SUSTAINABLE DEVELOPMENT THROUGH GREEN BUILDING CONCEPT IN SRI LANKA

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Abstract: The construction sector accounts for a large percentage of the world's total energy consumption and green house gas emissions. One of the effective and intelligent initiatives in infrastructure sector is sustainable development through green building concept. "Green Building" concept is a practice of creating structures and using processes that are environmentally responsible and resources-efficient through the building life cycle. Implementing the green building concept can result in reduction of carbon emissions by 35%, water usage by 40%, energy usage by 50% and solid waste by 70%. This paper also discuss the factors to be considered for green building construction and the Leadership in Energy and Environmental Design (LEED) assessment method to declare a building as a green building. The unique departure from traditional building model to green model delivers savings in energy cost, reduction in water consumption, reduce in water cycling in green building constructed in Sri Lanka are highlighted in the paper.

Key Words: Sustainable development, Green building

1. Introduction

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs [1]. Sustainable development ties together concern for carrying capacity of natural systems with the social challengers facing humanity. Three most important indicators of sustainability are Environment, Society and Economy [2].

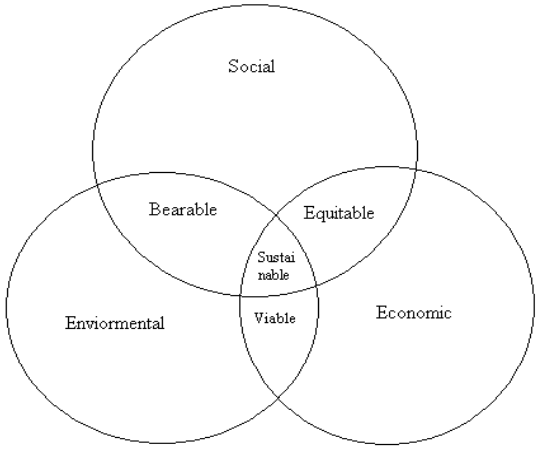

Figure 1: *Components of Sustainable development*

One of the main indicators of environmental sustainability is the process of ensuring that the existing method of human interaction with the environment is as pure as naturally possible. Also the economic sustainability is the economic development with minimal environmental degradation or equitable development that environmentally and socially sounds. Social sustainability indicates that the future generations should have the same or greater access to social resources as the current generations.

The concept of green building emphasize saving water, energy and material resources in construction and maintenance of buildings that can reduce or eliminate the adverse impact on the environment and

occupants. It can be highlighted that implementing the green building concept can result in reduction of carbon emissions by 35%, water usage by 40%, energy usage by 50% and the solid waste by 70% [3].

A representation of elements of green building taken into consideration at the design stage [2]

