falling elements. Demolition thus results in largely mixed heaps of material (figure 2), with the material being carried to dumps (where some separation may take place, especially if metallic elements are present).

Several large-scale demolition operations have been undertaken in recent years, producing valuable experiences and learning. The former industrial area of the EXPO 98 site was totally cleared resulting in 750.000 tons of crushed concrete used in provisional roads and as a base layer for final roads, 100.000 tons of masonry rubble used for soil stabilization and 100.000 sqm. of existing granite paving blocks reused in the exhibition grounds (BIE, 1999). More recently, a considerable number of buildings were demolished in the Cacém "Pólis" urban renewal program, following very detailed work plans, listing demolition types and techniques, establishing principles for component salvage and demolition waste processing / reuse. (Morujão, 2003)

Figure 2. Typical early XX century building under demolition in Lisbon. Notice large percentage of soil content, with mixed metal, stone and wood elements

3 DESIGN FOR REUSE

3.1 *In situ building reuse*

There is a large tradition of whole building reuse in Portugal, especially large and medium scale built heritage. This habit can be traced back to the early XVIII century when the extinction of the religious orders left hundreds of monasteries and convents empty. These were gradually appropriated for other uses such as universities, military and police garrisons, hospitals, ministries and even the National Assembly. Considering their heritage value, they continue to be adapted to a variety of functions (museums, hotels, etc.).

There are also various examples of whole building reuse of more recent buildings (XX century stock), especially in urban centers. These operations include use change (offices to hotels, offices to hospitals), building growth (adding floors) or building remodelling ("facelift").

Nevertheless new construction prevails over refurbishment works as new building construction takes up 36% of the overall yearly investment in the construction sector, and remodeling and demolitions account for only 6% and 0,1% respectively. The development of territorial infrastructures accounts for 41% of the overall investment in the construction sector. Half of the investment in the building construction sector goes to housing construction (1,9 billion Euros / year), while the remaining half is essentially divided among the sectors of services, commerce and education (INE, 2005).

3.2 *Moving buildings*

Building transference is an almost unknown practice of which there are few examples. All constructions known to have been moved recently had steel structures, allowing disassembly and reassembly in a new location The pavilions that composed the southern section of the international exhibition area of Lisbon’s Expo 98 were sold after the Expo end to a variety of locations in Southern Portugal where they were rebuilt as smaller exhibition structures, while Portugal’s national pavilion in Hanover’s Expo 2000 was reassembled in Coimbra. These processes were undocumented and no technical, economical or environmental profitability studies were undertaken. In March 2005, the former Macao Pavilion at Expo 98 was disassembled for rebuilding in the new Loures town park. This process is yet unfinished but is the subject of an undergoing study by the author, whose preliminary conclusions point to economic parity with a new structure, with a positive environmental balance (figure 3).

Figure 3. Former Macao Pavilion being reassembled in Loures (April 2007)

3.3 *Component reuse*

As mentioned earlier, harvesting of components from historical buildings is fairly common (including theft from abandoned buildings), as these decorative elements are widely reused in refurbishment projects or by interior designers seeking to achieve a traditional / ancient look.

Component reuse from more recent buildings is quite rare, as these often do not have aesthetic appeal, are not economically competitive with new comparable components and are generally unavailable when needed or wanted. There are rare cases of component reuse in the context of agreements between different firms, exchanging materials for workforce, or using materials as payment. One such case was the use of materials and components from the interiors of an existing office building in Lisbon in the new siege of an engineering company in Sintra.

The author, focusing on financial and environmental profits gained, is currently studying this project. A variety of circumstances contributed to this exceptional case (the “harvesting” company was about to change facilities, the materials were compatible with the ongoing project for the new site, and transport distances were very short), and while technical difficulties occurred, this was an overall successful project, attaining a reused material incorporation of 20% (figure 4).

Figure 4. Work in progress at the new IP offices in Cacém (March 2006). Doors, wood veneer wall panels and all lighting fixtures were being reused after disassembly from original location in Lisbon.

4 ENHANCING MATERIALS RECICLABILITY

Material separation for recycling is already a widespread practice concerning household waste, resulting in large quantities of salvaged paper, plastic and glass. Several other specific waste streams have also been the object of attention (hospital waste, farming waste, used vehicles) but CDW has largely been ignored and thus recycling of specific materials associated particularly with the construction industry is still very low and undeveloped, although the situation is slowly changing.

All CDW sorted materials that can be processed via other waste streams (plastics, metals, glass, and paper) are already almost fully recovered, while wooden materials are primarily used as fuel. But, given the prevailing construction habits in Portugal, with a predominance of reinforced concrete structures and a high percentage of ceramics in exterior and infill walls and in interior finishes, the largest percentage of CDW is composed of these types of materials, and these are the waste flows where greater effort is now required. Also worthy of mention are the remains from stone quarrying, in which up to 90% of extracted material is waste, and which cause serious environmental issues.

Current scientific research has focused mainly on recycled aggregate reuse, including in reinforced concrete, with recently issued legislation allowing for reuse in a variety of applications (LNEC, 2006). A potentially very beneficial recycling issue would be the use of crushed ceramic materials (including gypsum boards) as a secondary raw material, replacing virgin materials in clinker due to high silica and lime content (Hendriks, 2001). This could prove a quite important measure as Portugal is one of Europe's largest consumers of cement, with one of the highest per capita values in Europe (CEMBUREAU, 2004), and the resource extraction associated with cement production has major environmental impacts, hotly contested by populations.

