Eco-Friendly Buildings or Green Buildings

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Abstract— Green building also known as sustainable building or green construction. In India vast environmental problems are rising in construction industry due to leading urbanization. Increase in demand of houses which lead to consume more energy, resources and raw materials which are responsible for the rise in carbon content in air and which are harmful to environment and human health. The green building is an eco-friendly component, since it is based on the basic rule" REDUCE, REUSE, And RECYCLE". Eventually, the green buildings afford a high level of environmentally responsible and resource-efficient throughout a building's life-cycle. A green building depletes the natural e-sources to the minimum during its construction and operation. The aim of a green building design is to minimize the demand on non-renewable resources, maximize the utilization efficiency of these resources, when in use, and maximize the reuse, recycling, and utilization of renewable resources. It often insist on taking advantage of renewable resources, e.g., using sunlight through passive solar, active solar, and photovoltaic equipment, and using plants and trees through green roofs, rain gardens, and reduction of rainwater run-off. It uses minimum energy to power itself; uses efficient equipment to meet its lighting, air-conditioning, and other needs; uses efficient waste and water management practices; and provides comfortable and hygienic indoor working conditions.

Key words: Green Buildings, Sustainable Construction

I. INTRODUCTION

Green building - also known as sustainable or high performance building - is the practice of increasing the efficiency with which buildings and their sites use and harvest energy, water, and materials; and Protecting and restoring human health and the environment, throughout the building life-cycle:

The `Green Building' concept is gaining importance in various countries, including India. These are buildings that ensure that waste is minimized at every stage during the construction and operation of the building, resulting in low costs, according to experts in the technology.

The techniques associated with the `Green Building' include measures to prevent erosion of the soil, rainwater harvesting, and preparation of landscapes to reduce heat, reduction in usage of drinking water, recycling of waste water and use of world class energy efficient practices.

II. BENEFITS OF GREEN BUILDING

The benefits of green building can range from environmental to economic to social. Green construction methods when adopted while design and construction provide most significant benefits. Those benefits of green building include:

A. Environmental Benefits

- Reduce wastage of water
- Conserve natural resources
- Improve air and water quality
- Protect biodiversity and ecosystems

B. Economic Benefits

- Helps in reducing operating costs of buildings such as energy & water cost
- Increases market for green product and services

C. Social Benefits

- Improve quality of life
- Minimize strain on local infrastructure
- Improve occupant health and comfort

III. HOW DO BUILDINGS AFFECT CLIMATIC CHANGE?

The energy used to heat and power our buildings leads to the consumption of large amounts of energy, mainly from - oil, natural gas and coal - which generate significant amounts of carbon dioxide (CO^2), the most widespread greenhouse gas. Buildings may be associated with the release of greenhouse gases in other ways, for example, construction and demolition debris that degrades in landfills may generate methane, and the extraction and manufacturing of building materials may also generate greenhouse gas emissions.

IV. GREEN BUILDING CONCEPT

- Sustainable site planning
- Building Design optimization
- Energy performance optimization
- Renewal energy utilization
- Water and Waste management
- Solid waste management
- Sustainable building material and construction technology
- Health, well-being and environmental quality

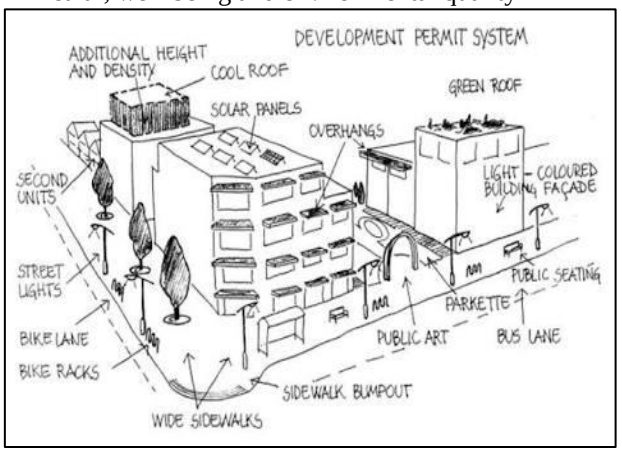

Fig. 1:

V. GREEN BUILDING RATING SYSTEM

A green building rating system is an assessment tool that measures environmental performance of a building through its lifecycle. Comprises of a set of criteria covering various parameters related to design, construction and operation of a green building project is awarded points once it ful fills the rating criteria. The points are added up and the final rating of a project is decided. Globally, greenbuildingratingsystemsarelargelyvoluntaryinnatureandhavebeeninstrumentalinraisingawarenessandpopularizinggreenbuildingdesigns.

