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Green Buildings – A Review

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ABSTRACT

Today we all have heard the term 'Green Building' more and more often just because the Green Movement is getting more and more popular with each passing year. A green building is the one which uses less water, optimises energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building. The "built" environment has a vast impact on the natural environment, human health, and the economy. By adopting green building strategies, we can maximize both economic and environmental performance. Green construction methods can be integrated into buildings at any stage, from design and construction, to renovation and deconstruction. In the year 2001, the Indian Green Building Council (IGBC), formed by Confederation of Indian Industry (CII) is continuously striving towards wider adoption of green building concepts in our country. It has licensed the LEED (Leadership in Energy and Environmental Design) Green Building Standard from the U.S. Green Building Council and at present certifies the LEED-New Construction and LEED-Core and Shell buildings in India. The Energy Conservation Building Code (ECBC) was launched by the Indian Bureau of Energy Efficiency (BEE) as a guide for energy efficiency standards. The Green Building movement spearheaded by CII - Sohrabji Godrej Green Business Centre in Hyderabad since 2001 has come a long way. With a meagre green building footprint of 20,000 sq.ft in 2003, today over 400 million sq.ft have been rated by IGBC. India ranks third among the top ten countries for LEED and in 2016, nearly 650 projects in India earned LEED certification. According to a recent USGBC survey, 87 percent of Indian professionals anticipate that use of LEED in India increasing overall, with nine out of ten industry senior executives in India anticipating that their LEED related work will increase over the next several years. The effective use of the natural resources is the need of present days. The Indian green building movement is surging ahead and well poised to reach greater heights, in the years to come.

Keywords: Green buildings, IGBC, LEED, energy efficiency, Building management system

I.INTRODUCTION

Construction Industry in India is one of the rapidly growing sectors and contributes significantly to the Nation's economy. The sector contributes to 10% of India's GDP. Indian construction sector is growing at a rate of 9.2% as against the world average of 5.5%. The sector is likely to record higher growth in the coming years. India has construction capabilities in the areas of buildings, infrastructure development and highway projects. The growth of construction industry provides impetus to other manufacturing sectors like cement, iron & steel, power, chemicals, etc.

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1.1. WHAT IS A GREEN BUILDING?

'A Green building should create delight when entered, serenity and health when occupied and regret when departed' – Perhaps this is one of the most inspiring definitions of a Green building, articulated in the book 'Natural Capitalism'.

A green building is the one that makes the greatest possible use of natural light and air and least possible utilization of energy and water. It uses industrial by-products, emphasizes on recycling of waste water, harvesting of rain water, least use of air conditioning, less production of Carbon dioxide and tries to safeguard the environment in every possible way.

The appearance of a Green Building will be similar to any other building. However, the difference is in the approach, which revolves round a concern for extending the life span of natural resources; provide human comfort, safety and productivity. This approach results in reduction in operating costs like energy and water, besides several intangible benefits.

Fig.1. Ashok Leyland corporate office, Gold rated, Chennai

1.2 WHY GREEN BUILDINGS?

The "built" environment has a vast impact on the natural environment, human health, and the economy. By adopting green building strategies, we can maximize both economic and environmental performance. Green construction methods can be integrated into buildings at any stage, from design and construction, to renovation and deconstruction. However, the most significant benefits can be obtained if those involved in the design and construction of the building work together from the earliest stages of a building project.

Some of the salient features of a Green Building are:

I. Minimal disturbance to landscapes and site condition.

II. Use of Recycled and Environmental Friendly Building Materials.
III. Use of Non-Toxic and recycled/recyclable Materials.
IV. Efficient use of Water and Water Recycling.
V. Use of Energy Efficient and Eco-Friendly Equipment.
VI. Use of Renewable Energy.
VII. Indoor Air Quality for Human Safety and Comfort.
VIII. Effective Controls and Building Management Systems.

Making of a Green building begins at the planning stage itself. Also, the safety is utmost as if a labour die while the construction is on, the building is never given a green certification.

