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3. Feasibility Analysis of Green Building

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Abstract:

Change in climate, caused by the release of greenhouse effect causing gases (primarily carbon dioxide) into the atmosphere, has been recognized as one of the greatest threats of the 21st century. Share of the global energy consumption in India and China has also been on the rise due to heavy industrialization, urbanization, population explosion, and intensive growth of IT.

Buildings are the prime energy consumers in modern cities accounting up to 40 to 45% energy consumption. Their consumption can be largely confined through improving efficiency, which is an effective means to lessen greenhouse gas emissions and slow down depletion of fossil fuels.

There is a heavy (over 50%) saving potential in the building sector and thus it is considered as a potential sector to meet the challenges of global energy demand and climate change. Along with the advent of energy efficient measures, more effective means are needed to induce or compel greater efforts, especially to the signatories of the Kyoto Protocol.

This technical paper highlights the importance of sustainable construction, discusses role of energy efficiency in green buildings in Indian context to reduce the energy consumption and environmental degradation through Green House Gas emission (GHG). Also it points out to the benefits of green construction as well as the incentives from govt. and municipal bodies for GRIHA certified green building.

Keywords: Green Buildings, LEED, GRIHA.

3.1 Introduction:

Buildings are a major energy consuming sector in the economy. About 35 to 40% of total energy is used by buildings during construction. The major consumption of Energy in buildings is during construction and later in lighting or air-conditioning systems. This consumption must be minimized. Possibly, this should be limited to about 80-100 watts per sqm. The building construction industry produces the second largest amount of demolition waste and greenhouse gases (35-40%). While, various amenities like lighting, air conditioning, water heating provide comfort to building occupants, but also consume enormous amount of energy and add to pollution. Further, occupant activities generate large amount of solid and water waste as well. The recent trend toward sustainable buildings is obvious in new construction as architects and contractors focus on using green techniques in the building process – as well as making sure the building follows eco-friendly standards in its usage. Renovations and additions follow this same concept. There are steps to be taken to make existing buildings follow the same opportunities of green living that are expected from new buildings.

3.2 Concept:

A feasibility study is an assessment of the practicality of a proposed project or system. A feasibility study aims to objectively and rationally uncover the strengths and weaknesses of an existing business or proposed venture, opportunities and threats present in the natural environment, the resources required to carry through, and ultimately the prospects for success. In its simplest terms, the two criteria to judge feasibility are cost required and value to be attained. A well-designed feasibility study should provide

a historical background of the business or project, a description of the product or service, accounting statements, details of the operations and management, marketing research and policies, financial data, legal requirements and tax obligations. Generally, feasibility studies precede technical development and project implementation. A feasibility study evaluates the project's potential for success; therefore, perceived objectivity is an important factor in the credibility of the study for potential investors and lending institutions. It must therefore be conducted with an objective, unbiased approach to provide information upon which decisions can be based. A Green Building uses less energy, water and other natural resources creates less waste & Green House Gases and is healthy for people during living or working inside as compared to a standard Building.

3.3 Solutions Provided:

a. **Exterior Solutions:** Following are the exterior solutions which can be provided easily.

b. **Green Roofs:** Green roofs reduce the temperature of the building and the surrounding air in multiple ways: Shading: They provide shade to the top of a building. Evapotranspiration: the plants in a green roof absorb water through their roots, and then use surrounding heat from the air to evaporate the water.
While some roofs can reach temperatures of up to 90°F in the summertime, these two features can allow green roofs to actually be cooler than the surrounding air temperature! This in turn mitigates the urban heat island effect. Multiple layers work together to produce a green roof's high efficiency and quality:

