PLAN AND DESIGN OF G+2 GREEN HOME

Jatin Ahuja, Jatin, Harpreet Singh, Sahil Gupta and Abhishek Anand

School of Civil Engineering, Lovely professional University, Phagwara, INDIA

Abstract: In the modern era, all works are done by using software or a computer. As engineers, we have a responsibility to develop a sustainable world. To start the plan of home Firstly, we collect the information about the site like location, surrounding sites, site weather, native vegetation. For designing a home, we use Autodesk Revit software. It is a Building Information Modelling (BIM) software that helps us to draw the plan and making the 3D model. The home is tried to be made fully green or sustainable. Sustainable and green materials are used in home designing. The green vegetation has grown around the home to remain cold during extreme summers and to provide a healthy environment for living persons. The home is rated by our team on the SVA-GRIHA manual provided by TERI which shows the rating of the green home and the home is energy efficient or not. We design an exterior view of the home from every direction and make a 3D view to make the home attractive and green. The area of the site is 695.25m² with 22.5m × 30.9m dimensions. The home consists of 5 bedrooms, 4 washrooms, 2 kitchens (1 terrace kitchen), 1 study room. The home has a terrace garden to provide greenery in the home and to provide protection from sunlight to heat a home in summers. In the end, we conclude that Revit Software is user-friendly and suitable for 3D modelling because it provides many options for designing structures. It reduces time, additionally gives a render option that's utilized to form a photorealistic picture of the 3D model. And the rating system plays an important role to increase the understanding of green homes and making more sustainable home.

1. INTRODUCTION

A house may be a single-unit personal building, which can range in quality from a simple hut to a fancy structure of wood, brickwork, concrete or different material, outfitted with plumbing, electrical, and heating, ventilation, and air conditioning frameworks. Restriction of space, growth of populace and fast urbanization leads to the community-dwelling culture which increased issues like CFC emissions, inadequately ventilation, increment of waste materials during construction and maintenance of house stimulate. It is found that the building industry will expend 40% of add up to worldwide energy and discharge around 3800 megatons of CO2 into the climate. According to a report the building industry has the following impacts:

- 40% consumption of the world's total energy.
- Use 30% of raw materials.
- Timber harvesting going down by 25% - 35% of CO2 emission.
- 16% of fresh water is being depleted.
- 40% solid waste is generated.
- 50% CFC's are use.
- 30% of residents have sick building syndrome.

The above-mentioned issues have constrained man to think along with the terms of sustainable advancement which gave the solution for this issue through the "Green Building" concept.

Green building may be a resource-efficient strategy of construction that produces more beneficial buildings which have less impact on the environment and fetched less to preserve. This sustainable approach to development accounts for a building's whole life cycle: siting, plan, development, operation, maintenance, redesign and demolition.

The United State Environmental Protection Agency stated that "*Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practise expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building is also known as a sustainable or high-performance building.*"

A green building rating system is an instrument that assesses the performance of a building and its effect on the environment. In India, there are transcendently three rating systems – Leadership in Energy and Environmental Design (LEED), the rating systems from Indian Green Building Council (IGBC) and the Green Rating for Integrated Habitat Assessment (GRIHA). In expansion, there's moreover the Energy Consumption Building Code (ECBC) and the National Building Code (NBC), which provide rules on energy consumption. All buildings in India ought to comply with these endorsed guidelines.

1.1 Leadership in Energy and Environmental Design (LEED):

It is a green building certification program that recognizes top-notch building techniques and practices. Glass plays a vital part in LEED certification and can essentially affect a building's rating. LEED-certified buildings save cash and resources, and have a positive effect on the health of occupants, whereas advancing renewable energy. LEED gives third-party confirmation that a building or community has been planned and built utilizing strategies pointed at improving performance overall measurements: energy savings, water efficiency, CO2 emanations reduction, improved indoor environmental quality, and stewardship of resources. The Indian Green Building Council, which had adopted the LEED framework, has presently launched nine modern rating systems of it possess. The building has to earn points for LEED certification based on these six categories:

- Selection of Sustainable sites.
- Innovative Design.
- Resources & Materials.
- Quality of Indoor Environment.
- Efficiency of Water.
- Atmosphere & Energy.

