

Green Building Technology Applications in Construction

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Abstract— A green building, which is also known as a sustainable building is designed to meet some objectives such as occupant health; using energy, water, and other resources more efficiently; and reducing the overall impact to the environment. It is an opportunity to use the resources efficiently while creating healthier buildings that improve human health, build a better environment, and provide cost savings. All the development projects lead to over-consumption of natural resources. The government should support the green construction in each part of the country, and put the rules or policy that can be understood easier. To promote the green construction in the firms that apply the green construction should be given the incentives with various kinds to continue their green development.

Keywords: Green Building, Human Health

I. INTRODUCTION

Green Building, also known as Sustainable Building, is the practice of creating structures and using processes that are environmentally responsible and resource efficient. It encompasses factors such as site selection, design, construction, operation, maintenance, renovation, and deconstruction. Using green building materials and products promotes conservation of dwindling nonrenewable resources internationally. In addition, integrating green building materials into building projects can help reduce the environmental impacts associated with the extraction, transport, processing, fabrication, installation, reuse, recycling, and disposal of these building industry source materials.

Green Building refers to a structure and using a process that is environmentally responsible and resource efficient throughout a building's lifecycle. Since buildings consume nearly 50% of World's Total Energy, Green Buildings, on the other hand, consume minimum amount of energy with the use of energy efficient materials. Hence, location of green buildings in the close proximity would create a green zone and providing much healthier environment with minimum heat island effect. In India, there are 2 primary rating systems for green building: GRIHA (Green Rating for Integrated Habitat Assessment); LEED (Leadership in Energy and Environmental Design).

The LEED Green Building Rating System developed and managed by the USGBC, is the most widely used rating system nationally and internationally. Buildings are given ratings of platinum, gold, and silver or "certified", based on green building attributes. The Indian Green Building Council (IGBC) founded by the collaboration between the Confederation of Indian Industry (CII) and the private manufacturer Godrej, has taken steps to promote the green building concept in India. LEED-India rates buildings on environmental performance and energy efficiency during design, construction and operation stages.

Green Building when compared to a conventional building seems same externally and in building use but

differs in the operational savings and concerns for human comfort and indoor environment. Green Buildings enjoy the benefits of saving 40-50% energy by reducing CO₂ emissions into the atmosphere. It also saves about 20-30% water by using rain harvesting or grey water reuse techniques. It also reduces VMT (Vehicles Miles Travelled) by choosing the location near by public transport and conveniences which helps in reduction of gasoline consumption. But on the other hand, green buildings face many barriers like the high initial investment required for construction, Split incentives, whereby, the benefits of investing in a building project is enjoyed by the people who actually use the building and not by the person investing on its construction cost. The financial institutions face major hurdles of low financial returns, credit risks, uncertainty and difficulty in evaluating the added financial value of green buildings. Since green buildings save approximately 50% of the energy, so the annual power consumption is also reduced significantly thus saving the electricity bill. Green buildings are also cost effective in terms of CER issued by the Executive Board of the CDM of United Nations Framework Convention on Climate Change against 1 ton each of the CO₂ emissions saved. Sale of each CER would help earn a company 12 Euros each.

CII - Sohrabji Godrej Green Business Centre, Hyderabad is considered to be the first centre of excellence for green buildings, energy, environment, water, renewable energy and climate change activities in India.

The country has a number of policy initiatives to mainstream energy efficiency and green buildings as control and regulatory instruments. These include:

- Energy Conservation Building Code 2007: This is the nation's first building energy code and aims to have a major impact on energy-efficiency in buildings
- The Ministry of New and Renewable Energy has initiated several programs focusing on the utilization of renewable energy sources in buildings.
- Sustainable Habitat Mission under the National Action Plan on Climate Change: This include missions on enhanced energy efficiency, sustainable habitat, conserving water, creating a "Green India", establishing a strategic knowledge platform for climate change.
- Energy Labelling of Appliances: In a move to manage energy demands, BEE has made star rating for energy efficiency mandatory for a host of electrical appliances.

About 3000 projects had been certified under the LEED. To the degree that green buildings are simply "higher performing buildings", we need to design and build better buildings that can readily be accomplished by the existing industries. However, if one considers the innovation of rating and certifying buildings against energy and environmental design criteria, as in the LEED green building rating system, then we can apply a classical theory of diffusion of innovation which encompasses substitution

of new ways of doing things for old ways, to forecast market demand.