A. Some Agencies of Green Building Rating

1) LEED As the Us Green Building Standard

The United States Green Building Council (USGBC), a national non-profit firm, developed the Leadership in Energy and Environmental Design (LEED) Green Building Rating System to rate new and existing commercial, institutional, and high-rise residential buildings according to their environmental attributes and sustainable features.

LEED is one of the most popular green building certification programs used worldwide. LEED certification process enhances the environmental awareness among architects and building contractors, and to encourage the design and construction of energy efficient, water - conserving buildings that use sustainable resources and materials.

It has special rating systems that apply to all kinds of structures, including schools, retail and healthcare facilities. LEED certification is granted by the Green Building Certification Institute (GBCI). The certification process for design teams is made up of two consecutive applications: one including design credits, and one including construction credits.

a) LEED Six Categories
- Sustainable Sites
- Water Efficiency
- Materials and Resources
- Innovation & Design Process
- Energy and Atmosphere
- Indoor Environmental Quality

2) "Teri" In India

The Energy and Resource Institute plays a very important role in developing green building capacities in the country.
There are three primary Rating systems in India.
- GRIHA
- IGBC
- BEE

B. Green Rating for Integrated Habitat Assessment (GRIHA)

(GRIHA) is India's own rating system jointly;
Developed by TERI and the Ministry of New and Renewable Energy, Government of India. MNRE (ministry of new and renewable energy) adopted Griha in November 2007, and launched it in North India. Now, it plans to use Griha in the South. Griha will focus on Indian climatic conditions, also called bioclimatic architecture. It is a green building design evaluation system where buildings are rated in a three-tier process. The process initiates with the online submission of documents as per the prescribed criteria followed by onsite visit and assessment of the building by a team of professionals and experts from GRIHA Secretariat. GRIHA rating system consists of34 criteria categorized in four different sections.
Some of them are –

1) Site selection and site planning
2) Conservation and efficient utilization of resources
3) Building operation and maintenance, and
4) Innovation.

Some buildings like CESE (Centre for Environmental Sciences & Engineering), IIT Kanpur, Suzlon One Earth, Pune and many Other buildings have received GRIHA rating.

The CESE building in IIT Kanpur became the first GRIHA rated building in the country and it scored 5 stars, highest in GRIHA under the system. It has become a model for green buildings in the country. It has proved that with little extra investment, tremendous energy and water savings are possible.

C. Indian Green Building Council (IGBC)

The Leadership in Energy & Environmental Design (LEED) is the rating system developed for Certifying Green Buildings. The organization promoting sustainability through Green Buildings. LEED is a framework for evaluating building performance against set criteria and standard points of references. The benchmarks for the LEED Green Building Rating System were developed in year 2000 and are currently available for new and existing constructions.

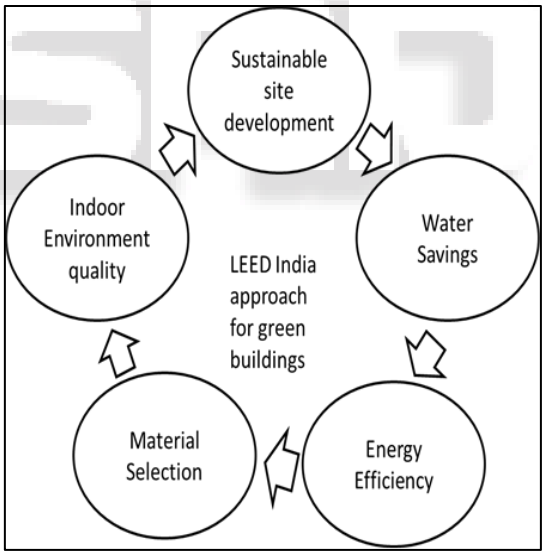

Fig. 1:

Confederation of Indian Industry (CII) formed the Indian Green Building Council (IGBC) in year 2001. IGBC is the nonprofit research institution having its offices in CII-Sohrabji Godrej Green Business Centre, which is itself a LEED, certified Green building

D. Bureau of Energy Efficiency (BEE)

The Indian Bureau of Energy Efficiency (BEE) had launched the Energy Conservation Building Code (ECBC) on February 2007. BEE developed its own rating system for the building based on 1 to 5 star scale. BEE has developed the energy performance Index(EPI).The unit of Kilo watt hours per square meter per year is considered for rating the building and especially targets air conditioned office buildings.

1) Green Buildings In India

Some top green buildings which have established in India are as follows-

1) ITC Green Centre, Gurgoan
2) Suzlon One Earth, Pune
3) Patni (i-GATE) Knowledge Center, Noida
4) OlympiaTech Park, Chennai
5) Infinity Benchmark, Kolkata
6) CRISIL House, Mumbai
7) Indira Paryavaran Bhawan
8) ITC Maurya Hotel, New Delhi
9) Infosys, Hyderabad
10) Cisco Building, Bangalore

Fig. 2:

VI. INNOVATIVE MATERIALS THAT MAY BE USED IN ECOFRIENDLY BUILDINGS

A. Eco-Friendly Materials

1) Grass Crete

Grass crete is a method of laying concrete flooring, walkways, sidewalks, and driveways in such a manner that there are open patterns allowing grass or other flora to grow. While this provides the benefit of reducing concrete usage overall, there's also another important benefit — improved storm water absorption and drainage.

Fig. 3:

B. Hemp Crete

Hemp Crete is just what it sounds like – a concrete like material created from the woody inner fibers of the hemp plant. The hemp fibers are bound with lime to create concrete-like shapes that are strong and light. HempCrete blocks are super-lightweight, which can also dramatically reduce the energy used to transport the blocks, and hemp itself is a fast-growing, renewable resource.

Hempcrete or Hempline is bio-composite material, a mixture of hemp hurds and lime (usually natural hydraulic lime, sand, pozzolans) used as a material for construction and insulation. It lacks the brittleness of concrete and consequently does not need expansion joints.

Fig. 4:

C. Ferrock

Ferrock is a new material being researched that uses recycled materials including steel dust from the steel industry to create a concrete-like building material that is even stronger than concrete. This unique material actually absorbs and traps carbon dioxide as part of its drying and hardening process – making it not only less CO^2 intensive than traditional concrete, but actually carbon neutral.

Fig. 5:

It is used to construct relatively thin, hard, strong surfaces and structures in many shapes such as hulls for boats, shell roofs, and water tanks.

D. Coloured Lime Plaster

Though low VOC (Volatile Organic Compounds) paints are available but by using coloured lime plaster as paint it reduces the painting for whole structural life. It is maintenance free, washable and water proof. Its shine and glossiness increases as the time passes. It gives better aesthetic look than conventional painting work. Regular paints are replaced by coloured lime plaster. This is very cheap and long lasting as compared to regular paints. Cost of regular paint is Rs.10/sq. ft. and cost of coloured lime plaster goes Rs. 35/sq. ft. including three coats of plaster.

Fig. 6:

E. Reflectasol Glass

Reflectasol glass gives better indoor quality than the normal clear glass. It keeps the inner temperature cool in hotter summers which reduce the energy consumption. This glass reduces the solar heat gain but allows the optimum lighting through the day which reduce electricity load. It is a good resistant of U.V rays which reduces the cause of skin retention of occupants. It also gives privacy as compare to the normal clear glass. The regular glass is replaced by the reflectasol glass and the cost comparison of the glass is, reflectsol glass is 20% high costs as compared to normal glass. But the advantages of reflectsol glass are more and its life span is also more.

