Motives for design for disassembly in building construction

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ABSTRACT: Design for disassembly, DfD (Design for Deconstruction), is an essential action to reduce the use of energy and resources and the production of waste in building construction. DfD has many environmental, economical as well as social benefits. It seams obvious to include the aspects of DfD, in both on-site and off-site production. Some countries have observed the importance of DfD and taken action but in many countries this is still a disregarded issue. This paper presents an overview of motives for DfD in building construction. The aim is to encourage clients and all actors in the building process to improve the discussion on DfD. The overview is based on the result of a systematic analysis of related fields such as DfD in product design, energy and resource efficiency in buildings, building deconstruction and salvaging of construction waste.

1 INTRODUCTION

Design for Disassembly, DfD, is an important measure to achieve sustainable building. What is DfD and what are the motives? DfD can be defined as a method to design a building/product in such a way that it enables the disassembly of building/components and reuse/recycling of its parts/materials. DfD requires a new approach to design and will result in a building/component designed for all the stages of its life-cycle. DfD is an essential action to accomplish the goals to reduce the use of both of energy and resources as well as the production of waste. DfD can also be regarded as an implicit meaning of the word *reduce* in the slogan “reduce, reuse, recycle”..

Within product design, research in DfD has been carried on for more than 25 years and DfD is today a well integrated method in product design. Within building design, general ideas regarding the favour of DfD (or Design for Deconstruction) was presented already in the 1970th by the architect Christopher Alexander. It was later developed in the 1990th by for example architects such as Francis Duffy and Stuart Brand.

In the last years, many countries worldwide has been given a lot of attention to DfD. Authorities, special interest oragnisation and companies have produced guidelines for DfD in building construction. Research have been carried out, doctoral thesis have been written and some are under way. In the Neatherlands, the Ministry of Housing, Spatial Planning and the Environment (VROM) implemented a project called Industrial, Flexible and Demountable, IFD, in which a great amount of demountable buildings have been built. Many developers and housing corporations in Holland have recently started to integrate DfD aspects in their development (Durmisevic 2007). In for example Australia, Canada and Great Brittan, an analysis of the building code regarding environmental issues was commissioned by the government. Several bodies for considerations pointed at DfD as an important matter to notice and develop.

There are many motives, both environmental, economical and social, for DfD in building construction and in the sections below is given an overview of motives and benefits. The motives can be summarised in

Economical motives
- Increased costs for waste handling
- Increased costs for extraction of resouce
- Increased score in environmental labelling for demountable buildings
- Increased terminal value for demountable buildings

Social motives
- Demeographic changes and changes in household structure
- Buildings are demolished before intended time

Enviromental motives
- Increased problems with waste production
- Lack of virgin resources
- Recycling and the quality of the end products
- Reduced need of energy need for building operation
- Climate changes

2 ECONOMICAL MOTIVES

2.1 *Increased costs of waste handling and resources*

Both waste and resources are connected with great costs in building construction. Economic instruments for environmental purposes are used in most European countries and are increasing. By 1994, the number of instruments had increased by over 50 % compared to 1987 [Hamilton 2001] and waste and resources are affected fields. In the 1990th, many countries introduced tax on waste, e.g. Denmark, Sweden, Holland, Finland, UK, and Germany [EFR]. Denmark introduced waste tax already in 1987, it has been increased continuesly and in 2001 it was tendoubled compared to 1987. Many countries have also tax on virgin materials. Tax on gravel was e.g. introduced in Sweden 1995, Denmark 1998, France 1999, and UK 2002 [EFR].

Easier disassembly would facilitate recycling, reduce waste and save resources.

2.2 *Environmental assessment of buildings*

Environmental rating is a widespread measure to promote the production of environmental products in general and there is a large number of environmental rating systems for buildings. The construction company Skanska considers environment rating as a necessary complement to legislation as it provides help to customers and lets the market work [Skanska 2007]. Environmental rating is also used by many construction companies and developers to market building projects, e.g Skanska and Brittish Colombia Construction Association, BCCA [Skanska, BRCCA 2007].

Consumers also consider envronmental rating systems as useful and in a survey, 32 % of the consumers answered that they certanly would pay 5 % more for an environmentally produced product and 48 % that they would consider to do so [Swedish EPA 2006].

In recent years, a few rating systems have included DfD-aspects, e.g. HK-BEAM, GreenGlobe and GBTool, and other systems are discussing the possibilities to include both DfD-parameters and recycling potential, e.g. EcoEffect [Glaumann 2007]. DfD is closely connected with the recycling potential and both are important parts of the environmental assessment of buildings. The goal is to develop a protocol that fairly allocates the loads, while at the same time encouraging planning and design decisions that facilitate greater recycling potential at the end of the use period [IEA 2001].

