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A Step towards Sustainable Environment for Better Tomorrow

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Abstract: -- **Sustainability is a process in which the design, planning and construction are done in such a way that it minimizes the total environmental impact while enhancing user comfort and productivity. This paper mainly focuses on the achievement of CII - Sohrabji Godrej Green Business Centre (CII Godrej GBC), the first LEED platinum rated building in India, in the field of sustainability with the combination of high tech innovative techniques and efficient resource using methods. The paper describes the effective implementation of the sustainability parameters in the building such as incorporating traditional concepts into modern and contemporary architecture like extensive landscaping, incorporating solar PV systems, indoor air quality monitoring, a high efficiency HVAC system, a passive cooling system using wind towers, high performance glass, aesthetic roof gardens, rain water harvesting, and root zone treatment system which reduces adverse effects of the building on environment. As a result, CII Godrej GBC gasconades a 50% saving in overall energy consumption, 35 % reduction in potable water consumption and usage of 80% of recycled/recyclable material, which is much more as compared to the conventional green building [1].**

The paper also emphasizes on how these techniques and methods can be implemented in every commercial or residential building at small or large scale, which will not only improve the present environmental conditions of the country to a large extent but also reduce the exploitation of natural resources.

***Index Terms*:--sustainability, environmental impact, green building, and resource utilization.**

I. INTRODUCTION

Since 1950s, the world has experienced unprecedented growth including intensive farming, a technological revolution and a massive increase in the power needs which is putting on a greater pressure and strain on the planet's resources. The world population is growing at a rate of around 1.13% per year. With the increasing rate of urbanization, it is found that urban centers consume a lot more resources than the rural centers for various purposes. The conventional energy sources are being exploited at a tremendous rate and are on the verge of extinction. Tons of waste is generated everyday across the world, with no proper management system to dispose it off. Over exploitation of resources, degradation of environment, increasing global warming has led to climate change, which is the most urgent issue affecting the whole planet currently. The concept of sustainable development has grown out of concerns about these trends.

The concept of sustainable development emerged in the 1980s as a response to the destructive social and environmental effects of the prevailing approach to economic growth. Sustainability is meeting the needs of today's population without harming the ability of future generations to meet their own needs. Also, it can be defined as a process in which the design, planning and construction are done in such a way that it minimizes the total environmental impact while enhancing user comfort and productivity. Globally, buildings are responsible for approximately 40% of the total world annual consumption. Energy consumption in buildings can be reduced by passive measures such as provisions for natural lightning and ventilation that will reduce the primary energy demands and exploitation of renewable resources which will reduce dependency on fossil fuels.

This paper presents a case study on CII – Sohrabji Godrej Green Business Centre (CII Godrej GBC) which is the first LEED Platinum Rating in India in 2003. The paper describes various sustainable aspects implemented in the building to achieve economic and social development without neglecting environmental protection.

II. DETAILS OF THE CASE STUDY

CII – Sohrabji Godrej Green Business Centre (CII Godrej GBC) was undertaken by The Government of Andhra Pradesh in partnership with Pirojsha Godrej Foundation and the Confederation of Indian Industry (CII). It is a commercial building consisting of office buildings, research labs and conference rooms, is nestled

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close to Shilparamam, Hyderabad. The building is located near the main road for easy access and also near public transport stations to ensure minimum use of vehicles and reduce pollution. The climate is tropical wet and dry. The average temperature during summer is around 40^{o}C and during winters is 16^{o}C& the humidity also shoots up so there is a need of proper air-conditioning. In order to manage the temperature variations various measures are taken.

III. SUSTAINABLE DESIGN APPROACH

3.1 Sustainable Site:

The building design was conceived to have minimum disturbance to the surrounding ecological environment. The disturbance to the site was limited within 40 feet from the building footprint during the construction phase. This has preserved the majority of the existing flora and fauna and natural micro- biological organism around the building. Extensive erosion and sedimentation control measures to prevent topsoil erosion have also been taken at the site during construction.

3.2 Circular Form of Structure:

The circular form of structure gives maximum Orientation to the sun for optimum solar gain & provides limitless flexibility of Design and & Layout. Approximately 25% less exterior surface area is exposed to the weather and possible heat losses. It also provides unlimited circulation of air.The circular structure is at least 10 times stronger than conventional square construction &circular footprint creates approximately 25% more square footage than a square building, using the same amount of materials.

IV. SUSTAINABLE FEATURES

4.1 Water Conservation

4.1.1 Water-efficient Strategies

Water usage is reduced by over 35% with water efficient strategies such as Rain Water harvesting, swales for storm water collection, water-less urinals in men's restroom, water-efficient fixtures: ultralow and low flush fixtures. Root Zone Treatment is one of the most innovative and eco-friendly wastewater treatment methods. It makes use of biological and physical-treatment processes to remove pollutants from wastewater. The treated water meets the Central Pollution Control Board (CPCB) norms and is used for landscaping.