1.3 BENEFITS OF GREEN BUILDINGS

A Green Building can have tremendous benefits, both tangible and intangible. The immediate and most tangible benefit is in the reduction in operating energy and water costs right from day one, during the entire life cycle of the building. The energy savings could range from 25 – 40 % depending on the extent of green specifications. Other tangible savings would be reduction in first costs and enhanced asset value.

Intangible benefits of Green Buildings include increasing productivity of occupants, health, safety benefits and a green corporate image. Several Corporate are now seeing Green Building Rating as a tool to enhance marketability.

Tangible benefits:

a) Energy savings: 20 – 30 %
b) Water savings: 30 – 50 %

1.4. WHY PEOPLE ARE ATTRACTED TO GREEN BUILDINGS

This question has been posed to several occupants of a green building. Of all the many reasons, the three top reasons often cited are the followings-

Operational Savings: Green buildings consume at least 40-50 % less energy and 20-30 % less water in a conventional building. This comes at an incremental cost of about 5-8 %. The incremental cost gets paid back in 3-5 years' time.

Daylights & Views: Working in environment with access to daylight and views provides connection to the exterior environment. This has a soothing effect on the mind. Various studies prove that the productivity of people who have access to day lighting and views is at least 12-15 % higher.

Air Quality: Green buildings are always fresh and healthy. Every green building will have to purge continuous fresh air to meet the ASHRAE 62 requirements. The green buildings use interior materials with low volatile organic compound (VOC) emissions. A typical office building would require purging of fresh air of about 15 cfm/person which provides a fresh ambience inside the building.

1.5 INDIAN GREEN BUILDING COUNCIL (IGBC)

IGBC, which is part of CII-Godrej GBC, has taken on the initiative of promoting the Green Building concept in India. The council is represented by all stakeholders of construction industry Corporate, Government & Nodal agencies, Architects, Material manufacturers, Institutions, Media etc. The council operates on a consensus based approach and member-driven. The vision of the council is to serve as single point solution provider and be a key engine to facilitate all Green Building activities in India.

As part of indigenization of the LEED rating system, IGBC has been working on LEED – India. LEED India for New construction (LEED India NC) was formally launched in January 2007 and followed by LEED India CS (Core & Shell). Projects in India will be accepted for certification under the LEED-India rating system. The LEED-India rating system has incorporated few changes like more emphasis for water conservation andadoption of local Indian Codes and standards. For example LEED-India would adopt the NBC guidelines, MOEF guidelines for large projects, ECBC for energy efficiency, etc.

1.6 HOW ARE GREEN BUILDINGS CERTIFIED?

The LEED (Leadership in Energy and Environmental Design) green building rating system developed by the US Green Building Council is now recognised as an international rating system and followed by more than 24 countries. The LEED rating system has been indigenized by the Indian Green Building Council to suit the national context and priorities. It evaluates environmental performance from a whole building perspective over a building's life cycle, providing a definitive standard for what constitutes a green building. LEED is a measurement system designed for rating new and existing commercial, institutional and high-rise residential buildings.

Measurement / Audit for Green Concept in Buildings:

Parameters	Points
Sustainable site	12
Water efficiency	8
Energy and atmosphere	17
Material and resources	13
Indoor Environment Quality	15
Design process and innovation	4
Employing LEED designer	1
Total points	**70**

Table – 1: Categories for Rating LEED points

LEED Certified	Level 26 to 32
Silver rated	Level 33 to 38
Gold rated	Level 40 to 52
Platinum rate	Level 53 and above

Table - 2: Certification for green buildings

Building	Built- up Area (Sq. Ft)	Consumption of Conventional Building (kWh)	Consumption of LEED Designed Building(kWh)	Reduction (%)	Annual Energy Saving (Rs in Lakhs)
Wipro Technologies, Gurgaon	1,75,000	48,00,000	31,00,000	40%	102
TC Green Centre, Gurgaon	1,70,000	35,00,000	20,00,000	45%	90
CII Godrej GBC, Hyderabad	20,000	3,50,000	1,30,000	63%	9

