“GREEN BUILDINGS”

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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DECLARATION

I hereby declare that the work presented in the Project report entitled **"GREEN BUILDINGS"** 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 **Prof.(Dr.) Ashish Kumar.** 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 BUILDINGS"**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 **Ujjwal Kumar (181603)** during a period from July, 2021 to May, 2022 under the supervision of **Prof.(Dr.) Ashish Kumar** (Head of Department), 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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ABSTRACT

A green building, which is otherwise called a sustainable building, is built to attain some goals, such as better occupant health, more productive utilization of water, energy and other available resources, and less environmental effect. As most of the development processes results in an excess use of resources specially the natural ones so the green building concept is a good way to make efficient use of resources while constructing healthier buildings that eventually help in making of good environment, encourage human health and results in saving money. Retrofitting of a constructed building into a green building, by taking into accounts of various parameters such as water, energy, materials and cost concerns, to increase inhabitant comfort, environmental performance, and economic returns. In this project, we propose giving credits to assess the existing building for its many green elements using the GRIHA rating system, as well as suggesting strategies to improve the building's green performance.

The project undertaken deals with

- Understanding the concept of Green Building.
- To model an existing Residential Building on Revit.
- Giving points to assess the existing building for its various green elements using the GRIHA rating systems.
- Analyze and Optimize that Residential Building.
- Suggesting strategies to improve the building’s green performance.

Keywords: Retrofitting, Green Building, Sustainable Building, Human Health, Natural Resource, Energy, etc.

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.1 GENERAL

The construction industry poses a significant environmental threat such as those buildings account for at least 40 percent of worldwide energy utilization. Buildings absorb around 42 percent of worldwide water utilization and 50 percent of worldwide raw material use when the manufacturing, construction, and operational periods of buildings are considered. Furthermore, construction operations are responsible for 50 percent of global pollution specifically air and water, 42 percent of GHG emissions, 50 percent of all water pollution, 48 percent of whole solid wastes, also 50 percent of entire CFCs (chlorofluorocarbons).

These construction-related environmental issues are also faced by India. In 2004–05, the entire built-up region added to residential and business areas was roughly 40.8 million square metres, or about 1% of the yearly average completed floor area around the world, with trends indicating a 10% increase in the next years. Building energy consumption has increased from a low of 14 percent in the 1970s to over 33 percent in 2004–05, thanks to a near-consistent 8% increase in yearly energy consumption in the residential and commercial sectors (Song, et al., 2017). Unless sudden measure steps are made to enhance energy generation, energy consumption will continue to climb.

According to TERI estimates, the annual demand for electricity to meet end-use energy requirements for residential and commercial buildings has increased by roughly 5.4 billion units (kWh).

During the process of construction, buildings use major amount of water (for cooling,occupants and landscaping). In 1990, per capita water usage was 2464 m^3 per year, but with a 1.4 billion population predicted by 2025, it will reach up to lesser than 1700 m^3 per capita per year and this will lead it to the verge of stress category. According to information gathered from Indian state governments, around 93 percent of the metropolitan population had access to drinking water delivery facilities as of March 2004. The coverage figures simply reflect accessibility; in some situations, the sufficiency, even-handed circulation, and per-capita arrangement of these essential administrations might miss the mark concerning the commanded guidelines. The impoverished, for example, especially population living in slums and stumpy communities, are frequently denied of these necessities. Similarly, water supply is vital not just for daily water demand for drinking purposes, but also for agricultural and other related industries.

While we are dealing with a water deficit, there is a big opportunity to bridge the resource gap by treating waste water and reusing it for multiple purposes. As indicated by the (CPCB) Central Pollution Control Board's evaluation of wastewater age and treatment in Class I and Class II urban areas in India during 2003-04, around 26 254 million litres each day (MLD) (9.51 billion m^3 (BCM) was created in 921 Class I and Class II urban areas (housing more than 70 percent of urban population) also so far, waste water treatment capacity was 7044 MLD which accounts near about 27 percent of waste water generated in urban centres (2.57 BCM/year) (Kapshe, Manmohan, Paulose, Garima , & Akhilesh , 2013).

Another key difficulty that requires consideration is the management of construction and demolition trash, as well as solid waste generated by building tenants. The CPCB estimates that 48 million tonnes of solid scrap is generated in India annually, of which 25% waste is contributed by construction industry.

Urbanisation on a large scale is responsible of ‘heat island’ effect which is uncontrollable. Replacement of vegetation and tree covers by expansion of pavements extensively, construction of buildings and other structures results in take-off of cooling done by trees through evapotranspiration and shade.

As a result of this ozone is formed in the ground zone which has a harmful impact on human health. Due to urban heat island effects temperature can rise by up to 10 degrees Fahrenheit which automatically results in higher demand for AC. As the need for ac increases, there will be higher power generation which makes a significant contribution to greenhouse gas emissions. Due to all this, these matters needs to get proper attention.

As we design our developmental route, it is necessary to keep an eye on the environmental damage that we cause due to these processes. So for the sake of Mother Earth if required we must make required changes to get the desired results. Green buildings are well known for their enormous capability to cut utilization and recover assets from squander and inexhaustible sources, bringing about a mutually beneficial arrangement for the client, the proprietor, and the climate.

1.2 IMPACTS OF CONVENTIONAL BUILDINGS

Green Buildings are possibly the most suited solution to counter various environmental impacts that a conventional building produces in its life cycle. Conventional Buildings produces significant amount of greenhouse gas emissions and also various other damaging air pollutants. Buildings also produce lot of demolition waste, which obviously has a very bad impact on flora and wildlife. Conventional buildings use enormous amount of energy worldwide. As per the reports released by the IEA in 2008, more than 40% of global primary energy use and 24% of global CO2 emissions are done by Existing Buildings.

During the whole life cycle of the building, it requires a lot of energy that majorly comes from the fossil fuels. There are lot of issues to get addressed but the big concerns are GHG emissions and indoor air pollution. Buildings not only release greenhouse gases but also variety of other contaminants also that are very dangerous. Outside air pollution is not just the case; in fact there may be possibility that air pollution within a building is significantly higher. It is estimated that indoor pollution level can be 2 to 5 times more than the outside pollution level. Indoor air pollution parameter became relevant as we spend significant time in the building. One way to counter this parameter is to make sure that indoor air is timely replaced by the outside air that has less contamination in it. Conventional buildings are generally under-ventilated which unfortunately results in the air that is not safe to health of building inhabitants. On the other hand health and well-being of the inhabitants is the top most priority of green buildings.

Generally building outflow is discharged into municipal sewer systems rather than being treated or used for non-portable uses. Also as the buildings are constructed, the vegetation that can absorb precipitation gets removed which results in overwhelmed municipal sewer systems.

Various building operations can also be benefitted from "grey(gray) water." The water that has been discharged from baths, showers, washer-dryer, and sinks which can be gathered and reprocessed is known as grey water. Grey water can be used in irrigation (gardening) purposes, as it contains valuable nutrients like phosphorus, which is good for plants growth.

1.3 NEED FOR STUDY

The phrases "green building" and "high-performance building," "sustainable design," and "conserving precious resources" are often utilized reciprocally. "Green" in India, according to the CII, is defined as "the voluntary pursuit of any activity that is concerned with energy efficiency, environmental management, water management, renewable energy, waste management, and recycling." Green strategies at last add to long haul advancement and more equivalent development.

Green building is totally linked to the concept of sustainable development and sustainability. The need of the study is due to the reason that green construction can result in:

1) Running costs gets lower due to increased efficiency and less use of energy and water.
2) Indoor air quality increases which leads to better public and resident health.
3) Effect of different ecological issues, for example, storm water spillover and the warming impact gets diminished.

1.4 WHAT IS A GREEN BUILDING?

The goal to design a green building must be addressing all the negative environmental impacts that a building has on it over its whole life cycle like preserving ground cover, trees, water and energy which is getting diminishing as buildings are taking their place, various building operations and inhabitants’ functions generate huge amount of garbage that needs to be either recycled or reused directly. It is very well known that designing and construction of a green building requires more cost than the other types of buildings. However, if it comes to the maintenance of the building it is known truth that it is less expensive to maintain a green building and also it has significant environmental benefits and in addition to that it also provides better living for its residents.

The spirit objective of the green structure is to decrease non-inexhaustible asset interest, increment the productivity of these when being used, and amplify the reuse, reusing, and use of sustainable assets. It amplifies the utilization of productive structure materials and development rehearses; enhances the utilization of on location sources and sinks through bioclimatic design rehearses; utilizes minimal measure of energy to drive itself; utilizes proficient hardware to meet its lighting, cooling, and different necessities; expands the utilization of sustainable power sources; utilizes effective waste and water the board rehearses; and gives agreeable and clean indoor working circumstances.

Figure 1: Schematic diagram featuring select green structure highlights.

To summarise, the following areas of green building design are investigated in depth.

1) Site preparation.
2) Design of the building envelope.

3) Design of the building system (HVAC [heating ventilation and air conditioning], lighting, electrical, and water heating).
4) Generation of energy On-site with the help of renewable energy sources.
5) Management of water and waste.
6) Selection of environmentally sustainable materials.
7) The state of the indoor environment (maintains indoor thermal and visual comfort and air quality).

1.4 BENEFITS OF GREEN BUILDING

1) Generally when green buildings are compared to conventional structures, they use 40% to 60% less electricity. This is mainly due to their dependency on passive architectural interventions and high-efficiency materials and technology in the building's engineering design.
2) Green Buildings also make an effort to generate on-site energy through the use of renewable energy sources to meet their energy requirements. FOR EXAMPLE, Solar PV panels can assist in the generation of electricity, reducing the building's reliance on grid power.
3) Generally Green buildings use 40% to 80% less water than conventional structures. Green buildings not only minimize their need for water by utilizing waste-water recycling systems and rain-water harvesting, but they also consider on-site supply sources to meet both internal and exterior (landscape) water demands.

1.5 GRIHA

India, a significant economy, is the world's 6th biggest country. The development business has a huge influence in the Indian economy, as seen by the nation's thriving land advancement. The change to a greener structure industry has ended up being inescapable considering the developing energy shortfall, asset shortage, and rising ozone depleting substance emanations. Since the most recent couple of years, the GRIHA, Simple Versatile Affordable GRIHA, and GRIHA for significant improvement rating frameworks have attempted to conquer these difficulties and accomplish maintainability.

The GRIHA Council has contrived a rating framework for existing structures involving this as a benchmark. The GRIHA for Existing Buildings (EB) rating is an incorporated instrument for surveying existing structure execution and giving economical arrangements while further developing inhabitant solace. Structures that have been evaluated will have further developed energy and water productivity, as well as higher warm and visual solace, bringing about lower functional and upkeep costs. The ideal worth of the property cost and higher inhabitant maintenance of the reviewed structures will help business structures much more. The GRIHA for existing buildings rating was made in view of explicit objectives, like decreasing natural effect, simplifying it to carry out, lining up with nearby and public objectives, and being financially savvy. The rating means to give answers for different structure typologies and ages that oblige to India's various climatic zones, while additionally including RWAs and territory clients simultaneously. The grade would be founded on specific parts that are basic for the structure's general presentation improvement.

On a worldwide scale, efforts are being made to improve the efficiency of current structures. The Indian government is implementing a number of initiatives aimed at improving "Demand Side Management" in the energy sector. GRIHA envisions the implementation of an integrated process encompassing regulatory mandates, codes, and standards in India, as highlighted in India's "Intended Nationally Determined Contributions (INDCs): Working Towards Climate Justice" document submitted to the United Nations Framework Convention on Climate Change (UNFCCC) (Griha India). From couple of past years GRIHA has been aiming on new structures under the motto "what gets measured gets managed," and with a similar assurance, we will try to "Inspire, enable, and engage with society" and accomplish an economical living space for everyone.

From the above information it can be assessed that conventional buildings have significant negative impact on the environment. So I have taken an existing conventional building located at Sidhra, Jammu and try to analyse it as per GRIHA rating system discussed above. On the basis of result I got I proposed some green practices so that my building should attain more points and my building gets optimized in various areas. The structure will produce less waste, use water efficiently and same in case of energy part also which will help the client to save money also so my building will be cost effective also in longer course of time. As the building will use resources efficiently, the green building motto will also be attained and eventually there will be lesser negative impact on the environment by new proposed green building in comparison to earlier conventional structure.

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

Construction of Green buildings is one of the methodologies proposed to minimize the adverse consequences of the existing structure stock on the climate, mankind, and wealth. The amount of examinations on green buildings has expanded in the last few years. The definition and extent of green structure, measurement of green structure benefits contrasted with existing structures, and various strategies to accomplishing green structures are pervasive topics. From the findings it was concluded that most of the work was focused on environmental aspect of green structure. Rest of the aspects of green building sustainability, particularly social sustainability, are largely ignored.

