

Green trends in civil engineering for feasible implementation in buildings

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Abstract- A Green Building is an environmentally sustainable building which is designed and constructed to operate and minimize the total environmental impacts. In this paper we are going to discuss on green technology to create a healthier environment for people to live and work, using various green building strategies. This paper concentrates on using renewable energy sources and recycling the used resources to meet the needs of present generation without depleting the resources to be met by the future generation. The various benefits offered by a green building and some tips to modify our house into a simple green building are explained in detail. The comforts that a green building provides us and how it helps in retaining the natural environment from depletion and destruction are also explained. In addition to the above a clear and detailed picture of the rating system of IGBC (Indian Green Building Council) followed in India namely the “LEED CONCEPT” with its categories for rating a green building is also explained along with some of the top rated green buildings in India and its special features are also highlighted. Statics showing emergence off green building concept is discussed.

Index Terms— LEED, IGBC, GRIHA, green building, etc.

I. INTRODUCTION TO GREEN BUILDING

Green Building (also known to be sustainable construction) is the practice of building structures using processes that are environment-friendly and resource-efficient throughout the lifetime of the building from design, construction, operation, maintenance, renovation till deconstruction. It uses less water, optimizes energy, helps in conserving our natural resources, generates less toxic waste and provides healthier spaces for living when compared with a conventional building.

II. WHY BUILD GREEN ?

- The buildings which we work, live and play, protect us from nature's extremes, but they also affect our health in countless ways thereby affecting the environment also.
- As the environmental impact due to buildings is becoming more apparent in the recent years, a new field called "green building technology" has started to gain momentum.
- In order to meet the needs of the present generation without compromising for future

generations, the green building strategy helps to meet the rising demand.

- By adopting green building strategy, we can maximize economic and environmental performance.

III. OBJECTIVES OF GREEN BUILDING

The common objective is that green buildings is to reduce the negative impact of the built environment on human health by:

- Efficient usage of energy, water, and resources
- Protecting the occupant health and improvising the employee productivity
- Reducing pollution and environmental degradation.
- Using environmentally preferable building materials and following strict specifications
- Waste reduction and recycling of materials
- Toxicity reduction
- Improving the indoor air quality which proves in healthier environments for people to live and work
- Provide natural daylight and thermal comfort.
- Smart growth and sustainable development.

IV. RATING METHODOLOGY

A building is green or not based on its rating. Certain norms are followed by different countries to rate the buildings. This rating shows the level off eco-friendliness of the building. This is achieved by allocating points to different aspects of the buildings such as water efficiency, innovation in design, materials and resources etc.

Some of the common rating systems followed:

- BREEAM (United Kingdom)[1]
- LEED(United States and Canada)[2]
- CASBEE (Japan)[3]

Green building codes and standards, such as the International Code Council's draft International Green Construction Code, are sets of rules created by standards development organizations that establish minimum requirements for elements of green building such as materials or heating and cooling

The IGBC (Indian Green Building Council) has licensed the LEED[5] (Leadership in Energy and

Environmental Design) Green Building Standard from the U.S. Green Building Council and currently is responsible for certifying Core and Shell buildings in India.

V. LEED CERTIFICATION

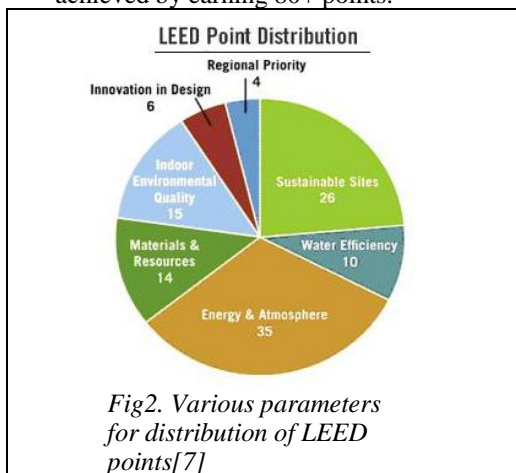
- The LEED rating system offers four certification levels such as Silver, Gold and Platinum that correspond to the number of credits obtained in design categories as given below:



fig2. The different certification levels in rating a green building [6]

Fig 1. Certification levels of LEED

- LEED certification for a building if it is awarded 40-49 points.
- If the building is awarded 50-59 points, then it is LEED Silver certified.
- If the building gets 60-79 points, then it becomes LEED Gold certified.
- A LEED Platinum certification can be achieved by earning 80+ points.



