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Role of Construction Management in Sustainable Building Design and Concept

KEYWORDS: Construction Project Management, Green Technology, Optimization of resources, Project Life Cycle Assessment, Sustainable Materials.

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ABSTRACT *In India, The construction isndustry is the second largest industry of the country which provides employment for huge number of people and makes a major contribution to the national economy after agriculture. The infrastructural development is sign of the economic development of any country. At the same time, the consumption of energy and resources for the construction activities is very enormous. Green and sustainable building design and concept is the only way to control the above problem. The importance of green buildings has been frequently discussed at many platforms and suggested many techniques. But, some of the barriers like complication in planning and design, lack of knowledge in green concept and sustainability, the initial cost overrun for installation, additional cost for special techniques, etc. have hindered the adaptation of green and sustainable structures. The incorporation of proper planning and construction management strategies in green buildings can facilitate to mitigate these barriers. In this paper, some of the management techniques and strategies at various stages of project life cycle have been studied and identified as tools to overcome the problems in green and sustainable buildings from the selected case study.*

INTRODUCTION

Green and sustainable building construction is becoming popular in India. Because, increasing construction activities are consuming large amount of raw materials and embodied energy during its lifecycle and resulting environment degradation. Generation and extraction of raw materials and energy consumes fossil fuels, forest, soil, and other natural resources which generate significant amounts of carbon dioxide, the most widespread greenhouse gas (GHG). Construction activities also indirectly coupled with the release of GHG. Construction and demolition debris that degrades in landfills may generate methane and generate GHG emissions. As per the UNEP report (2007), India, China and Brazil are the countries spending more amounts for infrastructure development. Sustainable building practices are the only way to trounce the environmental problems created by the construction activities. Kibert (1994&2008) very well defined about sustainable construction as "the creation and responsible management of a healthy built environment based on resource efficient and ecological principles". Practically, it is believed that green buildings are having fewer lifetimes and more expensive than traditional technologies. But, it has the potential to have a shorter payback period due to significantly reduced utility bills. With the current economic condition, cost-effective designs will certainly drive the market forward (Glover et al., 2009).

PROJECT LIFE CYCLE AND ENERGY CONSUMPTION

Building consists of five phases (Jones, 1998). The first phase corresponds to the manufacturing of building materials and components, which are termed as embodied energy. The energy required to transport materials from production plants to the building site is second phase and termed as grey energy. Third phase is induced energy which is used in the actual construction of the building. The energy consumed at the operational phase (operation energy) is the fourth phase, which corresponds to the running of the building when it is occupied. Finally, demolition and recycling energy is consumed in the demolition process of buildings as well as in the recycling of their parts, when this is promoted (UNEP Report, 2007). But, Forbes et al. (2002) observed that most of the green initiatives have been focused on the design and operation stages of the project life cycle, which overlooks the construction stage. In India, more energy was used in first phase, construction stage, for cooling at operation stage (UNEP Report, 2007).

The primary goal of building commissioning, from an energy perspective, is to verify and optimize the performance of energy systems within a building over the entire life-cycle (IEA Annex 40, 2006). Other performance indicators should be considered when commissioning a building, including economic, social and other environmental aspects.

Effective Green Buildings are more than just a random collection of environment-friendly material and technologies (NBMCW, 2011). They require systematic attention to the full life cycle impacts of the resources embodied in the building and to reduce consumption and pollution emissions over the complete life cycle of the building. Maximum benefit is achieved by implementing green practices from an early stage of the project. To achieve true environment-friendly architecture, eco-friendly ideas need to be supported by everyone involved in the process from planning to demolition. New buildings should be designed and constructed with green method and operated to be Green Building. Existing buildings can also be made as green building through remodelling, retrofitting and improved operations.

Even though, a project has many stages in the life span of structure, the decisions made at the planning, design and construction can significantly affect the costs and efficiencies of construction and operation stages. The costs of energy at various stages are differing with different magnitudes. From the recent studies, incorporating green building techniques during planning, construction or renovation could result in cost savings during operation, as well as increases in employee productivity. Hence, life cycle cost analysis is the better way to reveal and estimate the actual benefits of green building concepts.

ROLE OF CONSTRUCTION MANAGEMENT IN SUSTAINABLE STRUCTURE

The factors governing the management of a project are: life-cycle cost, live load, dead load, material and recycled materials management, life-cycle assessment, building performance analysis, waste management, optimization, equipment management, material management, labour manage-

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ment, etc. The life cycle design and assessment equip the guidance for the proper selection of technology, materials, equipment. The construction management tools could provide the better idea and guidelines to justify the sustainable construction. Detailed planning for the recycling and reusing of waste generated in the building phase and post-building phase would be incorporated in the initial planning itself.