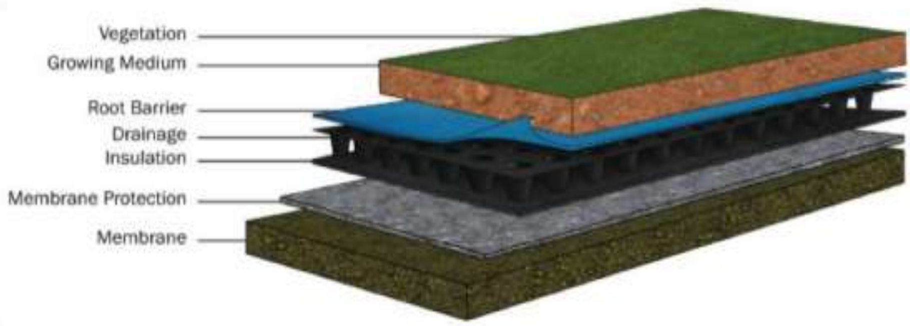

Fig 3.1 Green Roofs

c. **Vegetation:** The top layer of a green roof consists of vegetation. Chosen plants should be based on the type of roof, surrounding climate, and condition of the building. For flatter roofs and stronger buildings, taller and heavier vegetation can be used. Lighter and shorter vegetation is recommended for slanted roofs.

a. **Growing Medium:** The growing medium is the foundation for all the vegetation on the top later. The medium type, mixture and depth area all depend on the plants chosen for the green roof. A wind erosion layer, commonly made of burlap jute blankets, can also be installed to prevent wind from blowing top soil off the roof.

b. **Root Barrier:** Root barriers are associated with deep-rooted plants such as trees and shrubs. A root barrier prevents roots from reaching the membrane on the bottom layer, 4 which when punctured, could potentially cause roof leaks and decay. Common materials used for this layer are foil or plastic.

c. **Drainage:** A drainage layer is installed to adequately remove excess water from a green roof. Green Roof Solutions states that drainage systems are designed to ensure storm water can be used by the top plants for extended periods of time without oversaturation of the entire green roof system. Note that this layer can also be found above the root barrier layer as well.

d. **Insulation:** The insulation layer is the protector of the membrane layer below. The insulation prevents the weight of the green roof from crushing the insulation and impairing the membrane. A light weight extensive green roof can include insulation below the membrane.

e. **Membrane Protection:** The roof's membrane needs protection to prevent deterioration. The protective layer can be a slab of lightweight concrete, insulation, thick plastic, copper foil or any combination of these.

f. **Membrane:** A membrane is the bottommost layer of a green roof, and is the main separation between the green roof above and the structural supports below. Due to the excessive water amounts associated with green roofs, the membrane must be strong enough to support this water weight and to not let it seep through.

g. **Building Materials-** Concrete is a material that quite literally holds our cities together. From homes and apartment buildings to bridges, viaducts, and sidewalks, this ubiquitous gray material's importance to modern urban life is undeniable. But you might have heard that it also has a dirty secret: the production of commercial concrete materials releases tons of the greenhouse gas carbon dioxide (CO_2) into the atmosphere each year, contributing to the calamity that is climate change.

h. **Grasscrete:** As its name might indicate, Grasscrete 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 perk — improved storm water absorption and drainage.

i. **Bamboo:** Bamboo might seem trendy, but it has actually been a locally-sourced building material in some regions of the world for millennia. What makes bamboo such a promising building material for modern buildings is its combination of tensile strength, light weight, and fast-growing renewable nature. Used for framing buildings and shelters, bamboo can replace expensive and heavy imported materials and provide an alternative to concrete and rebar construction, especially in difficult-to reach areas, post-disaster rebuilding, and low-income areas with access to natural locally-sourced bamboo

3.4 Rainwater Harvesting:

Rain water harvesting is collection and storage of rain water that runs off from roof tops, parks, roads, open grounds, etc. This water run off can be either stored or recharged into the ground water. A rainwater harvesting systems consists of the following components:

- catchment from where water is captured and stored or recharged,
- conveyance system that carries the water harvested from the catchment to the storage/recharge zone,
- first flush that is used to flush out the first spell of rain,
- filter used to remove pollutants,
- storage tanks and/or various recharge structures.