2.1.1 CONCEPT OF UTILIZATION OF WASTE ELEMENTS:

Basically, waste elements can be obtained from many sites as demolition sites provides recycled aggregates, power plants provide fly ash, fume, furnace slag, moreover these waste elements are broadly divided into many parts as domestic waste includes plastic and garbage and commercially waste includes rubber waste. Partially replacing Portland cement with waste materials will help to reduce environmental pollution as well as cement and other construction materials manufacturing. The conservation of the environment is one of our society's primary challenges.

- An experiment was conducted on the presentation of concrete using solid waste fibers and discovered that the loading capability of concrete expanded, it also stated a limit of 2% of fibres could be utilised for strength and a maximum of 6% could be used for removal (Malagavelli & Paturu, 2011).
- Using plastic waste as a coating over aggregates improved attributes of the aggregates, and that the ideal proportion of plastic, based on the stability values, was 6-8 % (Sultana & Prasad, 2012).

- An experiment also conducted on the utilization of recycled plastic in form of a bunch of cells with dimensions ranging from 150mm * 150mm to 200mm * 120mm and depths ranging from 50mm to 100mm, which were laid over a compacted base, the analysis found that the process of construction can help in increasing the flexibility of concrete with little maintenance and that the surface does not break and the lifespan is estimated to be between 15-20 years (Pandey, 2012).
- By partially substituting the cement with fly ash helps in 25% of the volume consumption of cement, resulting in a 15% reduction in building costs provided fly ash is collected effectively (Basak, Paria, & Bhattacharya, 2004).
- During 7-14 days substantial strength is less in the fly ash cement concrete, as per the completion of 28 days, the cement components and pozzolanic reaction result in quick hardening qualities, with 25% fly ash substitution(Suryawanshi & Nemade , 2012).
- It was discovered that using 50 percent fly ash as an additive improved the compressive strength of ordinary concrete(Chaudhary, 2012).
- In an experiment it was discovered and reported that 15% -20% recycled aggregates by volume can be used to attain all of the qualities of regular concrete(Bindra, Sana, & Tadulkar, 2003).
- Recycled and secondary aggregates can be utilised at a maximum of 20% -30% by volume without changing the w/c ratio to achieve all of the needed qualities of conventional concrete(Dhir & Paine, 2010).
- It was found that no significant improvement in concrete strength after 7 and 28 days, but a substantial improvement in compressive strength after 90 days in blast furnace slag aggregate concrete (10.11%) compared to stone aggregates(Marik & Roy, 2005).

2.1.2 CONCEPT OF ENERGY EFFICIENCY:

Energy productivity is a proportion of how much energy is utilized to offer an assistance. By further developing energy effectiveness, the public will get and save additional energy from the energy that is presently being consumed. Energy proficiency implied utilizing less energy to achieve or make more undertakings or exercises. Besides, energy-effective growth should be seen as a fast and minimal expense way of new energy, as the expense of conveying energy can be cut altogether. Energy proficiency is basic for society's prolonged practicality.

Energy proficiency can also help to nourish processes, allowing for less energy to be used to provide many facilities such as lighting, heating, ventilation, and air conditioning (HVAC), and so on. Energy efficiency is widely recognised as a means of lowering greenhouse gas (GHG) emissions. To accomplish energy efficiency, use electrical feeding that is energy efficient, such as employing light-emitting diode (LED) light bulbs and sensor systems, passive design, and cross ventilation and while using renewable energy sources such as solar energy is another smart approach to improve energy efficiency (Hussein & Chen, 2015).

- The energy consumption of GB technology indicated a 50 percent and 43 percent annual reduction in energy usage in the Indian building industry and the American home, respectively(Dong , Andrew, & Jing, 2016).
- Integrated design approaches have been claimed to lower energy consumption by 72 percent, however projects can be more expensive than individual solutions(Ramesh & Emran , 2016).
- It was investigated the HVAC system's energy consumption characteristics(Jinkyun, Seungho, Jonghurn, & Hiki, 2014). The empirical investigation decline was explored by a group of scientists within a range of -0.4 to 21%(L.N. & K.N., 2016).
- The use of a double skin green front on high-rise structures in Hong Kong to reduce energy consumption. He indicated that the solar conduction of lone and multiple layers of creeping floras like Virginia creeps varies between 0.43 and 0.14, and that it can reduce solar output by 40-80%(Wong & Baldwin, 2016).

2.1.3 GREEN BUILDING RATING SYSTEM:

A green building rating system is a method for assessing a building's environmental performance throughout its life cycle. It usually consists of a set of standards that encompass many aspects of a green building's design, construction, and operation. Each criterion contains a set of pre-assigned points and establishes verifiable performance standards and targets. Once a project meets the rating criteria, it is given points. The points are totaled to determine a project's final rating. Rating systems need a project to be evaluated by an impartial third party, and several mechanisms are in place to assure a fair evaluation. Green building grading systems have been significant in spreading awareness and popularizing green building concepts around the world. They are mostly voluntary in nature.

- Various appraisal tools have been made to support the advancement of green structures like Leadership in Energy and Environmental Design (LEED, USA), BRE Environmental Assessment Method (BREEAM, UK), Green Building Council of Australia Green Star (GBCA, Australia), Green Mark Scheme (Singapore), DGNB (Germany), Comprehensive Assessment System for Built Environment Efficiency (CASBEE, Japan), Pearl Rating System for Estidama (Abu Dhabi Urban Planning Council), Hong Kong Building Environmental Asse (Malaysia)(Jian & Zhen, 2013).

- All of these green building assessment tools are offered on a voluntary basis rather than as a requirement. It was created by each country's or region's green building council. The assessment is carried out by green building council-commissioned accredited personnel. The World Green Building Council was formed to bring together the activities of several green building councils around the world (Jian & Zhen, 2013).

- A comparative and spatial analysis of the LEED-India and GRIHA rating systems has been conducted in which LEED-India is affiliated with the internationally recognised LEED programme, which is administered in India by the International Green Building Council (IGBC) was founded in 2001 as a spinoff of the United States Green Building Council's (USGBC) LEED programme, "To enable a sustainable built environment for all and assist India in becoming one of the global leaders in sustainable built environment by 2025," says the IGBC's mission statement(Smith, 2015).LEED-India is a privately run green certification system that aims to promote the construction of environmentally friendly structures in India therefore in general, western firms and the private sector in India choose the LEED methodology for green certification. The grading system is centred on encouraging the use of environmentally friendly design and construction techniques in the construction of new buildings. Projects are given points for their performance in terms of sustainable site development, water conservation, energy efficiency, material selection, and indoor environmental quality.

LEED-India grants certification on four levels, similar to other LEED systems: Certified, Silver, Gold, and Platinum.

2.1.3.1 COMPARISON BETWEEN LEED-INDIA AND GRIHA

In India, number of green projects have been registered for certification or have already been certified under the LEED or GRIHA systems. A wide range of projects like a small individual level hometo huge developments of up to 123 acres are part of these projects.

According to data obtained from the relevant organisations, 810 green projects in India are under review or have been accredited by the two ranking systems; GRIHA has 365 projects under consideration for certification, whereas LEED-India has 445 projects registered for certification(Smith, 2015). As there is significant name awareness of LEED, also the implementation date of it is earlier, so there is no surprise that LEED-India has a bigger total number of projects. While on the other hand GRIHA, has a built-in advantage in terms of government support and mandates for particular projects to comply with the GRIHA standard.

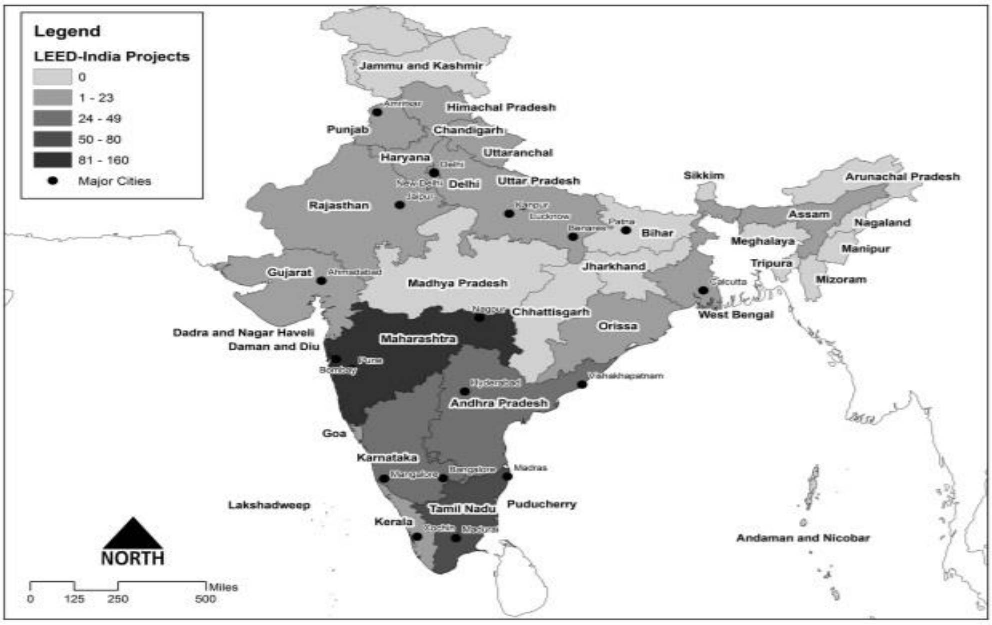


Figure 2: Complete number of LEED-India projects in India by state/union territory. Source: IGBC.

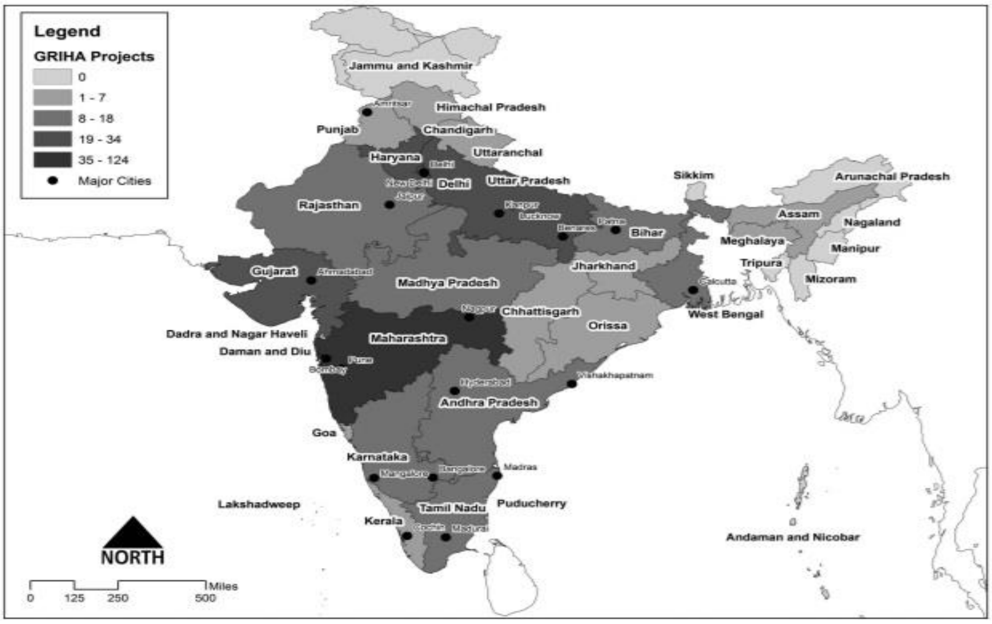


Figure 3: All out number of GRIHA projects in India by state/union territory. Source: ADaRSH.

CONCLUSION OF THE PAPER

India has barely 20,000 square feet of green building space in 2003, with 1.1 billion square feet of green building space; India is the world's second greatest producer of green space, trailing only the United States, which has over three billion square feet(Smith, 2015). The cost of planning and constructing green buildings has reduced as the demand for green buildings has increased. In India in the early 2000s, a green building cost about 18 percent more to construct than a regular building. Today, the difference between the two types of structures is barely 5%. The green building movement of LEED-India and GRIHA will continue to grow as the benefits of green buildings become more evident and the cost disparity between traditional and green builds narrows.

2.2 RESEARCH GAP

Strategy and market obstacles, monetary and financial hindrances, data advancement and training boundaries, and managerial and organisational barriers were recognized through a review of literature. The end of these holes could well affect the green development industry. A portion of the singular holes are of the 'mutual benefit' assortment, which are moderately easy to fill since they exclusively bring about wins. Simultaneously, there are tradeoff holes that could bring about pay misfortune.

1) STRATEGY AND MARKET OBSTACLES:

An outside hole coming about because of insufficiency of guideline because of an absence of sufficient motivators for the advancement of green structure, unfortunate execution and execution of building and energy codes, unfortunate norm of appointing structures, and different variables that adversely influence a partner's advantages. Green rating methods are not broadly utilized because of the unassuming size of green structure markets, and thus, expenses and resale values are not sufficiently alluring to captivate financial backers.