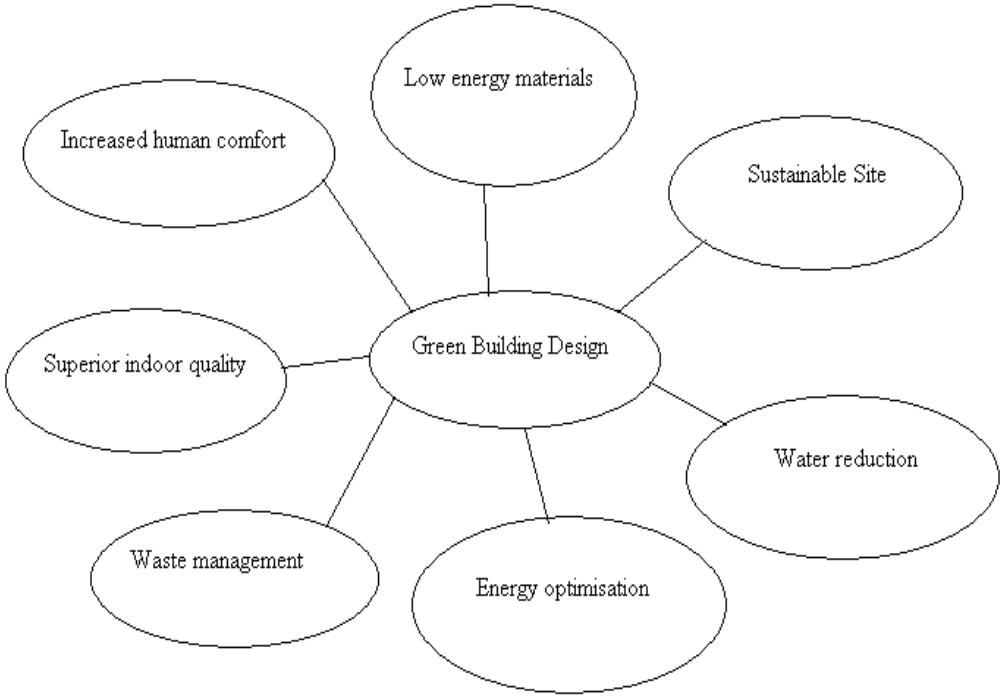

Figure 2: *Components of Green Building Design*

The benefits of green building can be illustrated as follows: (i) reduce energy consumption, (ii) reduced destruction of natural resources, (iii) reduced water consumption, (iv) limited waste generation, (v) increased user productivity and (vi) corporate image enhancement.

2. Benefits of the green building construction.

Conserve the external environment at the building location, Improve internal environment for the occupants, Preserve the environment at places even far away from the building

2.1 Green building conserves the external environment at the building location

When planning to construct any type of building, the site should be selected after taking into consideration the conservation of local vegetation, wildlife, natural water resources etc. Specially a site with biodiversity should be either avoided or the building should be planned to reduce site disturbances.

2.1.1Land

The landscaping and exterior design in a green building shall be done to ensure more shaded area, the light trespassing can be eliminated and local species of plants can be grown.

2.1.2 Water

The green building design shall not disrupt natural water flow. Rainfall in the catchments shall be harvested fully to either replenish the ground water table in and around the building or to be utilized in the services of the building. The toilet shall be fixed with low flush fixtures and the plumbing system should have separate lines for drinking and flushing, Grey water from the kitchen, bath and laundry shall be treated and reused for either gardening or cooling towers of air conditioning. Bidets

help eliminate the use of toilet-paper reducing sewer traffic and increasing possibilities of re-using water on site. The use of non-sewerage and grey water for on-site use such as site irrigation will minimize demands on the local aquifer. Waste water from sources such as dish washing or washing machines can be used for subsurface irrigation or if treated for non-potable purposes e.g. flush toilets and wash cars.

2.1.3 Waste

Green architecture also seeks to reduce waste of energy, water and materials used during construction. Well designed building also help reduce the amount of waste generated by the occupants as well, by providing on-site solutions such as composite bins to reduce matter going to landfills. By collecting human waste at the source and running it to a semi-centralized biogas plant with other biological waste liquid fertilizer can be produced.

2.1.4 Energy

The solar energy at the top of a green building is harvested supplement conventional energy. Solar water heating further reduces the energy load. Natural light is harvested in intermediate floors to minimize electricity usage. In addition, effective window placement (day lighting) can provide more natural light and lessen the need of electric lighting during the day. Sunlight is restricted by the high-growing trees outside lower floors of the building. High efficiency light fittings make pleasant lighting in addition to saving energy. High efficiency windows and insulation in walls, ceiling and floors ensure better temperature control. The use of low-energy sources such as compact fluorescent lamps and solid state lighting with light emitting diode bulbs (LED) lamps and 'low voltage' electrical filament-incandescent light bulbs, and compact metal halide, xenon and halogen lamps can be used. Also timers, motion detectors and natural light operation sensors reduce energy consumption and light pollution even further.

2.2 Green building improve internal environmental for occupants

2.2.1 Light

In a green building, occupants shall feel as if they are in a natural environment. Interior and exterior designs shall go hand in hand by blending natural and artificial lighting.