Zero-net-energy (ZNE) structure which means the energy consumed in the life cycle is equal to energy produced in the structure itself, is the new concept forwarded by many researchers (Hernandez and Kenny 2010, Kang et al. 2012). Project planning with the integration of possible methods in all phases only helps to achieve the zero-net energy structures. The major problem in implementing the green practices is the cost overrun of the project due to initial cost. The pre-planning of a project results in the cost reduction during the life cycle of the building (Kang et al. 2014). Imada (2002) proposed that project management is to be the key factor that most often determines the success or failure of any project.

A proper project planning and program helps in satisfying the owner's expectations for the building and the facilities can be accommodated within the budget and time. Inaddition to the preplanning requirements, planning for the protection of the existing landscaping, trees and vegetation in the site during construction is also to be incorporated. Planning for the construction in a predefined area without disturbing the existing landscape and earmarking the construction area for guiding the construction people will help to achieve the sustainability. Also, provisions for the replanting and safeguarding the damaged trees or vegetation in the construction site are very much essential in planning. The planning should include the methods to preserve the existing site features.

STRUCTURAL DESIGN CONSIDERATION FOR THE SUSTAINABLE BUILDINGS

Unlike in the conventional structural design, special considerations to be specified and design loads must be critically evolved for the structural integrity (Behm, 2012) for the sustainable building designs.. Many evidences are available for the collapse of building due to improper load considerations during design phase (Knapschaefer 2011). The effects of recycling and reusing materials in the design are also taken into account which probably varies in strength and behaviour. The building could be called green building when it is constructed using materials that are non-toxic, reusable, renewable and recyclable wherever possible. The properties of the green building materials are to be considered in the design. Steel structures are considered as most environmentally friendly structures which are sustainable, restorable, recyclable and reusable and reducible.

PRE- ENGINEERED STRUCTURES

Prefabricating the elements of parts of the building at a common yard and assembling at the required site is known to be pre-engineered buildings. This technique is helping in many ways to enhance the green measures. It enables in lowering the life cycle cost. The construction or erection is easy and faster which is reducing the cost, time and labour (Prabhakar, 2013). It is also optimizing the materials, reducing the waste, maintaining the quality in construction. More than that this technique will reduce the air, water and land pollution during construction. Indian Green Building Council (IGBC) also insisting, in LEED (Leadership in Energy and Environmental Design) rating system, to integrate the pre-engineering concept for the design, construction and operation of high performance green and sustainable buildings. LEED (India) prescribes that sustainable sites, materials & resources and innovation & design are the main categories for the rating. Due to high quality construction, the operation and maintenance cost also very much controlled during the life time of the structure. The high efficiency and performance of these building could result in lowering the maintenance cost and increasing the net profit which can lead to higher the building value.

CASE STUDY - 1

Residence of Mrs. Rakshitha at Bengaluru has been taken for this study. This is a three storeyed building and located in an urban with a total built area as 3000 sq.ft and a plot area of 2500 sq.ft. This house exhibits lot of cost effective techniques and materials which show the way to sustainable design and construction.

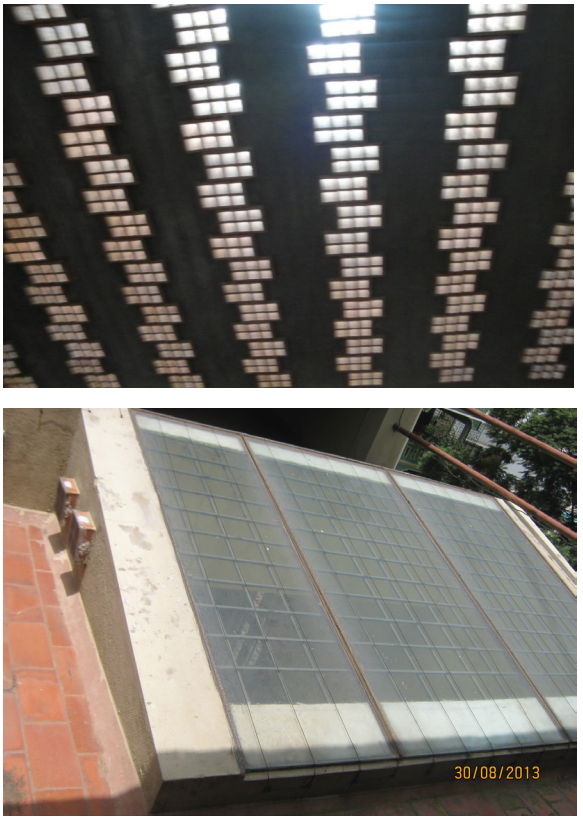

Fig.1: Roof Treatment for Harvesting Day Light and Solar Energy

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Fig. 2: Material Selection - Sustainable and locally available