Fig. 7:

F. Ash Crete

AshCrete is a concrete alternative that uses flyash instead of traditional cement. By using fly ash, a by-product of burning coal, 97 percent of traditional components in the concrete can be replaced with recycled material.

At present, generation of fly ash in India is more than 60 million tons per annum. Fly ash as such is a pollutant but when used, as Building Material is Eco-friendly. Fly ash can be used for making a variety of building products some using simple low cost processes and other high investment processes producing high quality products. The present state of manufacture of fly ash products is given below.

1) Clay Fly Ash Bricks.
2) Stabilized Mud Fly Ash Bricks.
3) Autoclaved Aerated Concrete.
4) Cellular Light Weight Concrete.
5) Cast-in-situ fly ash walls.

1) Clay Fly Ash Bricks

Fig. 8:

Fly ash brick (FAB) is a building material, specifically masonry units, containing class C fly ash and water. Compressed at 28 MPa(272 atm) and cured for 24 hours in a 66 °C steam bath, and then toughened with an air entrainment agent, the bricks last for more than 100 freeze-thaw cycles. Owing to the high concentration of calcium oxide in class C fly ash, the brick is described as "self-cementing". The manufacturing method saves energy,

reduces mercury pollution, and costs 20% less than traditional clay brick manufacturing.

2) Cellular Lightweight Concrete

Cellular Lightweight Concrete (CLC) is one of the recent emerging technology in making concrete. It has many advantages when compared to the normal conventional concrete.

3) Fly Ash Based Cellular Lightweight Concrete

- It is a version of lightweight concrete that is produced like normal concrete under ambient conditions. It is produced by initially making a slurry of Cement +Sand + Fly Ash (constituting26% – 34 % content) + water
- A cellular concrete is a lightweight product consisting of Portland cement, cement-silica, cement-pozzolan, lime-pozzolan, lime-silica pastes or pastes containing blends of these gradients and having homogeneous void or cell structure, obtained with gas-forming chemicals of foaming agents.
- CLC is an air-cured lightweight concrete with fly ash as a major ingredient that can be produced at large project sites just like traditional concrete, utilizing equipment and moulds normally used for traditional concreting.
- It is especially suitable in India for low-rise load bearing constructions and for partitioning work in multi-storey blocks.

4) Green Power -Solar & Wind Energies Energy Efficient Light

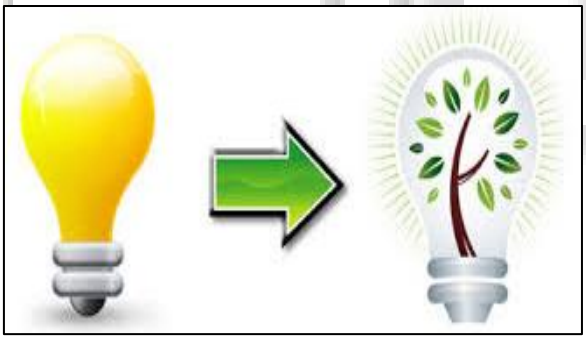

Fig. 9:

Maximum use of available solar energy and other forms of surrounding energy in building designs and construction achieves Energy-Efficiency in Green buildings. Whatever combination of solar, wind, and utility power is available; the entire power system would be greatly enhanced by a reliable, zero maintenance, ultra-long life, and lower life cycle cost power storage and management system.

5) Water use Efficiency

a) Drip Irrigation

In Green buildings, the superstructure is constructed over a cellar which is used to capture the excess rainwater. The basement is below the ground level and stores the water where it is treated and cycled for use. This method has a low maintenance cost and is user friendly. It is highly viable in both flood prone and drought prone areas to store the water from rainy season for the summer. A drip irrigation system delivers water to the crop using a network of irrigation equipment like mainlines, sub-mains and lateral lines with emission points spaced along their lengths.

Fig. 10:

b) Rain Water Harvesting:

Rainwater harvesting is a technique used for collecting, storing, and using rainwater for landscape irrigation and other uses. The rainwater is collected from various hard surfaces such as rooftops and/or other types of manmade above ground hard surfaces.