VI. SUSTAINABLE SITE SELECTION

- This includes that the selection of site should be near to other resources and populated areas.
- Extra credits will be awarded if the site re-uses land or existing buildings which were unused.
- The things that are to be considered are the site's access to mass public transportation and its ability to maximize open space thereby minimizing its impacts on the surrounding environment.

1) Water efficiency:

- Credits will be awarded for the buildings that effectively cut down water usage by installing rainwater collectors, low-flow plumbing fixtures and regulating the amount of water that is used for the whole day.
- In addition to that, points can be earned if a building can effectively recycle water and use it throughout the building.

2) Energy & atmosphere:

- It mainly concentrates on making the building more and more energy efficient by usage of energy-star approved appliances.
- Energy monitors and regulators can also cut down on the electricity to a particular extent. There are some ways in which passive wind and solar energy can be utilized which are renewable energy resources.

3) Materials & resources:

- Points will be awarded if a building can effectively use recycled products or materials and the materials that are thrown away.
- In addition to that, credits can be earned if the building resources come from a local company in the region, since the materials travel a smaller distance and the carbon-footprint and cost of shipping these materials to the site of the building is reduced.

4) Indoor environmental quality:

- It is important to be noted that indoor environmental quality is important for the health and morale of an occupant.
- By maximizing natural sunlight (daylight), air, the environmental performance that these workers work in is significantly impacted.
- Points will be awarded for minimizing the use of volatile organic compounds (VOC) in the construction of the buildings and for efficient insulation which decreases the need for heating and cooling systems.

VII. BENEFITS OF GREEN BUILDING

1) Environmental benefits:

- Enhances and protects biodiversity
- Improves the quality of air and water
- Reduces waste mixing in streams
- Conservation and restoration of natural resources

2) Economic benefits

- Reduces operating costs

- Increases the market demand for green products and services
- Improves the occupant productivity
- Optimize life-cycle economic performance

3) Social benefits

- Helps in enhancing occupant comfort and health
- Increases aesthetic qualities for the building
- Minimizes the strain on local infrastructure
- Improves the overall quality of habitation

4) Increased Comfort for Occupants

- Natural daylight
- Reduced temperature variation and thermal insulation
- Improved indoor air quality and ventilation

5) Help environment

- Reduced energy consumption
- Reduces emission of CO₂
- Reduce global warming

VIII. FEASIBLE TRANSFORMATION OF BUILDINGS TO IMPLEMENT GREEN CONCEPTS

This section provides simple strategies and solutions to implement some of the green concepts to our home

- Heating and Cooling
- Windows and Exterior Doors
- Lighting (daylight and skylights)
- Exterior Finishes
- Insulation and Weatherization
- Hot Water Systems
- Ventilation

1) Heating and Cooling

Simpler changes made in buildings, such as sealing the air ducts and installation of a programmable thermostat can improve the efficiency, performance and save your money. Installing a new energy efficient heating and cooling system such as ENERGY STAR and regular cleaning of your filter along with scheduled annual maintenance by a qualified contractor.

2) Ventilation

Providing ventilation such that natural fresh air flowing into a house can be a low-cost and potentially energy-efficient way to cool a home and maintain good indoor air quality. A ceiling fan can consume less electricity than a central air conditioner. Window fans ideology can also be implemented.

3) Passive solar cooling

To obtain natural shade during the warm months of the year, plant or retain the already existing shade trees on the west and southern side of your home.

Major design elements of passive solar heating and cooling will include:

- House orientation with south-facing windows.
- More number of trees for shading and wind break.

4) Lighting

There are many ways to reduce electricity consumption in your home using natural lighting (sunlight for day time) and other strategies such as selecting energy-efficient light bulbs (LED) and fixtures, and installing lighting control sensors to automatically turn lights on and off as per the usage.

5) Weatherization

Weatherization, in general, refers to cost-effective energy efficiency measures that would take care of the heat losses from the building and electricity loss due to consuming appliances. Some of the common weatherization techniques that are used for windows and doors include caulking and weather-stripping the leaky areas and installing of storm doors and windows

6) Hot Water Systems

As per a case study, water heating is the third largest energy consumption and expense in your home. It typically accounts for about 13% of the monthly bill. So, solar panels can be installed in order to effectively use solar energy for many purposes. One of the easiest ways to cut your water-heating bill is to insulate your hot and cold water pipes effectively.