- Absence of financial motivating forces as expense exception or awards for interests in green structures by the public authority on account of interest in green structures.
- Non-execution of the building regulations in the country (National Building Code and Energy Conservation and Building Code), which helps avoidance from development guidelines.
- Trouble in understanding the rating instruments by the financial backers, making them incredulous of the evaluations.
- Absence of interest and supply side push prompting slow take off of green structures.
- Time taken in authorizing an undertaking and nontransparency of the framework.

2) MONETARY AND FINANCIAL HINDRANCES:

Green structure take-up is hampered by the expensive beginning venture, restricted monetary assets, and financial plan imperatives. What's more, the area has different difficulties like an absence of delicate advances, a long reimbursement period, and trouble evaluating benefits. Green structures are viewed as having high capital uses and a long bring period back. A potential obstruction is the danger of peril considered by banks and monetary speculations on credit reimbursement by clients because of a hazy pace of profit from green ventures. In this area, there are divided impetuses on the grounds that the entertainers who spend the cash and the financial backers who benefit from the speculation are not something similar. Green development is tied in with moderating energy, water, and space while additionally taking advantage of them. Measurement of the worth of green structure ventures is oftentimes a hole.

- High beginning speculation expenses of new green and supportable strategies goes about as a deterrent in putting resources into elite execution building.
- Non-unwinding in loan fees from monetary foundations for new pursuits with high introductory speculation costs.
- The recompense time of such speculations is high and returns are low. They can't get alluring charges or higher rents in spite of the benefits they have.
- Absence of interests in green structures because of heterogeneity between the individuals who burn through cash on further developing structure highlights and the people who receive reward out of them.
- Apathy toward green structures emerging because of the absence of estimation and trouble in evaluating possible investment funds in energy, water and waste from the reception of a specific methodology.

3) DATA ADVANCEMENT AND TRAINING BOUNDARIES:

This hole create because of data unevenness, an absence of information and ability in building life cycle costing, etc. Uneven data on specialized and the board components has large amounts of the area, affecting the venture choices of different undertakings and partners. Uneven data concerns subjects, for example, energy proficiency, energy naming, development codes, squander, etc.

- Need is given to the underlying expense of development and beginning use leaving out the computations on use throughout the existence season of building. There is an absence of aptitude in carrying out methods/highlights connected with green structure.
- Time and asset expenses to investigate the highlights and items which are more energy proficient, water-saving and waste limiting is very high.

- Absence of appropriate information on the monetary, ecological, wellbeing and innovative advantages emerging out of green structures.
- High prerequisite of new gear, foundation, and gifted experts to get into green development.
- Befuddling rating frameworks and their focuses and problematic needs and realism in execution.

4) MANAGERIAL AND ORGANIZATIONAL BARRIERS:

This hole happen inside because of the board and authoritative designs that disincentivize partners, coming about in poor green structure speculations. Capital planning, everyday booking of standard errands, clashing timetables, anxiety toward surpassing timetable and financial plan, and discontinuity and majority in the area, for instance, all outcome in stagnation and apply strain on partners, bringing about thinks twice about green reasons.

- Exploring different avenues regarding another plan might infer spending plan over runs and the critical rationale to work under the designated financial plan goes about as a boundary for new green highlights.
- A recent fad or example of development can antagonistically influence the serious conveyance time and can bring about plan clashes
- Unbending nature to embrace new practices because of opposition towards change, carelessness and inclination to adhere on to 'business as usual.'
- Clashes from need conflicts emerging from shortterm agreements and assortment of partners.
- No motivators as benefits or charges for the partner to empower the shift to the green highlights.

2.3 RESEARCH OBJECTIVES

Green building (which is otherwise known as green construction or sustainable building) refers to a structure as well as the use of environmentally responsible and resource-efficient processes throughout the life-cycle of a building: from site selection to design, construction, operation, maintenance, renovation, and demolition. In other words, green building design entails striking a balance between home construction and environmental sustainability.

Objectives of present study are-

1) Understanding the concept of Green Building.
2) Study of efficient construction materials and practises; increases the use of natural sources and sinks in the building's surroundings; reduces the amount of energy used to run the building; employs highly skilled equipment for the indoor area; employs highly skilled water and waste management methods. Lighting, air conditioning, and all other necessary equipment are included in the indoor equipment.
3) To investigate how the development and operation of a building has a detrimental influence on the environment and how to mitigate it.
4) To research energy conservation through the use of green construction concepts, as well as various strategies for reducing water usage, treating and reusing waste water, and filtering water received from precipitation.
5) To model an existing Residential Building on Revit.
6) Analyze and Optimize that Residential Building.

CHAPTER 3

METHODOLOGY

3.1 GENERAL

In this chapter I am going to discuss the methods which I have taken into consideration to obtain the results of my study. I have taken GRIHA rating systems for my project and various criteria and rating process of it is discussed below.

3.2 RATING PROCESS

1) FEASIBILITY CHECK

The owner and maintenance team is accountable for inspecting the facilities and housekeeping as a primary step. They must use the GRIHA website's online feasibility check calculator to see whether their project falls under the criteria of GRIHA for existing buildings grade and fulfilling the necessary conditions. Based on the provided information by project supporter then calculator finally predicts the level of rating. 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

After passing the feasibility check, the project proponent can register the proposal on the GRIHA Council's website under the Existing Building category by submitting an expression of interest (EOI) form. After the completion of registration process, project supporter will be given a login and password to access the online panel's documentation.

3) ORIENTATION WORKSHOP

Further registration process is followed by a GRIHA Council-led orientation workshop. The goal is to supply extensive data on already existing building ratings, as well as to answer specific questions about the certification process from project proponents.

4) DOCUMENT SUBMISSION

Following the orientation session, the project supporter will submit all documents using the username and password supplied at registration on the web panel.

5) PRELIMINARY EVALUATION

Following the online submission of papers, group of experts and professionals from the Council of GRIHA conducts a preliminary evaluation. For all attempted criteria, the documentation must be complete in every way. Any attempted criteria lacks insufficient documentation will not be further assessed. Filling out and submitting online calculators for specified criteria are required. Professionals from the GRIHA Council examine the project's compliance with the mandatory requirements first, and will get rejected, if it does not lie in the provided norms. The GRIHA Council will next assess the elective norms and calculate the sum total of scores that can be earned. Within 20–25 working days of receiving the documents, a preliminary review report must be produced.

6) DUE DILIGENCE SITE VISIT FOR VERIFICATION

The GRIHA Council must conduct a due diligence site visit to compare the supplied documentation to the on-site execution. After the site visit, the due persistence report must be submitted within seven-ten working days.

7) FINAL EVALUATION

The GRIHA Council assesses papers presented in response to the preliminary assessment and due persistence report. Once required material is collected from the Final score card will be generated by GRIHA council based on this review within 20–252 working days, once the project team provides needed material from the preparatory assessment and due application report.

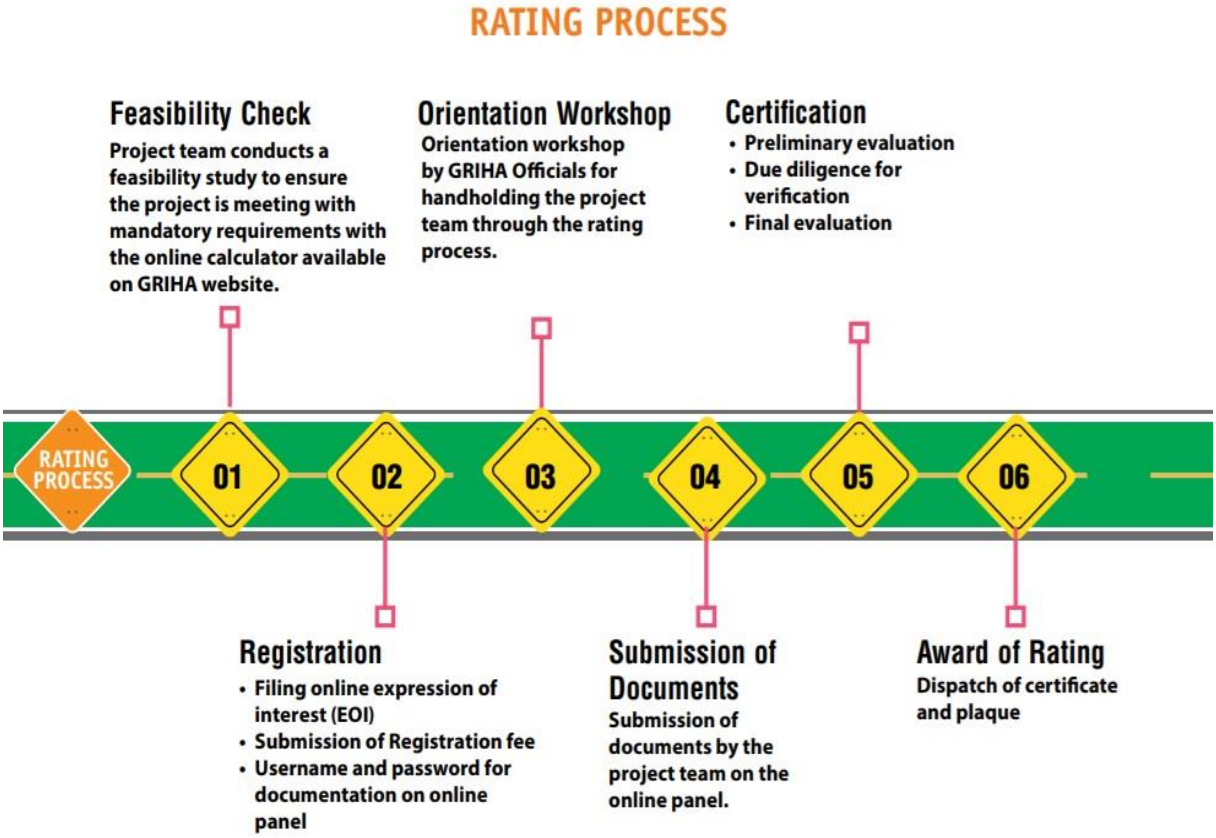


Figure 4: Rating Process. Source: GRIHA India.

3.3 CRITERIA AND THEIR WEIGHTAGE

The GRIHA for already existing structures rating is a production-based methodology in which points are awarded for satisfying the criteria's intent (appraisals). Points were allocated for each criterion.

Compliances must be provided in the relevant criterion and then must be submitted in the provided format. While few of the criteria are self-validating by nature, as energy usage, eye and thermal comfort, noise management, and levels of indoor pollution, must be checked on-site by performance monitoring. After verification by optimizing validation and monitoring parameters and documents/photographs to support the award of point, the points connected to these criteria (as provided in the sections) are granted.

GRIHA for existing buildings is a 100-point grading system with 12 criteria divided into seven sections: Site Parameters, Maintenance & Housekeeping, Energy, Water, Human Health & Comfort, Social Aspects, and Bonus Points. Six of the twelve requirements are required, while the remaining six are optional.

Except for the six necessary requirements, each criterion has a number of points attached to it. It indicates that a project that aims to achieve the criteria will be eligible for points.

Based on the number of points achieved, several levels of certification (one to five stars) are awarded. Certification requires a minimum of 25 points.

Threshold	GRIHA for Existing Buildings
25–40	★
41–55	★★
56–70	★★★
71–85	★★★★
86 and above	★★★★★

Figure 5: Threshold and Stars in GRIHA. Source: GRIHA India.

Section	Criterion Name	Intent	Max. Points
SECTION I. SITE PARAMETERS	Criterion 1 Accessibility to Basic Services	Promote walking, cycling and public transport	02
	Criterion 2 Microclimatic Impact	Lower the impact of UHIE, and promote plantation of trees	04
SECTION II. MAINTENANCE & HOUSEKEEPING	Criterion 3: Maintenance, Green procurement and Waste management	Ensure good practices for safety, waste management and green procurement	07
	Criterion4 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	08
	Criterion 10: Maintaining Good IAQ	Ensure good indoor air quality	04
SECTION VI. SOCIAL ASPECTS	Criterion 11: Universal accessibility & Environmental Awareness	Promote accessible for persons who are differently-abled & elderly persons and to increase environmental awareness amongst the building users & visitors.	05
	Criterion 12: Bonus Points	Adoption and implementation of innovative strategies in improving the sustainability of the project	04

Figure 6: Criteria and their weightage. Source: GRIHA India.

Section 1. SITE PARAMETERS

The section focuses on two areas of the site: basic service accessibility and reducing the influence of the Urban Heat Island Effect (UHIE).

One of the primary criteria that impacts the amount of energy utilised by inhabitants in transportation is their availability to general amenities from the project site provided. This component of the site characteristics tries to lessen the negative environmental impact of using automobiles for general assistance accessibility. The 2nd portion of this area focuses on improving the project site's microclimate.

Criterion 1.ACCESSIBILITY TO BASIC SERVICES

To meet the occupant's basic needs, this criterion aims to limit the usage of private automobiles and this will enhance peopleto walk, cycling and public transportation.

Criterion 2. MICROCLIMATIC IMPACT

The main aim of the work is to enhance tree planting and to put in place suitable measures on-site to mitigate the effects of the cities heat group effect and to improve the project site's microclimate.