The Number of Points in LEED Certification are:

- Certified= 40-49 points
- Silver= 50-59 points
- Gold= 60-79 points
- Platinum= 80+ points

1.2 GRIHA:

Its full form is Green Rating for Integrated Habitat Assessment and it is a rating apparatus that assesses the performance of a building against satisfactory benchmarks. Created by TERI and embraced by the Indian Government in 2007, it serves to carry out a subjective and quantitative evaluation and appropriately rate a building on its level of 'Greenness'. GRIHA right now works beneath ADARSH (Association for Development and Research on Sustainable Habitats) and is upheld by the National Advisory Council (NAC) and Technical Advisory Committee (TAC). The GRIHA criteria classified into 4 categories:

- Planning & Selection of site.
- Construction & Planning of Building.
- Maintenance & Operation of Building.
- Innovative Design.

These categories are assist classified into obligatory, discretionary, appropriate, and specifically appropriate. Points of certification under TERI GRIHA system:

- 25-40 points = 1 star
- 41-55 points = 2 star
- 56-70 points = 3 star
- 71-85 points = 4 star
- 85 or more points = 5 star

1.3 Indian Green Building Council (IGBC):

IGBC is part of the Confederation of Indian Industry (CII) and formed in the year 2001. The vision of this is, "To empower a sustainable built environment for all and encourage India to be one of the worldwide pioneers within the sustainable built environment by 2025". It offers a wide cluster of services which include creating modern green building rating programs, certification services and green building training programs. The council too composes Green Building Congress, its yearly flagship occasion on green buildings. All the partners of the construction industry comprising of designers, engineers, product manufacturers, corporate, Government, the scholarly community and nodal organizations take part within the committee exercises through nearby chapters. The council too closely works with a couple of State Governments, Central Government, World Green Building Council, two-sided multi-lateral.

~ Each rating system has a different level:

- Certified - best practices
- Silver - outstanding performance
- Gold - national excellence
- Platinum - global leadership

1.4 Benefits of Green Building:

With modern innovations always being developed to complement current hones in making greener structures, the benefits of green building can range from environmental to economic to social. Green construction methods, when coordinates with eco-friendly plan and construction, give the foremost critical benefits. Benefits of green building are:

I. Reduce Energy and Water Waste.

II. Conservation of Natural Resource.

III. Improvement of Water and Air Quality.

IV. Protection of Ecosystem & Bio-diversity.

V. Reduction in costs and increase in value.

VI. Improvement of Occupants productivity.

VII. Improvement of the Quality of life.

The existing rating tools had a few restrictions when connected to an Indian built environment. So, new rating system have to develop for measuring the sustainability of the building in the environment of India with the help of (PCA) Principal Component Analyse (Vyas 2016). The knowledge and skills of Project management to overcome the challenges for green construction. General challenges are higher cost, a technology issue, document issue, issue of communication, project or client-related issue and materials and labour related issue (Bon-Gang Hwang 2012). The green materials are do not more resistance and organic materials are more susceptible to fungal growth than inorganic materials. Increasing the spore levels and the presence of external nutrients promote fungal growth (Chi P. Hoang 2010). Perlite-based ceiling tile was the most reactive test material with ozone and Transport and surface reaction resistances plays vital roles in ozone removal onto ceiling tile. Materials with coatings have lower ozone deposition velocities which indicate that coatings prevent some ozone reaction (Kerry A. Kinney 2009).