Table – 3: Monitoring of energy savings in LEED rated buildings

Fig.2. L&T, EDRC 1, Silver rated, Chennai

Fig. 3.CII – Godrej GBC, Hyderabad, Platinum Rated

Energy efficiency in design has been achieved by a number of buildings in India by adopting the LEED India green building rating system. A LEED rated building consumes 30-50% lower energy as compared to a conventional building. These buildings are designed to surpass the ASHRAE 90.1.2004 standards or ECBC (Energy Conservation Building Code). Energy performance of three 'LEED Platinum' rated buildings have been monitored for about 3 years and energy savings achieved are shown.

II. BUILDING CONCEPT

Green building design and construction practices address:

I. Sustainable site planning
II. Safeguarding water and water efficiency
III. Energy efficiency
IV. Conservation of materials and resources

By addressing these criteria in an environmentally sensitive manner it is possible to significantly reduce or eliminate the negative environmental impact of buildings.

Sustainable site planning: - When choosing a location to build a building there are some factors owners should consider before purchasing. Sites that are close to jobs, schools, shops, and services will reduce the amount of time that owners have to spend in their cars, which has environmental as well as social benefits. Lots that are in compact, walkable neighbourhoods are also easier to service with transit and infrastructure, such as sewer and water.

Safeguarding water and water efficiency: - Water discharge should be zero in a green building. Good green architecture reduces wastage of water in a big way. A green building should ideally have all waste water biologically treated and recycled. Ample structural specifications are incorporated in green buildings for harvesting rainwater. Grey water (water left after washing utensils and clothes) can be used for gardening and flushing purposes.

Energy efficiency: - Energy utilization should be optimum in a green building. Care should be taken to reduce the load of air conditioning on the power system.

Conservation of materials and resources: - Effort should be made to use recycled materials in the construction of the building like fly ash Ready Mixed Concrete (20% fly ash + 80% cement) in construction. Aerated concrete blocks can be used instead of bricks for better insulation and heat rejection. Roof insulation should be done with clay rather than chemicals. Maximum bamboo products should be used in flooring.

2.1 ENERGY EFFICIENCY IN BUILDING DESIGN AND CONSTRUCTION

A study conducted by Energy Information Administration (EIA), U.S. Department of Energy indicates that there is a visible trend across the globe where in the growth rate in total energy consumption has been greater than the population growth rate. In the developed countries the energy consumption growth rate is only marginally higher compared to the population growth rate. For example, in USA, energy consumption is projected to grow at1.3% while the population growth rate is projected to grow at0.8%.In contrast, in developing countries like India population growth rate is expected to grow at 1.3% while the energy consumption rate is expected to grow at 4.3%. This trend would strain the energy sector to a large extent. The construction industry in the country is growing at a rapid pace and the rate of growth is **10%** as compared to the world average of 5.2%. Hence energy efficiency in the building sector assumes tremendous importance. Commercial buildings are one of the major consumers of energy and are the third largest consumers of energy, after industry and agriculture. Buildings annually consume more than 20% of electricity used in India. The potential for

energy savings is 40 –50% in buildings, if energy efficiency measures are incorporated at the design stage.

