“CONVERTING EXISTING BUILDING INTO GREEN BUILDING”

A

PROJECT REPORT

Submitted in partial fulfilment of the requirements for the award of the degree

of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision

of

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to

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

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HIMACHAL PRADESH INDIA

MAY,2022

DECLARATION

I hereby declare that the work presented in the Project report entitled **"GREEN BUILDING"** submitted for partial fulfilment of the requirements for the degree of Bachelor of Technology in Civil Engineering at **Jaypee University of Information Technology, Waknaghat** is an authentic record of my work carried out under the supervision of **Mr. Chandrapal Gautam** This work has not been submitted elsewhere for the reward of any other degree/diploma. I am fully responsible for the contents of my project report.

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CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"GREEN BUILDING"** in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering submitted to the Department of Civil Engineering, **Jaypee University of Information Technology, Waknaghat** is an authentic record of work carried out by **Muskan Negi (181626) and Abhishek Sharma (181637)** during a period from jan 2022 to may 2022 under the supervision of **Mr. Chandrapal Gautam** (**Assistant Professor (Grade II)),** Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.

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ACKNOWLEDGEMENT

The success and final outcome of this project require a lot of guidance and assistance from many people and we are extremely privileged to have got this all along the completion of our project. All that we have done is only due to such supervision and assistance and we would not forget to thank them.

We would like to express our sincere gratitude to **Mr. Chandra Pal Gautam, Assistant Professor (Grade II)** for his valuable guidance.

We would like to extend our sincere thanks to sir. We are highly indebted to all of them for their guidance and constant support.

ABTRACT

Green infrastructure refers to a collection of practises, techniques, and skills aimed at decreasing, eventually eliminating, the bad repercussions of buildings on the environment and health.. Before turning to upgrading building into sustainable green building this study we know about GRIHA.. It often taking advantages of renewable resources , e.g. using sunlight through photovoltaic equipment, and using plants and garden in balcony of the house, led lighting, and vermin compost plant, grass pavers. Many more methods are utilised to transform existing structures to green structures. The costs of building and installation have also been calculated. The study focuses on the positive results of converting a building to a green building.

Key words *- Green building, REVIT , GRIHA, vermin composite plant, grass pavers, solar power generation.*

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CHAPTER 1

INTRODUCTION

1.1 GENERAL

There are important future issues, such as having a responsible attitude to nature. There is also the hunt for an ecologically friendly energy source that is both resource and climate friendly.

The construction industry accounts for up to forty percent (40%) of global primary energy consumption and a significant portion of total water use. Meanwhile, the life span of the both new and restored buildings is quite long. As a result, these structures have a significant impact on projected energy and water demands over the next 50 to 80 years. This means that they must be conceived, built, and operated using energy efficiency, climatic considerations, and water conservation principles even today. This is true even when global plans to combat climate change appear to be too far away to understand. Green Buildings are structures that exhibit certain characteristics of sustainability.

The wider green building movement is being driven by the sustainability paradigm, which affects not just physical structures but also the operations of the companies and organizations that fill the building design, as well as the hearts & minds of the public who live there. Other significant factors, such as changing climate and the rapid depletion of the worlds largest oil supply, pose a threat to the economies and quality of life of industrialised countries. Both are connected to our use of fossil fuels, notably oil. Many authoritative scientific organizations and Nobel laureates assume that changing climate will have a significant impact on future temperature conditions and weather patterns, owing in part to increased concentrations of human-generated co 2, methane, and other gases in the earth's atmosphere. Much of today's built environment will survive the approaching period of increasing temperatures and rising seas; but, little thought has indeed been given to how human influence and building construction might adapt to potentially major climatic changes. When making assumptions regarding passive design, the building envelope, and material choices, global temperature rises must now be taken into account.

1.2 IMPACT OF CONSTRUCTION

Infrastructure is critical for the growth of both emerging and industrialised countries. Experts predict that building production would expand by 85 percent by 2030, but this gain will come at a cost. Construction has several negative environmental effects, including trash pollution, noise pollution, dust, solid wastes, air pollution, land usage, water pollution, and hazardous emissions. Carbon dioxide and methane emissions from the building industry are significant. The Construction accounts approximately 25 to 40% of worldwide carbon emissions. The environmental effect of building is influenced by a variety of factors, including construction techniques, activities, and materials. The utilisation of energy is a crucial issue in construction-related operations. The worldwide building industry utilises roughly 36% of overall energy consumption.

Construction is among the most resource-intensive industries. Approximately 23percent of total of air pollution, 40percent of drinking water contamination, and 50percent of total of landfill waste is caused by the building industry. Construction operations have an influence on an area's biodiversity. Highways and other infrastructure projects in India have severely diminished forest cover, harming the flora and wildlife of the areas where they are being built. Noise and light pollution have a significant negative influence on animals.

Without a question, construction's environmental effect is one of the world's most pressing challenges today.

Buildings require a large amount, and the bulk of that energy is derived from the combustion of fossil fuels. Indoor air pollution and greenhouse gas emissions are major concerns. Unfortunately, gas emissions aren't the only hazardous pollutants emitted by structures. Buildings emit a wide range of harmful pollutants, not simply gases. Within a structure, air pollution levels may be substantially greater than outdoors. Indoor pollution is especially important since we spend the bulk of our time indoors. Indoor pollution levels are two to five times greater than outside pollution levels, and occasionally more than 100 times higher. Pollution may come from a variety of sources One technique for reducing the incidence of these toxins is to ensure that indoor air is replaced with adequately filtered outdoor air on a

regular basis. Unfortunately, buildings are typically under-ventilated, and the resultant air is not thoroughly filtered, resulting in air that is possibly harmful to building occupants' health. People who live in green buildings have their health and well-being as a major priority.
People who live in green buildings place a premium on their health and well-being.
Structures that are constructed using normal construction procedures are known as conventional buildings. The conventional technique is a regular or typical building approach that uses established procedures and materials while staying within a set of parameters. The bulk of traditional buildings are inefficient in terms of energy use and employ standard building materials. Traditional structures require regular upkeep and are quite costly to maintain. Traditional structures are made of non-recyclable materials that affect the environment.
These structures are not designed to preserve the environment; rather, they are designed to meet the needs of the individual. However, in the future, everyone will be required to employ sustainable construction techniques and ecologically friendly materials.
Construction project development has benefits since it may contribute to economic and social growth. Construction provides for the creation of new employment, positive construction, and the generating of money and jobs from new development from an economic aspect.
Construction helps to revitalise run-down inner-city areas by replacing old structures by new ones, providing affordable housing, and reducing crime. Construction raises the standard of living and increases the life quality. The issue with building is that it has an impact on the environment during its life cycle. Building has a dark side; fast growth in construction activities can lead to a slew of economic and environmental issues. Construction's influence on health and the environment is causing increasing concern. The problem of environmental degradation is becoming more visible across the world. The globe is on the verge of an environmental disaster due to major environmental challenges.
Construction has been the primary source of pollution and environmental dangers. Dust, toxic gases, noise, and solid and liquid wastes are all examples of pollution and risks.
Many countries make every effort to reduce the harmful environmental effects of building. Northern Turkey's construction activity has harmed the country by hastening environmental degradation through pollution.

1.3 GREEN BUILDING

India's construction industry is booming, contributing significantly to the country's economic growth. This bodes well for the country, and there is a pressing need to implement green concepts and approaches in this area so that growth can be sustained. Green construction principles and approaches may assist solve national challenges such as water efficiency, energy efficiency, reduced fossil fuel consumption for transportation, consumer waste management, and natural resource conservation. Above all, these ideas can improve occupant health, productivity, and happiness.

The phrase "green building" relates to the quality and attributes of a structure built utilising sustainable construction concepts and practises. Green buildings are "healthy facilities planned and developed utilising environmentally based concepts in a resource-efficient way." Similarly, concepts like ecological design, sustainably design, and green design highlight how sustainability principles are applied to architectural design.

Climate change is something we've all heard about. The air is becoming warmer, the sea level is rising, glaciers melt faster than they should, and water and air pollutants are increasing as a result of global warming. These environmental concerns are well-known to us.

The notion of green construction is based on four fundamental principles: –

- Reduction of the structure's environmental consequences, or rather side effects.
- Improving and enhancing the health conditions of the occupants in structure.
- Savings and investment returns to investors and the society.
- Considering the life cycle during planning and design process.

It's not only about being more efficient when it comes to building green. It's all about designing buildings that maximise the use of local resources, local ecology, and, most crucially, electricity, water, and material usage. According to TERI projections, India could save more than 8,400 megawatts of power annually if all buildings in Indian metropolitan areas were converted to green building concepts.

Natural resources are utilised as little as possible during the construction and maintenance of a green building. Green building design aims to minimise non renewable resource demand, improve resource efficiency while in use, and optimize the reuse, recycling, and use of renewable resources. It is created through a design process that needs all parties involved – the architect, landscape designer, and air conditioning, electrical, plumbing, and energy consultants – to collaborate and address all areas of building and system planning, design, construction, and operation as a team. They critically assess the environmental consequences of each design decision and develop viable design solutions to mitigate the negative effects while enhancing the favourable effects.

A green building is the one that decreases negative effects on our climatic events surroundings while simultaneously having the potential to create positive ones through its design, structure, or operation. Green building conserves water and boosts energy efficiency. In comparison to a traditional structure, it helps to conserve, creates minimum waste, and provides a better atmosphere for people. Building owners, operators, and tenants benefit financially from sustainable structures. Energy, water, maintenance, and repair expenditures are often cheaper in sustainable buildings. Although certain sustainable design elements have greater initial costs, the payback period for the added investment is frequently quick, and the lifespan cost is often lower than most regular structures. In comparison to traditional structures, green buildings are environmentally benign, energy efficient, and financially beneficial in the long run.