The WAMBUCO - Waste Manual for Building Construction research project was recently completed, encompassing contributions from several other European countries (CEIFA, 2005). The purpose of this manual is to provide an easy usable method to estimate waste generation from building construction activities, be it a new building or a remodeling. This manual, although not yet available to the general public, could work as a good base for enhancing material reciclability by allowing a timely organization of CDW flow processing and management.

5 ECONOMICS OF DECONSTRUCTION AND MARKETING OF USED BUILDING MATERIALS

Since there is little demand, there is also little supply, and thus it is difficult to define market dynamics of reused building materials and components. As mentioned earlier, contemporary component disassembly is quite rare and usually motivated by very specific conditions. In the context of the study of material harvesting between interior projects mentioned on chapter 3.2, the cost of disassembly and transportation represented 50/60% of the price that the materials recovered would cost as new. This is considered a rather high value, probably exceptional in the context of a more generalized reused materials and components market.

6 DESIGN OF BUILDINGS AND COMPONENTS FOR DECONSTRUCTION

The link between design community and building industry is not very strong in Portugal, leading to the existence of very few initiatives for product development initiated from the design community. Current architectural design methodologies do not contemplate deconstruction as an objective, especially since not even maintenance needs are adequately considered or catered for, and a long default service life is assumed independently of building type. Energetic performance is slowly reaching the top of design priorities and it can be considered that this will probably hinder future deconstruction on current buildings as the performance demands of the new 2006 RCCTE (Building Energetic Performance Regulations) will lead to a generalized use of continuous exterior insulation, as ETICS or projected PU, rendering future material separation of building skins even more difficult if not impossible.

The revision proposal of the RGEU National General Building Codes proposes to establish a minimum service life of 50 years for buildings, which may already be out of tune with present building average lifetime, but which probably will raise the issues of adaptability and flexibility. The promotion of these last two parameters by building layers dissociation and adoption of adequate technical constructive solutions will probably be the most promising road for deconstruction in Portugal, further promoting whole building reuse (already an historical habit). However this will require informing architects and designers, which are for the vast majority unfamiliar with open building principles, still tailoring buildings for a given program without other use scenarios, even on very fast changing programs. DGIES - General Directorate for Health Facilities and Equipments - is already trying to find a solution to the high rate of spatial and facilities change in hospitals, and has had a recent workshop with Dr. Stephen Kendall to acquaint itself with “Open Building” principles, based on deconstruction logics (Kendall, 2002).

7 BARRIERS AND OPPORTUNITIES FOR DECONSTRUCTION

7.1 *Barriers*

As Portugal still has (apparently) considerable natural resources, and CDW is not yet perceived as a real problem. So there is no real motivation for adoption of deconstruction, other than a social or ecological awareness based one.

Government efforts have been put into Municipal Solid Waste prevention and processing, thus CDW is not yet perceived in its full dimensions (waste, energy and materials loss) and legal framework does not promote or enforce deconstruction. No specific regulations exist yet regarding CDW, although more general laws mention CDW and Best Environmental Processing Option “ladders” are in print. There are no legal obligations or tax benefits from building materials component reuse or donation, other than profits gained from sorted materials sold for recycling and as dumping fees at landfills are still quite low (from 1 euro/ton to 60 euro/ton), companies prefer dumping to disassembly (in the cases when it was possible).

There is no “take back” policy on building materials, so the producers have no responsibility for their products. The only known exception is the SIKA Company, which provides a take back service on their PVC waterproofing membranes, be it new construction leftovers or materials recovered from demolitions and refurbishments. Provided materials are uncontaminated and transported to its facilities in Switzerland.

No legal obstacle exists to building components reuse except that they must comply with prevailing regulations, namely fire safety, insulation performance and structural performance. This effectively limits component reuse to decorative and finishing materials or spatial configuration elements.

Public tender rules allow contractors to submit alternatives for specified materials, so it will be difficult for an architect to enforce the use of reused elements. The more plausible way of reused components finding their way to reuse would be in "design-build" tenders where the team dynamics could be more favorable. Nevertheless, the recent adoption of laws demanding that all materials used in public works be certified will make it more difficult to adopt reused materials and components, as there is no body or responsible for its reappraisal.

7.2 *Opportunities*

The high dependency on oil imports, a growing social and political awareness of the negative impacts of current consumption patterns will progressively lead to a change of perception towards material and component reuse, providing the legal framework that both permits and stimulates the adoption of these logics by the market.

The high percentage of new building construction could be used to produce a large stock of more deconstruction friendly buildings if adequate information was spread quickly enough, even considering current prevailing building "heavy and wet" matrixes.

Certain demographic sensitive programs such as primary schools, or primary health centers could benefit from pro-deconstruction projects allowing changes in the buildings size without long and costly adaptation works, or without being abandoned.

8 FURTHER RESEARCH

More accurate CDW quantification is needed and is already undergoing, which will allow the general public to perceive the dimension of the problem. Concurrently, studies must be made to evaluate the possibilities and benefits of deconstruction (demolition vs. disassembly, new building vs. reuse) specifically in the Portuguese context, demonstrating both the economical and environmental feasibility of such operations. The concept of deconstruction must be divulged, especially near the concerned actors, including students, via manuals such as SEDA - Design and Detailing for Deconsctruction, framing deconstruction into the broader objective of sustainability and laying foundations for the adoption of principles compatible with Portuguese standards and practice.

9 CONCLUSION

Deconstruction is virtually unknown in Portugal, as there seems to be need for it, and construction matrixes in Portugal are historically and currently unsuitable for building disassembly. Nevertheless, consumption patterns are highly unsustainable and must be addressed urgently, including the construction industry that has an important role to play in this change due to its expressive contribution to economic activities.

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