2.1.1 Typical Energy Consumption Pattern in Buildings

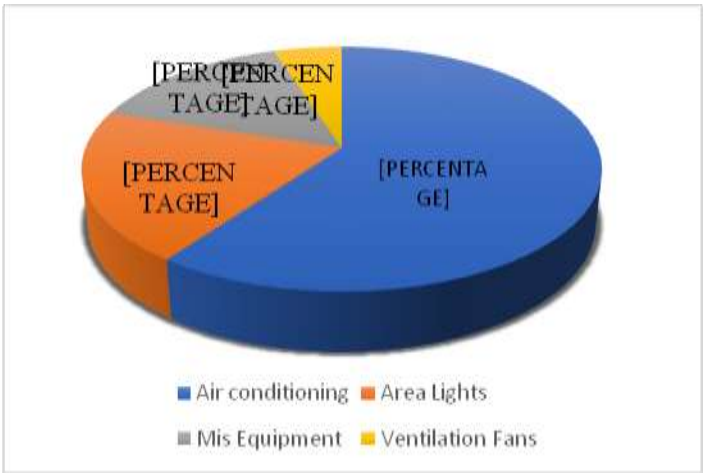

Fig. 4. Break-up of energy consumption in a building

In a typical building, air conditioning is the highest consumer of energy followed by lighting and other miscellaneous equipment. Therefore, if the initial design considers energy efficiency measures in these areas, substantial energy savings can be realised.

2.1.2 Typical Energy Saving Approach in Buildings

Orientation: This is the first step to achieve energy efficiency. The following measures can be adopted:

a. Minimize exposure on the south and west.

b. Use simulation tools and techniques which can help in designing the orientation to minimize heat ingress and enhance energy efficiency.

2.2 Building Envelope:

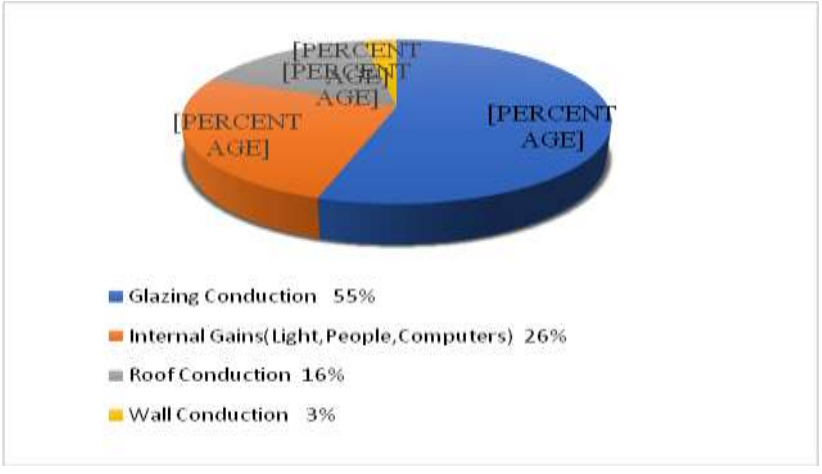

Fig.5. Typical break-up of heat gain in a building

The following envelope measures can be considered

i. Select high performance glazing with low U- Value, Low shading coefficient and high VLT (Visual Light transmittance)
ii. Insulate the wall, the option for insulation materials can be Extruded polystyrene, Expanded polystyrene (thermocool), Glass Wool etc.
iii. Brick Wall with air cavity can also significantly reduce the heat ingress.
iv. Hollow blocks, fly ash bricks are also good insulators.
v. The heat ingress through the roof can be as high as 12-15%. Insulating the roof can substantially reduce the heat ingress.
vi. Consider shading devices for window openings.

2.3 Equipment & systems

i. Select chiller with high Coefficient of Performance (COP).
ii. Install Variable Frequency Drives (VFD) for supply & return air fans and pumps.
iii. Select high efficiency cooling towers.
iv. Use high efficiency motors, transformers and pumps.
v. Install Heat recovery wheels and economizers.
vi. Consider night purging with ambient air to flush out the heat trapped within the building during the day.
vii. Adopt controls and building management systems for effective control.
viii. Engage a commissioning authority to ensure that savings are realised once the building becomes operational.

2.4. Lighting

i. Design in such a way that the building gets maximum day lighting.
ii. Overall lighting power density can be designed as less as 1.0 W/sq.ft.
iii. Use daylight-cum-dimmer controls.
iv. Install occupancy sensors.
v. Select energy efficient luminaries like CFL, T-5, LED, etc.

