

# HISTORICAL PERSPECTIVE AND CONCEPT OF GREEN BUILDING IN INDIA – A REVIEW

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**Abstract**—The concept of green building has created an immense importance in a developing country like INDIA. The theory implies of minimizing the wastage and the cost of construction. Green Building encompasses a wide range of design practices, building systems integration, product specification, and construction techniques Green building approach is consistent with the mission of most affordable housing developers, and the most community development corporation mission statements which include language about ensuring that low income people have access to safe, decent and affordable housing. The concept of green buildings is not as emerging as we think it is. The Evolution of housing started by utilizing nature and natural resources like trees and caves as shelter from the severity of natural elements like sun, rain, wind, etc. Based on such complex experiences, our Vedic philosophy evolved certain methods to maximize the use of Panch Mahabhuta or the 5 basic elements of nature, i.e., Jal (water), Agni (fire), Prithvi (earth), Vayu (wind), and Avkash (space). In this review paper we study on various historical perspective and concept of green building in India and conclude that the concept of energy efficient building is not a new concepts it was continued since over historical buildings development.

**Index Terms**—Green Building, Heritage Buildings, Rating System

## I. INTRODUCTION

Cities cover less than 50 % of the earth's surface but are disproportionately responsible for causing climate change. Currently, around 50% of the world's population lives in cities. Until 2030, 60% of the world's population growth will occur in cities. Cities and urban areas consume some 75% of the world's energy and are responsible for up to 75% of greenhouse gas emissions. Cities directly or indirectly account for 60% of world's water use. So a majority of the world's energy consumption either occurs in cities or as a direct result of the way that cities function. A study recently conducted showed that more than half of the reduction potential lies within buildings. Making existing and new buildings to Green Buildings is one of the most effective levers to meet the challenges of CO2 reduction in cities. A Green Building is an outcome of a design which focuses on increasing the efficiency of resource use - energy, water, and materials - while reducing building impacts on human health and the environment during the building's lifecycle, through better siting, design, construction, operation, maintenance and removal.

Green Buildings can have tremendous benefits, both tangible and intangible. The most tangible benefits are the reduction in water and energy consumption right from day one of occupancy. The energy savings could range from 20 - 30 % and water savings around 30 - 50%. Intangible benefits of Green Buildings include enhanced air quality, excellent day lighting, health & wellbeing of the occupants, safety benefits and conservation of scarce national resources.

The concept of Green Building has evolved to create environmentally sound buildings and reduce the overall impact on human health. Green buildings are designed to efficiently use energy, water and other natural resources to create a health conducive indoors and reduce the overall impact on the environment as well as non-renewable natural resources.

To define Green Building and establish a common standard of measurement in India, the IGBC (Indian Green Building Council) developed Green Building Rating System from the LEED (Leadership in Energy and Environmental Design) Rating System. In addition, IGBC promotes whole building design practices, recognizes environmental leadership in the building industry, stimulates green competition, raises consumer awareness of green building benefits and transforms the building market into a more environmentally responsible entity. So, in this report the IGBC Green Building Rating System has been discussed.

IGBC Green Building Rating System addresses green features under the following categories: Site Selection and Planning, Water Efficiency, Energy Efficiency, Materials, Indoor Environmental Quality, Innovation & Design Process. Methods and techniques under these categories have been discussed. Case study on few famous green buildings is also presented. The Green Buildings Paradigm in India has been covered briefly.

*Cities account for 75% of world energy and emits 75% of greenhouse gases. Adopting the "Green Building" concepts can effectively reduce energy consumption and better use of natural resources.*

## II. HISTORICAL PERSPECTIVE

The concept of green buildings is not as emerging as we think it is. The Evolution of housing started by utilizing nature and natural resources like trees and caves as shelter from the severity of natural elements like sun, rain, wind, etc. Based on such complex experiences, our Vedic philosophy evolved certain methods to maximize the use of Panch Mahabhuta or the 5 basic elements of nature, i.e., Jal (water), Agni (fire), Prithvi (earth), Vayu (wind), and Avkash (space). Our ancient builders tried to harmonies these five elements in building planning and construction so that maximum advantage of these elements can be taken and ill effects can be avoided. They called this science as Vastushastra.