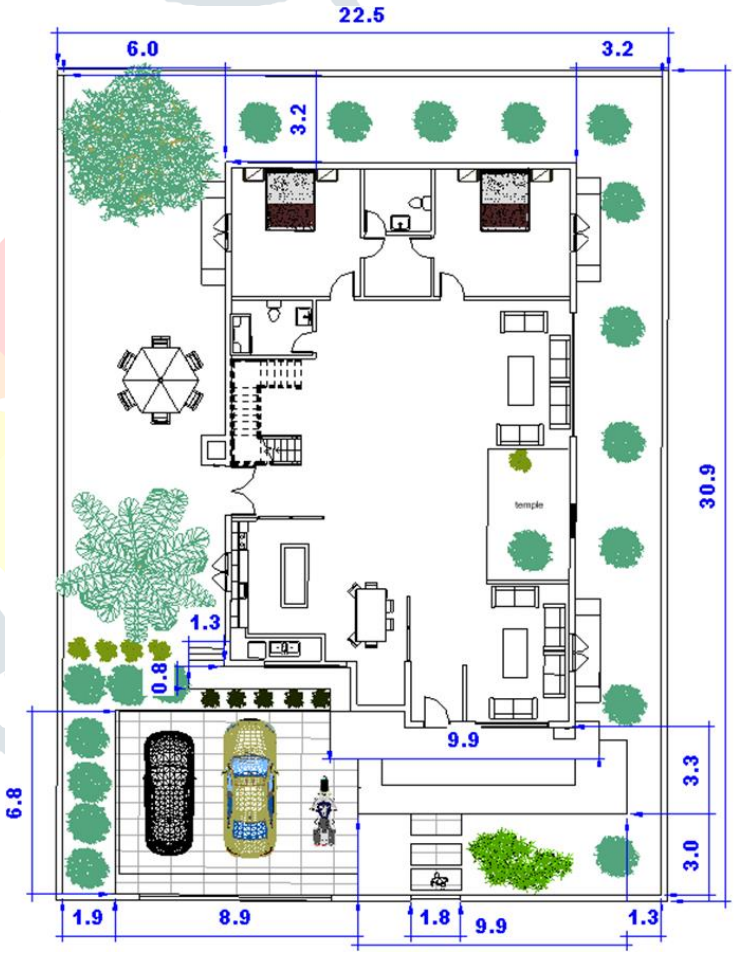

Fig. 1 Site Plan Layout units in m.

2. Methodology

Green Building construction needs a proper plan and its execution. The proper rule is followed in this project/paper. We also used a Rating system to measure the level of sustainability of home. The Rating system is known as

SVA-GRIHA. Home is designed with proper natural lightning and ventilation which decrease the need of artificial lights and ventilators that consumes electricity. The whole house is design to construct with fly ash bricks and fly ash cements which are green materials. Revit software is used for designing of building. It is user-friendly and suitable for 3D modelling because it provides many options for designing structures.It reduces time, additionally gives a render option that's utilized to form a photorealistic picture of the 3D model.

2.1 Site:

The project location is in outskirts of Siwan city near green area. The dimensions of site are 22.5 x 30.9 m. Area of project site is 695.25m². Area of building footprint is 261 m² and the area of hard paved surface is 110 m². The front facing is in North direction. Around the building proper vegetation are grows. On site two car's and 2 bike's parking is available in front of house building. In east and west direction of house, proper windows are designed to provide natural lights and proper ventilation. In south direction no any window is designed. In east side of house, a private garden is designed to do enjoyment and to do exercise in morning and to enjoy morning tea with rising sun. In west direction 3.2 m length space is designed between site wall and house wall for vegetations. In east and west side deciduous trees are plans to grow. In south direction, Evergreen plants are plans to grow to provide all season protection to house from hot sunrise and helps to remain house cool that decrease the use of AC

.

2.2 Ground Floor:

We design with the proper planning so that the energy will conserve more, the ground floor area is 261 m². Size of D1 door is 915mm x 2400mm. Size of D2 door is 716mm x 2134mm. Size of D3 door is 1800mm x 2400mm. All window size is 1400 x 1800mm. The bedrooms have proper natural lightening and ventilation. The main entry is in north direction. Left side of main entry is Formal living Area and on right side is kitchen. In the centre of house, a big Hall is designs for family gathering or other purposes. Right side of hall is way to garden and stairs for upper floor and left side is informal living area and temple. Temple area has a tree and proper ventilation through walls and roof. On ground floor two bedroom are designs with attached dressing room and washroom. East side bedroom has window on east side for natural lightning and ventilation. West side bedroom has window on west side of room. Common dressing room has access from both rooms. West side of informal living area has a big glass window from which a sufficient amount of light will reach the room so energy will conserve automatically. The Staircase has glass boundary so that light will reach and it has duct for ventilation so the people did not feel suffocation and outside the house, we plant some grass and deciduous trees or plants which have a different benefit and also provide greenery and fresh air.