2.2.2 Air

A comfortable atmosphere at workstations improves staff attendance and increases productivity. In and air-conditioned environment, a green building shall be specially equipped to ensure in indoor air quality necessary for a healthy atmosphere. The inhabitants can breathe air free from any odor of paints, polish or varnish.

2.3 Green buildings preserve the environment at places far from the building

Buildings are constructed using cement, sand, steel, stones, bricks and finishing materials. Collectively these are responsible for about 20% of the green house gases emitted by a building during its lifetime. Green buildings use products that are non-toxic, reusable, and recyclable wherever possible. Locally manufactured products are preferred which also save the fuel ordinary used to transport materials. Preference should also be given to recycled materials. Materials with higher recycled content should be selected in order to reduce the embodied energy of the buildings, thereby decreasing the environmental impact of extraction and processing of energy extensive materials. Ecology blocks, recycled stone, recycled metal, recycled concrete, garbage, wood, rice husk ash, compressed earth blocks, baked earth, foundry sand, demolishing debris in construction projects are few of materials that can be use for green building.

3. Impacts on Green Building construction & operation

The most criticized issue about constructing environmental friendly buildings is the price. Photovoltaic, new appliances and modern technologies tend to cost more money. Most green buildings increase the construction cost by 20-25% but the yield 10 times as much over the entire life

of the building. The statics have shown green building reduce 30-40% in operational cost of the building.

4. Green building rating system

Buildings constructed based on green building concept should conform to prescribed standards. There should be continuous assessment and monitoring from the planning/design stage up to the completion of construction, in order to declare a building a green building. The LEED (Leadership in Energy and Environmental Design) green building rating is followed in this assessment of a building. In this system, points are awarded for adopting green concepts in various categories and the buildings are certified green at levels such as Silver, Gold, or Platinum based on the total number of points they get in this LEED rating.

5. Constructed green buildings in Sri Lanka

5.1. The MAS intimates Thurulie factory in Thulhiriya [4]

Energy cost reduce by 40%

Low energy "evaporative cooling" system used in place of air conditioners and this alone saves 65% of the energy consumed. Light usage is minimized by depending amply on daylight to light the premises and individual sewing machines are kitted out with an LED based task light. 10% of the plant's power provide by solar panels.

50 % reduction in water consumption

Rain catchment tanks are used to collect water for non-drinking purposes, such as flushing toilets and landscaping.

95% waste recycling

All sewage is treated by on-site anaerobic digestion sewage treatment facility and bio-gas which is a by product of this will be used in the kitchen.

Reduced absenteeism

Green roof with grown vegetation and cool roofs with high solar reflectivity ensure a cooler interior. Amenities such as relax-stations, picnic areas and a holistic centre ensure better comfort the employees.

5.2 Brandix Causualwear, Seeduwa [3]

Energy cost reduction by 50%

New screw-type chiller unit provide energy –efficient air conditioning for the entire factory. Square ducts were converted to round ducts to reduce distribution loss in air conditioning. Sophisticated new LED used as task lights provide light to the sewing machines.

60% reduction in water consumption

A serious of measures exists to reduce water consumption through recycling. Direct rainwater is recycled for all use except for drinking. A tertiary filtration system and a disinfection process allows the used water to be recycled again for toilet flushing and gardening.

95% waste recycling

The factory has a solid waste disposal system by recycling or reusing the solid waste it use. Canteen waste is being composed and contributes to biogas generation.

Reduced absenteeism with improvement health standard to 2%

An advanced intelligent building management system controls relative humidity and carbon dioxide levels to improve comfort levels for workers. The green areas in the gardens have been increased.

5.3 HNB, Nittambuwa
Reduce energy cost by 30% and 56% reduction in portable water

5.4 CKT Apparel, Mihila
Reduce energy consumption by 48%, reduce 60% total water by harvesting of rainwater

6.0 Calculating number of luminaries require for an area of a green building
Energy consumption of a green building from luminaries can be further reduced by rearranging & selection of luminaries for the area.
The number of luminaries needed for a particular area can be calculated from Utilization Factor method. First, Room Index (K) of the area must be calculated.

$$K = \frac{LxW}{(L+W)xH_m} \quad (1)$$

Where L= length of room
W= width of room
H_m = height of luminaries above working plane

Utilization Factor can be found from light fitting manufacturer's tables [5], when the room index (K) and the reflectance of the room are known.