Section 2. MAINTENANCE & HOUSEKEEPING

Facility management is critical to the operation and upkeep of all operations in an existing building. Building upkeep, tasks and housekeeping, the utilization of practical and harmless to the ecosystem strategies and items, the utilization of low ozone depletion materials, and waste administration are completely compensated in this part. This segment looks at execution observing and approval in the upkeep/retrofitting and housekeeping manuals of associations.

Criterion 3.MAINTENANCE, GREEN PROCUREMENT & WASTE MANAGEMENT

This measures' goal is to confirm that fine practises are followed in building system operation and maintenance, so that environment-friendly products are used for housekeeping, that will enhance the energy-efficient, and that solid waste is overseen adequetly inside the project limit.

Criterion 4. METERING & MONITORING

The vitalize precise metering of the energy and water utilised by the building so that we can analyse the performance is the goal of this criterion.

Section 3. ENERGY

When it comes to reducing energy usage, building efficiency is crucial. Now days by reducing the demand of energy for building works without any compromise with the comfort and personal health of the individual, this will automatically improves energy performance in already existing buildings. This strategy necessitates more than just technological breakthroughs. Building retrofitting, for example, represents a huge opportunity to increase energy efficiency. They represent a "lost opportunity" for savings in some ways, as they obviate design and construction decisions that could have resulted in significant reductions in energy use and carbon emissions during the building's lifetime. The task for existing building efficiency is to "unlock" that tremendous abilities and grab the advantages of a comfortable, efficient, and cost-effective built environment (Griha India).

From a holistic standpoint, the section recognises the usefulness of energy sustainable uses and the usage of renewable energy. Auditing and retrofitting are vital, and the rating systems that these instruments provide incentivize habitats to adopt energy-saving techniques (EEMs).

Criterion 5. ENERGY EFFICIENCY

This criterion's goal is to help the project lower its energy usage by implementing energy-saving methods.

Criterion 6. RENEWABLE ENERGY UTILIZATION

This' measure will probably inspire the use of environmentally friendly power advancements and empower nearby energy age.

Section 4. WATER EFFICIENCY

Water efficiency becomes priortized criteria for evaluating an existing structure. This section recognises improved technology and practises that reduce the usage of potable water supplied by municipal local bodies. It also focuses on implementing no-cost or low-cost water conservation methods, as well as water recycling and reuse, to improve overall water performance.

Integrative strategies like double pipes, low stream apparatuses, on location sewage treatment, downpour water gathering, etc are probably going to be investigated while a structure's underlying retrofitting is assessed concerning water effectiveness; in any case, they are conservative in the drawn out run. Thus, the embraced water preservation measures would be compensated, and their execution would be considered as a component of the structure/long haul venture's feasibility.

Criterion 7. WATER FOOTPRINT

The main aim of the work was consumability of water for numerous uses and to identify prospective regions within the project boundaries where water consumption might be reduced.

Criterion 8. REDUCTION IN CUMULATIVE WATER PERFORMANCE

The objective of the rule is to energize reusing of water to meet non-compact water necessities while additionally bringing down absolute water interest from the nearby civil stock/ground water..

Section 5. HUMAN HEALTH & COMFORT

This segment centers around expanding human wellbeing and solace regarding building tenants' warm, visual, and acoustic solace. An additional concern is good quality of fresh air (IAQ: Indoor air quality) and quantity, which is assessed using established markers.

Criterion 9. ACHIEVING INDOOR COMFORT REQUIREMENTS (THERMAL, VISUAL, AND ACOUSTIC)

The objective of this basis is to affirm, that the structure's inside regions are agreeable for building occupants with regards to warm, visual, and acoustic solace.

Criterion 10. MAINTAINING GOOD IAQ

The objective of this criterion is to give great and natural air quality for all building tenants.

Section 6. SOCIAL ASPECTS

This region is committed to advancing boundary free access for the older and distinctively abled. This part likewise centers around raising issues connected with climate among the structure's clients and guests.

Criterion 11. UNIVERSAL ACCESSIBILITY & ENVIRONMENTAL AWARENESS

The objective of this basis is to make the undertaking available to the advanced age individuals and incapacitated one's, as well as to raise ecological awareness among building clients and guests.

Criterion 12. BONUS POINTS

The objective of this rule is to energize the reception and execution of imaginative arrangements that will further develop the undertaking's drawn out suitability.

I have taken an Existing Building into consideration for this project. The Conventional Building is located at TAWI VIHAR SIDHRA, JAMMU, JAMMU AND KASHMIR, INDIA. The proposed site plan is of 90’ x 60’ (Plot No. 86) in Tawi Vihar Colony. It is a duplex building having 4 master Bedrooms with attached dressing room and bathroom, Open Kitchens, a large living area, stores etc.

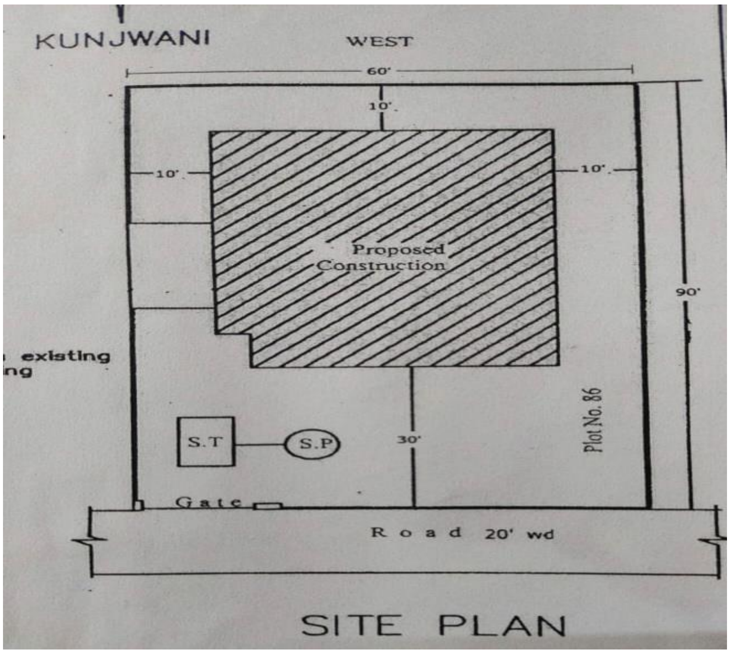
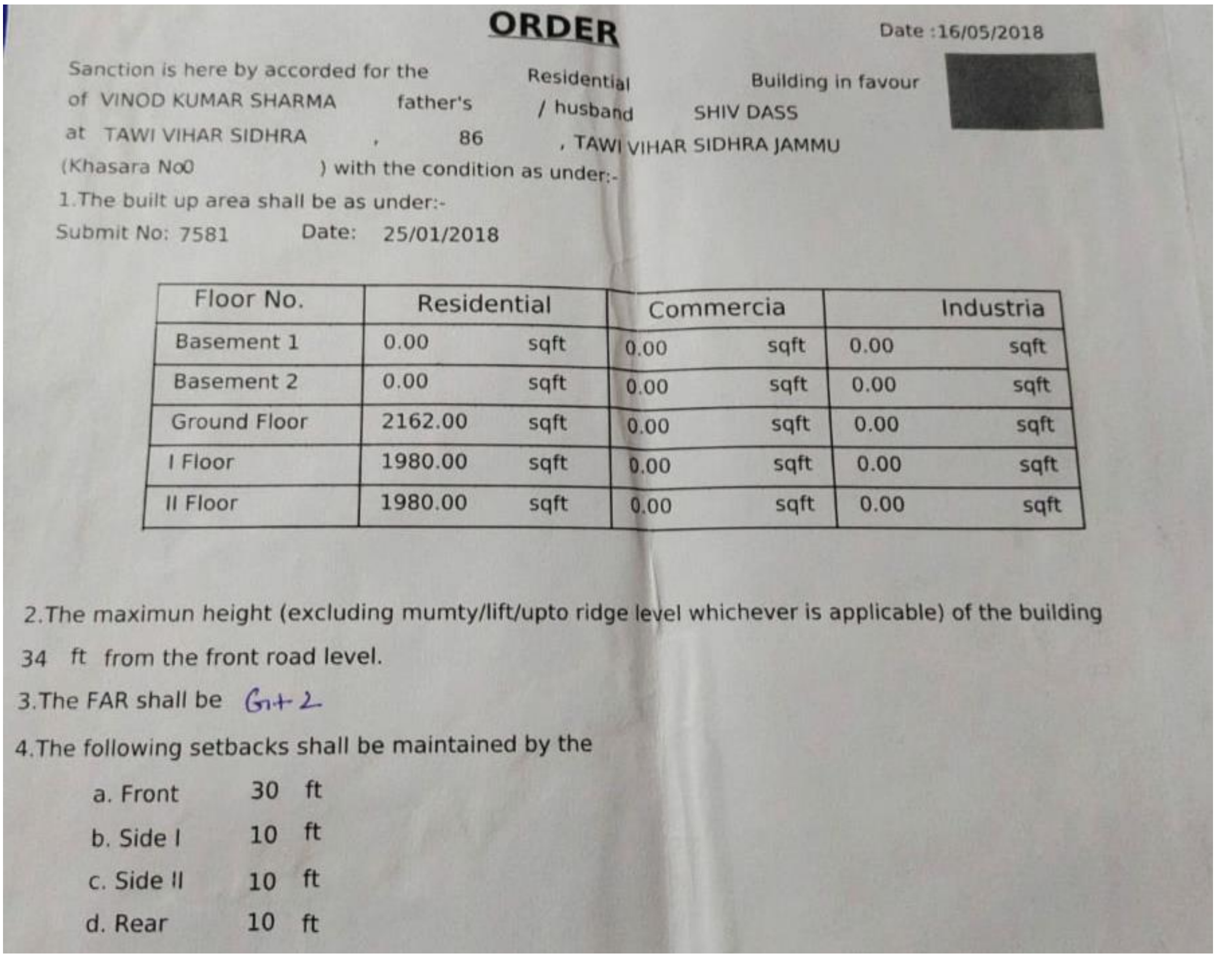


Figure 7 : Site Plan

ORDER

Sanction is here by accorded for the Residential Building in favour of **VINOD KUMAR SHARMA** father's / husband **SHIV DASS** at **TAWI VIHAR SIDHRA, 86, TAWI VIHRA SIDHRA JAMMU** (Khasrara No) with the condition as mentioned in figure.



ORDER

Date :16/05/2018

Sanction is here by accorded for the Residential Building in favour of VINOD KUMAR SHARMA father's / husband SHIV DASS at TAWI VIHAR SIDHRA , 86 , TAWI VIHAR SIDHRA JAMMU (Khasara No0) with the condition as under:- [redacted]

1.The built up area shall be as under:-

Submit No: 7581 Date: 25/01/2018

Floor No.	Residential		Commercia		Industria	
Basement 1	0.00	sqft	0.00	sqft	0.00	sqft
Basement 2	0.00	sqft	0.00	sqft	0.00	sqft
Ground Floor	2162.00	sqft	0.00	sqft	0.00	sqft
I Floor	1980.00	sqft	0.00	sqft	0.00	sqft
II Floor	1980.00	sqft	0.00	sqft	0.00	sqft

2.The maximun height (excluding mumty/lift/upto ridge level whichever is applicable) of the building 34 ft from the front road level.

3.The FAR shall be G+2

4.The following setbacks shall be maintained by the

a. Front 30 ft

b. Side I 10 ft

c. Side II 10 ft

d. Rear 10 ft

Figure 8 : Order of the Building.

First of all I have taken the floor plans from the concerned person. I modelled the same in Revit which I will discuss in the Chapter 4. I applied all the 6 sections (12 criteria) of GRIHA explained above on this building (conventional) and got a score.

After this I tried to make green score of that building as big as possible by applying some of the green practices as per the Rating System.

I did energy analysis part of our building in Revit and got results like window wall ratio etc.

One of the major parameter of GRIHA and GREEN BUILDINGS is Water Efficiency. In my project I have designed a full rainwater harvesting setup for the buiilding. Catchment area is rooftop and underground R.C.C. water tank is designed to store the water.

Rainfall data is collected from IMD for the district Jammu. Then I designed the whole setup as stated in IS Codes. Various IS Codes that are taken into consideration are:

1) Is code 15797- 2008: Roof top Rainwater Harvesting – Guidelines.
2) Is 3370 Part 1: 2009: Indian Standard Concrete Structures For Storage Of Liquids - Code Of Practice Part I General Requirements.
3) Is 3370 Part 1: 2009: Indian Standard Concrete Structures For Storage Of Liquids - Code Of Practice Part 2 Reinforced Concrete Structures.
4) Is 3370 Part 3: 1967(Reaffirmed 2008): Indian Standard Concrete Structures For Storage Of Liquids - Code Of Practice Part 3 Prestressed Concrete Structures
5) Is 3370 part 4: 1967(reaffirmed 2008): Indian Standard Concrete Structures for Storage of Liquids - Code of Practice Part 4 Design Tables.
6) Is 1172- 1993: code of basic requirements for water supply, drainage and sanitation.