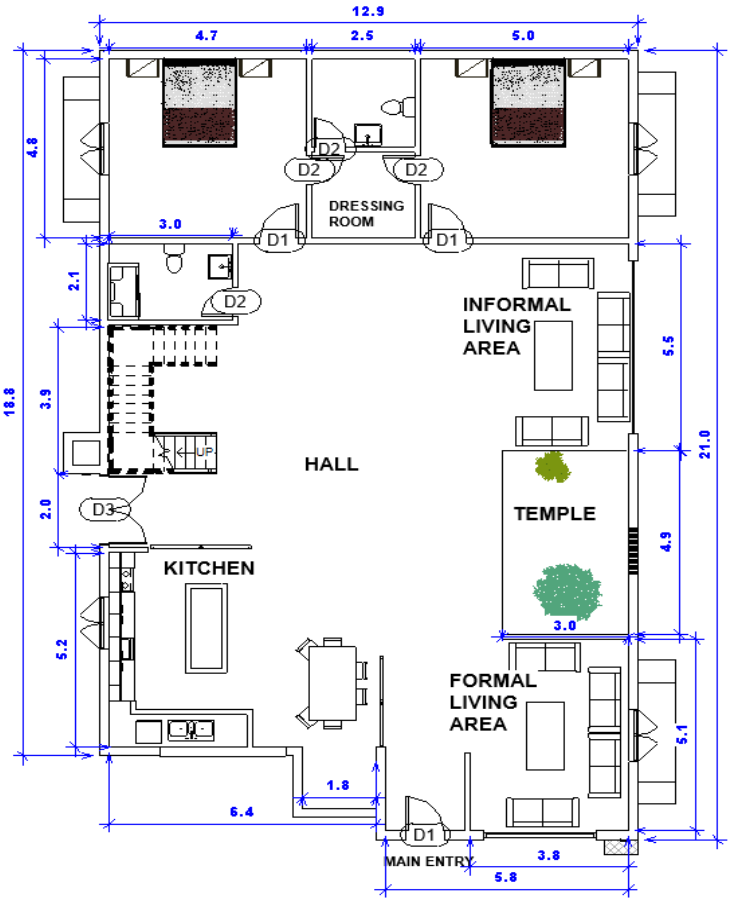

Fig. 2 Ground Floor plan layout (Level 1) measurements are in metre

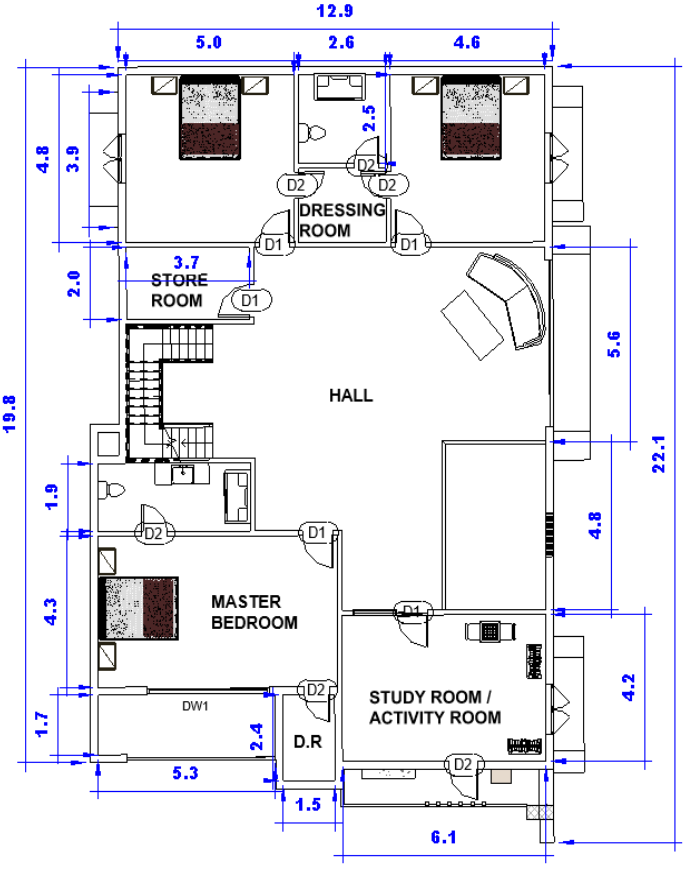

Fig. 3 First Floor plan layout (Level 2) (units are in m)

2.3 First Floor:

The first-floor area is 256 m². Size of D1 door is 915mm x 2400mm. Size of D2 door is 716mm x 2134mm. All window size is 1400 x 1800mm. The bedrooms have proper natural lightening and ventilation. The entry on first floor by staircase is through east side in hall. On first floor, three bedrooms are designed. Master bedroom is in North-East of floor. Master bedroom is connected with personal washroom, Dressing room (D.R) and balcony. Right Side of master bedroom, Study/Activity room is designs with proper ventilation. Temple (on first floor) Area is opens for air circulation in whole house and for natural lightning in whole house. In centre, Hall is deigning for family sitting and for family functions. In south, two bedrooms are design with common washroom and dressing room. One store room is also design to store materials those are not uses in daily routine. Washrooms are full furnished. To go on 2nd floor same staircase place is designs to run stairs from 1st floor to 2nd floor. The study room has a balcony along with two side opening which provides proper circulation of air and maintains/regulate the room temperature. The washroom of this floor has a duct for pipeline or ventilation. The open area has a proper circulation of air which regulate the temperature. The furniture is made up of Cane generally known as Sugarcane. It is durable for long term.