II. GREEN BUILDING FEATURES

Eco-Friendly-by least disturbance to eco system

- Energy efficient-through the natural lighting ventilation and solar passive designs
- Efficient use of water-through recycling and water harvesting
- Use of renewable energy-through photo voltaic systems and solar system etc.
- Non toxic material in door environment
- Use of recycle/recyclable materials
- Efficient waste utilization and disposal

III. WHY IT IS NECESSARY TO MAKE THE BUILDINGS GREEN?

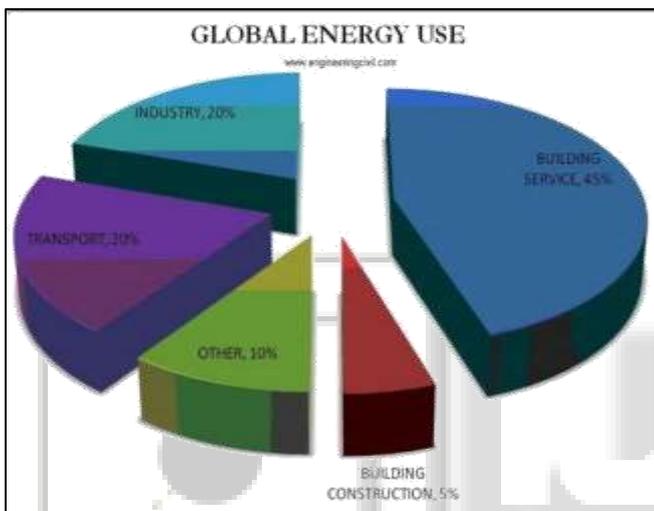


Fig. 1: Construction Industry Contributes to nearly 50% of Energy Consumption

IV. PRINCIPLES OF GREEN BUILDING

- Sustainable Site Design
- Water Quality and Conservation
- Energy and Environment
- Indoor Environmental Quality
- Materials and Resources

V. INDIAN GREEN BUILDING COUNCIL



Fig. 2

The Indian Green Building Council (IGBC) was formed in the year 2001 by Confederation of Indian Industry (CII).The aim of the council is to bring green building movement in India and facilitate India to become one of the global leaders in green buildings.

VI. IGBC RATING SYSTEM

IGBC has developed green building rating programmers' to cover commercial, residential, factory buildings, etc. Each rating system divided into different levels of certification is as follows:

- 1) Certified to recognize best practice
- 2) Gold to recognize national excellence
- 3) Platinum to recognize global leadership

VII. GREEN BUILDING PROJECT IN INDIA

Some of the important Green Building Projects in India are as follows:

- Suzlon Energy Limited-Pune
- Biodiversity Conservation India-Bangalore
- Olympia Technology Park-Chennai
- Rain tree Hotels-Chennai
- Rajiv Gandhi International Airport-Hyderabad
- ABN Amro Bank, Chennai
- Palais Royale at Worli, Mumbai
- Punjab Forest Complex, Mohali
- MNIT, Allahabad

VIII. DIFFERENT FROM OTHER BUILDINGS

The design, maintain and construction of buildings have tremendous effect on our environment and natural resources. Green Building is different from the other buildings because it use a minimum amount of nonrenewable energy, produce minimal pollution, increases the comfort, health and safety of the people who work in them. It also minimize the waste in construction by recovering materials and reusing or recycling them

IX. INCREASING GREEN BUILDINGS IN INDIA

Today we have already achieved 6.33 billion sqft green buildings target in india and our target is to achieve 10 billion sqft by 2022 according to IGBC.About 1400 LEED certified projects are currently running in india.

X. NATURAL RESOURCES

- According to surveys 107.3 million acres of total land area is developed, which represents an increase of 24 percent land covering green buildings over the past 3 years.
- In terms of energy, buildings accounted for 39.4 percent of total energy consumption and 67.9 percent of total electricity consumption.
- Reduce operating costs Create, expand, and shape markets for green product and services Improve occupant productivity.