Six broad and linked themes are covered by the Green Building Guidelines:-

• Unleash the site's full potential. This principle includes aspects like proper site selection, consideration of any existing buildings or infrastructural facilities, street and household orientation for solar passive features, frontage roads location, parking, potential hazards, and any major priority assets that should be preserved, such as trees, waterways, slowdowns, and animal habitats..

• Reduce energy use and employ renewable energy strategies. This principle includes things like reducing overall energy loads (through insulating material, efficient technologies and lighting, and cautious detailing of the a whole envelope), limiting the amount of fossil fuels used, incorporating renewable energy systems like photovoltaics, geothermal heat pumps, and solar water heating whenever possible, and purchasing green power to reduce greenhouse gas emissions.

- Water conservation and protection This approach encompasses factors such as limiting leaks by ensuring thorough inspections during construction, as well as decreasing, managing, or treating site runoff.

- Make use of environmentally friendly products. This principle applies to products that are retrieved, made out of recycled material, conserve natural resources, lower total material use, are exceptionally durable or low maintenance, are naturally or minimally processed, end up saving energy and/or water, and/or reduce pollution or waste generated by operations..

- Improve the quality of indoor air. This idea applies to tactics that improve acoustic, thermal, and visual quality, all of which have a substantial influence on health, comfort, and productivity. Other factors to consider include adequate lighting, ventilation, and moisture management, as well as the use of low- or no VOC products.

- Improve your operations and maintenance procedures. This approach applies to materials and systems that simplify and decrease operating needs, use less water, energy, harmful chemicals and cleansers, and are cost-effective and lower life-cycle costs.

On a life-cycle costing (LCC) basis, green buildings almost always make sense, even if they are more costly on a capital, or first-cost, basis. Energy-saving lighting and air-conditioning systems with excellent reactivity to interior and outside conditions will be more expensive than their traditional, code-compliant equivalents. Rainwater harvesting systems which capture and store precipitation for nonportable applications will necessitate the installation of extra pipelines, pumps, controllers, storage tanks, and filtering components. Most essential green building solutions, on the other hand, will quickly return their initial expenditure. The payback period will shorten when water and energy prices rise owing to rising demand and dwindling supply. By analysing their performance across the span of a building's useful life, LCC provides a consistent methodology for establishing the real economic advantage of these alternative technologies.

Figure 1 : Green building characteristics shown in this schematic design.

1.3.1. BENFITS OF GREEN BUILDINGS

Green building benefits range from environmental to economic to social, and new technologies are always being developed to complement current strategies for producing greener structures. Greener practises can help us achieve better economic and environmental outcomes. Green New construction can provide several tangible and intangible benefits. The most immediate advantages are the lower water and energy use from the first day of occupancy. Energy savings of 20 to 30 percent and water savings of 30 to 50 percent are possible. Improved air quality, superb daylighting, occupant health and well-being, safety advantages, and conservation of limited national resources are some of the intangible benefits of green new buildings.

Benefits of green building include:

- **Environmental Benefits**

1. Saves Water and Energy - Going green certified by that of the Indian Green Building Council (IGBC) saves 20–30% water and 40–50% energy as compared to conventional constructions in India.

Green buildings in Australia that have gained the Green Star certification have been shown to use 51% less potable water and produce 62% fewer greenhouse emissions than buildings built to meet industry minimum criteria.

When compared to the industry standard, green buildings that have earned the Green Star certification in South Africa have been demonstrated to save between 20 and 30 percent drinkable water per year, as well as 30 to 40 percent energy and carbon emissions. Green buildings that have obtained the LEED certification in the United States and other countries have been shown to use 11 percent less water and 25 percent less energy than non-green constructions. Conserves Natural Resources - When compared to other major polluting industries, the building sector has the greatest potential for lowering greenhouse gas emissions.

Direct building initiatives such as efficiency, fuel switching, but the use of renewable energy are expected to save up to 84 gigatonnes of Carbon dioxide by 2050. (GtCO2).

In 2050, the construction industry has the ability to save 50% or more energy, helping to keep global temperature rises to 2°C (beyond pre-industrial levels) – UNEP, 2016.

3. Improves Air and Water Quality - According to studies, improved air quality including low CO2 and pollution concentrations and strong ventilation rates can result in up to 8% performance gains.

4. Biodiversity and ecosystems are preserved – Green building promotes effective use of energy, water, and other resources, which improves ecosystems. It also makes use

of renewables such as solar power. In most cases, steps are taken to decrease pollution and waste while also allowing for resource reuse and recycling. The materials used are non-toxic, environmentally friendly, and long-lasting.

- The environment is taken into account throughout design, building, and operation, allowing for adaptation to changing conditions.

- **Economic Benefits**

1. Reduces Construction Costs & Increases Property Value - These structures lower construction expenses and boost property value for developers; global energy efficiency programmes might save between €280 and €410 billion in energy costs. According to Dodge Data & Analytics, green structures, whether new or renovated, command a 7% asset value premium over traditional structures.

2. Green building aims to build facilities which are not only environmentally friendly but also help humans live healthier, happier, and more productive lives. Renters and households may save money on their utility bills by becoming more water and energy efficient.

3. Different countries and regions have different characteristics, such as unique weather conditions, distinct traditions and cultures, diverse various building and ages, or multiple ecological, economic, and social priorities, all of which shape green buildings to make green buildings best suited to their own markets.

- **Social Benefits**

1. Improves Tenant Quality of Life - The design, production, and management of green buildings all consider the tenants' quality of life. It benefits the residents' health and comfort. According to studies, improved air quality (low CO_2 and pollutant concentrations, and high ventilation rates) can raise performance by up to 8%.

2. Workers in green, well-ventilated workspaces improve their cognitive scores by 101 percent (brain function). As per the American Academy of Sleep Medicine,

employees who worked in offices with windows slept 46 minutes longer each night on average.

3. Green buildings work with local governments and utilities to provide green building and energy efficiency training and incentives, easing the strain on local infrastructure. They also offer free lectures, online forums, and specialized training to assist local infrastructure in coping with the increased demand.

Existing homes may be converted into totally sustainable, non-toxic, zero-water, and zero-energy constructions in a simple and cost-effective manner.

1.4 ZERO ENERGY BUILDING

Zero-energy buildings combine energy efficiency measures with productions to utilise as much energy as is generated onsite utilising renewable sources of energy over a set period of time. Zero-energy is a high goal that is gaining popularity across geographical areas and economies. In response to regulatory restrictions, private commercial property owners are growing more interested in developing zero-energy buildings to satisfy their business goals, while federal government institutions and many municipal governments are beginning to move toward zero-energy construction targets.

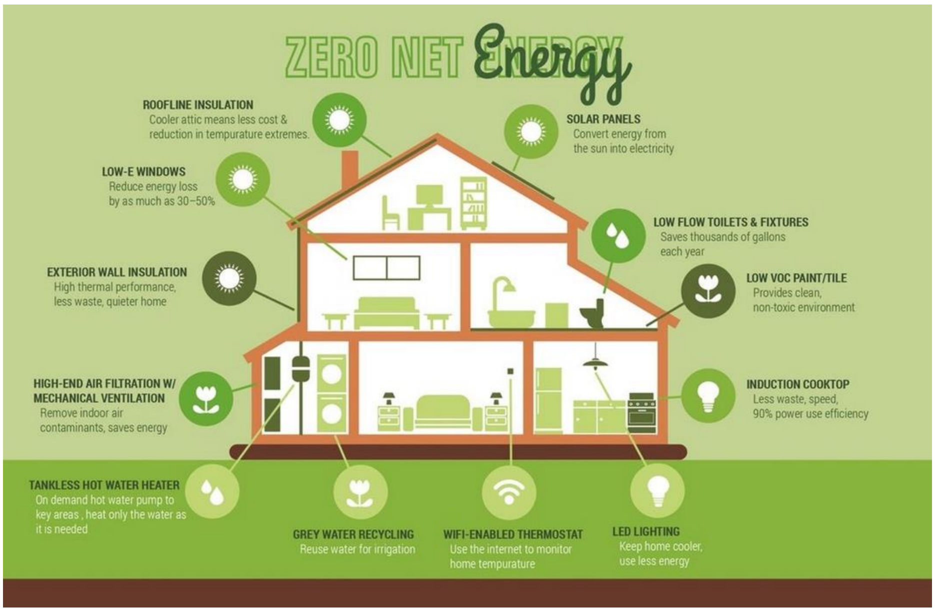

Figure 2: Zero net energy

1.5 LIFE-CYCLE ASSESSMENT

The relevance of life-cycle assessment (LCA) is expanding since it allows for the measurement of the environmental implications of design decisions across the project's full life cycle. Previously, LCA was used to evaluate goods and building assemblies, which gave some guidance on how to improve decision-making but didn't provide any information on the long-term consequences of building operation.

LCA begins with the raw material and ends with the final disposal location. LCA steps include raw material selection, manufacture, distribution, and installation, as well as final reuse or disposal. By analysing the whole spectrum of implications associated with all stages of a process from start to finish, LCA may help prevent a restricted view on environmental, social, and economic problems.

1.6 GREEN BUILDING RATING SYSTEM

In India, green building grading methods are used to quantify and estimate a structure's environmental effect. India now has three green building grading systems, which are shown below.

1) Energy and Environmental Design Leadership (LEED).

2) Green Building Council of India (IGBC).

3) Integrated Habitat Assessment Green Rating (GRIHA).

1.6.1 Leadership in Energy and Environment Design (LEED).

The LEED Green Building Rating Standard is a voluntary, general agreement standard for green building design, construction, and operations. It instructs architects, engineers, building owners, designers, and real estate experts on how to transform the construction environment into one that is more environmentally friendly. Green building approaches may significantly decrease or eliminate negative environmental impacts while also improving existing unsustainably designed structures. Green design methods also save operating costs, improve building marketability, boost employee productivity, and limit possible liability from poor indoor air quality.

The rating systems were created to accommodate various building functions. The process is always the same, however the measures alter depending on the application. New construction and upgrading of residences and non-residential structures are now being evaluated. There are assessments for communities, commercial interiors, and core and shell, in addition to single and full structures. Sustainable Sites, Water Efficiency, Energy and Atmosphere, Material and Resources, and Innovation are the five environmental areas that the ranking system is divided into.