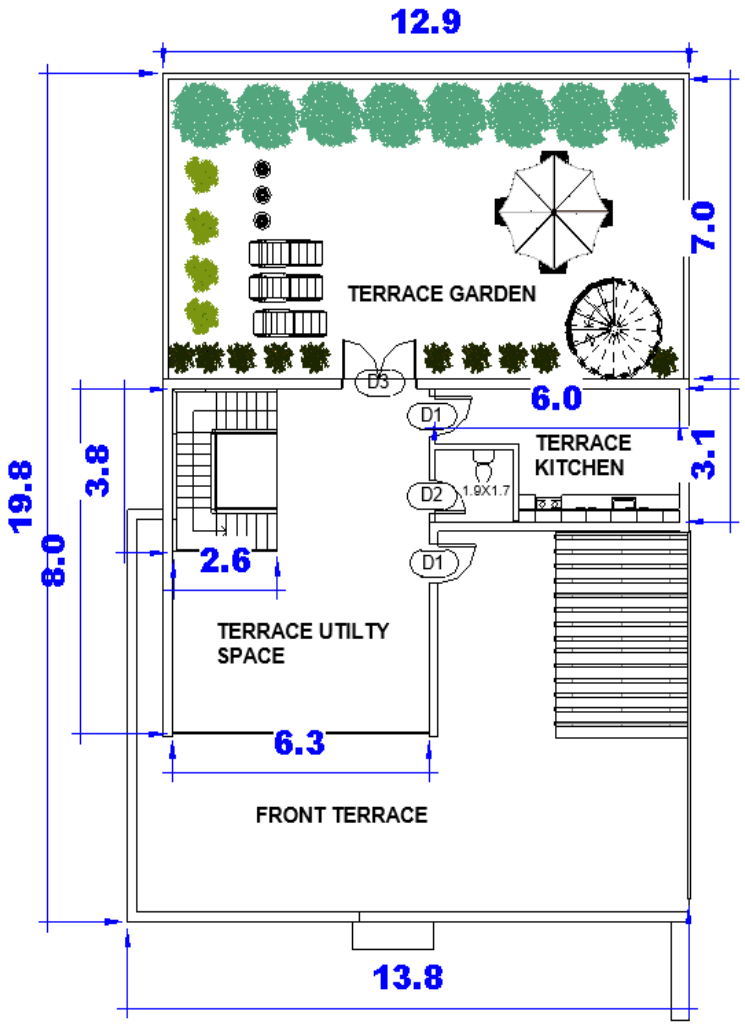

Fig. 4 Second Floor Plan Layout (Level 3) units are in m.

2.4 Second Floor:

The second-floor area is 249 m².². Size of D1 door is 915mm x 2400mm. Size of D2 door is 716mm x 2134mm. Size of D3 door is 1800mm x 2400mm. On Second floor Terrace kitchen is designs which is occasionally used for party or other purposes, Terrace kitchen has a proper circulation system for air and also have proper light. Terrace kitchen is designs in west side. We also design a terrace garden where we plant normal trees which are generally used in every house for aesthetics view or also for improvement of the air quality and provide greenery and freshness. Terrace garden is designs in South direction. Terrace garden protects house to become hotter from sunlight. Some commonly used plants are Aloe Vera, Asparagus Fern, Rose plant, Tulsi, Money Plant, Jade Plant- (it retains water in round leaves and survive for 1-2 weeks without water), Orchid etc. On Level 4, We design a water tank of capacity 5000L. We also design installation of Solar Panel at the terrace to convert solar energy into electricity.

3. RESULT AND DISCUSSION

In this section, we discuss the rating system. SVA-GRIHA rating system is used in the project to rate our building. Discussion will be on what are the criteria or points given in the SVA-GRIHA manual to rate any green building on which our rating is based, what are those points and how the points are distributed in each criterion? We also show the results of our project with the help of a photorealistic image of the whole plan and from all sides of the plan. The Interior is also designed and the pictures are also given below.