III. GREEN BUILDING MATERIALS AND EQUIPMENTS IN INDIA

While constructing Green Buildings in India, the availability of materials and equipment is one of the major issues to be addressed. A few green materials and equipment are available in the country. To name a few - Fly-ash cement, Fly-ash block, Recycled Aluminium, Recycled steel, Recycled tiles, Low VOC paints, Bamboo based products, HFC based high efficiency chillers, Building Controls, Green wood, Recycled wood, etc.

Green wood: A Stanford team has done a research for wood alternate. Hemp fibers and biodegradable plastic when pressed together and heated form layers and this material is as strong as wood. When buried in

land fill, it degrades faster. This wood creates more raw materials when it breaks down. Microbes produce methane gas when they decompose this wood substitute and other debris thrown into landfills. Another type of bacteria a new wooden plank. By this cycle, there is a continuous source of raw material for this wood. When this material at research comes to market, it may help to control deforestation and promote the rainfall.

IV.BUILDING MANAGEMENT SYSTEM (BMS)

It is basically a solution which is put into a system so as to ensure an environment that is safe, secure, energy efficient and comfortable. It has the following benefits-

i. Optimize energy consumption
ii. Provide alarm systems so as to take corrective actions
iii. Monitor and control indoor comfort conditions

The additional investments on BMS pays itself through its savings in energy consumption.

Typical applications-

i. Lighting and HVAC control
ii. Emergency lightning
iii. Safety and security solutions
iv. Water management and control

Optimizing Energy Efficiency – It is capable to reduce the energy cost by 15 – 20% as compared to a building without BMS. Specific examples are-

i. Night time purging to cool the building
ii. Chiller management
iii. Lighting control
iv. Temperature and humidity control.

Performance monitoring – It helps in real time monitoring and records of the past data. It also helps in redefining the baseline energy consumption which can help in continuous improvements.

Enhancing indoor air quality – It automatically controls the amount of fresh air that enters a building and thereby helps to maintain a healthy environment. It can automatically track the number of occupants in the building and accordingly regulates the flow of fresh air.

Safety of assets and security solutions – It is very important to detect, notify and evacuate in the event of fire. It can be combined with Fire safety control panels with backup power supply, audible alarms, emergency voice evacuation systems etc.

Access control system – It controls the movement of the people and integrates this data with back end applications such as Time attendance systems, Payroll processing, Hazard monitoring, Vehicle management etc.

Video surveillance system – It is the first line of security that allows the staff to monitor through a wide range of the area.

4.1 NATIONAL CODES AND STANDARDS

Government of India has launched the *'Energy Conservation Building Code (ECBC)'* code. This code is voluntary and applicable to buildings or building complexes that have a connected load of 500 KW or a contract demand of 600 KVA, whichever is greater. This code addresses the minimum performance standards for energy efficiency i n a building covering building envelope, mechanical systems & equipment, service hot water heating, interior & exterior lighting and electrical power & motors. This is an excellent initiative which will enable design of high performance buildings.

V.CONCLUSION

Green buildings are not only a part of environmental assessment but also a new way of energy saver. It is a boon to the world, it not only provides a ecofriendly atmosphere, it also acts as a power house of natural renewable energy for a sustained living. The green building experiences in India have been exciting and challenging as well. Since its introduction in 2001, the LEED rating has emerged as a very useful tool in designing a green building. With the tremendous growth the country is witnessing, energy efficiency in buildings assumes paramount importance. The energy saving potential can be as high as 40-50%, if addressed right at the design stage. The application of codes like ASHARE /ECBC as a benchmark can help in designing high performance buildings. There exist tremendous opportunities to introduce new materials, equipment and technologies which can help enhance energy efficiency of buildings. The LEED rating provided opportunities to introduce new products and 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. Now there is an imminent need for service providers, who would be required in large numbers, not in hundreds but thousands, as the movement is heading to reach greater heights. The green building movement is here to stay for the benefit of individuals, society and the country at large.

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