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RESEARCH ARTICLE OPEN ACCESS

Rejuvenating Existing Building – A Sustainable Approach towards Green.

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ABSTRACT
The concept of Green Building has gained a tremendous role in modern construction. It reduces the environmental footprint and provides a healthy environment for the occupants. Various innovative technologies and building materials available in the market make the construction of greener buildings easier. This paper looks into the different methods that can be adopted to convert an existing building into a green building.
Green Rating for Integrated Habitat Assessment is an initiative by the Government of India to promote and implement Green and Sustainable practices across the country. The existing department building of College of Engineering Kidangoor is evaluated based on the criterion mentioned in GRIHA and possible renovations are suggested to improve the rating. The suggestions include Rainwater Harvesting System, Modern HVAC System, Vertical gardening, Greywater Treatment System, Onsite Waste Collection and Segregation methods, etc. which comes under sections such as Water, Energy, Human Health and Comfort, Maintenance and Housekeeping, etc... The suggested renovations lead to an energy-efficient and self-sufficient building with long-term benefits.
Keywords **-** Greywater treatment, Green Building, GRIHA, Rainwater Harvesting, Vertical Gardening.

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I. INTRODUCTION

Green building is a structure that uses renewable energy and resources utmost effectively, making a negligible impact on the surrounding environment throughout its life-cycle that is from planning to renovation.

Existing buildings can also be modified to reduce their primary water and energy demands, which improves the performance of the building and make a sustainable living. During the entire procedure, careful monitoring is required to improve its performance in an economic way. With the growing stock of buildings, the potential for enhancing resource efficiency in existing buildings is an opportunity to reduce consumption, optimize operational & maintenance costs, and provide indoor comforts to the occupants. Different rating methodologies and retrofit methods have been developed in the recent past. [1] Amongst them, GRIHA existing building rating system has been prudently designed to suit Indian codes and bylaws. Buildings that are awarded a GRIHA rating will get benefits from local authorities in terms of tax benefits. Also, they get tangible benefits in terms of increased comfort, reduced costs, and energy conservation as well as the green environment. All types of buildings like offices, institutional buildings, hotels, hospitals, residences, apartments, etc., can apply for certification that is provided by GRIHA for Existing Buildings. [5]

II. OBJECTIVE

As per the study conducted on the campus building located in Kidangoor, Kerala it was found that various parameters have to be added to the existing building so as to fulfill the GRIHA criterion. Hence the following objectives are drawn:

- Rainwater harvesting system
- Provision for waste water treatment.
- Design of parking area.
- Providing suitable air-conditioning systems.
- Providing suggestions for on-site waste collection and segregation.
- Vertical garden.

III. GRIHA FOR EXISTING BUILDINGS

The GRIHA for Existing institutions is developed as a framework to evaluate and rate the environmental performance of existing institutions across India. The rating intends to develop a

dynamic attitude amongst the students and staff to reduce their environmental footprint and adopt a greener lifestyle.

India's National Rating System on Green Buildings - GRIHA (Green Rating for Integrated Habitat Assessment) has been endorsed by the MNRE (Ministry of New and Renewable Energy), Govt. of India which is suited for all kinds of building in various climatic zones of the country. By its qualitative and quantitative assessment criteria, GRIHA assesses a building on the level of its greenness. The rating is applicable for new as well as existing buildings, may be of any nature – residential, commercial, or institutional. [5]

GRIHA for existing building consists of 12 criteria divided into seven sections:

- Site Parameters
- Maintenance & Housekeeping
- Energy
- Water
- Human health & comfort
- Social aspects
- Bonus points

III.I. POINTS FOR GRIHA

GRIHA certification is given in the form of stars (1 to 5 stars) depending upon the number of points scored. Minimum 25 points are required for certification. Core points are obtained on fulfillment of mandatory criteria while remaining are scored after fulfillment of compliances promised during the inspection.