a. **Interior Solutions:** The following are the interior solutions that must be provided in a building.

b. **Flooring:** There exists an even wider selection of flooring materials today than ever before. The most common include wood, bamboo, tile, vinyl, linoleum, and carpeting. When it comes to building green, not all of these materials are equal. For instance, vinyl flooring, like other PVC products, is made of petroleum, is not recyclable, and tends to off-gas harmful chemicals. Most carpeting is currently made from nylon, another petroleum-based product. Neither vinyl nor nylon is biodegradable. Stone flooring is durable but non-renewable and requires a large amount of energy for extraction, transport, and installation. Bamboo and cork- Bamboo and cork are rapidly renewable alternatives to hardwood. Bamboo is harder than hardwood, while cork is softer but just as durable as wood.

c. **Lighting Strategies:** Daylight, a free resource, is the first factor to consider. Some spaces can be lit entirely with day lighting methods. Thoughtfully arrange rooms and partitions so that most occupants spend the majority of their time in daylight areas. In office buildings, this can be accomplished by grouping private rooms in the centre and locating open offices around the perimeter to allow daylight to penetrate more of the building. Skylights and solar tubes can also be used to bring light into otherwise dark areas in top 7 floors. When designing a building to take advantage of day lighting, it is important to implement proper window shading to reduce glare and unwanted heat, while also allowing light to enter.

d. **Building Insulation:** Insulation is not the most attention grabbing building component, but it is essential to both the performance of the building and health of the occupants. Without sufficient insulation, large portions of the energy used to heat or cool a building will be lost to the outdoors.

Insufficient insulation can also lead to mild problems as heated air rapidly cools and causes water vapour to condense. Historically, 8 mud, asbestos, and cork were used as insulation materials for buildings and pipes. The insulation products available today are much more effective, especially in conjunction with air sealing and ventilation.

e. Fly ash Bricks: These bricks do not absorb heat, they reflect heat and gives maximum light reflection which causes less heating of huge structures. It provides an acceptable degree of sound insulation. The sound produced at one side of a wall made using Fly Ash bricks do not let the sound waves pass easily to the other side of the wall due to its compactness. Hence they may be considered for the abatement of the noise pollution. Double Glass System- An insulated glass unit (IGU) combines multiple glass panes into a single window system. Most IGUs are double glazed (two panes of glass) with three panes (triple glazing) or more becoming more common due to higher energy costs. The panes of glass in IGUs are separated by a spacer and a still layer of air or gas. The glass is then fitted into window frames, which is made wider to accommodate the two panes. Double glazed windows are an ideal energy efficient choice with the added benefit of minimizing noise.

3.5 Energy Rating System:

3.5.1 LEED Leadership in Energy & Environmental Design:

LEED Leadership in Energy & Environmental Design is an internationally recognized green building certification system and standard. It delivers third-party verification that a space was designed and built using best-in-class strategies to address its entire life cycle.

Developed by the U.S. Green Building Council (USGBC), of which GBA is a chapter, LEED provides building owners and operators with a concise framework for identifying and implementing practical and measurable green building design, construction, operations, and maintenance solutions.

LEED can be applied to all building types – and even to entire neighbourhood. Projects can earn any of four levels of certification based on the number of points they achieve:

Fig 3.2 Energy Rating System

All of the LEED rating systems address five main credit categories for certification and, within each of them, projects must satisfy prerequisites and earn points.