3.1 RATING SYSTEM:

Criterion number	Criterion name	Points	Points Obtained
1	Reduce exposed, hard paved surface on site and maintain native vegetation cover on site	6	6
2	Passive architectural design and systems	4	4
3	Good fenestration design for reducing direct heat gain and glare while maximising daylight penetration	6	4
4	Efficient artificial lighting system	2	2
5	Thermal efficiency of building envelope	2	2
6	Use of energy efficient appliances	3	3
7	Use of renewable energy on site	4	3
8	Reduction in building and landscape water demand	5	5
9	Rainwater harvesting	4	4
10	Generate resource from waste	2	2
11	Reduce embodied energy of building	4	3
12	Use of low-energy materials in interiors	4	4
13	Adoption of green Lifestyle	4	4
14	Innovation	2 (Extra Point)	0
Total		**50+2**	**46**

The building got 5-Star by the SVA-GRIHA Rating System. There is the proper explanation of the point distribution in each criterion:

Criterion 1

i) At least 50% of the total paved area on site should be soft and/or shaded – 2 points

Total paved area = Site area – (building footprint + landscape area)

110m = 695.25m-(261m+LA)

LA= 324.25m

ii) Trees should be planted on site in the prescribed ratio. i.e 3 no. of trees because our site area is between 250 sq.m. to 750 sq.m.– 2 points

iii) All new native trees are grown. Our site is situated at Siwan which is in Bihar. Some native trees are Sal, Kendu, Arjun, peepal tree- 2 points.

Criterion 2

Our site location is composite so as per table given in SVA-GRIHA we adopt a minimum 2 passive design measures building (Terrance garden and Light Shelves) and low energy cooling/heating systems are installed- 4 points.

Criterion 3

i) According to composite climate overall insolation through the fenestration reduce by 45%- 2 points

-Direct Heat gain through window = Insolation x Window area x shade coefficient

-DHGTW= 13.22 -Insolation= 2.3 -Shading coefficient (SC)= SHGC/0.86

-Direct heat gain through fenestrations= insolation x window area x SHGC

-DHGTF= 22.35 - Insolation= 5.5 - SHGC= 0.64

ii) More than 70% of the total living area falls under daylit zones (With the help of Revit software, area is taken on which sunlight is fallen in a whole day and the percentage is calculated -2 point

Criterion 4

Demonstrate lower IPD levels in building as compare to ECBC recommended levels- 2 points

LPD= Watt/Sq.m= 1300 watts (lighting wattage total for space)/695.25=1.86> 7.5(mention LPD in manual)

Criterion 5

Our site location is in Siwan city so the threshold is lower than 125 W/s.q.m.- 2 points

Criterion 6

All the AC, Fans and geyser which is installed on site are 5-star BEE labelled- 3 points

Criterion 7

i) Rated capacity of renewable energy system installed on site exceeds thresholds (8 panels are used each of 250 watts to generate 2kw energy. Area req. 200sq.ft. Monocrystalline solar panels are used because its gives efficiency higher than 20%)- 2 points

ii) Solar water heaters installed on site is equivalent to 50% which is mentioned in manual and calculated properly. - 1 points

Criterion 8

i) Total water requirement in the building reduce by 50% or more - 3 points

From the calculation, the amount of water uses per day is 2100 litres approx. by all the members. With the help of low flow fixtures, tap aerators and other techniques water flow is reduces and wastage of water also reduces. Now amount of water uses per day is 950 litres which is reduces by 50%

ii) Landscape water demand reduces by more than 50% (Uses native trees and shrubs to reduce landscape water demand and use low-flow fixtures for watering) - 2 points

Criterion 9

i) The total rainwater harvesting potential for the project (from the roof only) is equivalent to at least 75% of the total building water demand over 2 days – 3 points

-Rainwater harvested = daily average rainfall (for the location) x surface area x run-off coefficient of the surface

-Rainwater Harvested= 47.03Km2 - Rainfall per year= 1326mm

~ Enough rainwater is harvested from rainwater harvesting system to prevent usage of more water and 2 water storage tanks is installed of required size.

ii) Rainwater is recharged into the ground water aquifer and has a filtration system installed– 1 point

Criterion 10

Zero waste generation through adoption of strategies- 2 points

~ Bio-Gas plant and sewage treatment plant is installed to reduce the waste production and the waste is treated and used as a manure for plants and in garden.