The basic principal of Vastushastra is to get maximum advantage out of nature without harming nature. Leaving open spaces in a centre of a building was done to provide light and cross ventilation to adjoining rooms. Water storage and prayer rooms were positioned in the northeast direction to facilitate solar rays to disinfect water and rooms. The south west portion of the house was made heavy to protect it against heavy winds and heavy rains. The south east portion of the house receives comparatively less solar rays and hence the kitchen is placed here so that the general temperature of the kitchen is not raised. This was the kind of wisdom prevailing at that time. In simple terms, these were the by-laws for the planning and construction of any building. Our ancient builders desired that everyone should follow these rules religiously. Hence,

for better implementation of these rules, they coupled it with fear psychology. They associated each building norm with aspects of personal life and specified that lack of adherence to these norms would result in loss of health, wealth or even reputation due to the disapproval of nature gods. This was done to instigate fear so that building rules are adopted properly. What a way to implement and enforce the laws, without any police, inspector or supervisors!

The Green Building movement has gained tremendous momentum during the past 6 years, ever since the CII- Godrej GBC embarked on achieving the prestigious LEED rating for centre at Hyderabad. The 'Platinum Rating' for the Green Business Centre building has sensitized the stakeholders of the construction industry. Today, several corporate and Government organizations are considering Green Buildings in a major way.

From a humble beginning of 20,000 sq.ft of green footprint in the country in the year 2003, to a staggering 10 million sq.ft expected by end 2008, green buildings are well poised to reach scalar heights. Today a variety of green building projects are coming up in the country – residential complexes, exhibition centres, hospitals, educational institutions, laboratories, IT parks, airports, government buildings and corporate offices.

### ***Heritage Buildings: An Inspiration for Energy Efficient Modern Green Buildings***

India is known for rich Architectural and cultural heritage. Thermal performance and air quality inside the buildings can be improved substantially and energy can be saved through understanding the ancient design concept. Mughal architecture of India is known worldwide for the wonderful monuments. Landscaping was an integral part of Indian palaces and monuments. Trees, green areas and water body around a building improve the physical comfort along with the visual pleasure. In monumental buildings passive techniques used for the comfort in different climatic region. Jali is the ornamental feature provided in most of the palaces in Rajasthan, Taj Mahal and Agra fort which increase the ventilation and comfort. Study of historical city of Jaipur shows that in desert areas where water is in short supply step wells are built which improve the microclimate of the place. Courtyard was also an important design element in old residential buildings in hot dry climate called Havelis. It was an element of passive cooling for regular fresh air supply. One of the modern buildings designed in Jaipur on this concept using these factors is also discussed. The paper highlights the ancient passive techniques to improve the thermal comfort and ventilation through examples of heritage buildings which may prove an inspiration for energy efficient modern buildings design.

Indian vernacular architecture reflects the environmental realities. The architectural quality makes a building a heritage building. Hindus & Mughals built magnificent monuments. Traditional architecture is the outcome of centuries of optimization of climate consideration, of material use, construction techniques. Landscaping elements water body and trees provided in monumental buildings, temples improves the microclimate of the place and increase the comfort level in the buildings.

Environmental degradation, technology advancement and development of urban centers have highly influenced energy consumption in buildings. Energy is the important component for economic development of the country. The modern equipment and materials used in construction and to maintain indoor thermal environment consumes significant amount of our national energy. In view of the shortage of energy it is very much essential to review the historical origin of Architecture & Technology to restore the comfort inside the building. Climate responsive architecture is the need of the day. Today most building structures are designed to separate man from the outside environment and require application of significant energy quantities to create an acceptable indoor environment. Energy consumption can be reduced in heating & cooling from 50-80% if the buildings are designed and planned considering the microclimate, topography of the place, and other external features. Modern buildings are being built with little consideration of the climate. An overview of vernacular architecture will help to understand the climatic or technological limitations of the past. Control Of the microclimate around the building was always important in indigenous design. This happened not only for the palaces but for simple dwellings as well.