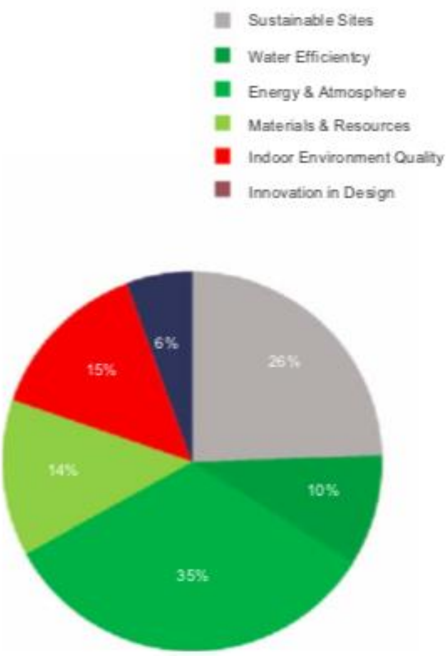

Figure 3: LEED RATING SYSTEM

1.6.2 Indian Green Building Council (IGBC).

The Indian Green Building Council was founded by the CII-Sohrabji Godrej Green Business Centre in response to the building industry's environmental concerns (IGBC). The International Green Building Council (IGBC) is a non-profit organisation that represents the construction sector and has over 1,923 members. Builders, developers, owners, architects, and consultants are encouraged to design and construct green buildings, therefore improving the economic and environmental performance of structures.

IGBC has been leading the Green Building Movement in India since 2001, through raising awareness among stakeholders. So far, the Council has helped to enable 2.23 billion square feet of green buildings around the country. The Council's efforts have helped to alter the market for green construction materials and technology. The IGBC is always working to develop technologies that make green building principles easier to adopt in India. Another key step in this approach is the creation of the IGBC Green New Buildings grading system.

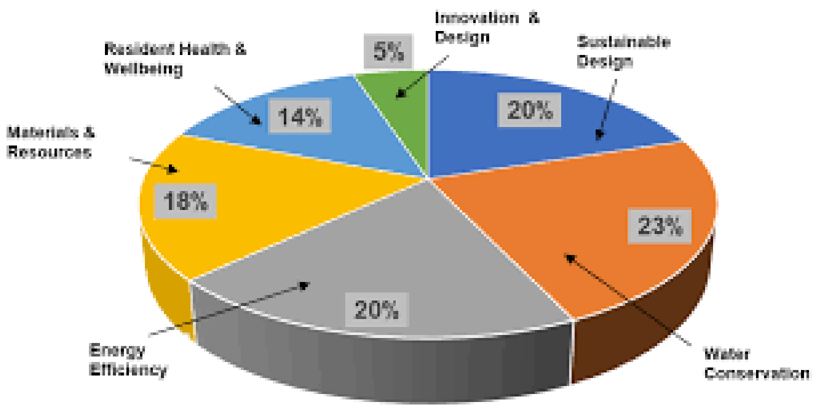

Figure 4: IGBC RATING SYSTEM

1.6.3 GREEN RATING FOR INTEGRATED HABITAT ASSESSMENT(GRIHA)-

The fast development of India's population and GDP has resulted in a massive demand for structures, putting a strain on available resources. Another major difficulty for Indian cities' built environments is the limited supply of water in metropolitan regions.

Policymakers at all levels are addressing the environmental concerns of increased resource demand paired with rapid climate change in order to ensure sustainable. National plans and programmes have devised and executed a number of legislative and regulatory mechanisms to address urban challenges. The Environment Clearance for big projects (i.e. more than 20,000 sq m constructed area), the Energy Conservation Building Code (ECBC) for air-conditioned commercial properties with connected loads greater than 100 kW, and the Solar Buildings Scheme for Energy

Efficient Buildings have all been developed by the Centre's Ministries and agencies and will be implemented by designated State agencies and municipal bodies.

Nevertheless, as in other countries, there is great space for policy efficacy to be improved by promoting a more amazing way approach to building. On the ground, a shortage of hindrances for noncompliance, organizations and systems functioning in factions, and the application of rules and standards before site validation all contribute to problems.

In view of the aforementioned, TERI has played a vital role in pulling together numerous projects that are important for the effective deployment and popularisation of ecological habitats in India. TERI created GRIHA(Green Grading for Integrated Habitat Assessment) with over 2 years of experience in green and energy efficient constructions. In 2007, the Government of India accepted it as the authorized rating scale for green buildings.

GRIHA is a rating system that allows individuals to assess their building's performance against nationally recognised criteria. It assesses a building's environmental practices across its whole life cycle, resulting in a precise definition of what qualifies as a "green building." GRIHA for Residential Buildings is a 100-point rating system divided into seven categories: site characteristics, maintenance and housekeeping, electricity, water, personal health and comfort, social concerns, and bonus points. Six of the twelve requirements must be satisfied, with the remaining six being optional.

GRIHA's fundamental characteristics are as follows:

1) The method was designed to help with the 'design and assessment' of new constructions (buildings that are still at the inception stages). The performance of a structure is predicted over its whole life cycle, from conception through operation. The following life cycle stages have been highlighted for evaluation:
2) Pre-construction stage 2: (inside and outside site issues like availability to public transportation, soil type, kind of land, location of properties, the natural landscape and features of land).
3) The stages of building planning and construction: The key resources mentioned in this section are land, water, energy, air, and green cover. Building operation and maintenance stage: (issues of operation and

maintenance of building systems and processes, and occupant health and well-being, and also issues that affect the global and local environment).

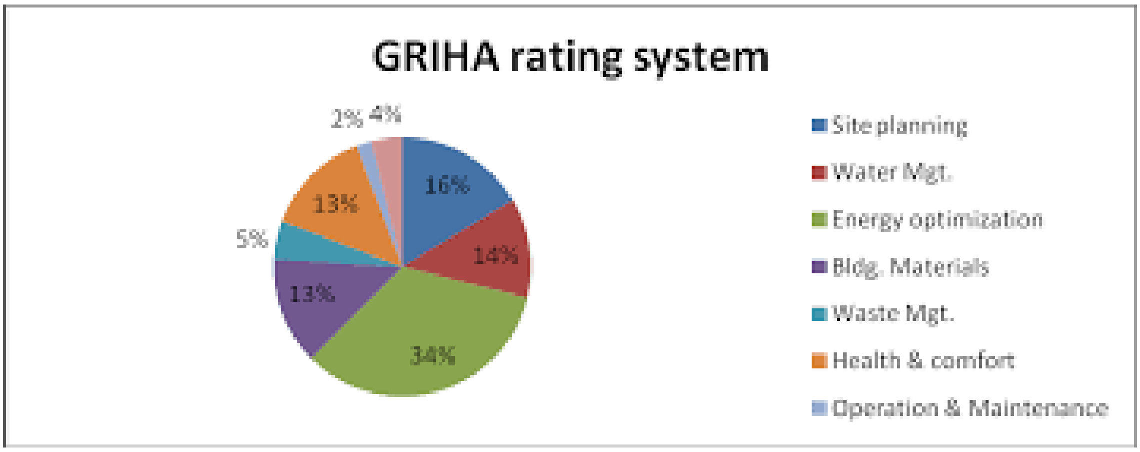

Figure 5: GRIHA RATING SYSTEM

1.6.3.1 Process of Rating

1. Check for viability –As a first step, the owner/maintenance group must inspect the facilities and housekeeping. They must utilise the online feasibility assessment technique on the GRIHA website to determine whether their proposal is suitable for a GRIHA for Existing Building structures grade. To be eligible for the GRIHA for Existing Buildings grade, the project must meet the necessary conditions. The calculator predicts the level of rating based on the information provided by the project proponent. The feasibility check rating is only an indicator; the final rating will be given after the project has been registered and the provided documents have been assessed and validated by the GRIHA Council.
2. Registration – Immediately after the end of the viability assessment, the responsible party can submit an indication of interest under the Existing Building category on the GRIHA Council's website. The contribute to the research will be given a login and password for the online panel materials once the project has been registered
3. Orientation session – Following registration, the GRIHA Council hosts an orientation workshop. The goal of this workshop is to provide extensive information on existing building ratings that include all criteria and to answer specific questions about the certification procedure from project proponents.

4. Documentation submission – Following the orientation session, the responsible party must use the username and password supplied at registration to submit all papers for all criteria on the online panel.
5. Introductory assessment –Following the online document submission, a group of professionals and specialists from the Council of GRIHA undergoes a preliminary examination. For all attempted criteria, the documentation must be complete in every way. Any criteria that are proposed but still have insufficient documentation will not be assessed. Filling out and submitting online calculators for specified criteria is required. Professionals from the Council of GRIHA evaluate the project's compliance with the mandatory requirements first, and if it does not, the project is rejected. The GRIHA Council will next assess the optional parameters and calculate the total amount of points that can be earned. Within 20–25 working days of receiving the documents, a preliminary review report must be produced.
6. Validation site visit as part of reasonable care – Council of GRIHA must conduct a due diligence site visit to compare the provided documentation to the on-site execution. After the site visit, the due diligence report must be submitted within 7–10 (15) working days.
7. Final assessment – Council of GRIHA reviews materials given as a reflex to the preliminary assessment and due diligence report. After the project team provides requested information sought during the preliminary evaluation and due diligence report, Council of GRIHA will generate a final score card based on this review between 20–252 working days.
8. Award of Rating – The Advisory Committee must be given the final score., which comprises of renowned persons and acknowledged specialists in the field, for approval and grading.. The rating will be valid for five years from the day the project was given the rating. Note that the GRIHA Council reserves the authority to audit any criteria for which points have been granted at any time.