Working stress method is used for the design of R.C.C. underground water tank as it does not allow formation of cracks and is safer for liquid retaining structures.

Working Stress Method Design Constants m,k,j,R:

1.) m= Modular ratio: Modular Ratio in RCC is defined as the ratio between Modulus of Elasticity of Steel and Modulus of Elasticity of Concrete (Es/Ec).
    In the **working stress method,** the modular ratio is assumed to have a value of **280/3σcbc.**

2.) k= neutral axis depth factor : **(m*σcbc)/(m*σcbc + σst)**

3.) j= lever arm depth factor : **1 – k/3**

4.) R= moment of resistance factor : **0.5*σcbc*j*k**

    where, **σcbc =** Permissible bending stresses in concrete.
    σst = Permissible stresses in steel

Use of Design Constants of Woking Stress Method:

1.) M = Rbd^2
    Therefore Depth Required = Sq. root(M/Bb)
    where M = Moment

R = Moment of resistance factor
b = Width

2.) Area of Reinforcement due to moment : (M/σst*j*d)

3.) Area of Reinforcement due to Tensile or Compressive force : T/σst

Values of permissible tensile, bending stresses in concrete and steel are calculated form Table 1,2,4 of IS 3370 Part 2: 2009

As I am working on underground tanks so the very first step towards a sound system design is assessing the site conditions.So criteria like unit weight and internal friction of the site soil is taken into consideration.

The M25 grade of concrete and Fe415 Steel is used for calculation.

There are two conditions as per which the tank is to be designed:

Condition 1: When water tank is empty and there is saturated soil pressure outside.

Condition 2: When water tank is full and there is no soil pressure outside.

After all this I have calculated the breakeven period. The time period which our rainwater harvesting setup will take to cover the entire cost that is going to be invested initially. In this I have done cost estimation of conventional water bill vs new rainwater harvesting setup. The cost estimation of conventional part is simple as it is purely from the water bill of the building. In addition to that I have taken into consideration initial miscellaneous expenses (5%) and inflation at the rate of 2% annually.

In rainwater harvesting part I have calculated the quantities of cement, sand, and coarse aggregate that is to be used in construction of R.C.C. underground water tank. After the calculation of quantities, I have calculated approximate respective costs of constituents. After doing this I have compared these two setups.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 GENERAL

In this Chapter I will discuss about the Results I got in our project.

I modelled our building in REVIT 2019. This includes Floor plans, Elevations, Schedules and 3D view of the Building which are shown below in figures.

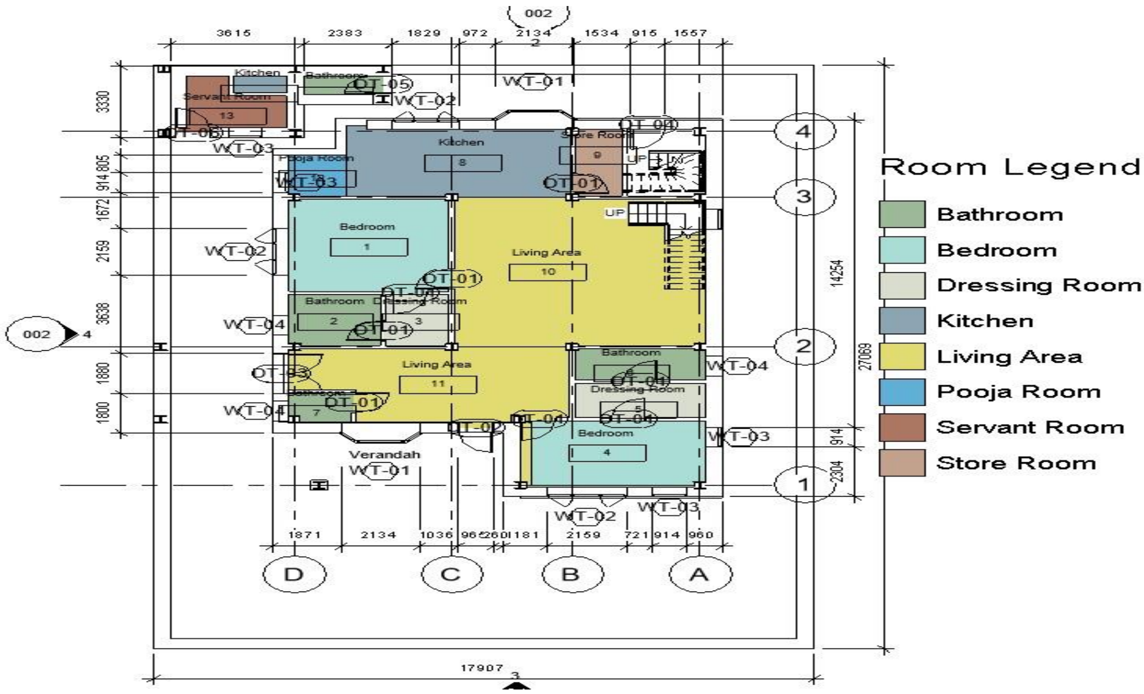


Figure 9: Ground Floor Plan.

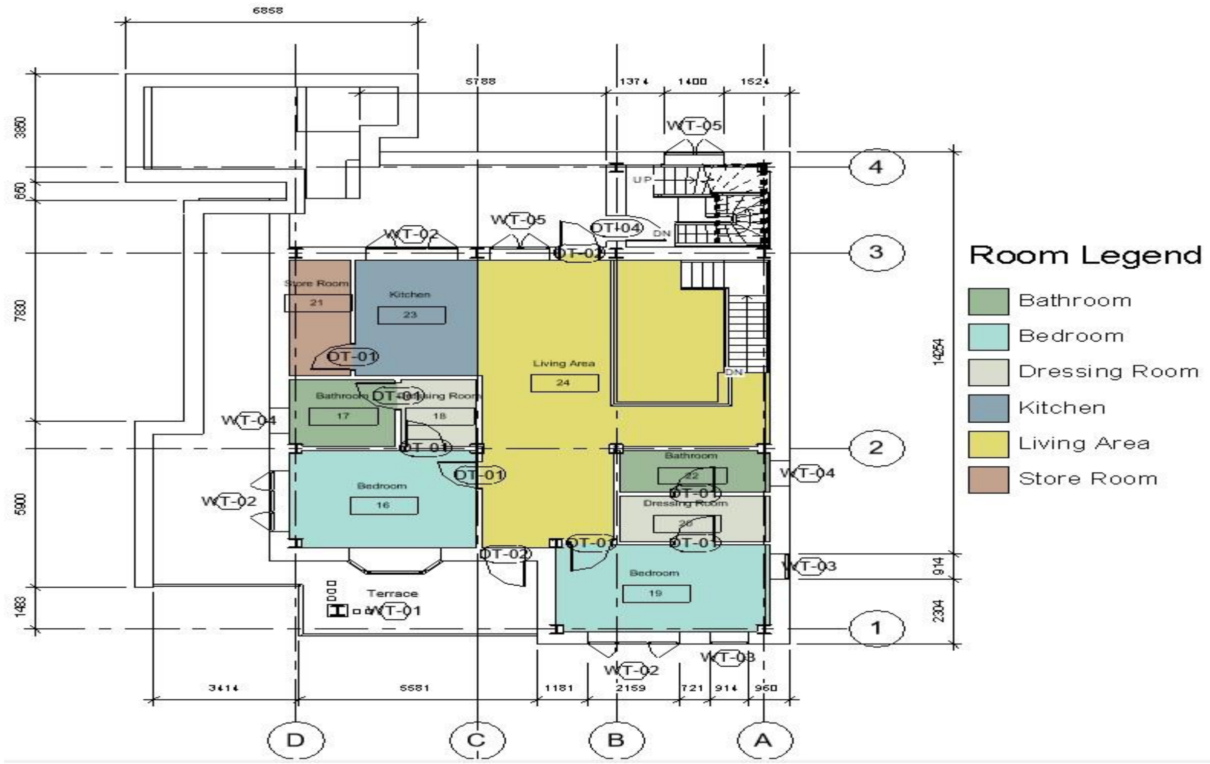


Figure 10: First Floor Plan.

ELEVATIONS :

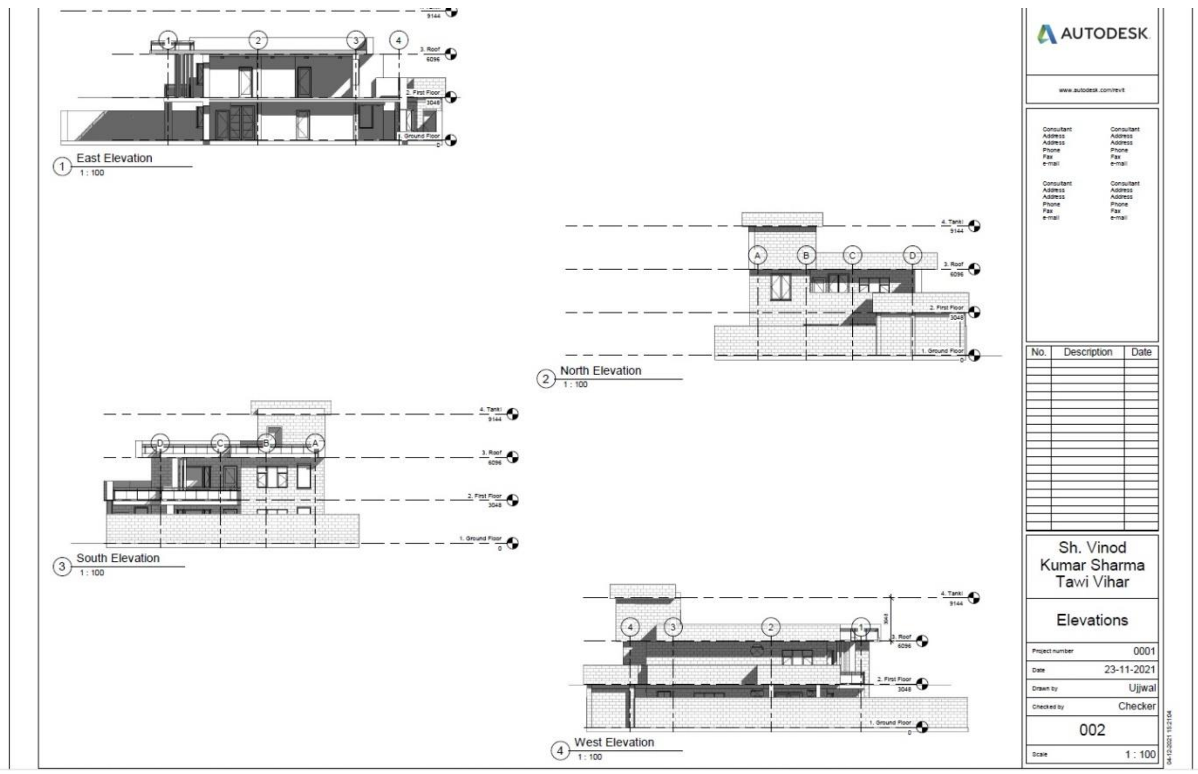


Figure 11: Elevations of the Building.

3D VIEW :

Figure 12: 3D View of the Building.

After making the whole structure in REVIT, I applied all the criteria of GRIHA in the conventional building and got a score of 24. As per this score this building falls in zero(0) star category of GRIHA green rating system.

As the score obtained by the building is 24 but this is not the highest score that can be achieved by this building. We can increase this score by applying various green practices like use of renewable source of energy (e.g. : use of solar energy), rain water harvesting, treatment of grey water on site etc. After applying green practices and modification of this building the score can be updated upto 70-75 (approximately).

After doing all this modelling and getting tentative scores from both the conventional and proposed green building I am now determined to perform the required practices/techniques that are mandatory to achieve the score approximately equal to number discussed above.

4.2 ENERGY ANALYSIS

First of all I have done energy analysis of the building and obtained the following results:

For operation and functionality of a building and maintaining the comfort of user a significant amount of energy is required. For the estimation of needed energy demand energy balance is necessary.

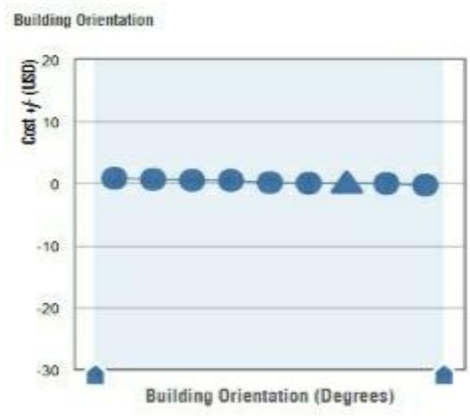


Figure 13: Orientation of our building.

Building performance is significantly affected by windows and the parameter which shows how much portion of exterior wall is comprises of windows is called as Window Wall Ratio (WWR). Following graph shows the WWR of our building from each directions.

