Green Architecture and Sustainable Development: Applications & Perspectives

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Abstract: - In this paper we examine the concept of “Green Architecture” or “Green Building”. We analyze the relative terms, the functionality and efficiency of their application through references to international practices (USA, Europe, Asia) and techniques of famous green designers and builders.

Key-Words: - Green Architecture, Sustainable Development, Renewable Resources, Green Building

1 Introduction

Sustainability in architecture is related to the concept of "green architecture" or “green building”. The two terms, however are often used interchangeably to relate to any building designed with environmental goals in mind, often regardless of how they actually function in regard to such goals [1].

Sustainable architecture and green architecture for that matter is framed by the larger discussion of sustainability and the pressing economic and political issues of our world [2]. In the broad context, green architecture, seeks to minimize the negative environmental impact of buildings by enhancing efficiency and moderation in the use of materials, energy, and development space [3].

2 Green Architecture

The focus of green architecture is for the project to work in harmony with the natural features and resources surrounding the site, and to use materials that are sustainably grown or recycled rather than new materials from non-renewable resources.

Building materials may be sought within a 500-mile radius of the building site to minimize the use of fuel for transportation. The building itself may be oriented a particular direction to take advantage of naturally occurring features such as wind direction and angle of the sun. When possible, building materials may be gleaned from the site itself; for example, if a new structure is being constructed in a wooded area, wood from the trees which were cut to make room for the building would be re-used as part of the building itself. Taking advantage of available natural light reduces dependence on artificial (energy-using) light sources. Well-insulated windows, doors, and walls help reduce energy loss, thereby reducing energy usage. To further address energy loss hot water heat recycling is used to reduce energy usage for domestic water heating.

Low-impact building materials are used wherever feasible: for example, insulation may be made from low VOC (volatile organic compound)-emitting materials such as recycled denim, rather than the fiberglass insulation which is dangerous to breathe. To discourage insect damage, the insulation may be treated with boric acid. Organic or milk-based paints may be used.

Architectural salvage and reclaimed materials are used when appropriate as well. When older buildings are demolished, frequently any good wood is reclaimed, renewed, and sold as flooring. Many other parts are reused as well, such as doors, windows, mantels, and hardware, thus reducing the consumption of new goods. When new materials are employed, green designers look for materials that are rapidly replenished, such as bamboo, which can be harvested for commercial use after only 6 years of growth, or cork oak, in which only the outer bark is removed for use, thus preserving the tree.

Good green architecture also reduces waste, of both energy and material. During construction phase, the goal is to reduce the amount of material going to landfills. Well designed buildings also help reduce the amount of waste generated by the occupants as well, by providing onsite solutions such as compost bins to reduce matter going to landfills.

To reduce the impact on wells or water treatments plants, several options exist. "Grey water", wastewater from sources such as dishwashing or washing machines, can be used to flush toilets, water lawns, and wash cars. Rainwater collectors are used for similar purposes, and some homes use

specially designed rainwater collectors to gather rainwater for all water use, including drinking water. Green architecture often emphasizes taking advantage of renewable resources, e.g., using sunlight through passive solar, active solar, and photovoltaic techniques (see Figure 1) and using plants and trees through green roofs, rain gardens, and for reduction of rainwater run-off. Many other techniques, such as using packed gravel for parking lots instead of concrete or asphalt to enhance replenishment of ground water, are used as well.

Figure 1: K2 sustainable apartments in Windsor, Victoria, Australia by Hansen Yuncken (2006) features passive solar design, recycled and sustainable materials, photovoltaic cells, wastewater treatment, rainwater collection and solar hot water. Source: Hansen Yuncken (2006)

3 Green building

Green building is the practice of increasing the efficiency with which buildings and their sites use and harvest energy, water, and materials, and reducing building impacts on human health and the environment, through better sitting, design, construction, operation, maintenance, and removal — the complete building life cycle.

Green building is also sometimes known as *sustainable building* or *environmental building*, although there are slight differences in the definitions [8]. The practice of green building can lead to benefits including reduced operating costs by increasing productivity and using less energy and water, improved public and occupant health due to improved indoor air quality, and reduced environmental impacts by, for example, lessening storm water runoff and the heat island effect [6].

Green building is an essential component of the related concepts of sustainable design, sustainable development and general sustainability.

Practitioners of green building often seek to achieve not only ecological but aesthetic harmony between a structure and its surrounding natural and built environment [7]. The appearance and style of sustainable homes and buildings can be nearly indistinguishable from their less sustainable counter-parts.

3.1 Green building and Natural building

Green building and natural building are both sets of building techniques that aim to be more sustainable than conventional construction. However, there is a difference in degree of sustainability. In practice, green building tends to be popular with professionals in the development industry who are convinced that building more sustainably is not only necessary to lessen impact on the environment, but also makes good economic sense. Green building is increasingly governed by standards, such as the Leadership in Energy and Environmental Design (LEED) standards developed by the U.S. Green Building Council [11]. Natural building, on the other hand, tends to focus on the use of natural materials that are available locally. It is usually on a smaller scale and tends to be more sustainable [4].

3.2 Practices of Green buildings worldwide

Many countries have developed their own standards of energy efficiency for buildings.