The number of points a project earns determines its level of certification:

3.5.2 Main Credit Categories:

a. Sustainable sites credits encourage strategies that minimize the impact on ecosystems and 10 water resources. (14 possible points total)
b. Water efficiency credits: It promote smarter use of water, inside and out, to reduce potable water consumption. (5 possible points total)
c. Energy & atmosphere credits: It promote better building energy performance through innovative strategies. (17 possible points total)
d. Materials & resources credits: It encourage using sustainable building materials and reducing waste. (13 possible points total)
e. Indoor environmental quality credits: It promote better indoor air quality and access to daylight and views. (15 possible points total)

3.5.3 Teri-Griha:

Formed by The Energy and Resources Institute (TERI), INDIA, it identifies projects that have demonstrated a commitment to sustainability by designing, constructing or owning a building to a determined standard. TERI (GRIHA) certification system consists of 34 criteria of the rating under 4 categories namely site selection and planning, building planning and construction, building operation and maintenance, innovation. Within each category, the credits awarded have an effective weightage by virtue of the numbers of credits awarded versus the total credits available. Different levels of certification (one star to five star) are awarded based on the number of points earned. The minimum points required for certification is 50. Building scoring 50 to 60 points, 61 to 70 points, 71 to 80 points, and 81 to 90 points will get one star, two stars, three stars and four stars respectively. A building scoring 91 to 100 points will get the maximum rating i.e. five stars.

3.6 Case Study:

(**CII-Godrej GBC**) The CII-Sohrabji Godrej Green Business Centre (CII-Godrej 11 GBC) is a unique and successful model of public-private partnership between the Government of Andhra Pradesh, Pirojsha Godrej Foundation and the Confederation of Indian Industry (CII), with the technical support of USAID.

The 1 858m2 building consists of an office building, a seminar hall and a Green Technology Centre, displaying the latest and emerging green building materials and technologies in India. The building was the first LEED [6] Platinum-rated building for New Construction (NC) outside of the US and a large number of visitors tour the building to view its green features annually. According to the Indian Green Building Council, the CII-Godrej GBC building “marked the beginning of the Green Building movement in India.”

- **Green Initiatives:**

PEDA Punjab Energy Development Agency (PEDA), Chandigarh is a state nodal agency responsible for development of new & renewable energy and non-conventional energy in the state of Punjab.

Solar Passive Complex, Chandigarh is a unique and successful model of Energy Efficient Solar Building, designed on solar passive architecture with the partial financial support of Ministry of New & Renewable Energy, GOI and Dept. of Science, Technology, Environment and Non-Conventional Energy, Govt. of Punjab.

It is setup at Plot No. 1 & 2, Sector 33-D, Chandigarh. Architectural building design needs to respond to the composite climatic context of the site. The final design solution needs to satisfy the diverse and often conflicting conditions of a hot-dry, hot-humid, temperate and cold period of Chandigarh.

3.7 Green Initiatives:

a. Architectural Design:

- This building has a 3 Dimensional form responding to solar geometry i.e., minimizing solar heat gain in hot dry period and maximizing solar heat gain in cold period.
- Overlapping floors at different levels in space floating in a large volume of air, with interpenetrating large vertical cut-outs enclosed within an envelope. These are integrated with light wells and solar activated naturally ventilating, domical structures.
- On the south western facade, dome shaped concrete structures have horizontal and vertical intersecting fins with glass fixed in the voids to allow natural light with reduced glare.
- These allow indirect light to enter the building in summers and direct sunshine in winters.

b. Thermal Comfort:

- The envelope attenuates the outside ambient conditions and the large volume of air is naturally conditioned by controlling solar access in response to the climatic swings during summer and winters.
- The large volume of air is cooled during the hot period by a wind tower, integrated into the building design, and in cold period this volume of air is heated by solar penetration through the roof glazing generating a convective loop.
- The thermal mass of the floor slabs helps attenuate the diurnals swings.

c. Orientation:

- Solar Passive Complex has been developed in response to solar geometry i.e. minimizing solar heat gain in cold period.
- The building envelope attenuates the outside ambient conditions and the large volume of air is naturally conditioned by controlling solar access in response to the climatic swings.

d. Shell Roof:

- The Central atrium of the complex having main entrance, reception, water bodies, cafeteria and sitting place for visitors constructed with hyperbolic shell roof to admit daylight without glare and heat coupled with defused lighting through glass to glass solar panels.
- The roof is supported with very light weight space frame structure.