Buildings designed for disassembly and reuse/recycling will get higher score in environmental rating and the buildings' retail value will increase.

2.3 *Increased terminal value*

On a free market, the value of a building is decided by access and demand and a building's location is an important factor. Closure of a company, important for the employment in the region may suddenly change the demand for residential buildings in the region. Buildings which are easy to disassemble, move and rebuild in another location is likely to have a much higher terminal value than buildings which are not possible to disassemble.

3 SOCIAL MOTIVES

3.1 *Demographic changes and changes in household structure*

There is a general trend in developed countries towards an increase in one person households and based on scenarios this trend will continue [Alders 1999].

In Sweden, the share of one person households increased from about 30 % in 1975 to 46 % in 1990 [SCBa]. Besides changes in household composition, there will also be changes in regional population. The population in some counties is assumed to increase about 30 % while in other counties the population is assumed to decrease about 30 % [Samplan 1999].

3.2 *Buildings are demolished before intended lifetime*

There is a clear tendency through out the world that buildings are demolished before the intended lifetime. In Sweden, 25 % of the buildings which were demolished after 1980, were less than 30 years old [SCBb]. In Japan, the etimated lifetime for wooden residential buildings is 25-30 years and many buildings are demolished after only fifteen years (Nakajima 2001]. In a on commercial and residential buildings in St. Paul , Minnesota, demolished from 2000 to mid-2003, 30% were all less than 50 years old and 6% in less than 25 years old [Trusty 2005].

These figures support the view that we should do more to develop flexible and demountable buildings.

4 ENVIRONMENTAL MOTIVES

4.1 *Waste*

Some of the problems associated with waste and landfill are loss of arable land, loss of amenity value of the land, methane emission (a very potent greenhouse gas), leachate problems (liquids containing materials from landfill).

Construction and demolition waste in Europe makes up for approximately 25% of all waste generated in the EU [WasteBase 2007]. Denmark has well developed waste statistics and in Denmark the construction and demolition waste makes up for about 1/3 of all waste [EPA 2005]. Based on the amount of Swedish construction and demolition waste released 1996 and the recycling rates 1996, the net recycling potential was estimated. In terms of energy, the recycling potential could be increased at least 20-40 % [Thormark 2001]. However, as the demolished buildings were not designed for disassembly, the disassembly would be extremely costly to implement. In addition, the quality of the recycled end products would not be as high as it would have been if the buildings were designed for disassembly and recycling.

4.2 *Lack of virgin resources*

How long the earth's resources will last in general, is an uncertain issue. Nevertheless, with decreasing access to easily extractable resources, more energy will be needed to extract new resources.

In addition, for some specific resources essential for building construction, fairly reliable data is available. Geological Survey of Sweden has estimated that many Swedish municipalities, the supply of natural gravel will run out in less than 20 years if the extraction rate isn't drastically decreased [GSS].

4.3 *Recycling and the quality of the end product*

The cleaner and more homogeneous the waste fraction is, the more economical and environmental efficient is the recycling process. Sorting plastics for example, is a prerequisite to obtain high quality of the end product.

4.4 *Reduced energy need for building operation*

With decreased energy need for operation of buildings, the energy need for the material part (production, transports, maintenance) will make up for an increasing part of the total energy need during a building's life time. In Swedish low energy houses, the material part accounts for about 60-75 % of the total impacts during a service life of 50 years [Thormark 2007].

An important next step to reduce the total energy need is therefore to take notice of materials and joinings in order to produce reusable/recyclable constructions.

4.5 *Climate changes*

Due to climate changes, there is an increased risk of flood in Europe. More than 10 million people live in the areas at risk of extreme floods along the Rhine [Commission 2006) In Sweden, a survey has been performed regarding risk areas and several areas in risk for flood or landslide has been identified [SGI 2006].

Some areas the risks are obvious, however, in some areas there is a possible risk. In the case when it is difficult to tell *if* flood or landslide will occur, then it is even more difficult to tell *when*. In those areas, if very attractive for building, it would be possible to build demountable buildings which can be removed if the risks in the future show to be obvious.

Due to climate changes, new demands on buildings can be assumed, e.g. improved shading devices, improved ventilation, insect screens due to increase in mosquitoes etc. [Steemers 2003]. Steemers has also suggested that attention to an 'adaptive capacity' would be valuable in the design of buildings.

5 CLONCLUSION

Design for Disassembly, DfD, is an important measure to achieve sustainable building and requires a new approach in the design of buildings and building components. The motives for DfD as well as the benefits from DfD are of both environmental, economical and social kind.

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