### ***Passive Techniques of Heritage Buildings Design***

Ancient buildings demonstrate the passive architecture of India. Without mechanical means these buildings are better than the newly designed buildings. Natural ventilation and advantages of solar direction was taken in those buildings. Materials are chosen for construction according to the climatic characteristics of the place. The Palaces in Rajasthan also demonstrates the natural ventilation techniques. Water body in temple premises, keeps the environment cool and improve the microclimatic conditions. Havelis of Rajasthan & Gujrat are good examples of passive architecture. The Mughals constructed excellent mausoleums, mosques, forts, gardens and cities. Taj mahal, Agra fort and, Fatehpur Sikri are few monumental buildings near Agra. Mughals laid out many beautiful gardens with water bodies in the centers in the neighborhood of Agra & Lucknow. These buildings are designed in such a way that all people are comfortable inside a building during the hot summer.

Indian architecture was greatly influenced by Persian styles. The Mughals constructed excellent mausoleums, mosques, forts, gardens and cities. Mughals built magnificent monuments. They also laid out many beautiful gardens with water bodies in the centers in the neighborhood of Agra and Lahore. Some gardens like Shalimar and Nishat gardens in Kashmir have survived to this day.

### ***Landscaping***

Mughal gardens are famous for planned landscaping. The general theme of a traditional Islamic garden is water and shade. Unlike English gardens, which are often designed for walking, Islamic gardens are intended for rest and contemplation. For this reason, these gardens usually include places for sitting with trees. Water greatly influence the microclimate of the place and improve the environment.

### ***Water***

Water is an architectural element which is extensively used in our ancient buildings and in garden of the Mughals. Water not only delighted the eye on a hot summer day but also provide the passive cooling. Water improves the physical comfort by the evaporative cooling of the surrounding air. Rate of heat loss from the moving air depends upon the area of water in contact with the air and careful zoning of the sheltered spaces so that strips of the water could be strategically placed around the structure. The beauty of Taj Mahal and Chota Immambada, Lucknow is enhanced by provision of water in front and built environment is comfortable in hot summer (Figure 1).



Figure 1 Water body in front of Taj Mahal and Chota Immambada, Lucknow

### *Baoli*

This method was employed over 1,500 years ago by local Rajasthanis, who built "baoli" or stepwells -- bodies of water surrounded by a descending set of steps, helping to create a microclimate in the surrounding structure. Chand Baoli is a famous step-well situated in the village of Abhaneri near Jaipur. It was built in the 9th century and has 3500 narrow steps in 13 stories and is 100 feet deep (Figure 2).



Figure 2 Chand Baoli – Step well in Jaipur

### *Ventilation Techniques in Heritage Buildings*

#### *Jali*

In monumental buildings Jali is the ornamental feature provided in most of the palaces In Rajasthan, In TAJ MAHAL, Agra fort etc (Figure 3). Fresh air enters in the building through jali with speed as well as stone jali protects the enclosure from direct solar radiation. Jali cast the decorative shadow in buildings which is also helpful in reducing the inside temperature.

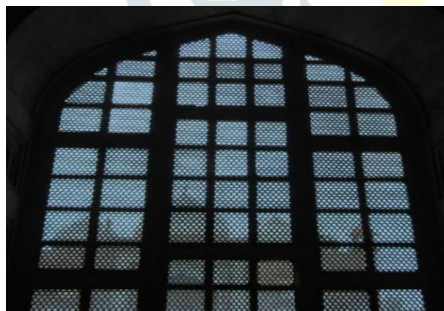


Figure 3 Inside and outside view of Taj Mahal Jali

### *Ventilator*

Natural ventilation is very important for comfort. Ventilation system provided in Bada Imambada Lucknow is the example to improve the natural air circulation (Figure 4).

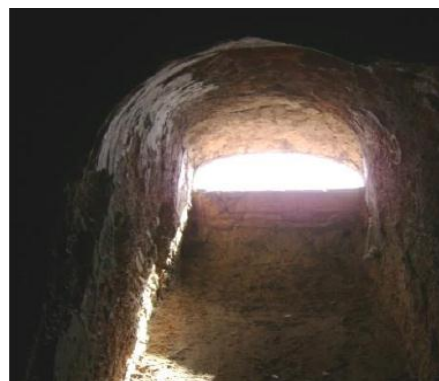


Figure 4 Bada Immambada, Lucknow



### Courtyard

Courtyard was also an important design element in old residential buildings in hot dry climate including palaces. It was an element of passive cooling for regular fresh air supply and for day lighting. These interior courts - a common feature of Rajasthan architecture - optimize circulation of air during the 50°C summers (Figure 5). The rooms around courtyard are comfortable for use.