Criterion 11

i) 100% OPC is replaced by PPC- 2 points

ii) Overall embodied energy of the floor slabs, roof slabs and walls are reduced by 5% or more (Fly ash bricks are used to reduce embodied energy because it has low embodied energy and it is biodegradable) - 1 point

Criterion 12

i) 70% of flooring is low energy (Cork is used in flooring. Because it is a green building material which have low energy and it is light in weight and have moisture resistance property. Ceramic tile and Glass tile are also used for flooring)- 1 point

ii) All interior paints are low-VOC and lead free- 1 point

iii) At least 70% of internal partitions/panelling/false ceiling/in-built furniture/ doors & window-panels & frames are low-energy (As we planned to use some Bamboo furniture; Mineral fibre and wood are used in panels because it is eco-friendly. Bamboo is antibacterial green building material which is powerful insulator and also have UV protection) – 2 points

Criterion 13

i) Built-up area meets the prescribed threshold (mentioned in manual for different types of building)- 1 point

ii) Total expected distance travelled to basic services in a year is less than 2100 km- 1 point

iii) Service staff is provided a dedicated toiled & resting room- 1 point

iv) Organic farming is carried out on site- 1 point.

All criterions are rated on the basis of our plans to construct and equipment used in house.

3.2 3D VIEW OF HOUSE:

These are the photorealistic pictures of the plan. With the pictures of interior designing. Image 1 is the photorealistic picture of exterior design of the plan. Image 2, 3 & 4 is the photorealistic picture of interior designing of Kitchen, Informal drawing area and bedroom.

Img.1 Front View

Img.2 Kitchen

Img.3 Informal Drawing Area

Img.4 Bedroom

4. CONCLUSION

In the end, results from our research and study on different research paper or facts are suggested that green building is a very good alternative to normal/conventional building. It has more benefits than a Normal building.

- It may cost a bit more to begin going green, but it will save energy costs by conserving energy. Green building is more speculation than anything else. Because the maintenance cost of green building will decrease and it is a more efficient or sustainable building or it will be able to save money.
- Green building materials are 100% biodegradable and recyclable. It does not have any impact on the environment and also do not have any carbon footprint. The materials have more benefits than the normal building materials.
- Green Building Rating System is the backbone of green building with it no one tells that how much the building is green and sustainable. It is used to give the rating to green building for the analysis of their sustainability. In India, mostly LEED, SVA-GRIHA and IGBC are used for rating.
- Autodesk Revit Software is user-friendly and suitable for 3D modelling because it provides many options for designing structures. It also provides a material family to make the plan easy to understand and to make a plan with details. It reduces time, additionally gives a render option that's utilized to form a photorealistic picture of the 3D model.
- Terrace garden plays a major role in the green building because it provides greenery in the home and also provides protection to the home from sunlight heat in summers. It will be a benefit for the atmosphere and reduce carbon footprint by planting a garden at home. The plants will help to improve the quality of the air for breath.

5. REFERENCES

1. Crawley, D., Aho, I., 1999. Building environmental assessment methods: applications and development trends. BUILD RES INF. 27(4-5), 300–308.

2. Y. Deng, S. J. Cao, A. Chen, Y. Guo. The impact of manufacturing parameters on submicron particle emissions from a desktop 3D printer in the perspective of emission, Build. Environ. 104(2016) 311-319.

3. P. Wolkoff, External eye symptoms in indoor environments, Indoor Air 27 (2017) 246-260.

4. S. Sharif, S.N. Kamaruzzaman, M. Pitt, Implementation framework of green building for government building: menara Kerja Raya, Malaysia, J. Des. Built Environ. 17 (2017) 27–36.

5. B.G. Hwang, J.S. Tan, Green building project management: obstacles and solutions for sustainable development, Sustain. Dev. 20 (2012) 335–349.

6. J. Sundell, T. Lindvall, Indoor air humidity and sensation of dryness as risk indicators of SBS, Indoor Air 3 (1993) 382-390.

7. Nguyen B.K., Altan H., 2011. Comparative review of five sustainable rating systems. PROCEDIA ENGINEERING. 21, 376-386.

8. J. Wei, Y. Li, Airborne spread of infectious agents in the indoor environment, AM. J. INFECT. CONTROL44 (2016) 102-108.

9. Wu, P., Low, S.P., 2010. Project management and green buildings: lessons from the rating systems. J PROF ISS ENG ED PR. 136(2), 64-70.