3.8 Advantages:

The world over, evidence is growing that green buildings bring multiple benefits. They provide some of the most effective means to achieving a range of global goals, such as addressing climate change, creating sustainable and thriving communities, and driving economic growth.

Highlighting these benefits, and facilitating a growing evidence base for proving them, is at the heart of what we do as an organisation.

Following are some of the major advantages of using a Green Building:

- **a.** Green buildings are designed to be healthier and having more enjoyable working environment. Workplace qualities that improve the environment and which help in developing the knowledge of workers and may also reduce stress and lead to longer lives for multidisciplinary teams.
- **b.** Reduced energy and water consumption without sacrificing the comfort level.
- **c.** Significantly, better lighting quality including more day lighting, better daylight harvesting and use of shading, greater occupancy control over light levels and less glare.
- **d.** Improved thermal comfort and better ventilation.
- **e.** Limited waste generation due to recycling process and reuse.
- **f.** Increase productivity of workers and machines. It is reported that productivity can be increased by about 25% while following such greenhouse norms.
- **g.** Green building activities result in reduction of operating costs by 25-30%.

The benefits of green buildings can be prominently grouped within three categories: environmental, economic and social.

3.8.1 Economic:

- **a.** Reduced costs for site preparation, building materials, and operational costs through sustainable siting
- **b.** Added market value of buildings
- **c.** Enhanced water efficiency practices leading to reduced annual water costs and municipal wastewater treatment costs
- **d.** Increased local economic development opportunities
- **e.** Enhanced energy efficiency practices leading to reduced peak power demand, reduced demand for new energy infrastructure, lower energy costs to consumers, and up to 70 percent lower annual fuel and electricity costs

3.8.2 Social:

- **a.** Equitable access to infrastructure services, such as transportation
- **b.** Fewer waste water sources
- **c.** Fewer new power plants and transmission lines in community
- **d.** Expanded market for environmentally preferable products
- **e.** Improved occupancy satisfaction, comfort, and individual productivity

3.8.3 Environmental:

a. Assist in the conservation of environmental resources, while also reducing pollution levels, greenhouse gas emissions, and waste. The report cites a 2007 United Nations Environmental Program (UNEP) study which estimates that sustainable design and green buildings could result in as much as 1.8 billion tones/year of averted carbon dioxide emissions worldwide.
b. Increased land preservation, lower resource and energy use, and the protection of ecological resources.
c. Preservation of water resources for wildlife and agriculture.
d. Lower electricity and fossil fuel use and decreased impacts of fossil fuel production.
e. Improved indoor air quality and, in turn, reductions in air pollution levels.

3.9 Conclusions:

In today‘s era where energy crisis is a major problem, green buildings gives a brilliant and promising solution. These are 20 designed to use minimum energy.

All the systems for cooling, heating, ventilating are designed such that they require very less energy. The IGBC has adopted the LEED rating system for evaluating green building performance in India.

The payback period for existing green buildings range from two to seven years, depending upon their certification level. The key challenges for the development of green buildings in India are mostly in the lines of awareness on the benefits of green buildings, green materials and technology.

The CII-IGBC and other professionals are working towards addressing these challenges to enable developers to operate with ease. Green building is a boon to the society where energy and water consumption can be reduced while still maintaining an increase in productivity for occupants, their health, safety and wellbeing.

In today ‘s era green buildings are essential as environmental balance is important for survival and further development of human beings, but first people have to be made aware not to see green buildings as an extra monetary burden. Green buildings are only way to a sustainable tomorrow.

Improving the quality of life is a goal we all dream for, which can be achieved by using natural resources responsibly. Green building concept includes smart approach for the saving of energy; it saves our water resources and helps us for minimizing wastages and maximizing reuse.

Green building concepts emphasizes in to improving health and wealth of the society and more importantly connects us with nature. It helps for creating jobs, value of resources used, increases energy efficient way and adds financial benefits for the society.

Green building 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.

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