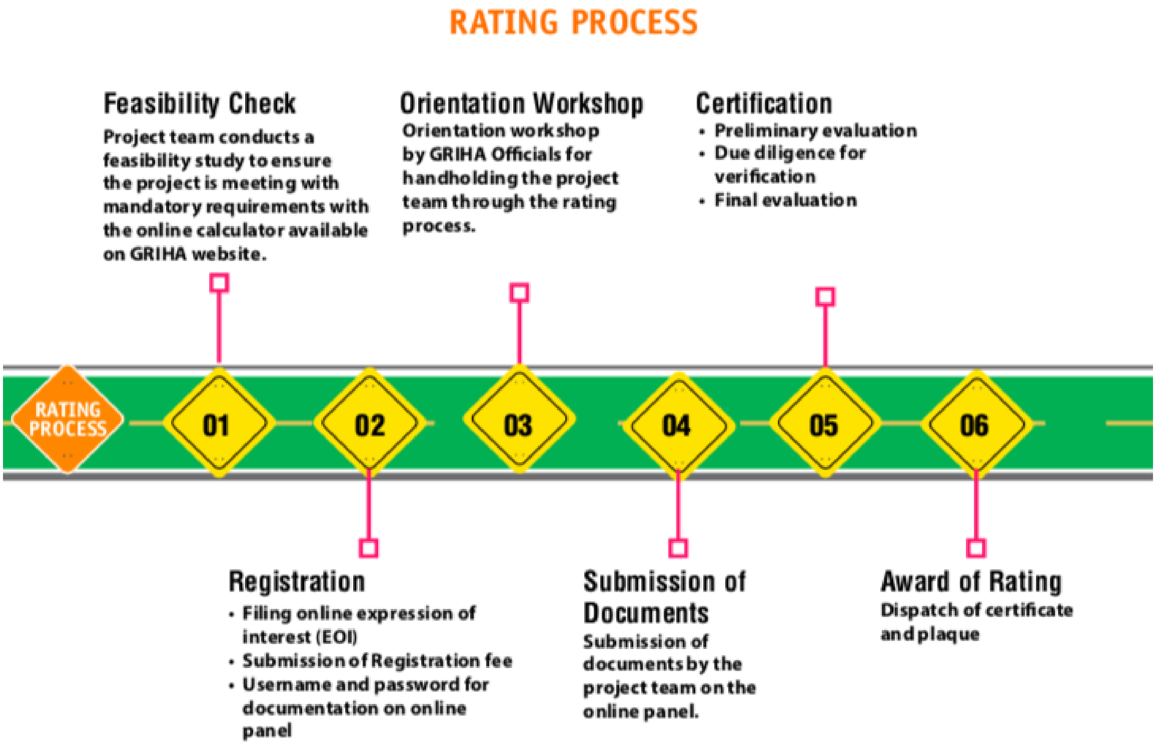

Figure 6: Rating process for GRIHA

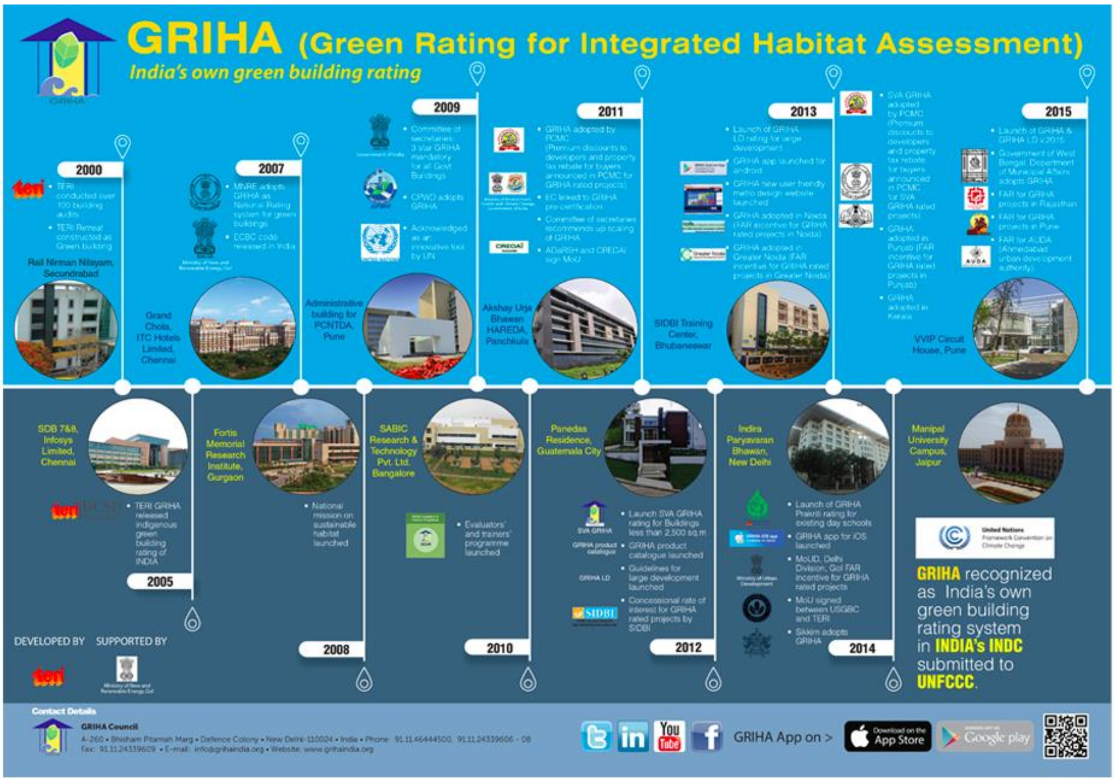

Figure 7: Sustainable habitats in India: GRIHA

For existing structures, the grading system of GRIHA is a 100-point system with 12 stated criteria. The amount of points obtained determines the degree of certification issued (one to five stars). Certification requires a minimum of 25 points.

Table 1 : GRIHA star for existing building

THRESHOLD	GRIHA star for existing building
25-40	1
41-55	2
56-70	3
71-85	4
86 and above	5

Section	Criterion Name	Intent	Max. Points
Section I. Site Parameters	**Criterion 1** *Accessibility to Basic Services*	Promote walking, cycling, and public transport	2
	Criterion 2 *Microclimatic Impact*	Lower the impact of Urban Heat Island Effect (UHIE), and promote plantation of trees	4
Section II. Maintenance & Housekeeping	**Criterion 3** *Maintenance, Green Procurement and Waste Management*	Ensure good practices for safety, waste management, and green procurement	7
	Criterion 4 *Metering & Monitoring*	Promote reliable metering and monitoring	10
Section III. Energy	**Criterion 5** *Energy Efficiency*	Ensure energy efficiency	20
	Criterion 6 *Renewable Energy Utilization*	Promote use of renewable energy	15
Section IV. Water	**Criterion 7** *Water Footprint*	Implement potential water conservation strategies	15
	Criterion 8 *Reduction in Cumulative Water Performance*	Reduce overall water demand of the habitat	10
Section V. Human Health & Comfort	**Criterion 9** *Achieving Indoor Comfort Requirements*	Ensure that building spaces provide for thermal, visual, and acoustical comfort	8
	Criterion 10 *Maintaining Good IAQ*	Ensure good indoor air quality	4
Section VI. Social Aspects	**Criterion 11** *Universal Accessibility & Environmental Awareness*	Promote accessibility for the persons who are differently-abled & the elderly and to increase environmental awareness amongst the building users & visitors	5
Section VII. Bonus Points	**Criterion 12** *Bonus Points*	Adoption and implementation of innovative strategies in improving the sustainability of the project	4

Figure 8: Criteria and their weightage

1.6.3.2 Criteria and their weightage

1) **SECTION 1 : SITE PARAMETER**

➢ **Criterion 1 Accessibility to Basic Services**

a) At least 5 services (from the list below) must be available on campus or even within 500 metres of the project's main entrance**.– 1 point**
Services include a food shopping, chemist, bank or ATM, garden, restaurants, community hall, gym, and a public transport stop.

b) For building residents, a group transportation service (as described below) to the nearby public transit nodes is provided. **– 1 point**

- Electric vehicles have preference parking.
- Parking preference for shared car
- Rental and parking of bicycles
- Transportation service

➢ **Criterion 2 Microclimatic Impact**

a) Analyze number of total of trees planted on the property and proof of compliance with GRIHA for Existing Building threshold of 1 tree per 80 m^2 of total site/plot area . Total number of trees on site must meet/exceed the GRIHA for Existing Buildings threshold. **– 2 points**

b) *To decrease the impact of the urban heat island:*:

- More than 25percent of the public open space visible from of the sky (including roof tops) is soft paved/covered with a high SRI coating (SRI greater than50), shaded by tree trunks by vegetation decks by solar panels, or a combination of these measures. **– 1 point**
- More than 50 per cent of the public open space visible to the sky (including roof tops) is soft paved/coated with a high SRI coating (SRI greater than 50), shaded by vegetation decks by solar panels, or a combination of these measures**.– 2 points**

2) SECTION 2 : Maintenance & Housekeeping

➢ Criterion 3 Wastewater Treatment, Green Sourcing, and Repair

1. **Green sourcing**
   a) Maintain and adhere to a strategy of purchasing environmentally friendly clean and pest control solutions with lower ODP in building interiors. **– 1 point**
   b) Maintain and adhere to a policy of acquiring equipment with a minimum 3-star BEE rating for all equipment purchased under the BEE Star Rating scheme. **– 1 point**
2. **Waste Management**
   a) Provide building inhabitants with infrastructure (multicoloured dustbins/different waste chutes) to ensure waste separation at the source.– **1 point**
   b) Provide dedicated, segregated and hygienic storage spaces in the project site to store different wastes before treatment /recycling. **– 1 point**
   c) Provide contractual tie-ups with waste recyclers for safe recycling for recyclable wastes, like metal, paper, plastic, glass, e-waste, etc. **– 1 point**
   d) Implement strategies to treat all organic (kitchen and landscape) waste on-site and to convert it into a resource (manure, biogas, etc.) and reuse. **– 2 points**

➢ Criterion 4 Metering & Monitoring

a) a) Advanced metering specifications as mentioned in Table 2.

