

An Assessment of Design Techniques and Rating System for Green Buildings Chiefly in India: A Review

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Abstract—Today's scenario of population growth results into urban expansion. Providing infrastructure to these urban expansions will result into tremendous increase in pressure on extensive resource consumption and higher economic crisis. The promotion of green building offers a way to avoid being locked into energy and resource intensive infrastructure. A green building refers to an infrastructure that makes efficient use of energy and resources in every aspect starting from designing to retrofitting. This paper presents a literature review on designing aspects of green building chiefly in India. It is reported that in India IGBC and TERI are promoting green building infrastructures and hence their rating system i.e. Leadership in Energy & Environmental Design is also been discussed. Present work is an attempt to make people, communities and general public aware about the advantages of green buildings for sustainable environmental development and management

Keywords: Green building, Contemporary Architecture, Green Design, LEED

1. INTRODUCTION

Urbanization is taking place at a faster rate in India. High cost of living is a major problem of cities. In Metro cities like Mumbai, Bangalore etc. it is very difficult for lower income groups to maintain a decent standard of living. Further, Buildings account for more than 40% of all global carbon dioxide emission, one of the main culprits implicated in the phenomenon of global warming in which India comes on 144th position (1.4 metric ton) in carbon emission rating in the world^[1]. Green building is the practice of constructing or modifying structures to be environmentally responsible, sustainable and resource-efficient throughout their life cycle. This includes efficiently using energy, water and other natural resources, protecting occupant health, improving employee productivity and reducing waste, pollution and environmental degradation^[2]. Agencies like IGBC and TERI have developed two benchmark rating system namely Green Rating for Integrated Habitat Assessment GRIHA and Leadership in Energy & Environmental Design LEED. The green building movement in India started with the establishment of the IGBC in 2001^[3], which was an initiative of the Confederation of

Indian Industries (CII) along with the World Green Building Council and the USGBC. The first green building in India, CII-Sohrabji Godrej Green Business Centre in Hyderabad, was inaugurated on 14 July 2004. This was a great symbolic achievement. Since then, the number and volume of green buildings in India has been phenomenal. The movement started with 20,000 sq ft in 2004 and has grown exponentially, with an expected green building footprint of 15 million sq ft by end-2008. There are 18 LEED certified buildings with a total area of about 8.5 million sq ft and 195 projects registered for LEED certification with a total area of about 110 million sq ft as of yearend 2007.

2. MOTIVATION TO STUDY

There are various advantages of green building which motivate me for this study. Some of these benefits are listed below:

2.1 Cost

Green Building saves much more money from the moment of creating during its lifetime as ordinary buildings. Even if they are higher in cost a little bit, because of some special requirements, during their usage they save so much energy that the money spent on its creation will return at least 10 times. The Californian Sustainable Building Task Force carried out a study in 2003. According to this study even 20% of investment into green building will elaborate 10 times more saving. So there is no significant difference in prices.

2.2 Energy efficiency

Green building has a great advantage of reducing both embodied and operating energy consumption. Studies proved that those buildings which are built with wood will have a lower embodied energy than buildings made of brick, steel or other materials. They use extra-insulation, high-performance windows, and passive solar design. The latter is very efficient especially if the windows are effectively placed. Also other ways of renewable energy are used too.

2.3 Material efficiency

Green buildings are built from green, rapidly renewable, non-toxic, reusable and recyclable materials as lumber, bamboo, straw, recycled metal/stone, sheep wool, compressed earth block, concrete, cork etc.

2.4 Temperature Regulation

Urban heat islands are elevated temperatures mostly in urban areas, formed mostly on surfaces where permeable and moist became impermeable and dry due to some buildings, roads etc. Urban heat island effect is caused mostly by the heat holding properties of tall buildings and urban (often toxic) materials – asphalt, concrete. It can be compensated by more green areas around the buildings such as green roofs and rain gardens.