XI. APPLICATION OF GREEN BUILDING ENERGY SAVING TECHNOLOGY

1) *Building layout can significantly reduce the energy consumption during construction use*

After the size, function, and area of a building are determined, the building shape and orientation will have a significant impact on building energy consumption. It is generally believed that the building shape coefficient is proportional to the size of the surface area corresponding to the unit building area. Reasonable building layout can reduce the power consumption of the heating and air conditioning system. From the perspective of thermodynamics and aerodynamics, the smaller body shape is proportional to the smaller external load. And the use of residential buildings for external load instability of its energy consumption accounted for the main factors. And for sports venues, cinemas and other large public use of the building, the internal heat is much higher than the external heat, so the design of the larger body shape more conducive to heat. In other words, ordinary residential and large public buildings because of the use of different, the heat of the factors are not the same, from the energy point of view, the design of its body shape requirements are the opposite.

2) *Building exterior wall insulation can significantly reduce the energy consumption of the building during use*

The external wall insulation of the building is a green energy-saving project that can greatly improve the thermal performance. The thickness of its external wall insulation material and its insulation effect is proportional to the relationship. The wide application of the external wall insulation technology not only in the cold winter to effectively avoid the rapid loss of indoor temperature, but also in the hot summer can also be effectively avoided due to solar radiation caused by the external wall temperature and then promote the indoor temperature rise, thereby reducing the air conditioning and other refrigeration equipment working load. In this way, through the laying of building exterior insulation layer not only to enhance the thermal insulation performance in summer also makes the winter insulation performance can be strengthened. This reduces the winter heating pressure and the summer cooling power load, so that the building's energy consumption is reduced. Therefore, from the point of view of reducing energy consumption, we should vigorously promote the building exterior wall insulation technology and technology for a wide range of implementation.

3) *The indoor environment for system control to achieve the purpose of a comprehensive system of energy conservation*

One of the major features of green building is the comprehensive utilization of air treatment, as much as possible the use of natural light, optimization and improvement, natural ventilation design, and many other integrated systems, integrated, multi-faceted optimization and system integration. The integration and optimization of various functions are carried out organically, and the energy consumption of buildings is reduced systematically and scientifically. HVAC system plays a very important role in the overall integrated control, because the HVAC system accounts for more than 50% of the total energy consumption

in the general buildings. It is of great importance to optimize and integrate the HVAC system of the building scientifically and reasonably. To reduce the energy consumption of HVAC system, the first step is to start with the optimization of HVAC system design, and the key factor of its success or failure is the automatic control of HVAC system. From the current HVAC design of air conditioning system implementation effect, the highest energy efficiency basically is the green building system based on Distributed Control Technology in general, the HVAC system energy efficiency up to 30%.

4) *Make full use of clean and rich solar energy natural energy*

Currently, solar energy is the most important has been the development of green energy in energy is inexhaustible, widespread natural energy, it has very many advantages such as cheap and clean. At present, solar energy air-conditioning, solar water heaters and solar cells are the main solar energy utilization in residential buildings. For our country, solar energy resources are still relatively abundant, the average annual sunshine hours is 2100-2500 hours. This provides favorable conditions for the development and utilization of clean solar energy resources in china. Now the biggest factor restricting the use of solar energy is the energy conversion rate is too low, but from the point of view of development, with the progress of science and technology, the scope of the use of solar energy will be more widely, the energy conversion efficiency will be higher.

5) *The reclaimed water system is introduced to make rational exploitation and use of water resources and avoid waste*

The average annual water resources in China is 281 billion 240 million cubic meters. The average annual water resources per capita is only 2200 cubic meters, and the average annual water resources per capita is only 1/4 of the world's average annual water resources. China belongs to the United Nations and is one of the countries with shortage of water resources. In normal life, 95% of the use of washing and sewage is drinking water, causing great waste. Drinking water treatment requirements are very high, but only 5% of the use. Not drinking water 95% water diversion system (water, wash, wash) is no longer used in drinking water, after simple treatment can be recycled, saving potable water waste, reduce the cost of water treatment, so as to achieve the purpose of energy saving.

XII. THE MAIN ASPECTS OF GREEN BUILDING

U.S. Department of Energy estimated that buildings in the United States accounted for 73.6% of total electricity expenditures, and 40% of the total carbon emissions in 2012. Thus, new building technologies should constantly be introduced to minimize consuming electricity and harmful impact of the building on the surrounding environment. The main specifications of these technologies (green) should be namely

- 1) Using resources more efficiently (energy, and water);
- 2) Enhancing and protecting the health and well-being of the occupants

3) Reducing negative impacts (waste, sewage, and pollution).

The implementation of the sustainable (green) building needs to utilize green technologies that are more involved in the development and utilization of products, equipment and systems that conserve the natural environment and resources. These technologies can improve the performance of the buildings on environment, people, and economy.