Table 2: Advanced metering specifications– **3 points**

Energy metering requirements	**Water metering requirements**	**Comfort & Air Quality**
Sub-meters at the following point sources: **Commercial buildings:** • HVAC plant, AHU, cooling tower and chillers (BTU meters) • Lighting (indoor and outdoor) • Each commercial tenant • Water pumping **Residential buildings**: • Basement parking lighting, community/ recreation centre • Water pumping • Each apartment • Common areas Lighting	Sub-meters at the following point sources: • Irrigation • Cooling towers • Fresh water and waste water consumption at each building level Captured rainwater	Ensure that the following indoor air parameters are regularly monitored and openly displayed: • Air • temperature • Relative • humidity • CO_2 levels (ppm) Install sensors in basements, closed parking lots, and spots that are often frequented.

b) Install smart metres and monitoring systems that are one-way communicative.: – **3 points**

• Using a web-based gateway to track energy and water use.

• Relatively close data reporting every hour.

• Keeping track of consumer trends

• Establishing consumption goals and warnings.

• Making comparisons between historical and benchmark data.

• Comparing and contrasting historical and benchmark data. Monitoring in actual time with an user experience which can be used on mobile devices.

c) Provide two-way communication for consumers and connect to GRIHA IT platform to allow for communication on the following: **– 4 points**

• Monthly energy consumption and water consumption.

• Average energy and water consumption for display to building occupants to assess building energy and water efficiency.

3) SECTION 3 Energy

➢ **Criterion 5** ***Energy Efficiency***

a) Implementation of operation and maintenance no cost EEMs– **5 points**

b) Show a percentage reduced energy use compared to the baseline as mentioned in Table 3. **– 15 points**

- Reduction percentage of energy consumption = $\left(\frac{A-B}{A}\right) \times 100$

• where , A = energy consumprtion of base case(kWh/year)

• B = energy consumption of existing case (kWh/year)

Table 3: Reduction percentage of energy consumption

Reduction percentage of energy consumption residential building	**Reduction percentage of energy consumption non-residential building and commercial buildings**	**Point**
3	4	2

6	8	5
9	12	8
12	16	11
15	20	15

- **Criterion 6 Renewable Energy Utilization**

  This criterion's goal is to encourage the adoption of renewable energy technology and allow on-site energy production.. - **Maximum Points: 15**

a) Any of the other following options can be used to verify project compliance.
   Alternative I: Installing a renewable energy system on-site/off-site to offset a portion of the annual total energy usage.
   As Table 4 stated, points will be granted.

Table 4: Generation of renewable energy on site and off site in %

Daytime occupied commercial buildings' percentage offset	**Residential buildings percentage offset**	**Commercial buildings percentage offset for 24*7**	**Point**
2.5% (only On-site)	-	0.5% (only On-site)	Mandatory
5%	5%	1%	3
10%	10%	3%	5
15%	15%	5%	7
20%	20%	7%	10
25%	25%	10%	15

b) Alternative II: Renewable energy system located off-site to offset a portion of total energy use. As Table 5 stated, points will be granted.:

Table 5: Off-site generation of renewable energy sources in percentage

Percentage offset of energy consumption	points
10%	**Mandatory**
20%	**3**
40%	**5**
60%	**7**
80%	**10**
100%	**15**

4) SECTION 4 Water

- **Criterion 7 Water Footprint**

a) Water efficient fixtures reduce building water usage by 30 percent compared to the basic scenario.. – **3 points**

Calculating Reduced water use and usage is as follows:

consumption of water (l p d) = N×FR×U

where,

- N = Total number of inhabitants
- U = Number of uses of each kind of fixture fixed
- FR = Flow rate of each type of

$$\text{Water use reduction (\%)} = \frac{(A-B)}{A} \times 100$$

- A = Annual water usage by building fixtures - Base case (liters/year)

- B = Annual water usage by building fixtures - existing case (liters/year)

Reducing landscape water demand

b) Minimizing lawn area and restricting it to 25% of the total landscaped area. **– 2 points**

c) c) The use water-efficient irrigation methods to minimise water usage by at least 50 percent compared to the GRIHA baseline. **– 2 points**

The following formula is used to calculate the landscape water need and reduction:= ((Plant factor × Evapotranspiration rate (mpd) × Canopy area (sq.m)/Irrigation system efficiency) × 1000

where,
The water demand of plants is referred to as the plant factor.

The evapotranspiration rate is a measurement of how much water a plant needs for optimal development and how quickly it loses water through evaporation.

In a plan perspective, the overhead area refers to the region covered by shrubs, grasses, and trees.

The capacity of an irrigation purposes to distribute water to plants even without water loss is referred to as irrigation system efficiency.Provision of on-site sewage water treatment system:

c) 100 points for on-site grey water treatment

Treatment of sewage water (including grey and black water) to satisfy 100% of non-potable water requirements – 4 points

d) Rainwater harvesting system installation: only roof rainwater collecting – 2 points

For covering 100% of the catchment area. – 4points

- **Criterion 8 Reduction in Cumulative Water Performance**

a) Cumulative water performance (WP) reduces to 20% of total water use. **– 2 points**
b) Cumulative WP reduces to 30% of total water use. **– 3 points**
c) Cumulative WP reduces to 50% of total water use. **– 6 points**
d) Cumulative WP reduces to 70% of total water use. **– 10 points**

Cumulative water performance = (Annual water demand of the municipal or ground water /Annual water demand of the project)× 100

5) SECTION 5 Human Health & Comfort

- **Criterion 9 *Achieving Indoor Comfort Requirements***

a) Show that the project can meet the NBC 2005 or ASHRAE 55 thermal comfort criteria, or the Indian Adaptive Comfort Model requirements. 22 – 2 points

b) Exhibit the following —

c) Limits on artificial lighting Lux levels (lower and upper ranges), space/task specific lighting levels as per NBC 2005 - 2 points

A Daylight Factor (DF) of at least 25% of total living space should fulfil the SP 41 minimum requirements. – 2 points

d) Indoor noise levels should be under NBC 2005 permissible limits, and important noise sources on site (such as diesel generators, chiller plants, and so on) should have enough acoustic insulation to meet NBC 2005 standards. – 2 points

- **Criterion 10 *Maintaining Good IAQ***

Comply with the minimal standards –

a) CPCB NAAQS (National Ambient Air Quality Standard) for fresh air quality. **– 2 points**
b) ASHRAE Standard 62.1–2010, Ventilation for Acceptable Indoor Air Quality or a NBC- 2005 for quantity of fresh air. **– 2 points**

6) SECTION 6 Social Aspects

- **Criterion 11 *Universal Accessibility & Environmental Awareness***

a) **Universal Accessibility**

Provide facilities in residential & public buildings that comply with the Harmonised Guidelines & Space Standards for a barrier-free physical environment for individuals with disabilities and the elderly.. **– 2 points**

b) • There is a slope at the entrance.

c) • Parking (favored parking near the entrance, parking requirements for people with disabilities to be met).

d) • Toilet for those with disabilities.

f) Environmental consciousness

Choose any three of the following strategies to raise environmental consciousness among users and tourists.: **– 3 points**

7) SECTION 7 Bonus Points

➢ **Criterion 12 *Bonus Points***

A max of two strategies can be used in the project. Each approach has two components. points.

– **4 Points**

The following are some examples of ways that a project might use to show compliance:

Net zero water discharge, net positive energy/net zero energy—
creation of energy from renewable sources on-site, previously
GRIHA certified project, urban farming, and any other strategy not covered in the previous section that can significantly improve the project's sustainability are examples of strategies that projects can choose to demonstrate compliance.

1.7 REVIT

Autodesk Revit may be used to produce building information models by architects, structural engineers, mechanical, electrical, & plumbing (MEP) technicians, designers, and contractors. The original programme was created by Charles River Program, which was formed in 1997, rebranded Revit Technology Company by 2000, and purchased by Autodesk in 2002. Users may use Revit program to design a building and its parts in 3-D, add 2-D drawing parts to the model, and retrieve building information from the model's database. Revit is a four-dimensional building information modelling (BIM software that allows you to plan and track all stages of the building lifecycle, from conception through demolition.

Key features of Revit are-

- Parametric components.
- Collaboration.
- Schedules.
- Interoperability
- Global parameters • Annotation
- Both standard and personalized family stuff is available.
- Customization and personalization
- Tools and solutions for developers
- Overrides and visibility settings

1.7.1 REVIT ARCHITECTURE USER INTERFACE

1. Application Menu
2. Quick Access bar
3. Info Center
4. Options Bar
5. Type Selectors
6. Properties Palette
7. Project Browser
8. Status Bar
9. View Control Bar
10. Drawing Bar
11. Ribbon
12. Tabs on the ribbon