4.1.2 Rain Water Harvesting

For rainwater harvesting they have provided permeable grid pavements and planted lots of trees on the open land, which directly gets rainwater. Some rainwater goes into soil by permeable grid pavements and increases ground water table. Remaining rainwater follows existing flow patterns in the site and at the end meets the water pond.

4.2 Storm Water Management

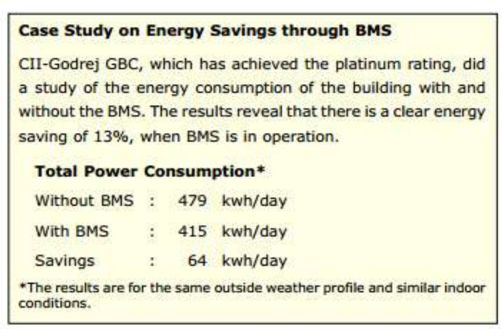
For proper functioning of every site it must have proper storm water management system, which drains and dries the site in less amount of time. Rainwater channels are constructed along the slope of site so that all storm water gets collected in it and flows along the slope in the channel and ultimately discharges in storm drains.

4.3 Energy Conservation

Buildings have a significant impact on energy use and environment. The local climate impacts the appropriate integration of said improvements and the resulting savings from energy efficient designs. The cost-effective energy efficiency improvements reduce a building's carbon footprint. The building is LEED certified which saves energy (18–39%) but with a large variation across individual buildings. Between 28% and 35% of building actually use more energy per square foot than a comparable non-LEED building [4].

4.3.1 Building Management Systems

State-of-the- art Building Management Systems (BMS) were installed for real-time monitoring of energy consumption as shown in Fig.1.


Case Study on Energy Savings through BMS

CII-Godrej GBC, which has achieved the platinum rating, did a study of the energy consumption of the building with and without the BMS. The results reveal that there is a clear energy saving of 13%, when BMS is in operation.

Total Power Consumption*

Without BMS	:	479	kwh/day
With BMS	:	415	kwh/day
Savings	:	64	kwh/day

*The results are for the same outside weather profile and similar indoor conditions.

Fig.1 Energy Savings through BMS (source: www.asiabusinesscouncil.org)

4.3.2 Lighting

The windows & other openings are mainly faced towards north direction due to which there is maximum day lighting. The North side of building has large windows, while the South side has smaller

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window. This optimizes the heating/cooling systems by not having to turn on the air conditioning in the afternoons. Energy-efficient lighting systems was achieved using compact fluorescent light bulbs (CFLs).The Courtyards acts as "Light Wells" which illuminate the adjacent work areas due to which no lights are used until late evenings. Jali or lattice walls are used to prevent glare and heat again while ensuring adequate day lightning and views.

4.3.3 Occupancy Sensors

There are occupancy sensors throughout the facility that turn off the lights when there is no activity in those areas to reduce the electricity used.

4.3.4 Indoor Environment Quality Control

Indoor air quality is continuously tracked and a minimum fresh air is pumped into the conditioned spaces at all times. The two wind towers facilitate the building with fresh air throughout the day. The use of low volatile organic compound (VOC) paints and coatings, adhesives, sealants, and carpets also helps to improve indoor air quality by reducing the emissions released. Natural light deflection systems can direct light deep into the room and ensure better natural lighting provisions.

4.3.5 Solar Energy

The solar panels are placed on the eastern side, which helps production of energy throughout the day and as it is a commercial building more amount of energy is consumed during the working hours compared to the evenings. Solar air-conditioning refers to any air conditioning (cooling) system that uses solar power.This can be done through passive solar, solar thermal energy conversion and photovoltaic conversion (sunlight to electricity). Solarair conditioning might play an increasingrole in zero-energy and energy-plus buildings design. By harnessing the solar energy 20% of the buildings energy requirement is catered. The solar PV has an installed capacity of 23.5KW. Average generation is 100-125 units per day. Air-Conditioning System Efficiency is 0.8KW/ton[6].

4.3.6 Energy-efficient Strategies

The use of aerated concrete blocks for facades reduces the load on air-conditioning by 15-20%. Double-glazed units with argon gas filling between the glass panes enhance the thermal properties. Use of eco-friendly electric car for transport and travelling within the premises helps in preventing pollution. Using such techniques they plan to save 120,000KWh/year[6].

4.3.7 Cooling Systems

They have used water-cooled scroll chiller, HFC-based refrigerant in chillers & secondary chilled water pumps installed with variable frequency drives (VFDs).