Many case studies were shown that home builders and developers have been embraced the concepts of Eco-friendly building, and emphasized on the green technologies with buildings, in order to increase ventilation control, enhance temperature control, enhance lighting control, and increase day-lighting. Thus, green technologies can significantly be correlated with high level of productivity and performance in the buildings. There are many equipment and tools, which are the results of the investigation and development of the green technologies for buildings, they can be categorized into four main groups in construction industry, as follows:

- Energy: Passive solar, heat pumps, and solar energy
- Water technology: Water harvesting, and aqueduct system;
- Natural lighting: Design with retractable awnings, and day-lighting design (sunlight transportation systems, energy efficient light bulbs, compact fluorescent lights (CFL), light emitting diodes (LED), and sustainable lighting, and;
- Natural ventilation.

XIII. GREEN MATERIALS

Another main aspect of sustainable buildings is green materials. It is very important to know that construction industry uses large quantities of natural resources today. In fact, construction activities utilize 60 percent of the raw materials, and similarly 60 percent of the nation's surplus and non-hazardous solid waste are belonged to construction industry in the USA. There are some materials that can be used in constructing buildings, as widely known green materials. These materials are recyclable, reusable and to prevent wasting energy in the houses.

Likewise, salvaging building materials and reusing them can save energy and reduce greenhouse gas emissions by minimizing the need to extract and process raw materials and ship new materials from long distances to construction projects. In addition, the green materials reduce the economic and environmental impact from waste disposal. As stated by Milani, a green material is one that simultaneously does the most with the least, fits most harmoniously within ecosystem processes, helps eliminate the use of other materials and energy, and contributes to the attainment of a service-based economy. The majority of materials in construction industry are not green, and the green materials can be specified in the following groups:

- Resource efficiency: It can be performed by utilizing materials that meet the following criteria:
 - Recycled content,
 - Natural plentiful or renewable,
 - Resource efficient manufacturing process,

- Locally available,
- salvaged, refurbished, or re-manufactured,
- reusable or recyclable, and
- Recycled or recyclable product packaging.
- Indoor air quality (IAQ): It can be enhanced by using materials that meet the following criteria:
 - Low or non-toxic,
 - Minimal chemical emissions,
 - Low-Voc assembly,
 - Moisture resistant, and
 - Healthfully maintained.
- Energy efficiency: It can be maximized by utilizing materials prevent wasting energy (insulating materials), and;
- Water conservation: It can be obtained by using materials that conserve and restore water (water harvesting and natural refinery for water).

XIV. GREEN BUILDING STANDARDS

Several countries including the U.S., U.K., Australia, Canada, Japan, Korea and India have either already presented the green building guidelines, or are in the process of developing them. Doubtlessly, green standards have the essential roles to design and develop sustainability in construction industry. The main aim of a green standard (checklist) is to ensure that the sustainable issues are comprehensively implemented in all stages of green housing project. Thus, using an established green building rating system is recommended. There are variety standards related to green building rating system, or green standards, such as, the American Leadership in Energy and Environmental Design (LEED), the U.K. Building Research Establishment Environmental Assessment Method (BREEAM), and the Green Building Council of Australia (GBCA) Green Star system, have been presented to assist the construction industry in implementing green building projects by providing guidelines for green buildings. Amongst these green standards, LEED or US green building standard is the best green building rating system.

The Leadership in Energy and Environmental Design (LEED) was created by the U.S. Green Building Council in 1998. The main targets of LEED are to promote healthful, durable, affordable, and environmentally sound practices in building design and construction within 7 topics: 1) Sustainable sites; 2) Water efficiency; 3) Energy and atmosphere; 4) Materials and resources; 5) Indoor environmental quality; 6) Innovation in design, and; Regional priority. The findings were revealed that the LEED certified buildings contributed toward the tenants' health and productivity because of "improvements in indoor environmental quality". This standard has a rating system with different checklists for new construction and major renovations based on sustainable development, it is also a set of performance standards for certifying the design and construction of commercial, or high-rise residential buildings of all sizes for both public and private, meet the sustainable criteria. Thus, the inspectors have important role to evaluate the building, and give a certain score for each stage of a building from first to the end step. Consequently,

the buildings can achieve awards ranging, if they met LEED guidelines in four levels. Meanwhile, LEED certificates can be granted to the green buildings based on the following scales:

- LEED certified 40-49 points
- LEED silver 50 -59 points
- LEED gold 60-79 points
- LEED platinum 80 points and above

XV. BENEFITS OF GREEN BUILDING

1) Benefits of green building on social perspective (Quality of life, health, and safety)

Acceptance of the green building guidelines in various societies can be attributed to comparatively a long history of this movement. Nowadays, the factor of “feel-good” is a social motivation to construct green buildings, especially in huge cities. The social benefits of sustainable design for buildings are more related to improve the quality of life, health, and well-being. High-performing sustainable buildings provide the best value for the individuals, and likewise positive effects on society. As a result, sustainable buildings have better indoor air quality, comfort, and economy, likewise sustainable building more likely to convince buyers for possessing a direct impact on their health and happiness. In non-green buildings, there are literally hundreds of contaminants in the materials used to construct homes, these dangerous chemicals have been linked to childhood asthma, adult respiratory problems, and headache. Often called “sick building syndrome”, these contaminants directly affected health of occupants in big cities. However, these problems can be easily eliminated by using the green materials

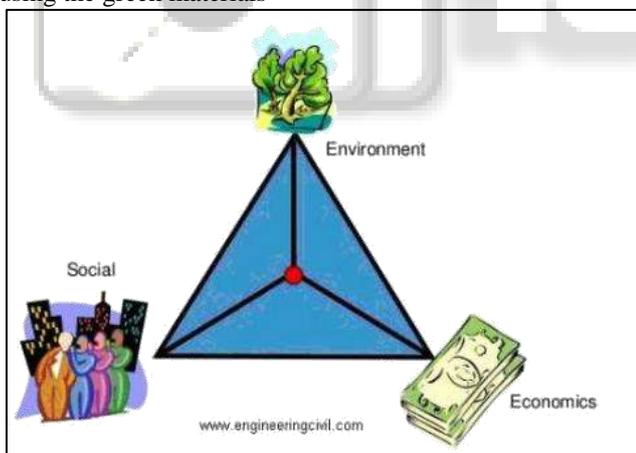


Fig. 3

2) Benefits of green building on economic perspective

The financial benefits of sustainable buildings are 10 times more than the average initial investment required to design and construct a sustainable building in long term. The benefits of life cycle cost savings on utility costs and maintenance costs make building green especially attractive to owners, and certain aspects of sustainable design mirror value engineering principles in right-sizing the building and systems. A sustainable building should be constructed or renovated by techniques, technologies, and materials that reduce the dependence of houses on fossil fuels, and minimize sewage. Without doubt, the greatest benefit of

green buildings is to low IJSRDV8I40629er energy and water bills. A survey of 99 sustainable buildings in the US indicated that an average of 30% less energy was consumed by green buildings in comparison with non-green buildings similarly, the results of several studies showed that sustainable buildings can save for

- 36% of total energy use and 65% of electricity consumption;
- 30% of greenhouse gas emissions;
- 30% of raw materials use;
- 30% of waste output, and;
- 12% of potable water consumption.

3) Benefits of green building on environmental perspective

The buildings and the built environment play a major role in the natural environment. Interestingly, green buildings have the potential to reduce the negative effects on the environment and offer business and occupant health related benefits. Sustainable buildings use energy, land, and water more efficiently, and produce less waste and pollution than conventional buildings. In green buildings, often the used materials are recycled, and low or non-toxic materials. Protecting the environment is certainly the primary benefits of sustainability in construction industry. Today modern American buildings should consider environmental issues, and follow sustainable criteria for constructing and renovating the buildings in different areas, such as: site selection, materials and resources, energy use and air pollution, water quality, and indoor air quality. According to USGBC, a building project should clearly measure and indicate that all processes in constructing and renovating a building are safe and clean for the environment. Perhaps the easiest way is to understand the principles of sustainable building design, and how negative impacts of the buildings can be reduced or eliminated through more effective planning, design, construction, and operation in sustainable building projects based on the guidelines of green standards.

XVI. CONCLUSIONS

The green building concepts helps to maintain the pollution free environment. Green building is a financially, health wise, and most important environmentally responsible idea that more people need to adopt. Many building materials and renewable energy source exists to lessen one's impact upon the environment. Through educating, making environmentally products more readily accessible and reliable, and by providing government incentives it is possible to encourage more people to adopt green building and all of the benefits that come along with it.

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