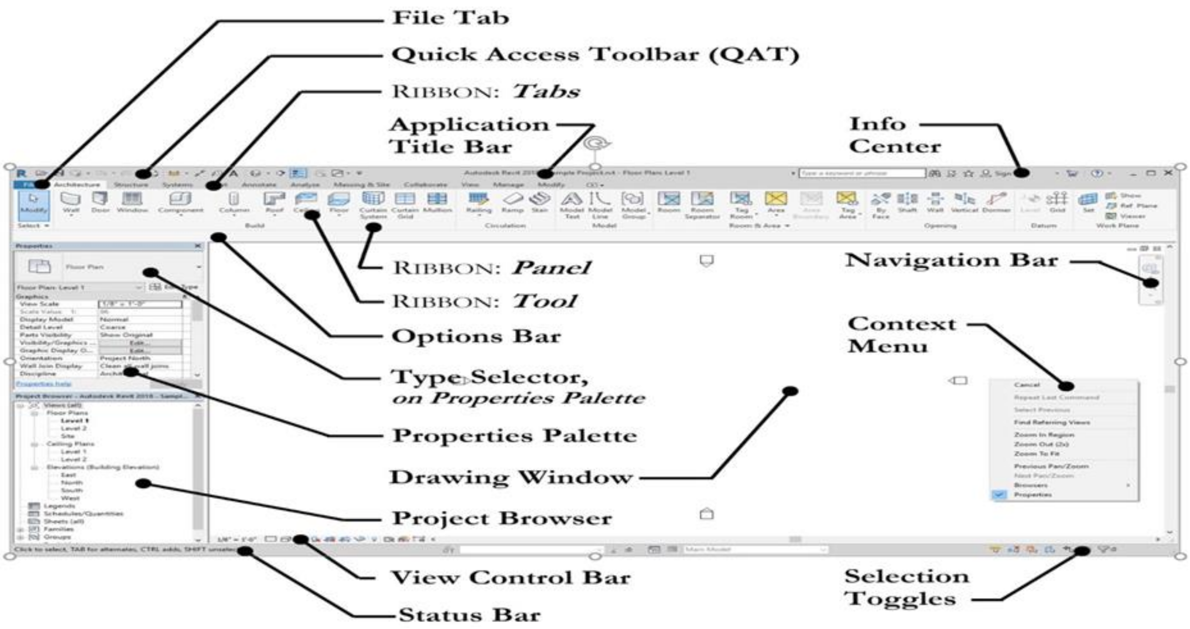

Figure 9: REVIT toolbar

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

Green building is a broad concept that starts with the concept that the built environment may have significant positive and negative consequences on the environment as well as the people who live in buildings every day. During the life cycle of a building, green construction focuses on maximizing the positive features of these consequences while minimising the negative ones.

Green building is described as the planning, design, construction, and operation of structures that take into account several key factors, including energy consumption, water use, interior environmental quality, material selection, and the structure's impact on its surroundings.

2.1.1 GREEN BUILDING

- The use of innovative construction technology will lead to a more efficient buildings with a green rating. Buildings are the main consumers of water, energy, and materials in today's world of growth and development. Green buildings promote the use of renewable energy sources and recycling. In comparison to traditional structures, green buildings conserve water, energy, and materials.
- Prof. Hemant Salunkhe, Mr. Apoorva V. Kotkar (2017) They conclude in their study article that studies may be divided into three categories: definitions and scope of green building, advantages and costs of green building, and methods for achieving green building. Their technological solutions are focused on environmental elements of sustainability, such as energy usage, water efficiency, and greenhouse gas emissions.
- • Rinku Parashar, Ashish Kumar Parashar (2012) They write about green techniques that we may employ in our homes to make them green homes in this paper. In India,

people have not yet fully adapted to the green home, and some are unaware, but we may be the first to take action in the preservation of the earth's natural resources.

- • Allaudin I. Shaikh, Akshay B. Mokal Uday J. Phatak, Shamashree S. Raundal, Sushma J. Prajapati (2015) We investigated the social and economic benefits of all construction materials for the construction industry as well as human health. Green building materials have less negative environmental consequences. to build an efficient, long-lasting construction that reduces environmental degradation, such as greenhouse gas emissions, resource depletion, soil contamination, and health risks
- • Pretty Remaru, Clinton Aigbavboa, and Elizabeth Ojo-Fafore (2018) Green buildings improve the quality of life for building occupants by improving indoor air quality, contributing to the emergence of more energy-efficient products and services, increasing luxury, satisfaction, and welfare of construction tenants, lowering environmental and emissions costs, supporting climate change protocols, and using fewer natural resources to protect the ecosystem. The top ten benefits of green buildings in Johannesburg were recognised as the extension of the economic life of green buildings, as well as the decrease of yearly water cost reductions.
- • Sulagno Banerjee, Dibas Manna (2019) According to the study, one of the primary causes of environmental degradation is building construction. They are responsible for a large amount of particulate pollution, accounting for about 30% of greenhouse gas emissions directly from their operations and another 18% indirectly from material, exploitation, and transportation. Buildings account for nearly 40% of global energy consumption (including 60% of electricity), 40% of waste generation (by volume), and 40% of material resource consumption. In cities, structures occupy % or more of land area.

• Peter Mösle, Michael Bauer, and Michael Schwar z The service life of both new and restored structures is extremely long. As a result, these structures have a significant impact on projected energy and water demands over the next 50 to 80 years. This means that they must be conceived, built, and operated using energy efficiency, climatic considerations, and water conservation principles even today. This is true even when global plans to combat climate change appear to be too far away to understand. Green Buildings are structures that exhibit certain qualities of sustainability.

2.1.2 Green building rating system

Green Rating for Integrated Habitat Assessment is abbreviated as GRIHA. The Sanskrit term GRIHA means 'Abode.' GRIHA is a method that tries to reduce construction resource use and waste output. In this approach, the environmental effect is also lessened. GRIHA is a grading system that allows individuals to compare their building's performance to nationally accepted criteria. It assesses a building's environmental performance over its full life cycle, establishing a definite benchmark for what defines a "green building." Green building grading systems have helped to raise awareness and popularise green building principles all around the world.

- • Govind Singh Chouhan, Dr. Mahendra Pratap Choudhary (2014) India is experiencing fast urbanisation, which will result in a massive rise in energy consumption in cities. Buildings that are energy efficient or green have the potential to cut energy demand by up to 40%. As a result, we can no longer disregard the advantages of green construction approaches that have a significant influence on our environment. All new Central Government and Public Sector Undertaking buildings must have a minimum GRIHA 3 star rating. Now we must go beyond buildings to guarantee that the notion of "green" is applied to all aspects of life.

• According to Shiva Ji, Sharmistha Banerjee, and Ravi Mokashi Punekar (2017), both tools are aimed at creating sustainable buildings, but the GRIHA criteria list places a greater focus on the environmental and economic pillars and less on the social pillar. LEED places a strong focus on all three pillars. The report concludes with recommendations for a list of social, cultural, and socioeconomic characteristics that should be added to GRIHA to improve its Social pillar.

• Vaishali Sahu and Hemant Kumar Certain required criteria must be met to establish good economic, environmental, and social systems in order to accomplish sustainable development. As a result, new green building development is necessary that focuses more on life cycle analysis in all product phases, knowledge integration, and the involvement of more experts from many fields. Also, considering the geographical condition of the location where the Green Building will be built, employing renewable materials, solar energy, rain water gathering system, and water reuse.

2.2 RESEARCH GAP

- We design existing building in revit and convert it into green building. This building is located at Kullu.
- Understand concept of GRIHA and use its criteria to score building that we design
- To convert existing building to green building , apply green practices like use solar panel , rainwater harvesting, grass paver etc**.**

2.3 RESEACRH OBJECTIVE

From site selection to design, construction, operations, maintenance, renovation, and deconstruction, green building is the discipline of developing buildings and employing procedures that are ecologically responsible and resource-efficient. The traditional architectural design objectives of economy, usability, durability, and comfort are expanded and supplemented by this method. A sustainable or high-performance building is often known as a green building.

Green buildings are meant to lessen the built environment's total impact on human health and environment environment by: • Using energy, freshwater, and other resources efficiently.

• Improving staff productivity and protecting occupant health • Reducing waste, pollution, and environmental damage

1) Understand the concept of green building.

2) GRIHA and its standards

3) What green techniques can we use to convert existing structures into green structures

CHAPTER 3

EXISTING BUILDING

1.1 GENERAL

We used REVIT software to design an existing structure. Autodesk Revit is a programme for building information modelling. Charles River Program, founded in 1997, renamed Revit Technology Company in 2000, and bought by Autodesk in 2002, produced the original software. Users may use Revit software to design a building and its parts in 3-D, annotate the design with 2-D drafting elements, and retrieve building information from the database of the building model.

We created a model of an existent building composition of (3+1) residential cum commercial(guest house) building at Raison district Kullu.