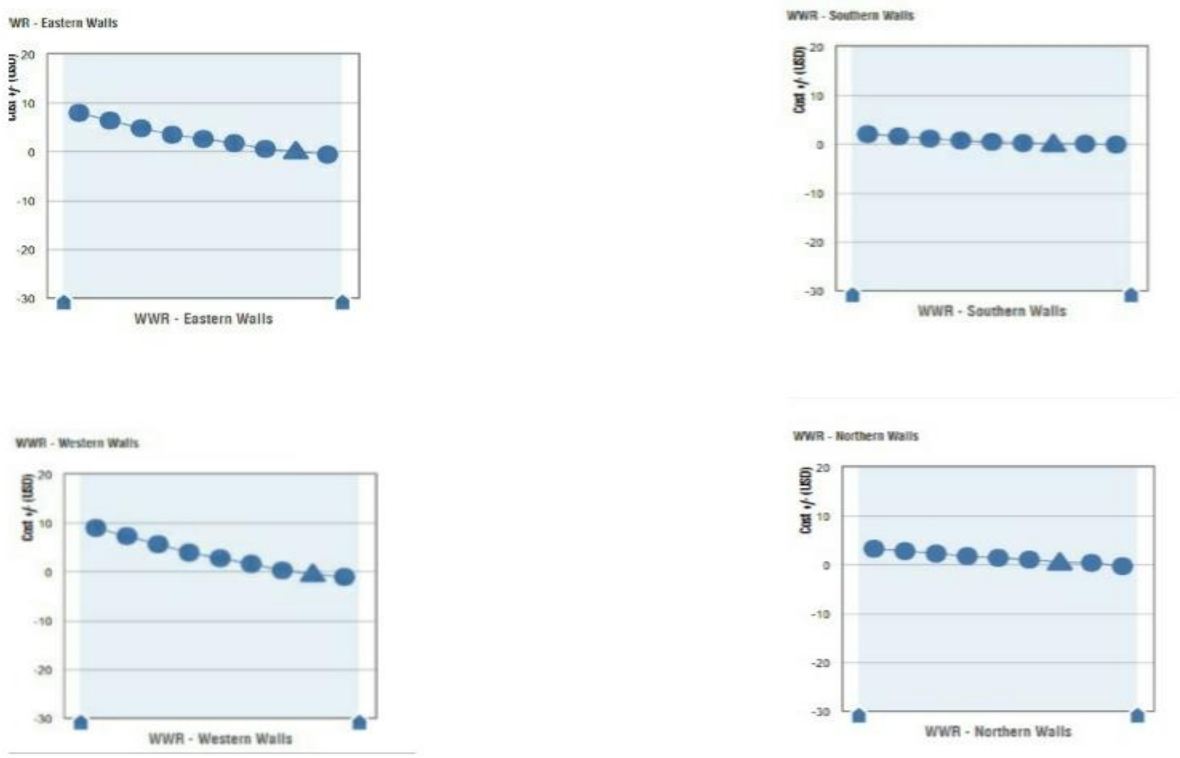


Figure 14: WWR of our building from each direction.

Another parameter is plug load efficiency. This is not considered to be important earlier but as the time is changing and buildings are becoming more energy efficient, the impact of plug loads are becoming significant. This parameter is very important as in high productive buildings, plug loads may be 50% of the total energy use. Graph shows the plug load efficiency of the building.

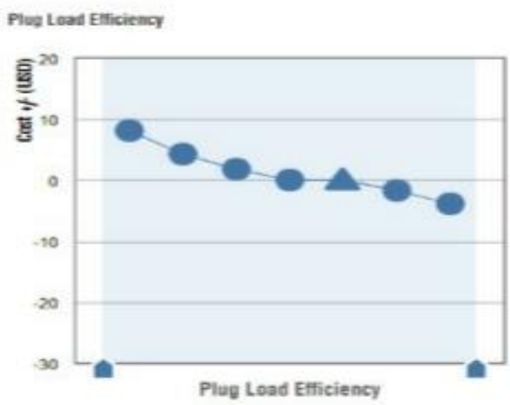


Figure 15: Plug load efficiency of our building.

In the present study, I have analysed our building in REVIT 2019 software and found that our building is nearly optimized. Parameters like orientation of building, window wall ratio, plug load efficiency falls in acceptable limits.

4.3 RAINWATER HARVESTING:

Then I have designed a rainwater harvesting setup which is as follows:

Daily Rainfall data from 1989 to 2018 is considered for analysis.

State Rainfall Mean:

Table 1 shows the mean precipitation (mm) of the state for the rainstorm months, southwest storm season and yearly during the period 1989-2018. It very well may be seen that the state gets most noteworthy precipitation (33%) of south west storm precipitation in July month while the August month get 32% of the south west rainstorm precipitation. June and September get 15% and 18% of south west rainstorm precipitation. Practically 44% of yearly precipitation is gotten during the southwest rainstorm season as it were.

Table 1: Mean rainfall (mm) of the state for the monsoon months, southwest monsoon season and annual.

Month	June	July	August	September	JJAS	Annual
Mean	84.1	184.8	178.5	101.2	554.5	1256.1

Rainfall Mean of Jammu District

My project site is situated at Sidhra (Distt. Jammu). Therefore to use rainwater I need to get data about it. So below table gives the rainfall statistics for the Jammu district of Jammu and Kashmir

Table 2: Rainfall statistics for Jammu district of Jammu and Kashmir for the four monsoon months, southwest monsoon season and annual.

Month	June	July	August	September	Monsoon	Annual
Mean	101.2	401.8	394.5	138.7	1036.1	1388.9

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

1.) Annual mean rainfall of Jammu district : 1388.9 mm

2.) The trends show that highest mean rainfall in Jammu district is received in the month of July which is 401.8 mm.

To utilize the rain water, I have to calculate the amount of water I can collect. For collection of water we will take the peak amount of rainfall which is usually received during the month of July and the value is approximately equal to 400 mm(as per the study from 1989-2018). The catchment area will be area of rooftop which is approximately equal to 182 sq. Meter (13m*14m).

Amount of water that will be available for the peak rainfall (400 mm) and corresponding catchment area (182 sq. Meter): **58.24 cubic Meter.**

Table 3: Water Demand of the building.

Month	**Rainfall (mm)**	**Inflow (ltrs)**	**Cumulative Inflow (ltrs)**	**Outflow (ltrs)**	**Cumulative Outflow (ltrs)**	**Inflow-Outflow (ltrs)**
Jan	70	10192	10192	19375	19375	-9183
Feb	112	16307.2	26499.2	17500	36875	-1192.8
Mar	100	14560	41059.2	19375	56250	-4815
Apr	60	8736	49795.2	18750	7500	-10014
May	25	3640	53435.2	19375	94375	-15735
June	101.2	14705.6	68140.5	18750	113125	-4044.4
July	401.8	58385.6	126526.1	19375	132500	39010.6
Aug	394.5	57366.4	183892.5	19375	151875	37991.4
Sept	138.7	20092.8	203985.3	18750	170625	1342.8
Oct	22	3203.2	207188.5	19375	190000	-16171.8
Nov	25	3640	210828.5	18750	208750	-15110
Dec	40	5824	216652.5	19375	228125	-13551

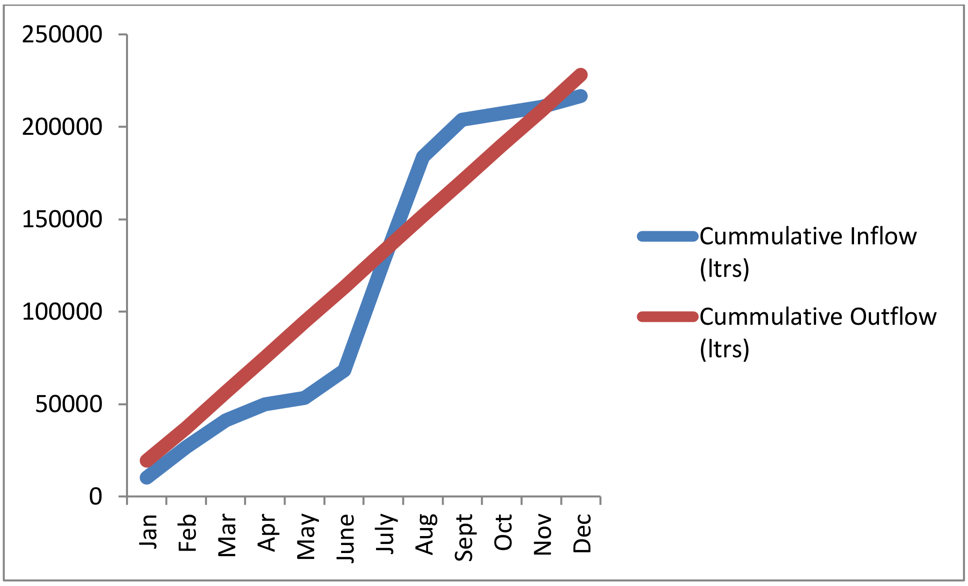


Figure 16: Graph showing cumulative inflow and cumulative outflow.

After taking the water demand into the consideration the amount of rainwater that needed to be stored: **39010.6 litres**.

As there are enormous amount of good water is lost in leakages.

Therefore, approximately water that need to be collected: 37000 litres.

= **37 cubic meter**

Design of Circular Underground Water Tank with Rigid Base:

As I have calculated earlier, the amount of water which is to be stored in our water tank is 37 cubic meter.

As I am designing a circular Water Tank, therefore the dimensions of the tank are as follows:

Required Volume = 37 cubic Meter.

Let height of the tank = 3 m and Let the free board height be = 0.2 m

Thickness = 0.2 m

So, Required Volume of tank = (22/7)*(R^2)*H

37 = (22/7)*(R^2)*3

Implies R = 1.98 m which is approximately equals to 2 m.

Final dimensions of the Water Tank are **D = 4 m ; H = 3 m ; T = 0.2 m**

Therefore, Volume of the Water Tank provided = **37.69 cubic Meter** which is greater than Required Volume.

As I am working on underground tanks so the very first step towards a sound system design is assessing the site conditions. As per IS 15797: 2008 The five main site conditions to be assessed are:

a) Availability of suitable roof catchment,

b) Foundation characteristics of soil near the house, which includes Soil properties like type of soil which is Sandy Clay Loam in our case with approximate saturated unit weight of **17.5kN/m^3** and as per correlations of strength characteristics for soils graph mentioned in Design Manual of Soil Mechanics the phi(Φ) value corresponding to the above unit weight is 27 degree which can be taken as **25 degrees** approx.

c) Location of trees,

d) Estimated runoff to be captured per unit area of the roof, and

e) Availability and location of construction material

The M25 grade of concrete and Fe415 Steel is used for calculation.

There are two conditions as per which the tank is to be designed:

Condition 1: When water tank is empty and there is saturated soil pressure outside.

Condition 2: When water tank is full and there is no soil pressure outside.

Unit weight of water = 10 kN/m^3

Submerged unit weight of soil = 7.5 kN/m^3

Active earth pressure coefficient Ka = (1-Sin Φ)/(1+Sin Φ) = 0.41

Condition 1: When water tank is empty and there is saturated soil pressure outside.

Active earth pressure = (Ka* γ'*H) + (γw*H)

= 41.84kN/m^2

Therefore, Compressive Stress = Pa*(D/2) = 92.048kN/m

We know that concrete is good in taking compressive stresses.

So Maximum Compressive Stress that concrete can take (IS:3370 Part – II, Table 2)

(92.048*10^3)/(1000*200) = 0.46024 N/mm^2 < 6 N/mm^2, which is OK.

Therefore no need of Reinforcement.

Condition 2: When water tank is full and there is no soil pressure outside.

Thickness of wall shall be: From top 0 - 0.4H = 150 mm

0.4H - 0.7H = 175 mm

0.7H - H = 200 mm

Hoop Tension as per Table 9 of (IS 3370 Part – IV) = C1*γw*H*(D/2)

where, C1 is a coefficient whose value depends on the ratio of (H^2/(D*t).

Now, H^2/(D*t) = ({3.2}^2)/({4.4}*0.2) = 10.24/0.88 = **11.63**

Values of C1 for different heights are calculated with the help of interpolation from the Table No. 9 of (IS 3370 Part – IV)

Table 4: Values of C1 for different heights.

Depth	0.1H	0.2H	0.3H	0.4H	0.5H	0.6H	0.7H	0.8H	0.9H
Value of C1	0.097185	0.20311	0.314035	0.43048	0.542815	0.6243	0.62486	0.48401	0.20508

The value of C1 is the maximum among the above values. i.e. **C1 = 0.62486**

Therefore Hoop Tension = C1*γw*H*(D/2)

= 0.62486*10*3.2*(4.4/2)

= 43.99 kN

Area of Steel = (43.99*10^3)/130 = 338.38 mm^2 (for two zones)

Minimum Steel Percentage = 0.24%

Area of steel at 0.5H = (0.24/100)*1000*175 = 420 mm^2

(Provide 10 mm dia @ 180 mm c/c = 436 mm2)

Tensile Stress in concrete: T/(Ag + (m-1)Ast)

= (43.99*10^3)/({1000*175}+{10*436})

= 0.245 N/mm^2

Also Permissible Tensile Stress in concrete for grade M25: 1.3 N/mm^2

As 0.245 N/mm^2 < 1.3 N/mm^2 so, OK.