VII. GREEN BUILDINGS FINANCIAL BENEFITS

Green Buildings provide financial benefits than Conventional buildings do. These benefits include energy and water savings, reduced waste, improved indoor environmental quality, greater employee comfort/productivity, reduced employee health costs and lower operations and maintenance costs.

A. Energy

Energy is a substantial and widely recognized cost of building operations that can be reduced through energy efficiency and related measures those are part of green building design. On average, green buildings use 30% less energy than conventional buildings.

B. Productivity and Health

There is growing recognition of the large health and productivity costs imposed by poor indoor environmental quality (IEQ) in commercial buildings—estimated variously at up to hundreds of billions of dollars per year. This is not surprising as people spend 90% of their time indoors, and the concentration of pollutants indoors is typically higher than outdoors, i.e 10 or even 100 times.

Following are some relevant attributes common in green buildings that promote healthier work environments:

- On average 25-30% more energy efficient.
- Much lower source emissions from measures such as better siting (e.g., avoiding locating air intakes next to outlets, such as parking garages, and avoiding re circulation), and better building material source controls (e.g., required attention to storage).
- Significantly better lighting quality including: more day lighting (half of 21LEED green buildings reviewed provide day lighting to at least 75% of building space), better daylight harvesting and use of shading, greater occupancy control overlight levels and less glare.

- Generally improved thermal comfort and better ventilation—especially in buildings that use under floor air for space conditioning.
- Use of measurement and verification, and CO^2 monitoring to ensure better performance of systems such as ventilation, heating and air conditioning measuring the exact financial impact of healthier, more comfortable and greener buildings is difficult. Green buildings are designed to be healthier and with more enjoyable working environments.

VIII. PERCEPTIONS AND REALITIES

Having covered on the benefits it is also important to know that people have different perceptions on green buildings. It is important to look at these:

A. Perception 1: Green Buildings Are Costlier

Reality: Considerable research and analysis has been carried out with regard to the cost impacts of a green building. The cost could be slightly higher than a conventional building. But then, this needs to be seen with a different way. The question is how do we compare the costs? There needs to be a baseline cost for all comparisons to be a like.

The incremental cost is always relative and depends on the extent of eco-friendly features already considered during design. The incremental cost would appear small if the baseline design is already at a certain level of good eco-design; it would appearhuge if the base designs has not considered green principles.

B. Perception 2: Green buildings have to be air conditioned

Reality: Green building concepts and the LEED rating can be applied for non-air conditioning buildings. It has been applied on three such building sin India viz., IGP office, Gulbarga, the Royal Engineering College, Hyderabad and LIC office, Shimoga. While performing the energy analysis using software tools, such buildings will input the same cooling system both in the baseline and the proposed design. This ensures that the building is recognized for any of the other energy efficiency measures incorporated, for example- the envelop, lighting, roof in sulation etc. This kind of an approach also ensures that an apple-to-apple comparison is made while evaluating two green buildings, whether conditioned or not.

C. Perception 3: Green buildings take more time

Reality: There is a general perception that going the green way may affect the project schedules. This was per haps the case for the CII-Godrej GBC building when it was the first time that a green building rating tool was being applied in the country. The design in this case took about one-and-half years while the construction was completed in about 9months!

IX. CONCLUSION

Green building concept is a smart approach for the saving of energy, water resources, for minimizing wastages and maximizing reuse. Green building concepts focus in improving health and wealth of the society and more importantly connects us with nature. This concept is a future need of a country and it leads us towards the healthier and wealthier environment and as well as it shows the way to keep in touch with nature. The green building experiences in India have been exciting and challenging as well. This will ultimately serve to improve not only the energy performance of buildings but will also assist the country conserve energy and natural resources by impelling increased recovery and recycling of building materials. The easy availability of most of the green materials and equipment in the country has made it easier for the designers to adopt local materials to a very large extent. Furthermore, over time the real advantages offered by green buildings will be recognized increasingly as critical to companies having a competitive edge.

We must think boldly and broadly about energy efficiency, conservation, and smart growth. While, clearly, this is true for reasons related to the well-being of our environment as we as for competitive arena of the business world. Besides, the importance of safeguarding our environment and health; high performance green building will also benefit India's economy.

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