SITE PLAN

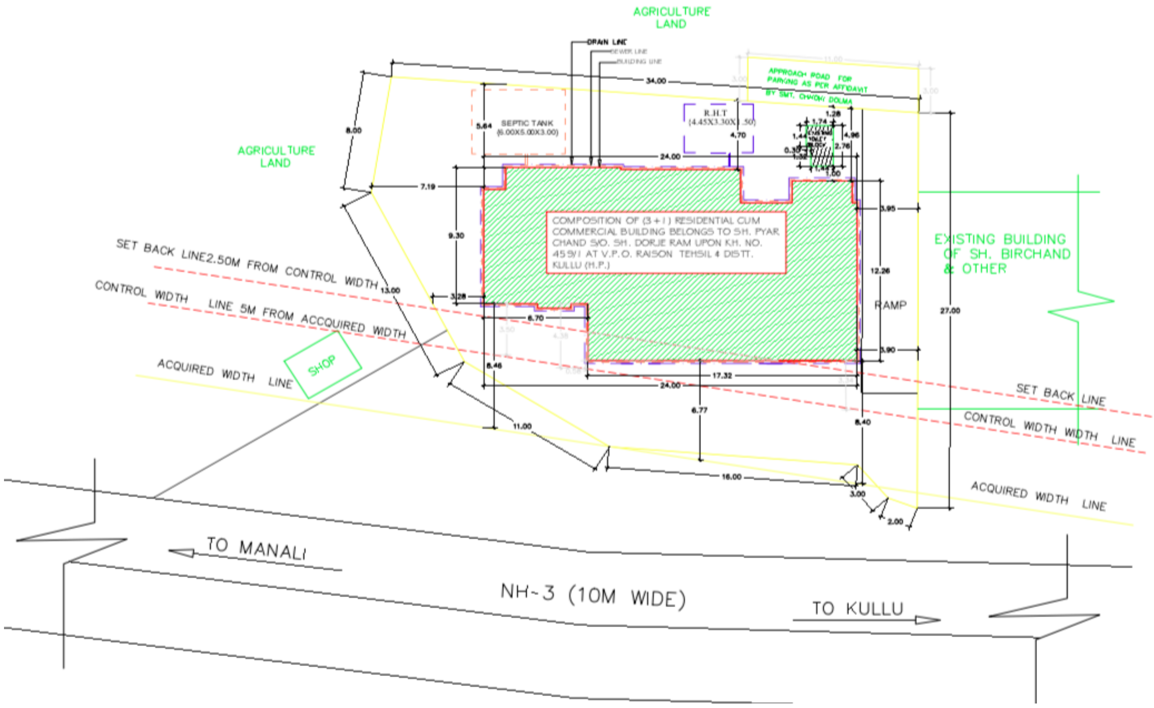

Figure 10: Site Plan

FLOOR PLANS

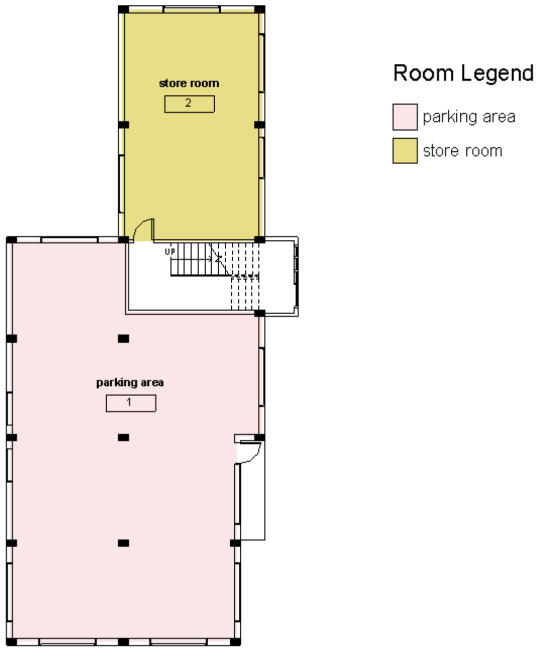

Figure 11: **G**round floor

Figure 12: First floor

Figure 13:Second floor

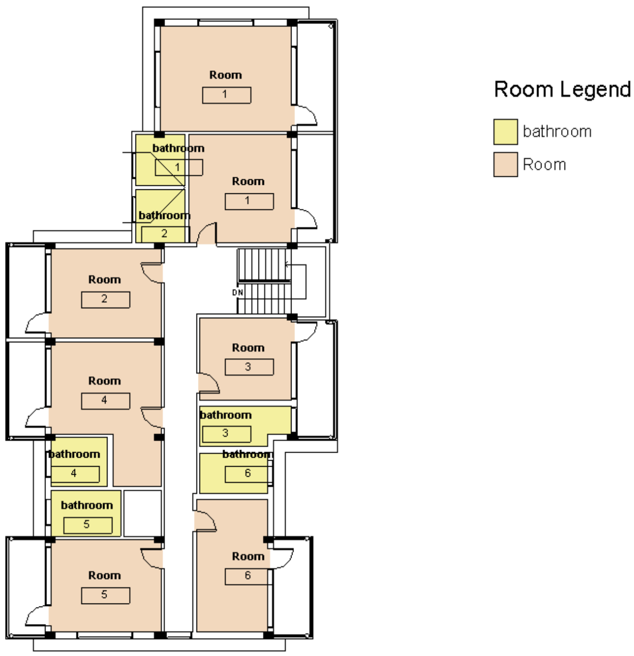

Figure 14:Third floor

3Dview

Figure 15: building at kullu

Figure 16: Back view

Figure 17: front view

when we designing building in revit . we study about GRIHA and give points according to the criteria to building.

Table 6: Give points according to the criteria to building.

SECTION	CRITARIA NAME	INTENT	POINT MAX	POINT OBTAINED
SECTION 1 **Site Parameters**	**Criterion 1** Accessibility to Basic Services	Promote walk, bike, or take public transportation.	2	2
	Criterion 2 Microclimatic Impact	Reduce the influence of the Urban Heat Island Effect (UHIE) and encourage tree planting	4	4
SECTION 2 **Maintenance & Housekeeping**	**Criterion 3** Wastewater Treatment, Green Sourcing, and Repair ,Waste Management	Ensure good practices for safety, Green purchases and waste management	7	4
	Criterion 4 Metering & Monitoring	Promote reliable metering and monitoring	10	4
SECTION 3 **Energy**	**Criterion 5** Energy Efficiency	Ensure energy efficiency	20	3

	Criterion 6 Renewable Energy Utilization	Promote use of renewable energy	15	0
SECTION 4 **Water**	**Criterion 7** Water Footprint	Implement potential water conservation strategies	15	2
	Criterion 8 Reduction in Cumulative Water Performance	Reduce overall water demand of the habitat	10	2
SECTION 5 **Human Health & Comfort**	**Criterion 9** Achieving Indoor Comfort Requirements	Ensure that building spaces provide for thermal, visual, and acoustical comfort	8	3
	Criterion 10 Maintaining Good IAQ	Ensure good indoor air quality	4	4
SECTION 6 **Social Aspects**	**Criterion 11** Universal Accessibility & Environmental Awareness	Promote accessibility for the persons who are differently-abled & the elderly and to increase	5	3

		environmental awareness amongst the building users & visitors		
SECTION 7 **Bonus Points**	**Criterion 12** Bonus Points	Adoption and execution of creative solutions to improve the project's long-term viability	4	0

Standard According to the criteria , total points we obtained is 31.

We can increase our score by applying many practices that is mention in criteria. Like rain water harvesting , solar panel grass paver etc. which will help in increasing our score and we can achieve a good number.

CHAPTER 4

RESULT

4.1 GENERAL

In this chapter we will discuss green practices which we can add in building to make it green building.

1) SOLAR POWER PLANT:- Solar power plants are also referred to as solar energy technologies, solar panels, solar power systems, and solar projects. Solar power is the direct conversion of sunlight into electricity using photovoltaics (PV), concentrated solar power (CSP), or a combination of the two. Solar cells employ the photovoltaic effect to convert light energy into electrical energy. In concentrated solar power systems, lenses, mirrors, and solar tracking systems are used to aim a large area of sunlight onto such a prime location, which is often used to power a steam engine.
2) RAINWATER HARWESTING :- Rainwater harvesting is a simple method of collecting and conserving rainwater at the surface or in a subsurface aquifer before it is discharged as surface runoff from rooftops, gardens, highways, open spaces, and other locations for later use. Water running down the ground during the rains will be collected in a tank beneath the ground surface in this method of collecting rainwater for irrigation.
3) GRASS PAVER :- Grass pavers are pavement tiles with a high number of rhombus-shaped gaps that allow water to seep through the ground, increasing the ground water table. Grass pavers also help with reducing the heat island effect, since anyone else paving material, such as concrete or bitumen, absorbs the heat during the day and functions as a heating island at night when the surrounding environment cools.
4) VERMIN COMPOSITING :- Vermin compost is the result of a procedure known as vermin composting, which involves the usage of earthworms to speed up the biodegradation process and assure higher-quality compost. Vermin compost is essentially what is used to fertilize garden plants. To improve production rate, waste materials from the home and kitchen is

employed, such as food waste, raw paper trash, cow manure, coconut waste, and egg waste, with the goal of increasing the rate of vermin composting or de composting. Vermin composting produces a rich, black, earthy-smelling compost that will aid in the positive growth of your plants. There is also vermin cast, which is slightly different from vermin compost. Worm castings, also known as vermin cast, is worm faeces that has been separated from the rest of the compost.

Solar power plant

- The analysis of energy saved per hour is given below:
  Total number of bulb = 80
  Power of 1 bulb = 9 watt
  Total power of bulb = 80 X 9 =720 watt = 0.720 kw
  Energy cost consumption per day = 0.720 X12 hrs per day = 8.64 kwh per day

- Total number of tube lights = 40
  Power of 1 tube light = 24 watt
  Total power all tube lights = 40 X 24 = 960Watt = 0.960 kw
  Energy cost consumption per day = 0.960 X 7 hrs per day = 6.72 kwh per day

- Total number of fans = 30
  Power of each fans = 30 watt
  Total power all fans = 30 X 30 = 900Watt = 0.900 kw
  Energy cost consumption per day = 0.900 X 10 hrs per day = 9 kwh per day

- Total number of fridge = 2
  Power of each fridge = 500 Watt
  Total power all fridges = 1000 Watt = 1 kw
  Energy cost consumption per day = 1X 24 = 24 kwh per day

- Total number of geezer = 8
  Power of each geezer = 1500 Watt

Total power of geezer = 12000 Watt = 12 kw

Energy cost consumption per day = 12 X 3 = 36kwh per day

- Other miscellaneous consumptions = 7000 Watt = 7kw

  Energy cost consumption per day = 7 X 5 =35kwh per day

Total energy consumption per hour = 22580 Watt = 22.58 Kilo Watt

Total energy consumption cost per day = 119.36 kwh per day

Calculate energy consumption cost per month = 119.36 kwh X 30 days = 3580.8 kwh per month

Cost of 1 Kilo Watt electricity = Rs. 7 for commercial

Where 1 unit = 1 kwh

Total energy consumption per month = 7 X 3580.8 = Rs. 25,065.6

Cost reduction:

Approximate cost reduction after implementation of changes = 1500 units per month

Total Energy reduction = (1500 kw X 6 hrs) – 3580.8 kwh

= (9000 – 3580.8) kwh = 5419.2 kwh per month

Whereas 1 kwh = Rs. 4.6

Total Cost of energy produced by solar power = Rs. 4.6 X 9,000 kwh = Rs. 41400.00

Total extra energy saved = 41400 – 25065.6 = Rs. 16334.4

COST ANALYSIS OF SOLAR POWER PLANT

Total solar system price = Rs. 6,00,000.00

The total energy consumption is calculated around 3580.8 kwh per month. The solar system with 15 kw capacity may generate 1500 units per month, or 9,000 kwh per 6 hr in a day. Therefore, total consumed energy per month is full filed by solar power plant and more energy is generated around 5419.2 kwh per month. It gives more profit of Rs. 16,334.5 . We can recover money

