Proceedings of the International Association for Shell and Spatial Structures (IASS) Symposium 2009, Valencia
Evolution and Trends in Design, Analysis and Construction of Shell and Spatial Structures
28 September – 2 October 2009, Universidad Politecnica de Valencia, Spain
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Reducing the Environmental Impact by Using Proper Construction Materials and Techniques

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Abstract

Throughout the world, building is one of the largest industrial sectors, and a significant part of the resource consumption is used by the construction industry. Furthermore, it generates waste at all levels of production, use and disposal, which can pollute air, soil and in some cases contaminate the water supplies. Until recently the main criteria for selecting building materials have been their structural suitability, costs, and aesthetics. Now the challenge is to create healthy building environments. Therefore the impact of the building process and the building itself on the environment, during the whole service life should be taken into account. The design process and execution has to be carefully controlled and efficient technologies have to be properly applied. In this paper, some of the main aspects in reducing the environmental impact of construction by using appropriate materials and techniques will be highlighted.

Keywords: healthy building environment, indoor air quality, efficient technologies

1. Introduction

Until recently the main criteria for selecting building materials have been their structural suitability, costs, and aesthetics. The climate change and the increasing energy costs are demanding a more sensitive use of resources. Consequently, materials durability and resource usage become some of the most important performance issues in construction activity. Increasing the service life of building products could be a long-term solution for preserving the natural resources.

Building materials are currently extracted and fabricated with little regard to their impact on the natural environment - the associated generated waste and polluting by-product, or even the loss of biodiversity by destroying the habitats being well known threats. At the same time one of the main environmental concerns is the amount of waste that is generated when a building is modernized, renovated, or demolished.

The topic of indoor air quality request gained attention when people learned and realized that many building materials release harmful chemicals into the air. Many of the products and materials traditionally used in construction include a multitude of hazardous chemicals, affecting the indoor air quality which is essential for the health and well-being of the occupants [3]. Therefore, the impact of the building process and the building itself on the environment, during the whole service life should be taken into account.

2. Evaluation of construction materials and techniques

The impact of constructions on the environment in terms of energy use, atmospheric emissions, raw materials use, waste generation, water use, and many other factors is massive. In order to establish a sustainable solution it is necessary to analyse in detail the involved materials, from manufacturing to specific installation techniques, maintenance methods, and recycling solutions for each stage of construction.

Design process and execution have to be carefully controlled and efficient technologies have to be properly applied, because the environmental burden imposed by the construction and operation of buildings will continue to rise. For instance, buildings use:

- aggregates (raw stone, gravel and sand) - leading to landscape destruction, and air - water pollution;

- wood and timber products - implicates deforestation, flooding, biological and cultural diversity losses;

- steel and other industrial processed materials - containing high embedded energy consumption, air and water pollution during fabrication and waste generation;

- transport activities - causing energy use and air - soil - water pollution;

- water withdrawals - competing with agriculture and ecosystems needs;

- solid waste - generating landfill problems, such as leaching of heavy metals and water pollution;

- energy use - involving local air pollution, acid rain occurrence, nuclear waste generation, risk of global warming.

Life-Cycle Assessment is a methodology for evaluating the environmental impact of a material through its entire life cycle, from its initial production through to its eventual reuse, recycling, or disposal. It attempts to identify and quantify all relevant characteristics of the construction materials so that comprehensive comparisons can be made. Sustainable design evaluates every design decision in order to estimate the potential impact on the environment, occupant health and comfort.

Achieving a higher indoor environmental quality of a building has a significant impact on occupants' health, comfort, and work productivity. It means to improve indoor air quality, to maximize day lighting, to provide appropriate ventilation and moisture control, and to use environment-friendly building materials [1]. Additionally, these are some of the main aspects regarding the sustainability of the building envelope, which represents as well the boundary between the indoor and outdoor environments.

Over the last few years, the public interest and concern regarding indoor air quality has grown considerably, because the majority of time people spent indoors, and the indoor air can be polluted by waxes, polishes, adhesives, cleansers, care-products and fabric protectors, causing health problems such as allergies, chemical sensitivities or respiratory ailments [4]. And it is also a fact that poor indoor air quality within the work place links to a lower quality of work done by the employees (Sick Building Syndrome).

Nowadays caulking and sealants are used extensively in order to create surfaces airtight as possible. Indoor surfaces, even those that do not emanate chemicals can contribute to the indoor air pollution, by retaining (adsorbing) pollutant molecules from the air and later re-emitting them. The ability of materials to adsorb airborne pollutants is difficult to change, but by being aware of the sources of pollutants and knowing how to deal with them, indoor air pollution can be kept as low as possible.

There has been a remarkable increase in the number of synthetic and composite materials used during construction activities, many of them introducing new chemical pollutants indoors [3]. When this situation combines with lack of natural ventilation, a multitude of different pollutants can reach concentrations which could become dangerous to the occupants health, and obviously, the best strategy for improving indoor air quality is through controlling pollutant sources.

The planning system has an essential role to play in assembling a set of targets in support of choosing a strategy for each stage of construction, involving every action, from the site analysis to the appropriate technical solutions and selection of materials, as well as from coordination of materials storage on the construction site so that theft and damage do not occur to overseeing that the waste management system is efficient.