Table 1: Maximum points for various sections as per GRIHA [5]

POINTS DISTRIBUTION	
SECTIONS	POINTS
Site Parameters	6
Maintenance & Housekeeping	17
Energy	35
Water Efficiency	25
Occupant Health & Comfort	12
Social Aspects	5
Bonus Points	4
TOTAL	100

Table 2: Star rating distribution as per GRIHA [5]

RATING DISTRIBUTION	
STAR RATING	POINTS
1 STAR	25-40
2 STAR	41–55
3 STAR	56–70
4 STAR	71–85
5 STAR	Above 86

IV. METHODOLOGY

The following methodologies have been adopted.

IV.I. RAINWATER HARVESTING SYSTEM

Rainwater harvesting (RWH) is that the gathering and storage of rainwater, rather than allowing it to flow away. Rainwater is collected from the rooftop and is redirected to a tank, cistern, deep pit, aquifer, or reservoir. Rainwater harvesting differs from storm water harvesting because the runoff is collected from the rooftops instead of creeks, drains, roads, or other land surfaces. It is used for day-to-day purposes like watering gardens, livestock, irrigation, and domestic use with proper treatment and domestic heating. The harvested water can also be committed to longer-term storage or groundwater recharge. [2]

The Civil Engineering department block is situated inside the campus with a nearly 1105m^2 built-up area. 250 students are studying in the department, whose daily requirement has to be served. As per the Average annual Rainfall date from the location and area of catchment, 3660000 Litres of water is obtained from rain yearly in which 1495720 Litres of water is obtained during the monsoon season. The yearly Water requirement for the department is 3240000 Litres of water. Considering the maximum rainfall and consumption rate an underground water tank of 900 cubic meter capacity is proposed.

IV.II. GREYWATER TREATMENT SYSTEM

Treatment means separation of solids and stabilization of pollutants and stabilization means the degradation of the organic matter till the point at which chemical or biological reactions stop. Treatment also means the removal of toxic substances which distort sustainable biological cycles, even after stabilization of the organic matter. The main purpose of greywater recycling is to substitute precious drinking water in applications such as gardening. Non-potable reuse applications include industrial, irrigation, toilet flushing, and laundry washing dependent on the technologies utilized in the treatment process. [3]

The Civil Engineering Department has 250 students and 15 faculties. Here around 3000 liters of greywater is generated per day. The Department

needs a large amount of water for gardening purposes. So to reduce the demand for freshwater, treatment of wastewater is required. The wastewater generated in the building without fecal contamination is collected and treated using Delphin Compact systems [6]. The main objective of water treatment is to reduce the demand for potable water and generate a new source from reuse for irrigation purposes.

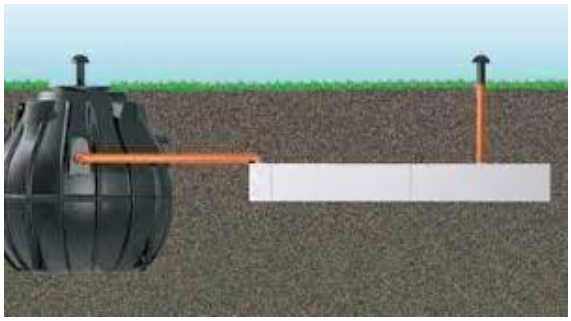

Fig.1: Greywater treatment using Delphin compact.[6]

IV.III. HVAC SYSTEM

Air conditioning offers a better way to ensure good Indoor Environmental Quality. Air conditioning is one way to keep indoor temperatures comfortable during any weather condition. During summers classrooms get overheated very quickly which results in reduced learning. When students are exposed to hot weather conditions it can reduce concentration, problem-solving, social skills, etc... When anyone is exposed to high temperatures for a long time it can lead to dehydration. Therefore a comfortable classroom environment is essential for learning.