4.1.1 Rain water harvesting

Table 7:- Rainfall data (kullu district) 2016 -2020

MONTH/YEAR	2016	2017	2018	2019	2020	Sumision
JANUARY	37.9	186.8	12.4	133.7	199.9	114.14
FEBRUARY	74.1	77.6	56.8	255.8	1.9	93.24
MARCH	186.6	106.9	67.5	145.1	214.7	144.16
APRIL	92.5	109.2	91.9	62.5	111.3	93.48
MAY	57.5	96.5	43.3	65.5	64.2	65.4
JUNE	58.6	146.1	100.1	68.7	63.9	87.48
JULY	185.9	218.9	204.9	161.7	194	193.08
AUGUST	282.6	106.2	194.4	276.9	249.2	221.86
SEPTEMBER	36.4	106.2	273.8	57.9	21.2	99.1
OCTOBER	4.9	1	10.7	22	0.3	7.78
NOVEMBER	0	19	88	105.6	89.7	60.46
DECEMBER	0.1	44.9	10.9	86.5	30.6	34.6
Summision	1017.1	1219.3	1154.7	1441.9	1240.9	

Total annual rainfall :- 1017.1 + 1219.3 +1154.7 + 1441.9 + 1240.9 = 6073.9

Average annual rainfall :- 6073.9/5 = 1214.78

From the above table we can conclude some results which are as follows:

1.) Annual mean rainfall of kullu district: 1214.78mm

To utilize the rain water, we have to calculate the amount of water we can collect. For collection of water we will take the peak amount of rainfall which is usually received during the month of august and the value equal to 221.86 mm.

The catchment area will be area of rooftop = 241.72 m^2

The IS Code which is taken into consideration for Water Availability is **IS 15797: 2008**

Table 8: Water Availability for a Given Rooftop Area and Rainfall (For sloping Roofs) (Clause 5.1)

Sl No.	Roof Top Area m^2	Rainfall, mm												
		100	200	300	400	500	600	800	1 000	1 200	1 400	1 600	1 800	2 000
		Water availability (m^3)												
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
i)	20	1.9	3.8	5.7	7.6	9.5	11.4	15.2	19	22.8	26.6	30.4	34.2	38
ii)	30	2.9	5.7	8.6	11.4	14.3	17.1	22.8	28.5	34.2	39.9	45.6	51.3	57
iii)	40	3.8	7.6	11.4	15.2	19	22.8	30.4	38	45.6	53.2	60.8	68.4	76
iv)	50	4.8	9.5	14.3	19	23.8	28.5	38	47.5	57	66.5	76	85.5	95
v)	60	5.7	11.4	17.1	22.8	28.5	34.2	45.6	57	68.4	79.8	91.2	102.6	114
vi)	70	6.7	13.3	20.0	26.6	33.3	39.9	53.2	66.5	79.8	93.1	106.4	119.7	133
vii)	80	7.6	15.2	22.8	30.4	38	45.6	60.8	76	91.2	106.4	121.6	136.8	152
viii)	90	8.6	17.1	25.7	34.2	42.8	51.3	68.4	85.5	102.6	119.7	136.8	153.9	171
ix)	100	9.5	19	28.5	38	47.5	57	76	95	114	133	152	171	190
x)	150	14.3	28.5	42.8	57	71.3	85.5	114	142.5	171	199.5	228	256.5	285
xi)	200	19	38	57	76	95	114	152	190	228	266	304	342	380
xii)	250	23.8	47.5	71.3	95	118.8	142.5	190	237.5	285	332.5	380	427.5	475
xiii)	300	28.5	57	85.5	114	142.5	171	228	285	342	399	456	513	570
xiv)	400	38	76	114	152	190	228	304	380	456	532	608	684	760
xv)	500	47.5	95	143	190	237.5	285	380	475	570	665	760	855	950
xvi)	1 000	95	190	285	380	475	570	760	950	1 140	1 330	1 520	1 710	1 900
xvii)	2 000	190	380	570	760	950	1 140	1 520	1 900	2 280	2 660	3 040	3 420	3 800
xviii)	3 000	285	570	855	1 140	1 425	1 710	2 280	2 850	3 420	3 990	4 560	5 130	5 700

Total rainfall and collection surface area determine the total volume of rainwater collected from any roof top surface. Infiltration, evaporation, and other losses are commonly calculated using a runoff coefficient, which ranges from 0.8 to 0.95.

We take value from table 8 for rooftop area ,by using interpolation method

Rainfall and Water Availability for a Rooftop(given) Area = 50.95 m^3

Total amount of water that will be available = 50.95 X 0.8 = 40.76 m^3

Area of roof top = 241.72 m2

Annual rainfall = 1214.78

Volume of water = 50.95m3

Actual volume of water = 40.76m3

Volume of tank required = 40.76 m3

Now assume depth = 2m

Area = volume / depth = 40.76/2 = 20.13 m2

Assume length = 6m

Width = area/ length = 20.13/6 = 3.35 = 3.4 (approx.)

- DIMENSION OF RAINWATER TANK = 6m X 3.4m X 2m

If we assume that one person water requirement is 225 l/c/d .

than if we divide actual volume of water with water requirement we will get total number of people who will get water from this water tank.

40260/225 =178.9

This water tank can fill approximately 179 people water requirement per day.

4.1.2 Grass Paver

The cost analysis of grass pavers is tabulated below:

Dimensions of grass pavers = 0.4mX 0.6m
Dimension of area to be paved = 1.8 m X 10 m

Total no of pavers required = 75
Cost of each paver = Rs. 50
Total cost of pavers = 50 X 75 = Rs. 3750
Placing charges = Rs. 400

Total cost = Rs. 4150

Cost comparison by using plain concrete brick pavers

Dimensions of grass pavers = 0.2 X 0.4

Total no. of pavers for the same area = 225

Cost of each concrete solid pavers = Rs. 30

Total cost of pavers used = 225 X 30 = 6750

Total cost with placing price = 6750+ 400 = Rs. 7150

Let us suppose cost saved on grass pavers use

Total cost saved = 7150 – 4150 = Rs. 3000.00

4.1.3 Vermin Composting

Table 9: total cost analysis of the vermin compost plant.

Total cost of excavation	Rs. 1000.00
Total cost of construction	Rs. 50000.00
0Total	Rs. 51000.00
Add miscellaneous and contingencies @ 5%	Rs. 2550.00
Total	Rs.53550
Cost of Earthworms	Rs.1260
TOTAL	Rs. 54810.00

Cost comparison by using manure with fertilizers from market

Cost of manure per kg = Rs. 200

Quantity of manure = 100 kg per year

Total cost of manure = Rs. 20,000

4.2 SCORE AFTER APPLYING SOME GREEN PRACTICES

SECTION	CRITARIA NAME	INTENT	POINT MAX	POINT OBTAINED
SECTION 1 **Site Parameters**	**Criterion 1** Accessibility to Basic Services	Promote walk, bike, or take public transportation.	2	2
	Criterion 2 Microclimatic Impact	Reduce the influence of the Urban Heat Island Effect (UHIE) and encourage tree planting	4	4
SECTION 2 **Maintenance & Housekeeping**	**Criterion 3** Wastewater Treatment, Green Sourcing, and Repair Waste Management	Ensure good practices for safety, Green purchases and waste management	7	6
	Criterion 4 Metering & Monitoring	Promote reliable metering and monitoring	10	5

SECTION 3 **Energy**	**Criterion 5** Energy Efficiency	Ensure energy efficiency	20	3
	Criterion 6 Renewable Energy Utilization	Promote use of renewable energy	15	0
SECTION 4 **Water**	**Criterion 7** Water Footprint	Implement potential water conservation strategies	15	11
	Criterion 8 Reduction in Cumulative Water Performance	Reduce overall water demand of the habitat	10	3
SECTION 5 **Human Health & Comfort**	**Criterion 9** Achieving Indoor Comfort Requirements	Ensure that building spaces provide for thermal, visual, and acoustical comfort	8	4
	Criterion 10 Maintaining Good IAQ	Ensure good indoor air quality	4	4

SECTION 6 **Social Aspects**	**Criterion 11** Universal Accessibility & Environmental Awareness	Promote accessibility for the persons who are differently-abled & the elderly and to increase environmental awareness amongst the building users & visitors	5	5
SECTION 7 **Bonus Points**	**Criterion 12** Bonus Points	Adoption and execution of creative solutions to improve the project's long-term viability	4	4

Total point we obtained is 51. We can get 2 star if we apply all these practises in building.

CHAPTER 5

CONCLUSION

The current investigation yielded the following findings.:

1) The total cost of installing solar panels on the building's roof is estimated to be Rs. 6,20,000
2) The total energy used by buildings has been calculated to be 3,715.2 kwh of about Rs. 22,291.20.
3) A 15 kw solar power plant produces around 9,000 kwh of electricity. Rs. 41,400.00
4) The annual electric energy saved after installing a solar system is estimated to be 5419.2 kwh, or around Rs. 16334.4, or roughly 30-40% of total monthly energy production.
5) This water tank has dimensions of 6m X 3.4m X 2m and can meet the daily water needs of about 179 persons.
6) The grass paver installation covers approximately 18 square metres.
7) The entire cost of the grass pavers is Rs. 3750.
8) Savings of Rs. 3000 by using grass paver.
9) The overall cost of the vermin composite plants is estimated to be Rs. 54810.

Paybacks of total cost

10) The total cost of the solar plant is estimated to be Rs. 6,00,000.00, plus Rs 20,000 in additional costs. The total price is Rs 6,20,000.
11) The solar power system saves roughly Rs 16,334.4 every month over the course of a year. If the lifespan of solar energy is 25 to 30 years, the cost of a solar panel will be recovered in 3 to 4 years.
12) The complete amount will be recovered in 7 to 8 years.
13) Total point we obtained is 51.
14) We can get 2 star if we apply all these practices in building.

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