General information about the further building site are usually available at the planning stage of the project, however visiting the site by the design professionals, construction manager and contractor is very important in order to get the maximum use of space in agreement with a variety of regulatory restrictions, and to find suitable locations for organizing the construction site.

Every construction site is the result of a planning action, and the appropriate management of its environmental performance is in part determined by the selection of building materials and technical solutions.

To evaluate the environmental performance of the building site it is necessary to focus on some factors which involve both construction works and site management [2]:

- Every action relating to each construction stage from the site analysis to the selection of appropriate technical solutions and materials: studying the microclimatic conditions of the area, selecting non-polluting and non-toxic materials, choosing technologies which minimize ground works and waste generation, ordering products in pre-arranged size to avoid further operations and losses etc.

- The management concerning all stages of the construction and the impact of each action on the environment: arranging an accurate organization of activities according to working processes, minimizing the social quality impact in the area by avoiding the isolation of a group of people, the obstruction of daily activities, or the interference with the local roads'

use, reducing the impact of the construction on the bio-water-air-soil system quality, diminishing the acoustic impact generated by noise operating tools etc.

The layout of the site for a new development can make a significant difference for the access to the construction site and to the amount of energy use in the future building. When considering the location of a new investment, following issues should also be taking into account:

- conserving the cultural and/or archaeological interest of the site,

- preserving the landscape and biodiversity;

- locating the existing services and adequate water supply;

- making positive use of the local topography to allow best use of natural daylight, solar energy and wind protection;

- careful positioning of the building within the landscape in order to avoid overshadowing or overheating;

- taking full advantage of the use of south-oriented slopes for buildings to facilitate a greater passive solar gain;

- providing accessibility for users including older people, those carrying luggage, young children, or people with mobility or sensory impairments;

- integrating the opportunities for renewable energy;

- avoiding the fragmentation or isolation of wildlife habitats;

- reducing the impact of the new construction in terms of landscape and vegetation by replanting appropriate flora for the expected climate conditions.

Efficient building techniques have to be properly applied while having in mind to reduce the environmental impact on each construction stage:

- during landclearing - to minimize the disruption of existing vegetation, by limiting the use of heavy machines which can damage soil and plants; excavated vegetal soil and plants can be used for landscaping;

- in foundation works - to limit the soil disturbance due to excavation; amount of excavated soil can be used as backfill;

- framing - to design in standard sizes to reduce cutting waste, with reusable forms or timber recovered from demolished constructions; waste wood has to be sent for recycling;

- through metalwork - to avoid over-ordering of materials and to diminish cutting waste; scrap metals have to be sent for recycling;

- finishing - storing materials carefully to avoid damage; excess of paints and solvents should be sent for recycling;

- organizing the materials storage on the construction site - to ensure that damage and/or air-water-soil contamination do not occur;

- controlling the efficiency of the waste management system.

One of the main environmental concerns is the amount of waste generated when a building is renovated or demolished, but there is also a massive resource of materials coming out of

demolition sites. During demolition projects, proper dismantle planning can allow materials to be recovered in a reusable form. Where suitable, renovation should be preferred over demolition. Major renovations projects involve the replacement of structural components, while routine repair and maintenance involve changes that have to be done in order to meet residents' requirements. In some situations materials cannot be reused, but waste reduction can still be achieved by recycling.

Solid waste generated by construction, renovation and demolition activities is an issue that has been gaining attention within both the public and private sectors. The costs of disposal are increasing, many landfill sites are reaching capacity, and sometimes waste is illegally dumped or burned, causing soil-water-air pollution. As contractors must include anticipated disposal costs in their bid costing, it will be reflected in the project costs. Therefore, reducing construction waste and salvaging valuable materials from demolition activities will significantly reduce the need to extract raw materials, the amount of waste at landfill sites and the life-cycle costs of building materials.

3. Conclusion

The planning system has an essential role to play in assembling a set of targets in support of choosing a strategy for each stage of construction. The design process as well as the execution has to be carefully controlled and efficient technologies have to be properly applied. Sustainable design attempts to have an understanding of the environmental impact of the project by evaluating the site, the embodied energy and toxicity of the materials, and the energy efficiency of design, materials and construction techniques [5]. Designers should consider materials and structural systems which allow flexibility and adaptability to meet future changes to the building function and also to facilitate the recycling of materials at end of buildings life cycle. As a result, the design phase is decisive for the environmental impact of a project, because at this stage the required building materials are selected, and the technical solutions for the construction systems are specified. A possible reduction of the environmental impact can be provided by:

- considering the potential to convert existing buildings, rather than providing new ones;
- planning constructions with flexible spaces which allow future activities to take place, and reduce the need of new buildings;
- using materials from local sources whenever possible, as saving energy and reducing pollution due transportation;
- making use of durable materials and components for maintenance and current repairs;
- reducing over-ordering of materials;
- improving the emissions control in processing and manufacture of building materials;
- using efficient renewable energy sources;
- increasing the recycled content of materials.

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