Similarly below table shows the Reinforcement for Hoop Tension for different heights of tank.

Table 5: Reinforcement for Hoop Tension.

S. No.	Depth from G.L.	Value of C1	Hoop Tension 70.4(C1) KN	Hoop Steel T/130 mm2	Thickness mm	Minimum Steel mm2 0.24%	Reinforcement Provided(both faces)	Tensile stress in concrete
1	0.1H	0.097185	6.84	52.62	150	360	10 mm dia @ 215 mm c/c = 365 mm2	0.045
2	0.2H	0.20311	14.3	110	150	360	10 mm dia @ 215 mm c/c = 365 mm2	0.093
3	0.3H	0.314035	22.11	170.078	150	360	10 mm dia @ 215 mm c/c = 365 mm2	0.144
4	0.4H	0.43048	30.31	233.15	150	360	10 mm dia @ 215 mm c/c = 365 mm2	0.197
5	0.5H	0.542815	38.21	293.92	175	420	10 mm dia @ 180 mm c/c = 436 mm2	0.213
6	0.6H	0.6243	43.95	338.08	175	420	10 mm dia @ 180 mm c/c = 436 mm2	0.245
7	0.7H	0.62486	43.99	338.38	175	420	10 mm dia @ 180 mm c/c = 436 mm2	0.245
8	0.8H	0.48401	34.07	262.08	200	480	10 mm dia @ 155 mm c/c = 500 mm2	0.190
9	0.9H	0.20508	14.44	111.08	200	480	10 mm dia @ 155 mm c/c = 500 mm2	0.080

As I have taken the rigid base case, so Bending moment and Shear force is also been generated in tank.

Bending Moment as per Table 10 of (IS 3370 Part – IV) = C2*γw*H^3

Where C2 is coefficient whose value also depends on the ratio of (H^2/(D*t).

H^2/(D*t) = **11.63** (calculated above)

Values of C2 for different heights are calculated with the help of interpolation from the Table No. 10 of (IS 3370 Part – IV)

Table 6: Values of C2 for different heights.

Depth from G.L.	0.1H	0.2H	0.3H	0.4H	0.5H	0.6H	0.7H	0.8H	0.9H	1H
Value of C2	0.00	-0.0000815	0.0001	0.000237	0.000374	0.001411	0.002411	0.002637	-0.0006295	-0.010733

The value of C2 is the maximum among the above values irrespective of the negative sign.

i.e. **C2 = 0.010733**

Therefore, Bending Moment = C2*γw*H^3

= 0.010733*10*(3.2^3)

= 3.517 kN m

Area of Steel = M/(σst*j*d) = (3.517*10^6)/130*0.86*150)

= (3.517*10^6)/16770 = 209.72 mm^2

Minimum Steel Percentage = 0.24%

Area of steel = (0.24/100)*1000*200 = 480 mm^2

(Provide 10 mm dia @ 155 mm c/c = 500 mm2)

Similarly below table shows the Reinforcement for Bending Moment for different heights of tank.

Table 7: Reinforcement for Bending Moment.

S. No.	Depth from G.L.	Value of C2	B.M. 327.68C2 kN m	Thickness mm	Minimum Steel mm2 0.24%	Reinforcement required mm2	Reinforcement Provided (both faces)
1	0.1H	0.00	0	150	360	0	10 mm dia @ 215 mm c/c = 365 mm2
2	0.2H	-0.0000815	0.028	150	360	1.67	10 mm dia @ 215 mm c/c = 365 mm2
3	0.3H	0.0001	0.033	150	360	1.97	10 mm dia @ 215 mm c/c = 365 mm2
4	0.4H	0.000237	0.078	150	360	4.65	10 mm dia @ 215 mm c/c = 365 mm2
5	0.5H	0.000374	0.123	175	420	7.33	10 mm dia @ 180 mm c/c = 436 mm2
6	0.6H	0.001411	0.462	175	420	27.55	10 mm dia @ 180 mm c/c = 436 mm2
7	0.7H	0.002411	0.790	175	420	47.11	10 mm dia @ 180 mm c/c = 436 mm2
8	0.8H	0.002637	0.864	200	480	51.52	10 mm dia @ 155 mm c/c = 500 mm2
9	0.9H	-0.0006295	0.206	200	480	12.28	10 mm dia @ 155 mm c/c = 500 mm2
10	1H	-0.010733	3.517	200	480	209.72	10 mm dia @ 155 mm c/c = 500 mm2

Max Shear at Base as per Table 11 of (IS 3370 Part IV) = C3*γw*H^2

Where C3 is coefficient whose value also depends on the ratio of (H^2/(D*t).

H^2/(D*t) = **11.63** (calculated above)

Values of C3 is calculated with the help of interpolation from Table No. 11 of (IS 3370 Part – IV) which is **0.147405**

V = 0.147405*10*(3.2^2)

= 15.09 kN

τv = V/(b*j*d)

= (15.09*10^3)/(1000*0.861*150)

= 0.117 N/mm^2

which is less than τc value as per IS 3370. So OK

Base Slab:

Thickness of Base Slab = 150 mm

Minimum Steel = (0.24/100)*1000*75

= 180 mm^2

Therefore, **(Provide 8 mm Dia @ 270 mm c/c).**

4.4 QUANTITY AND COST ESTIMATION

I have also done the quantity estimation, cost estimation of our circular underground R.C.C. water tank and the results of these are as follows:

The following table shows the quantity estimation of our underground water tank.

Table 8: Quantity estimation of circular underground R.C.C. water tank.

Quantity Estimation of Tank	
PCC Work	1.45 m3
R.C.C. Work	7.19 m3
Steel	600 kg
Total P.C.C. Work	8.64 m3
Grade M25 Ratio	01:01:02
Cement	96 bags
Sand	3.33 m3
Crushed Stone	6.66 m3

Table 9: Cost estimation of conventional setup for the first year.

Conventional Costing of First Year	
Entity	**Cost (Rs)**
Water Bill (annually)	4000
Initial Pipe for connection(1 km)	5000
Miscellaneous Prices(5%)	400
Inflation Rate(2%)	200
Total	9600

Table 10: Rainwater tank setup costing.

Rainwater Tank Setup Costing	
Entity	**Cost (Rs)**
Tank (cement, sand , C.A., pipe)	89000
Pump (1.5 HP)	7000
Total	96000

Now I have to compare the cost of above two setups: conventional and the rainwater one. The comparison is shown in the form of graph which shows that the breakeven period of our setup is approximately 19 years. Inflation rate is taken as 2% for calculation purposes.

The cumulative cost in conventional setup and cost of rainwater harvesting setup in 23 years is compared and similar trend has to follow in the upcoming years also but as I get my desired result in 19 years so I just comapred costes of 23 years only.

Table 11: Cumulative Cost vs Rainwater setup Cost.

Years	Cost(Rs)	Cumulative Cost(rs)	Cost(Rs)
1	9600	9600	96000
2	4080	13680	96000
3	4161.6	17841.6	96000
4	4244.832	22086.432	96000
5	4329.729	26416.16064	96000
6	4416.323	30832.48385	96000
7	4504.65	35337.13353	96000
8	4594.743	39931.8762	96000
9	4686.638	44618.51372	96000
10	4780.37	49398.884	96000
11	4875.978	54274.86168	96000
12	4973.497	59248.35891	96000
13	5072.967	64321.32609	96000
14	5174.427	69495.75261	96000
15	5277.915	74773.66766	96000
16	5383.473	80157.14102	96000
17	5491.143	85648.28384	96000
18	5600.966	91249.24952	96000
19	5712.985	96962.23451	96000
20	5827.245	102789.4792	96000
21	5943.79	108733.2688	96000
22	6062.665	114795.9342	96000
23	6183.919	120979.8528	96000

Here, cumulative cost(rs) represents cumulative cost of conventional setup.

Cost(rs) represents rainwater harvesting setup cost and it is going to be same in all the years as it only requires initial cost which is obivisouly the big amount as shown in table.

As mentioned above the breakeven period of our setup is approximately 19 years so the following graph showing the same.

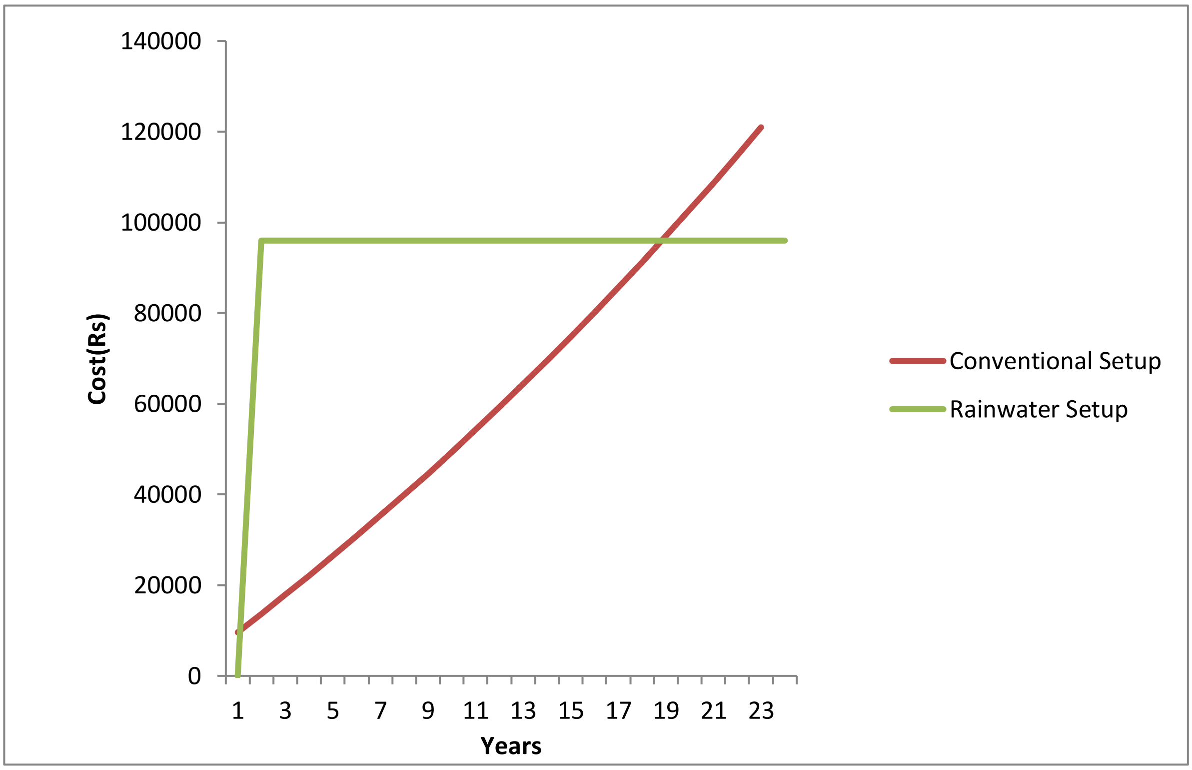


Figure 17: Graph showing breakeven period of our setup.

After doing all these operations I finally in the position to compare our building on the basis of GRIHA parameters. I tried to maximize the score of our building from the previous one and also succeded in our goal. I estimated that we can achieve the score of 70-75 but I fell short by 10-15 points and got 60 points which means that my building falls in 3 star category as per GRIHA criteria.

Table 12: Comparison of conventional structure and the new proposed one on the basis of GRIHA criteria.