Calculation of number of luminaries needed to provide required illuminance level can be found from

$$N = \frac{ExLxW}{NLx\Phi xMFxUFxLLD} \quad (2)$$

Where E= Required illuminance (Lux level)
N= Number of Luminaries
NL= Number of lamps in each luminaire
Φ= Lamp flux
MF= Maintenance Factor
UF= Utilization Factor
LLD= Lamp Lumen Deterioration Factor

6.1 Proposals to reduce energy consumption of luminaries
Energy consumption for lighting can be saved by reducing number of luminaries needed for a space. Further from the equation 2 for a particular lamp type MF, LLD & Φ are constants at the time of installation. Therefore by getting higher UF, the number of luminaries needed for the space can be reduced. Higher UF can be achieved by higher room index (K) for a correspondent reflectance of the space from fitting manufacturer's table. [5]

At the building design stage following steps are recommended to follow to achieve higher room index (K) which benefits for energy savings further in addition to using energy efficient lighting fixtures

1) Design a space to have high area to perimeter ratios means that the room should be more rectangular corridor shape
2) Decrease the height of the luminaire to the working plane
3) Increase reflectance from luminary by introducing polished or mirror like reflector fitting rather than opal or prismatic diffuser fitting in use.

7.0 Conclusion

Several benefits including environmental, economic, health, safety and community benefits can be achieved through adopting to the green building concepts instead of traditional building concept in the sustainable building construction and maintaining processes. Altogether these benefits lead to reduce operational cost and make the building sustainable. Rearrangement & reduction of lighting fixtures would be used as a tool to reduce energy consumption of these buildings too. Although construction cost of green buildings is 20-25% higher than the traditional buildings, the gaining advantages yield 10 times as much over the entire life of the building. Therefore for the sustainable development, green building concept must be integrated in all building codes.

References

[1] Code 2004, Publication of the Chartered Institution of Building Services Engineers, UK (CIBSE), 2004.
[2] Green Building Concepts: An approach towards sustainability, Technopak Perspective, Volume 4;58-62
[3] Mahendra S Jayalath, "Build Green to ensure Sustainability", SLEMA Annual Session, 30 July 2010; 1-32
[4] "MAS Intimates Thurulie", Publication from the Holcim (PVT) Ltd, 2008.
[5] "Utilization Factor table for 2x36W fluorescent fittings", Philips lighting Catalog, 1999; 5-10
[6] SLEMA Journal, publication from Sri Lanka Energy Managers Association, Volume 11, No:02 June 2004: 24-25
[7] Fjay Mither, "Energy Efficiency in Buildings in India an overview", Bureau of Energy Efficiency, Ministry of Power, Government of India, 20th December 2007; 1-10
[8] Code of practice for energy efficiency buildings in Sri Lanka - 2008, publications from Sri Lanka Sustainable Energy Authority, June 2009: 1-49
[9] LEED Green Building Rating System, Publication from Washington DC USA, Volume 2.
[10] Green Building Concepts, http://architecture.about.com/cs/greenconcepts/index.htm; 20-09-2010
[11] Energy Management Guide, Version 1, Sri Lanka Sustainable Authority, 3G-17, BMICH, Bauddaloka Mawatha, Colombo 07 , February 2010; 68-70
[12] National Energy Symposium 2010, Sri Lanka Sustainable Authority, 3G-17, BMICH Bauddaloka Mawatha,, 4th – 8th August 2010; 37-43
[13] Sri Lanka Energy Balance 2007, Sri Lanka Energy Managers Association,2007; 1-89
[14] Guidelines on Energy Efficiency of lighting installations 2007, Electrical & Mechanical Department (EMSD), Hong Kong; 4-6