2.5 Indoor air quality

When constructing green buildings great emphases are put on the ventilation system. It can be powered in different ways – passively, naturally or mechanically. It doesn't matter in which it is powered, the most important thing that a building should have a properly designed ventilation system in order to have a filtered and cleaner air. During construction low or zero emission materials are used. According to the data of the US Environmental Protection Agency indoor air pollution can be 2-5 times worse than outdoor air quality. It can cause early asthma and other respiratory disease. It is provoked by radon gas that's found in conventional buildings.

2.6 Indoor environment quality

Except poor air quality other circumstances like poor lightening, temperature variances, furniture, carpeting, pesticides, paints and high concentration of pollutants are causing different diseases – headaches, dermatological problems, allergies etc. The environmentally friendly circumstances of green building create healthier atmosphere.

3. RATING SYSTEM

Agencies like IGBC and TERI are involved in promoting green building in India ^[4]. GRIHA (Green Rating for Integrated Habitat Assessment), TERI (The Energy and Resources Institute) & SVAGRIHA (Small Versatile Affordable GRIHA) are green building rating system developed for Indian construction sector. GRIHA is a rating system which assesses the environmental performance of buildings on scale of 0-104. On the basis of number of points scored, a building can be rated between 1 & 5stars. GRIHA was developed by TERI and has now been adopted by the Ministry of New and Renewable Energy (MNRE) as the National Rating System for green buildings in India and to promote green buildings in India and to oversee the various activities associated with it, MNRE and TERI jointly established an independently registered society called ADaRSH (Association for Development and Research of Sustainable Habitats). ADaRSH functions as a platform for

interaction between various stakeholders as well as promotes GRIHA, SVAGRIHA and other similar green building rating systems in India whereas SVAGRIHA is a recently designed system especially for small scale project^[5].

4. DESIGN TECHNIQUES OF GREEN BUILDING IN INDIA

4.1 Sohrabji Godrej Green Business Centre, Hyderabad

This building is one of the world's best examples of passive architectural design. At the time of inauguration it was the first building outside of the US to be awarded LEED platinum rating ^[6]. The CII-Sohrabji Godrej Green Business Center (GBC) is unofficially world's most environment friendly construction for the use of water and energy efficient technologies. The building is literally made completely out of recycled material.

The building does not discharge any waste water and recycles all the used water. The building design comprises of two air conditioning towers where the incoming air is cooled 7 to 8 degrees by spraying water thereby reducing the load on air conditioning energy consumption. The roof is covered with roof garden as well as solar photovoltaic thereby reducing the energy consumption by almost 60% against a comparable conventional building.

4.2 CRISIL House, Hiranandani Gardens, Mumbai

Often dubbed the greenest commercial complex in India, this headquarters of the leading rating agency has 14 gardens inside the building. The building provides energy efficiency through a mix of innovation and cutting edge technology. 70 % of the work area does not require any artificial lighting during the day, which is very rare for commercial building in India. All the interiors are made up of recycled construction material, at the center of the building is an atrium that allows natural light to seep in even the interior parts of the building. Only energy efficient artificial lighting is used in the building that ensures reduced carbon footprint.

4.3 Infosys Limited, Mysore building

The overall water consumption of the building is 58% less as compared to other buildings of similar capacity. Most of the waste water is recycled and used for irrigation. The building is design comprises of an efficient building envelope, which includes insulated walls and roof, along with spectrally selective double glazed windows which are appropriately shaded. Moreover, efficient equipment and smart automation is used across the building that leads to a 40% reduction in energy costs. Almost 90% of the work spaces inside the building harvests natural light, the design of the building includes light shelves that ensures that natural light travels as deep as possible inside the building. Almost 100% of the building's energy consumption is met with green power. Infosys also ensured manufacturing of most of the building material locally to ensure reduced pollution due to transport.