4.3.8 Wind System

A wind catcher or wind scoop, a traditional Persian architectural element is used to create natural ventilation in buildings. Energy savings are achieved by the GBCs two wind towers. Air, cooled at 8^oC, is supplied to the Air Handling Unit, substantially reducing the load on the air conditioning system. A heavily insulated roof further reduces the cooling load. Wind Deflectors are installed in the facility due to the warm and humid climate ventilation becomes very essential; cross- ventilation becomes the major solution. This can be overcome by providing ridge ventilation or ventilation ducts or shafts for deeper rooms. The Energy Efficiency Index (EEI) is 84 KWh/m^2/year**[6].**

4.4 Materials & Resources

The materials used for construction purpose were of sustainable nature. 66% (by cost) of the material were sourced within a radius of 800km of this, 95% of the raw material was extracted or harvested locally[1]. Bagasse Board a substitute of plywood or particleboard was used as it has a wide application in making partitions, furniture etc. Low Volatile Organic Compound (VOC) paints have been used.Fly Ash Bricks were used which are lighter than clay bricks, have high strength, practically no breakage during transportation. Low water penetration, which considerably reduces seepage of water through bricks. 65% walls in GBC are constructed with this material hence reducing 20% cost of brick manufacturing[1]. Eco-friendly method does not involve any harm to timbers, unlike plywood.

4.4.1 Recycling of Material

An impressive 77 % of the building materials used are recycled in the form of fly ash, broken glass, and broken tiles, recycled paper, recycled aluminum, cinder from industrial furnaces, bagasse, mineral fibers, and cellulose fibers, and quarry dust.All of the new wood used was sustainably harvested, as certified by the Forest Stewardship Council. Reuse of construction waste stone in paving the gardens. Reuse of a significant amount of material salvaged from other construction sites like toilet doors, interlocking pavement blocks, stone slabs, and scrap steel, scrap glazed tiles, shuttering material and the furniture in the cafeteria. A large amount of energy and pollution was also reduced through choices in the production and transportation of building materials. A waste management plan ensured that 96% of construction waste was recycled. More than 50% of the construction waste is recycled within the building or sent to other sites and diverted from landfills[3].

V. GREEN FEATURES

5.1 Ground Hugging Construction

The concept of Ground Hugging Construction (one of the olden system of construction) is applied in the building which ensures natural modulation of microclimate and creates more interaction with nature and gives a sense of being close to nature.

5.2 Ground Covers

Conventional grass lawn consumes a large amount of water during summer. Excess growth of grass requires cutting using fuel-powered mover, which increases pollution. To counter this issue, Sohrabji Godrej GBC has replaced the use of grass with groundcovers. Adding mulch between plants not only holds the soil but also breaks the impact of heavy rainwater flow and prevents soil erosion. Unlike grass, it doesn't require fertilizers and pesticides. It also helps retaining moisture and acts as nutrient-fixing agent in the soil.When combined with plants and gravel stone creates a natural landscape with well-defined pathways and aids weed control.Thus, utilizing ground covers over grass has helped transform the lawn into sustainable, aesthetic and show area with comparatively lesser maintenance.

5.3 Earth Sheltering

The expression 'Earth-sheltering' is a generic term which refers to building design in which soil plays an integral role in the building's thermal control system. It's an old construction technique in which earth is used against building walls for external thermal mass. Earth sheltered house are less susceptible to the impact of external temperature variations than conventional houses. It ensures the indoor occupant comfort by cooling. The building's roof area is covered with soil and greenery which accounts for around 11,000 sq. feet accompanied by 24 KW capacity Solar Photo Voltaic panels. Green roofs enhance biodiversity, storm water management and reducing heat island effect (Heat island is an effect in which temperature of an area is comparatively much higher than the surrounding). Vegetation that was lost to the built area was recovered by 55% of the roof garden[1].

5.4 Vegetative Cover

Most of the natural vegetation was preserved during the construction phase. Vegetation that was lost to the built area was recovered by 55% of the roof garden. After the completion of construction, plantation of new vegetative species was encouraged. Moreover, plantation of native species of trees and shrubs was emphasized as they require less water and have more adaptability to the climate. Today, the site is home to more than 160 different species of vegetation

VI. CONCLUSION

The paper presents a case study depicting the importance of identifying and incorporating various sustainable aspects in any building that can contribute towards a socio-economic growth without disturbing the existing ecological balance. For example, it is observed that 88% of light energy savings, 55% of vegetated roof area to compensate for the vegetation loss, 35% reduction of municipally supplied potable water due to provision of water management, 95% of the raw material extracted or harvested locally, 77% use of the recycled building materials, and 96% of recycle of construction waste due to proper waste management plan was achieved in the project presented in the paper[5].Implementing these techniques and methods in every commercial or residential building at a small or large scale will improve the present environmental conditions of the country to a large extent and will also reduce the exploitation of natural resources.

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