7) Exterior Finishes

The exterior finish of a building adds aesthetic value to it and also prevents from air infiltration and water damage. During the selection of a finishing product, try to prefer recycled materials that are manufactured locally. High-maintenance materials (such as teak-wood) may be avoided to reduce repair and reduce costs. If you want to use paint on the exterior of your home, try to consider low-VOC (volatile organic compound)[9] products that will reduce air pollution.

Green Rating for Integrated Habitat Assessment [GRIHA]

GRIHA rating system is followed in India apart from LEED. It is categorized under various sections and consisting of 34 criteria such as Site selection, Building operation, Conservation of nature, efficient utilization of resources, Site Planning, and maintenance of buildings, and Innovation. 8 out of these 34 criteria are mandatory, 4 of these are partly mandatory, and the rest are optional. Levels of certification from one star to five stars are awarded based on the points that are earned. The minimum points to be required for certification is 50. All buildings except industrial complex and housing

sectors, which are in the designing stage, are eligible for certification under GRIHA.

- A project should be registered with ADARSH through the GRIHA website by filling the online registration form.
- Registration should preferably be done at beginning of a project, as several issues need to be addressed at the pre-design stage.
- The registration process includes access to the essential information related to rating. If desired by the applicant, a one-day training for the design team by ADARSH on the rating system is also included at a nominal additional cost.

IX. CONVENTIONAL VS GREEN MATERIAL

Table 1: Conventional Vs Green materials price comparison

CONVENTIONAL MATERIALS	PRICE
Cement concrete	3500 per cu.m
Clay bricks	Rs.6 per brick
O.P.C	10,080 per cu.m
Weathering course	Rs. 300 per sq.m
C.N.G	Rs.550 per cylinder
GREEN MATERIALS	PRICE
Pozzocrete	Rs. 4000 per cu.m
Fly ash bricks	Rs. 4 per brick
Bagasse cement	Rs. 14,050 per cu.m
Green roofing	Cheap and best
Electricity (solar panels)	Rs. 15 per KWh
Bio fuel (compost pit)	Rs. 15000 per cu.m

INFERENCE : Though the initial cost of construction is higher, the green materials will be cheaper to maintain and reduce the amount of carbon footprint in a long run.

X. CONCLUSION AND RECOMMENDATIONS

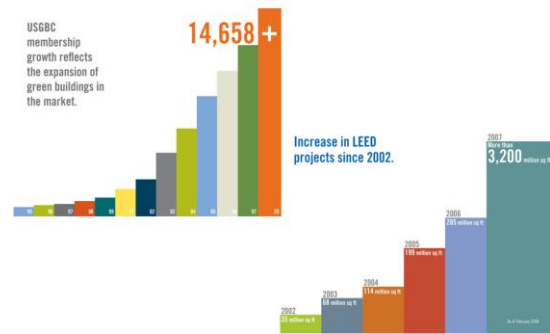
Statistics showing the growth of green building sector in recent years:



This bar graph released by the US government shows the increase in green building market value.

Inference - the building market value increase shows the increased demand for the green buildings

USGBC's Growth Trend



This bar graph shows the increase in green building phenomenon reflected in United States.

Traditional buildings consume more of the energy resources than necessary and generate a variety of emissions and waste. The solution to overcome these problems will be to build them green and smart. The main problem is that Green Building is “Too Expensive” to construct but hopefully reduces a large amount of degradation of our environment and retains its sustainability. We are in a world scenario where we can expect more and more green buildings in the future years. There is no doubt that green building technology has the aims to protect the environment in all possible ways. Moreover it is the sole responsibility of all the civil engineers to build an eco-friendly future by adopting green building concept.

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Author Profile



Raghavendra, V has completed his B.Tech in Civil Engineering and M.Tech in Structural Engineering from SASTRA University, Thanjavur, INDIA in 2014. He has worked with IISc, Bangalore on a project regarding Dynamic response of Underground Metro tunnel and also has done some research work on retrofitting using FRP techniques using MBC binders and analyzed it using ANSYS finite element software.