4.4 ITC Green Center, Gurgaon & ITC Hotels – Luxury Collection

ITC Gardenia Hotel, Bangalore

ITC Hotels the greenest luxury hotel chain in the world with all its ten premium luxury hotels LEED (Leadership in Energy and Environmental Design) Platinum certified. The buildings namely: ITC Grand Chola in Chennai, ITC Maurya in Delhi, ITC Maratha in Mumbai, ITC Sonar in Kolkata, ITC Grand Central in Mumbai, ITC Windsor & ITC Gardenia in Bengaluru, ITC Kakatiya in Hyderabad and ITC Mughal in Agra and ITC Rajputana in Jaipur. The headquarters of the ITC's hotel business in ITC Green Center, Gurgaon as of 2004 statistics was world's largest LEED platinum rated office space. ITC Gardenia, Bengaluru is the first Indian Hotel and world's largest, to get the LEED Platinum rating.

4.5 Infinity Benchmark, Salt Lake City, Kolkata

Inaugurated in 2009, this 5,60,000 sq. feet of space spread over 20 floors was then only the 2nd building outside the US and the 7th in the world to receive a LEED Platinum rating. This building is equipped with CO₂ monitoring sensors, intelligent humidification controls, rainwater harvesting & waste water recycling systems. The building design reduces the overall energy costs by 30%.

4.6 Suzlon One Earth, Pune

This headquarters of India's largest green energy company truly lives up to the expectations. Suzlon one earth is 100% powered by onsite and offsite renewable sources. The campus has 18 hybrid wind turbines that fulfil 7% of the total energy consumption, the rest of energy demand is met from offsite wind turbines. 90% of the occupied spaces in the campus have daylight exposure, all the lighting used is also LED that reduces the overall consumption. Daylight sensors & occupancy sensors are installed across the building that automatically controls the artificial lighting in presence of daylight and turn off the lights when no one is around. More than 70% of the building material used has a reduced carbon footprint. Jet fans are installed in the basements that push out stale air and bring in fresh air from time to time, this systems consumes 50% less energy as compared to conventional ducted basement ventilation system. Even the pavements and roads within the campus are designed to enable water percolation and thereby control storm water runoff thus, contributing towards an increased water table level.

4.7 Patni (i-GATE) Knowledge Center, Noida

This Noida office of Patni (now i-gate) is one of India's largest LEED Platinum certified office space. The building design utilizes passive (architectural) and active (mechanical/electrical) strategies to minimize energy consumption. The building depth has been optimally designed to capture daylight for more than 75% of the occupied interiors. More than 95% of the occupied workspace in the building receives outdoor

view. Almost 50% of the land cover is green area and the building does not discharge any waste recycling all its sewage water.

IGBC has developed the following green building rating systems for different types of building in line and conformity with US Green Building Council. Till date, following Green Building rating systems are available under IGBC;

1. LEED India for New Construction
2. LEED India for Core and Shell
3. IGBC Green Homes
4. IGBC Green Factory Building
5. IGBC Green SEZ
6. IGBC Green Townships

Green Buildings	Rating received
ABN Amro Bank N.V., Ahmedabad	LEED 'Platinum' rated
American Embassy School, Delhi	LEED 'Gold' rated
Anna Centenary Library Building, Chennai	LEED 'Gold' rated
Biodiversity Conservation India Ltd (BCIL) – Bangalore	LEED 'Platinum' rated
Birla International School, Jaipur	LEED 'Gold' rated
CII – Sohrabji Godrej Green Business Centre	LEED 'Platinum' rated
ITC Green Centre – Gurgaon	LEED 'Platinum' rated
Olympia Technology Park – Chennai	LEED 'Gold' rated
Rajiv Gandhi International Airport – Hyderabad	LEED 'Silver' rated
Suzlon Energy Limited – global headquarter in Pune	LEED 'Platinum' rated

5. CONCLUSIONS

Green buildings are today the most widely used form of architecture. Creating green buildings is an important focus of building owners and even governments worldwide. In India some world class Green Buildings have constructed in past few years, but still the concept of green buildings for general masses is in infancy stage. Present work is an attempt in the direction to make people, communities and general public aware about the advantages of green buildings for sustainable environmental development and management.

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