SECTION	CRITERION NAME	INTENT	APPRAISAL	MAX. POINTS	POINTS OBTAINED (CONVENTIONAL BUILDING)	POINTS OBTAINED (PROPOSED BUILDING)
Section I. Site Parameters	**Criterion I Accessibility to Basic Services**	Promote walking, cycling and public transport	1.) Accessibility of no less than 5 administrations (from the rundown given beneath) inside the grounds or inside 500m strolling distance from fundamental entry of undertaking. Services: Grocery store, Pharmacy, Bank/ATM, Park, Restaurant, Community Centre, Gym, Public transit stop / Metro Station (1 Point) 2.) Collective transport service (as listed below) to closest public transportation nodes is provided for building residents . • Preferred parking for EVs • Preferred parking for pooled vehicles • Rental/parking for bicycle. • Shuttle services(1 Point)	2	2	2
	Criterion 2 Microclimatic Impact	Lower the impact of UHIE, and promote plantation of trees	1.) Dissect complete number of trees planted nearby and show consistence with GRIHA for Existing Building edge of 1 tree for each 80 m2 of all out site/plot region . All out number of trees nearby should meet/surpass the GRIHA for Existing Buildings threshold.(2 Points) 2.) To minimize the urban heat island impact: • Greater than 25% of the site surface apparent tosky (counting building roofs) are either soft paved/covered with high SRI coating. (SRI>50)/concealed by trees/concealed by vegetated pergolas/concealed by solar panels or any mix of these methodologies.(1 Point) • Greater than 50% of the site surface visible to sky (including building roofs) are either soft paved/covered with high SRI coating (SRI >50)/concealed by trees/concealed by vegetated pergolas/concealed by solar panels or any mix of these methodologies.(2 Points)	4	4	4

Section II. Maintenance & Housekeeping	**Criterion 3: Maintenance, Green procurement and Waste management**	Ensure good practices for safety, waste management and green procurement	Maintenance : 1.) Guarantee that maintenance and housekeeping protocols are maintained and followed for electrical, HVAC, plumbing systems, and civil repair work.(Mandatory) 2.) Ensure the following: n the event of molded spaces all HVAC gear are sans cfc and all protection utilized in structures ought to be CFC-and HCFCfree OR get rid of plan for HCFC/CFC utilizing equipment.(Mandatory) • Firefighting hardware are Halonfree.(Mandatory) Green Procurement : 1.) Maintain and follow a policy of purchasing environment-friendly cleaning and pest control products for housekeeping materials with low ODP in building interiors.(1 Point) 2.) Maintain and follow a policy of purchasing appliances with at least 3-star BEE rating for all appliances under the scheme of the BEE Star Rating program.(1 Point) Waste Management : 1.) Provide infrastructure (multicoloured dustbins/ different garbage chutes) to building occupants to ensure segregation of waste at source. (1 Point) 2.) Provide dedicated, segregated and hygienic storage spaces in the project site to store different wastes before treatment /recycling.(1 Point) 3.) Provide contractual tie-ups with waste recyclers for safe recycling for recyclable wastes, like metal, paper, plastic, glass, e-waste, etc.(1 Point) 4.) 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)	7	3	4
	Criterion4 Metering & Monitoring	Promote reliable metering and monitoring	1.) Demonstrate compliance with the basic metering requirements. (Mandatory) 2.) Advanced metering requirements as mentioned in Table 6.(3 points) 3.) Install one-way communicable smart meters and monitoring system capable of: (3 points) • Tracking consumption of energy/water through a web-hosted portal. • Hourly data reporting in near-real time. • Tracking consumption patterns. • Setting consumption targets and alarms. • Comparing historical and benchmark data. • Real-time monitoring with user interface which can operate on mobile devices. 4.) 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.	10	2	3

Section III. Energy	**Criterion 5: Energy Efficiency**	Ensure energy efficiency	1.)Provide building energy consumption information as per compliance(Mandatory) 2.)Implementation of operation and maintenance no cost EEMs (5 Points) 3.)Demonstrate percentage reduction in energy consumption over the base case as mentioned in Table 7.(15 points) • % Reduction in energy consumption =(A–B)/A× 100 where • A = Base case energy consumption11 (kWh/year) • B = Existing case energy consumption(kWh/year)	20	2	7
	Criterion 6 Renewable Energy Utilization	Promote use of renewable energy	Project can demonstrate compliance with either of the two alternatives. 1.) Alternative I: On-site/On-site & off-site combination of renewable energy system installation to offset a part of the annual total energy consumption. Points will be awarded as mentioned in Table 8 : 2.) Alternative II: Off-site renewable energy systemto off set a part of total energy consumption.Points will be awarded as mentioned in Table 9:	15	0	3
Section IV. Water	**Criterion 7: Water Footprint**	Implement potential water conservation strategies	1.) Detailed water audit report clearly demonstrating the water supply and usage study, process and system audit, and discharge analysis.(Mandatory) 2.) Reduction in building water consumption by 30% below the base case through water efficient fixtures. Refer Tables 10, and Appendix 3 for flow values of water fixtures to create base case. (3 points) Methodology for calculating water consumption and water use reduction is as follows: Water consumption (lpd) = N×FR×U where, • N = Total occupants • FR = Flow rate of each type of fixtures • U = Number of uses of each type of fixtures fixed Water use reduction (%) = (A–B) / A× 100 where, • A = Annual building water consumption through water fixture- Base case (liters/year) • B = Annual building water consumption through water fixture- Existing case (liters/year) Non-applicability : All faucets, which are installed in spaces with water head heights less than 5 meter or 17 feet, in gravity fed systems,are exempt from calculations in the appraisal 2.) Reducing landscape water demand : 1.) 3.) Minimizing lawn area and restricting it to 25% of the total landscaped area.(2 Points) 4.) Use of water-efficient irrigation systems to reduce the water requirement by at least 50% from the GRIHA base case.(2 Points) Methodology for calculating landscape water requirement and reduction is as follows: Landscape water requirement (lpd)= (Plant factor × Evapotranspiration rate (mpd) × Canopy area (sq.m))Irrigation system efficiency × 1000 where, • Plant factor refers to water requirement of the plants. • Evapotranspiration rate refers to the amount of water required by the plant for healthy growth and determines the rate at which the plant loses water through evaporation.	15	3	10

			• Canopy area refers to the area covered by shrubs, grass covers, and trees in the plan view. • Irrigation system efficiency refers to the ability of an irrigation system to deliver water to plants without any water loss. Landscape water use reduction (%) = (A–B)/A × 100 where, A = Annual landscape water demand of base case B = Annual landscape water demand of existing case 5.) Provision of on-site sewage water treatment system: • 100 % of grey water treatment on site(2 Points) • Treatment of sewage water (grey water and black water combined) to meet 100% of non-potable water requirement (4 Points) Non-applicability: If the total waste water generated on site is less than 10 kLD, then the project is exempt from appraisal 5.) 6.) Provision of rainwater harvesting system: • Only roof rainwater harvesting (2 Points) • 100% of catchment area (4 Points)			
	Criterion 8: Reduction in Cumulative Water Performance	Reduce overall water demand of the habitat	1.) Cumulative water performance (WP) reduces to 20% of total water use.(2 Points) 2.) Cumulative WP reduces to 30% of total water use.(3 Points) 3.) Cumulative WP reduces to 50% of total water use. (6 Points) 4.) 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 where, Annual fresh water demand (liters/year) = (Annual water demand of the project) – (Annual water recycled & reused) Annual water demand liters/year of the project includes the water requirement of the following: • Planned and floating population, • Landscape, and • Services like HVAC, fire-fighting, and so on.	10	0	10
Section V. Human Health & Comfort	**Criterion 9: Achieving Indoor Comfort Requirements**	Ensure that building spaces provide for thermal, visual and acoustical comfort	1.) Demonstrate that project can achieve thermal comfort requirements of NBC 2005 or ASHRAE 55 or requirement of Indian Adaptive Comfort Model (Griha India).(2 Points) 2.) Demonstrate following – Artificial lighting Lux level to fall within limits (lower and higher range limits), space/task specific lighting levels as per NBC 2005 (Griha India).(2 Points) Daylight Factor (DF) of at least 25% of all living area should meet the adequate levels as prescribed in SP 41 (Griha India). (2 Points) 3.) The indoor noise levels should be within the acceptable limits as specified in NBC 2005 and key noise source on site (such as, diesel genset, chiller plant, etc.) should have sufficient acoustic insulation as per NBC 2005 norms (Griha India).(2 Points)	8	3	4

	Criterion 10: Maintaining Good IAQ	Ensure good indoor air quality	Smoking must be banned/ prohibited within the building premises. In case smoking is allowed, the air from the smoking area must be isolated to prevent recirculation of tobacco smoke-containing air to non-smoking areas (Griha India). (Mandatory) 2.) Meet the minimum requirements of - • CPCB National Ambient Air Quality Standard (NAAQS) for quality of fresh air. (2 Points) • ASHRAE Standard 62.1–2010, Ventilation for Acceptable Indoor Air Quality or a NBC2005 for quantity of fresh air.(2 Points) Non-applicability: Appraisal 2.) is not applicable for non-AC spaces / residential spaces with operable windows.	4	3	4
Section VI. Social Aspects	**Criterion 11: Universal accessibility & Environmental Awareness**	Promote accessible for persons who are differently-abled & elderly persons and to increase environmental awareness amongst the building users & visitors.	Universal Accessibility: 1.) Provide facilities as per Harmonised Guidelines and space standards for barrier-free built environment for the differently-abled person and elderly people for following minimum requirement in residential and public buildings (Griha India). (2 Points) • Provision of ramp at the entrance. • Parking (preferred parking near entrance, parking specifications for persons with special needs to be addressed). • Toilet for persons with special needs. Environmental awareness : 2.) Adopt any three measures from the list below to increase environmental awareness among users and visitors:(3 Points) • Innovative display on 'Environmental concerns and possible solutions at individual level' in common area/lobby or any other relevant location where the footfall would be maximum. • Local outreach through posters, brochures, newspapers, and social media. • Short tours may be organized within the facility to highlight the green initiatives taken by the project proponent. This may also be supplemented with a small video presentation focussing on sustainable measures taken in the building design to save energy and water (Griha India). • Awareness programmes for occupants/ and O & M staff. • Adopt innovative strategies such as labelling the lines highlighting the water source. For example, this water line uses rainwater harvested from the roof (Griha India). • A label for native species or aromatic herbs, which would raise awareness towards low maintenance and low water-consuming native species as compared to high maintenance exotic species (Griha India).	5	2	5
	Criterion 12: Bonus Points	Adoption and implementation of innovative strategies in improving the sustainability of the project	The venture can take up to a maximum of two strategies. Each strategy carries 2 points. (4 Points) Examples of strategies project can choose to demonstrate the compliance are • Net zero water discharge • Net positive energy/net zero energy—generation of energy from renewable energy sources on-site • Previously GRIHA certified project • Urban farming • Any other strategy that is not covered in the previous section but can significantly improve the sustainability of the project.	4	0	4

From the present study, I have examined that I have collected data from IMD and calculated the amount of water that I need to collect but collection of water is not the sole aim of our project instead I have to meet the water demand of the building. As mentioned in IS Code, I can take runoff coefficient from 0.8 to 0.95. In our calculation I have taken the worst case coefficient i.e. 0.8 and still I am able to approximately meet the whole water demand of the building. So from these findings I can conclude that our building water demand can be met if we collect water with more efficiency.

After meeting the optimized water demands for our building, I further proceed for its storage in the water tanks. So for that, I have opted to go for a circular R.C.C. underground water tank instead of rectangular one because rectangular R.C.C. water tank is a complex structure and there are lot of stresses that are coming on the structure in comparison to circular one and its going to be costlier also. I can also go for the plastic water tanks but as per the present market scenarios the amount of water we need to collect; plastic water tanks are going to be costlier option. As cost effective parameter is also there so I chose circular R.C.C. underground water tank. Also if we are going to place plastic water tanks on the roof, it just add up the load on our structure which eventually leads to crack formation which may results in the failure of structure. So, from this study we can conclude that rectangular R.C.C. water tanks are more feasible and eco-friendly option for making Green buildings.

After this I take a dig at costing and estimation part, as initial cost of rainwater harvesting setup is high so it is mandatory to check whether this setup is convenient to replace the previous one. For this I compared the conventional setup cost and the rainwater harvesting setup cost and found that our breakeven period is 19 years. This means that our building will not going to spend even a single penny on water after a time period of 19 years.

From the above findings I conclude that, after performing all the required and feasible green practices (water efficiency, energy efficiency) I have attained a 3 Star rating as per GRIHA criteria.

CHAPTER 5

CONCLUSION

Green building concept is best in the business to minimize energy usage, water consumption, various pollutions such as water and air, to encounter the needs of the time, to magnify residents quality of life. In the upcoming times, green building will become principal cultural notion, to fascinate people to purchase, for better relationship between humans and nature and many other parameters like common development circumstances. As there is progress in technology and economic growth, one of the biggest barrier to human's lives is the environmental problems, because with time people living environment is getting worse and it's a high time to notice of various environmental issues and take a step towards protecting our environment. Green building is one of the step. This sunrise mechanization concept in construction sector has an era-making significance, as it can minimize waste, improve utilization of resources, and also reduce nature destruction activities of human.The utilization of enviromental friendly energy saving technologies enabling green energy saving technologies to maximize their effectiveness in construction.In this project I have chosen a conventional building and tried to convert it into green building to avail all the benefits discussed above. The three basic parameters of green building are water efficiency, energy efficiency and material efficiency. As the building is in existing form therefore material efficiency part cannot be performed. I can work on rest two parameters. I designed rainwater harvesting setup and also performed energy analysis. After performing energy analysis I found that our building is nearly optimized. Parameters like window wall ratio, plug load efficiency falls in acceptable limits. Also in rainwater harvesting part I can conclude that our building water demand can be met if I collect water efficiently. In addition to that I also compared the conventional setup cost and the rainwater harvesting setup cost and found that our breakeven period is 19 years. This means that our building will not going to spend even a single penny on water after a time period of 19 years. After performing whole processes I managed to attain three star rating from GRIHA parameters. This report revealed that Green buildings provides a promising medium for efficiently saving energy and water that will further help in sustainable use of resources for prolonged period of time.

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