In this building appropriate materials and technologies are used to make the building more energy and cost efficient. Rough textured natural granite for walls and stone pillars are increasing the shaded area and reduce the radiation of heat. For the same purpose the exposed bricks for walls constructed without plastering. Glasses are provided for harvesting the sky lighting and skylights provide ample amount of day lighting inside the house which reduce the energy consumption. Hollow blocks are used for filler slab in the roof and wall which facilitate the reduction of heat transformation due to cavity. Low cost and sustainable materials have been used for the flooring. Cement flooring with red oxide coloring is very aesthetic and sustainable. Rattrap bonding for wall, filler slab for roof, steel girder as waist beam and wooden planks for steps of staircase and wooden balusters and handrails and stone ashlar masonry for few of the walls are sustainable techniques adopted in this building. The rat trap bond provides thermal comfort to the building and while filler slab reduces the material consumption. The orientation of the building, the natural vegetation surrounding the building, the position and size of openings ensure the good thermal comfort inside the building. Maintain the cool in summer and hot in winter. The water body (Pool) infront of the house cools the air that pass inside the house. Solar water heater is used instead of electric water heater.

CASE STUDY 2

Another residence at Bengaluru was designed by Ar. Premitha for her own family as well as for office use. The underground area is for office place and ground and first floors are for residential uses. The site is the rocky terrain and they have used the stone available in the site itself for the construction. The rock available in the site is dressed and used for walls, staircases and furniture. The set back around the building is widely used for providing natural lighting and ventilation.

Fig. 3: Management of Wall and Roof with Sustainable Concepts

CASE STUDY 3

A residential building at Thanajvur was constructed with filler slab for the roof and rattrap bond for wall. Exterior walls are not plastered and coated with water repellant pain only. Treatment of parapet wall with slit helps to reduce materials and increase the aesthetic look. Also air flow at terrace surface which helps to reduce the radiation in the interior of the rooms. Roof is covered with white paint which reflect the sun radiation and keep the inside cool.

Fig.4: Exterior Treatment at Wall and Terrace

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Fig.5: Isolated Steps fixed with wall

CONCLUSION

Practicing green building concepts will substantially reduce or eliminate adverse environmental impacts and improve upon existing unsustainable design, construction and operational practices. The guidance for the designer, contractor, consumer will be provided only by the futuristic planning and proper implementation of project management strategies in all stages of a project. The case studies demonstrate the successful implementation of the many strategies and benefit in the life cycle of the project.

REFERENCE

1. Behm, M., (2012), "Safe Design Suggestions for Vegetated Roofs", Journal of Construction Engineering and Management, Vol. 138, No. 8, pp: 999–1003 | 2. Glover, T., Golinveaux, t., and Woods, M., (2009), "Environmentally Sustainable Design for a Residential Building", Project Report, Worcester Polytechnic Institute, USA. | 3. Hernandez, P., and Kenny, P. (2010). "From net energy to zero energy buildings: Defining life cycle zero energy buildings (LC-ZEB)." Energy Building, 42(6), 815–821. | 4. IEA Annex40, (2006), Commissioning of Building HVAC Systems for Improving Energy Performance [Online]: http://www.ecbcs.org/annexes/annex40.htm. | 5. Imada, S. J. (2002). "An environmental management plan for the construction of green buildings." M.S. thesis, Univ. of Calgary, Canada. | 6. Jones, D. L. (1998). Architecture and the Environment. London, Laurence King Publishing. | 7. Kang, Y., Kim, C., Son, H., Lee, S. and Limsawasd, C. (2014), "Comparison of Preproject Planning for Green and Conventional Buildings", Journal of Construction Engineering and Management, ASCE, ISSN 0733-9364/04013018(1-9). | 8. Kang, Y., Spiegelhalter, T., Pala, N., Zhu, Y., and Bhattarai, A. (2012). "A dynamic and context-driven benchmarking framework for zero net- energy buildings." Proc., Int. Conf. on Computing in Civil Engineering, ASCE, Reston, VA. | 9. Knapschaefer, J. (2011). "Forensics team seeks cause of Midwest green roof collapse." Engineering News Record, Feb. 11, (http:// enr.construction.com/buildings/ sustainability/ 2011/0217-GreenRoofCollapse.asp). Accessed on 10.3.2014. | 10. Kibert, C. J. (1994). "Establishing principles and a model for sustainable construction." Proc. of First Int. Conf. of CIB TG 16 on Sustainable Construction, CIB (International Council for Building), Rotterdam, The Netherlands, 312–318. | 11. Kibert, C. J. (2008). Sustainable construction: Green building design and delivery, Wiley, New York. | 12. NBMCW Report, (2011), "Green Building Construction", http:// www.nbmcw.com/articles/ green-construction/23851-green-building-construction.html, Accessed on 01.03.2014. | 13. Prabhakar, M.K., (2013), Rising Emphasis on Green Building Strategies Drives Demand for PEBs, www.masterbuilder.co.in. | 14. UNEP, (2010), The 'State of Play' of Sustainable Buildings in India, UNEP – SBCI Report. | 15. United Nations Environment Programme (UNEP), (2007), Buildings and Climate Change – Status, Challenges and Opportunities. Report. |