Figure 5 Haveli of Shekhawati Rajasthan

### III. CONCEPT OF GREEN BUILDING

Green building does not mean building is painted green but building which has incorporated nature friendly features. Green represents nature.

Green building is the practice of increasing the efficiency with which buildings use resources - energy, water, and materials — while reducing building impacts on human health and the environment during the building's lifecycle, through better siting, design, construction, operation, maintenance, and removal.

Green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by:

- Efficiently using energy, water, and other resources
- Protecting occupant health and improving employee productivity
- Reducing waste, pollution and environmental degradation

Effective green building can lead to

1. Reduced operating costs by increasing productivity and using less energy and water,
2. Improved public and occupant health due to improved indoor air quality, and Reduced environmental impacts by, for example, lessening storm water runoff And the heat island effect, etc.

In short, 'A Green building should create delight when entered, serenity and health when occupied and regret when departed'

Energy efficient and environment conscious building design is essentially an integrated approach. The available options in architectural intervention, building materials and design methodologies need to be carefully evaluated to minimize energy usage, minimize the ecological degradation that may be caused by the construction of the building and provide cost effective solutions. The aim is to achieve the desired comfort with the least input of conventional energy. Though the rules are not very well defined, architects and designers accomplish the task through solar passive design, use of renewable energy technology systems, and/or natural building materials. While designing such buildings, not only new building stock can be targeted but also existing buildings can be retrofitted with energy efficient and eco-friendly technologies, thereby substantially reducing energy consumption.

- A green building depletes the natural resources to the minimum during its construction and operation.
- Main aim is to minimize the demand on non-renewable resources and maximize the utilization efficiency of these resources.
- Maximize the reuse, recycle and utilization of renewable resources.
- Optimizes the use of on-site resources sinks by bio-climatic architectural practices.
- Uses efficient equipment's to meet its lighting, air condition and other needs
- Use efficient waste and water management practices
- Provides comfortable and hygienic indoor working conditions.
- In sum, the following aspects of building design are looked into an integrated way in a green building:
- Site planning
- Building envelope design
- Building system design (HVAC, heating , ventilation and air conditioning, lighting, electrical and water heating)
- Integration of renewable energy resources to generate energy on site.
- Water and waste management
- Selection of ecologically sustainable materials (with high recycled content, rapidly renewable resources with low emission potential, etc.)
- Indoor environmental quality

### Problems in Conventional Buildings

All over the world we are finally beginning to recognize the threat that building construction is posing to the civilization. Buildings have major environmental impacts over their life cycle. There are various problems arising in the present scenario:

#### Conventional Building Pollute

1. Building contribute 40-50% of greenhouse gas (GHG) emissions
2. Building creates 65% of all solid waste, 90-95% of construction and demolition waste could be recycled

3. Indoor pollution often 2-100 times worse than outdoors

### ***Impact of Asia on Global Warming***

In next 25 to 30 years

1. Energy consumption of developing Asian countries will be more than double
2. CO2 emissions will increase more than three fold
3. Electricity generation in Asian countries is expected to make the greatest contribution to CO2 emissions

### ***Solution is a Green Sustainable Building***

- Energy efficiency is the most effective way to address climate change
- Energy efficiency is the cheapest source of additional energy supply and the most cost effective way to reduce GHG
- An efficient sustainable building will:
  - reduce energy usage and life cycle cost
  - create a better environment for occupants
  - reduce use of water and consumption of natural resources

### ***Economic Benefits***

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

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 appear huge if the base design has not considered green principals.

The second and rather critical paradigm is to look at the incremental cost in relation to the life cycle cost. This kind of an approach could be revealing. Who knows, a building would last for a 50 years or 60 years or 100 years! Over its life cycle, the operating cost would work out to 80-85 % while the incremental cost which is one-time cost is only about 8-10%

### ***Green Concept in Institutional Building***

The green movement is gaining momentum rapidly. But, is the rate enough? And the answer is of course 'NO'. It certainly needs more and more people's involvement to get visible and desired result. One can't blame anyone for non- involvement if they aren't aware of green concept. Certainly, they need to know it to get involved. The key is awareness.