- Haute Qualité Environnementale, France [10]
- Minergie, Switzerland
- *Passivhaus*, Germany, Austria, United Kingdom [9]
- Code for Sustainable Homes, United Kingdom
- Gold & Silver Energy Standards, United Kingdom
- EnerGuide for Houses, Canada (energy retrofits & up-grades)
- EnerGuide for New Houses, Canada (new construction)
- Leadership in Energy and Environmental Design (LEED), USA and Canada
- Green Globes, USA, Canada and United Kingdom
- National Association of Home Builders Green Building Guidelines, USA
- House Energy Rating, Australia
- Green Building Council of Australia's Green Star

4 Examples of Green Building Applications worldwide

The United States and Germany are the better known of the leaders in the domain. Here we present some of their initiatives as well as notables examples from other countries around the world.

United States

The United States Green Building Council (USGBC) has developed The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™, which is the nationally accepted benchmark for the design, construction, and operation of high performance green buildings. LEED gives building owners and operators the tools they need to have an immediate and measurable impact on their buildings' performance. LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality. They have developed specific versions of the LEED rating system to assist specific building types in achieving certification. Some of the commercially available systems are:

- LEED-NC: New Construction and Major Renovations (the most commonly applied-for LEED certification) [11]
- LEED-CI: Commercial Interiors
- LEED-CS: Core/Shell)
- LEED-EB: Existing Buildings
- LEED-Homes

Other versions that will soon be released for public consumption are:

- LEED-ND: Neighborhood Developments
- LEED for Schools
- LEED for Healthcare
- LEED for Labs
- LEED for Retail

The Green Building Initiative is a non-profit network of building industry leaders committed to bringing green to mainstream residential and commercial construction. The GBI believes in building approaches that are environmentally progressive, but also practical and affordable for builders to implement. The GBI has developed an easy to use, inexpensive and ANSI standard web-based rating tool called Green Globes.

The United States Environmental Protection Agency's EnergyStar program rates commercial buildings for energy efficiency and provides EnergyStar qualifications for new homes that meet their standards for energy efficient building design.

In 2005, Washington became the first state in the U.S. to enact green building legislation [12]. According to the law, all major public agency facilities with a floor area exceeding 5,000 square feet (465 m²), including state funded school buildings, are required to meet or exceed LEED standards in construction or renovation. The projected benefits from this law are

- 20% annual savings in energy costs
- 20% reduction in water costs
- 38% reduction in waste water production
- 22% reduction in construction waste

Germany

German developments that employ green building techniques include:

- The Solarsiedlung (Solar Village) in Freiburg, Germany, which features energy-plus houses.
- The Vauban development, also in Freiburg.
- Houses designed by Baufritz, incorporating passive solar design, heavily insulated walls, triple-glaze doors and windows, non-toxic paints and finishes, summer shading, heat recovery ventilation, and grey water treatment systems [5].
- The new Reichstag building in Berlin, which produces its own energy.

United Kingdom

The Association for Environment Conscious Building (AECB) has promoted sustainable building in the UK since 1989.

The UK Building Regulations set requirements for insulation levels and other aspects of sustainability in building construction.

Canada

Canada has implemented "r2000" guidelines for new buildings built after the year 2000. Incentives are offered to builders to meet the r2000 standard in an effort to increase energy efficiency and promote sustainability. In December 2002, Canada formed the Canada Green Building Council and in July 2003 obtained an exclusive license from the US Green Building Council to adapt the LEED rating system to Canadian circumstances.

Beamish-Munro Hall at Queen's University features sustainable construction methods such as high fly-ash concrete, triple-glazed windows, dimmable fluorescent lights and a grid-tied photovoltaic array.

Australia

The Green Building Council of Australia (GBCA) has its own green buildings standard known as Green Star. In 2007, the GBCA will host an Australasian green building conference and expo called "Green Cities - Where Our Future Lives".

In Adelaide, South Australia, there are at least two different projects that incorporate the principles of Green building. In the city centre there is the Eco-City development and Aldinga there is the Aldinga Arts Eco Village. Guidelines for building developments in each project are outlined in the bylaws. The bylaws include grey water reuse, reuse of stormwater, capture of rainwater, use of solar panels for electricity and hotwater, solar passive

building design and community gardens and landscaping.

India

The Confederation of Indian Industry plays an active role in promoting sustainability in the Indian construction sector. There are many energy efficient buildings in India, situated in a variety of climatic zones.

Malaysia

The Standards and Industrial Research Institute of Malaysia (SIRIM) promotes green building techniques. Malaysian architect Ken Yeang is a prominent voice in the area of ecological design

5 Famous Green Designers & Builders

- J. Baldwin
- Steve Baer
- Tom Bender
- Peter Calthorpe
- Eric Corey Freed
- Buckminster Fuller
- William McDonough
- Glenn Murcutt
- Rocky Mountain Institute
- Sim Van der Ryn
- Walter Segal
- Michael Sorkin
- Thompson, Ventulett, Stainback & Associates
- Brenda and Robert Vale
- James Wines
- Ken Yeang
- Hellmuth, Obata and Kassabaum

6 Conclusion

The practices of "Green Architecture" and of "Green Building" contribute first to the proper exploitation of nature and renewable sources and to the better savings of energy sources and second to the creation of standards for energy efficiency for buildings. Applications from the USA, Europe and Asia demonstrate the viability and efficiency of these "Green Architecture" methods. A number of famous "Green Designers and Builders" from around the world have contributed to this field and paved the way for future perspectives of these successful concepts.

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