The average temperature in classrooms is observed as 28℃. This is beyond the limits prescribed by ASHRAE 55 and NBC 2005. Thermal comfort requirements of NBC 2005 or ASHRAE 55 or requirement of Indian Adaptive Comfort Model are 22.8˚C – 26.1˚C in summer & 20˚C – 23.6˚C in winter. The Environmental Protection Agency recommends humidity levels of between 30% and 60% to reduce mold growth.

IV.IV. PARKING FACILITY

A parking facility is provided at the north-western side of the department for electric as well as other vehicles. Reserved parking for electric vehicles with charging slots is provided. Concrete pavement material is used for flooring. The pavement is laid in such a way that a sufficient slope is provided for the water is collected in the drain.

Each parking space is of size 2.5x5m and a driveway of 3m width is provided. A total of 10 passenger cars can be parked.

IV.V. VERTICAL GARDENING

A vertical garden is a technique used to grow plants on a vertically suspended panel by using hydroponics. These unique structures can either be freestanding or attached to a wall. Many buildings around the world have vertical gardens installed on their exteriors. Vertical gardens have the advantage of having direct sunlight that makes them thrive. Vertical gardens also give buildings protection and insulation from temperature fluctuations, UV radiation, and heavy rain. Vertical gardens use a process called evapotranspiration, which helps cool the air around it.

Fig.2: Vertical gardening at department.

IV.VI. ENVIRONMENTAL FRIENTLY PRODUCTS

Using environment-friendly cleaning and pest control products for housekeeping materials with low ODP in building interiors. Various eco-friendly products are available in the market which can be used in place of ordinary toxic products used.

IV.VII. WASTE MANAGEMENT

Multi-colored dustbins are provided at the department for different types of waste. This ensures the segregation of waste at the source. A proper storage facility is to be provided to ensure that the collected waste is stored properly till the time it is collected by a suitable treatment or recycling center.

Fig.3: Multi-colored waste bins

V. CALCULATIONS AND RESULTS

The total cost of all the renovation work was estimated as shown in table 3.

Table 3: Estimation of costs.

RENOVATION WORK	TOTAL COST
Underground rainwater sump	9994800
Greywater treatment system	205520
HVAC system	732000
Parking area	251800
Waste management	12000
Vertical gardening	25000
Total cost of renovation	Rs.11221120

The current monthly expense of the department building is about Rs.2,50,000 per month, which includes water charges, electric charges, maintenance charges, housekeeping charges, security charges etc...

Cost savings

1. Total Cost saved is about Rs.12,000 per month in a year from rainwater system.
2. The cost saved from previously installed solar power system is approximately Rs.2000 per month in a year.
3. Other savings including vertical gardening, greywater treatment system, and HVAC system is Rs.5000 per month in a year.

Table 4: GRIHA score calculations.

POINTS DISTRIBUTION		
SECTIONS	POINTS BEFORE RENOVATION	POINTS AFTER RENOVATION
Site Parameters	6	6
Maintenance & Housekeeping	2	7
Energy	15	15
Water Efficiency	2	23
Occupant Health & Comfort	10	12
Social Aspects	0	5
Bonus Points	0	4
TOTAL	35	72
STARS	1	4

VI. BENEFITS OF RENOVATION

The assessment showed that the conversion of the department building into a green building not only reduces or eliminates negative impacts on the environment, it also helps to provide good indoor environmental quality, complete energy efficiency, and self-sufficient in water and electricity needs.[4] After implementing the above-mentioned modifications in the department the total GRIHA score increased to 72, which means a 4-star rating can be obtained.

VII. CONCLUSION

By implementing the above-mentioned green renovations, an existing building is converted into a green building. Water is conserved, recycled, and reused for various purposes using sustainable methods. Installing vertical gardening and modern HVAC equipment can ensure a healthy and cooler environment and thus improving indoor as well as outdoor environmental quality. These concepts conform to GRIHA for existing buildings, which is endorsed by the MNRE (Ministry of New and Renewable Energy), Govt. of India which helps the building get a GRIHA recognition. These initiatives encourages other campuses and institutions to promote sustainability and adopt green practices not only in new construction but also in the existing structures.

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