To increase the awareness what would be a better place than an educational institution. Here thousands of students come every year. They stay, they learn, they grow here. It's the place to share new ideas and concepts. So if they get to see a live example of green initiative, they won't only know, but will be able to judge and see the benefits. They too may start thinking green and finding out new and better green ways. And then thousands of students go out every year to different places of their work field. They of course take their ideas with them and influence the people at their work place, which in turn further increasing the awareness.

## **IV. RATING SYSTEMS FOR GREEN BUILDINGS**

The United States Green Business Council (UGBC) has developed The Leadership in Energy and Environmental Design (LEED) Green Building Rating System, which is the internationally accepted benchmark for design, construction and operation of high performance green buildings. LEED gives Building owners and operators the tools they need to have an immediate and measurable impact on their building's performance. LEED promotes a whole building approach to sustainability by recognizing performance in 5 key areas of human and environmental health

1. Sustainable site development
2. Water saving
3. Energy Efficiency
4. Material selection
5. Indoor Environmental Quality

Recognizing that energy use and air pollution are important issues in India's buildings, Indian government enacted the Energy Conservation Act (ECA 2001), which promotes energy efficiency and conservation domestically. ECA 2001 mandated the creation of the Bureau of Energy Efficiency (BEE), authorizing BEE to establish an Energy Conservation Building Code (ECBC). Under BEE, National Building Code of India (NBC) first issued in 2005, but the issues of energy efficiency were marginally addressed. However, in 2007, the Ministry of Power and BEE issued ECBC - the first stand-alone national building energy code in India. While it is currently voluntary, ECBC establishes minimum energy efficiency requirements for building envelope, lighting, HVAC, electrical system, water heating and pumping systems. To develop ECBC, BEE collaborated with a diverse group of domestic and international technical experts.

Nonprofit organizations like The Indian Green Building Council (IGBC), The Energy and Resources Institute (TERI) are actively promoting green buildings in India.

### ***LEED Green Home Rating System***

Most of the green building rating systems focus on the same point - conservation of resources. But the LEED (Leadership in Energy and Environmental Design) rating system has turned out to be the most versatile and robust. So, the Indian Green Building Council (IGBC) decided to adopt the LEED rating system. The IGBC is working in India to indigenize the LEED rating system to include the local factors.

### ***IGBC Green Homes Rating System***

IGBC, in its endeavor to extend green building concepts to all building types envisioned a rating program for homes in December 2007. The rating system will be subjected to a review by the core committee, every 6 months, to ensure that it is updated and contemporary. The rating system evaluates certain credit points using a prescriptive approach and other credits on a performance based approach. The rating system is evolved so as to be comprehensive and at the same time user-friendly. The program is fundamentally designed to address national

priorities and quality of life for occupants. The guidelines detailed under each credit enable the design and construction of green homes of all sizes and types.

IGBC Green Homes addresses green features under the following categories:

1. Site Selection and Planning
2. Water Efficiency
3. Energy Efficiency
4. Materials
5. Indoor Environmental Quality
6. Innovation & Design Process

The rating system caters to projects like individual houses, apartments, motels, resorts, hostels, etc. Amongst the different types, projects are broadly classified into two categories:

- Projects where interiors are part of scope of work
- Projects where interiors are not part of the scope of work

Interiors include but not limited to materials like interior finishes & furniture and appliances like refrigerators, fans, lights etc. Different levels of green building certification are awarded based on the total credits earned. However, every Green Home should meet certain mandatory requirements, which are non-negotiable.

## V. CONCLUSIONS

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. 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

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. There exist tremendous opportunities to introduce new materials, equipment and technologies which can help enhance energy efficiency of buildings.

The launch of 'LEED India' Green Building rating system will facilitate to advance the growth of green buildings in India. The Indian Green Building Council would provide the right impetus for advancing the Green Building movement in India and enable India to be recognized as one of the leaders in Green buildings.

It is high time that an Indian green building council is formed based on Indian Conditions. India being a vast country, provisions also need to be made for utilization of regional methods and materials. Concrete using fly ash or slag is known internationally as green concrete.

Energy consumption represent about 25% of a building's total operating cost, making its conservation not only an environmental concern, but also an economic one; integrating energy efficient components from a building design is the best way to achieve optimal savings in both regards. The aim of green building design is to minimize the demand on non-renewable resources, maximize the utilization efficiency of these resources & maximize the reuse, recycling & utilization of renewable resources. It's the need of the day for every new construction to be a green building and to modify the present buildings with its features.

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