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Building Information Modelling For Green Building and IGBC Rating Analysis

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Abstract – Owners, architects and engineers are more worried about the sustainability and energy performance of proposed buildings. Evaluating and analyzing the potential energy consumption of buildings at the conceptual design stage is very helpful for designers when electing the design alternative that leads to a more energy efficient facility. Building Information Modeling (BIM) assists designers assess distinct design alternatives at the conceptual stage of a building life so that effective energy strategies are attained within the green building constraints. As well, at that stage, designers can select the correct type of building materials that have big impact on the building's life cycle energy consumption and operating costs. Although a large number of studies on Building Information Modeling (BIM) have been conducted in the past decade, a deficiency of consensus residue among researchers and practitioners regarding the applications of BIM for the development of green buildings, the activity of creating buildings in a way that protects the natural environment. As the usefulness of BIM has been broadly recognized in the building and construction industry, there is an urgent need to establish an up-to-date synthesis between BIM and green buildings.

Keywords – Energy Analysis, Green BIM, Green Building, Revit, BIM, IGBC

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I. INTRODUCTION

Green building is defined by the Office of the Federal Environmental Executive as the practice of increasing the efficiency with which buildings and their sites use energy, water, and materials, and reducing building impacts of human health and the environment, through better design, construction, operation, maintenance, and removal throughout the complete life cycle.

Green homes will have tremendous advantages, each tangible and intangible. The foremost tangible advantages area unit the reduction in water and energy consumption right from day one among occupancy. The energy savings may vary from twenty - half-hour and water savings around thirty - five hundredth. Intangible advantages of inexperienced homes embody increased air quality, wonderful day lighting, health & upbeat of the occupants, lower energy bills and conservation of scarce national resources.

BIM stands for Building Information Modeling, and will be a 3D modelling technique that permits style, engineering and construction professionals to vogue and build with intelligence. BIM is "an integrated technique that's used to facilitate the exchange of style and construction information to project participants".

BIM used in the construction industry by providing 3D view of a project containing all parameters and its mechanism. The building and construction industry has been driven to adopt green building strategies for increasing sustainability concerns such as reducing CO2 emission and increase energy efficiency. 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 design to construction, operation, maintenance and renovation.

BIM in green buildings permits property styles, permitting architects and engineers to integrate and analyses building performance. BIM enhances style and construction potency, BIM has been regarded by several as vital chance in design Architecture, Engineering and Construction (AEC) business. BIM will be wont to simulate energy consumption quickly and accurately. It will facilitate eliminate energy waste. It integrates and analyzes data at the development stage. it's wont to find out energy potency. The BIM is that the constant modification conception permitting the AEC companies to

additional effectively implement the property style and to boost larger building energy potency.

Building Information Modelling (BIM) is a new and innovative technology, which has emerged in recent years and makes possible the efficient achievement of more sustainable designs. .It is believed that BIM is a critical element in reducing industry waste including wasted energy, adding value to industry products and decreasing environmental damage.

Our current thrust is given to reducing energy usage further as carbon emissions in buildings. Energy potency is a vital feature in naming building materials as being environmentally friendly. The last word goal in mistreatment energy economical materials is to scale back the number of by artificial means generated power that has to be delivered to a lot. Building data Modelling tools facilitate users do complete energy analysis and explore totally different energy saving alternatives throughout the look stage.

Using BIM technology to watch building performance may be employed in coming up with appropriate situations to maximize energy savings so as to match style and performance of buildings. As per the recent studies, BIM based mostly energy analysis is taken into account to be helpful for energy analysis of building. Basically, utilizing BIM as a knowledge or an information supply for energy analysis makes the info input additional economical and also the existing data additional reusable.

Another objective of this comes to set up the programing of the complete work and determinative the value estimation analysis. Time and price controls area unit vital for any construction organization. BIM improves technical work on the planning stage by making 3D models that integrate all building's options and it higher represents the infrastructure's necessities. Those models will be increased if connected with schedule (4D) and costs (5D), the development can so be higher planned nearly entirely at the planning part. Correct estimation and coming up with of actual project prices also are vital for fulfillment in construction business. Handling the project value knowledge by BIM approach offer a chance to manage the development project prices a lot of expeditiously. As the construction costs unit known and connected to the development components and programing knowledge, the 5D building data model is formed.

There is also the Scheduling and 4D modelling use of BIM. The 4D Model is created when the element of time is added to the 3D Model by creating a link with the model and the critical path method schedule. This can be done using a single application or by combining model collaboration software with standard scheduling software. The 4D Model is an essential tool to the BIM Process because it identifies collision between construction activities. The 4D Model is a necessary tool to the BIM method as a result of it identifies collision between construction activities. 4D Modelling is employed to spot activities that square measure out of sequence, flow of trade work and relationships between construction tools. The Estimating and 5D modelling use of BIM entails using the data stored in the BIM to extract information and transfer that information into construction estimates. As the design progresses or changes occur, these estimates can be quickly updated based on information derived from the BIM model. More ever now it's a need of a construction industry to integrate BIM technology with a cost control factor.

After planning and value estimation the last objective of this project is to administer the classification system as per IGBC norms. That is one in all the simplest classification system in India for Green Buildings. Evaluating a building to be certified as "sustainable", in line with a classification system, may be a varied and multi-phase method, that ensures that measures are taken for the building to attain bound performance levels in aspects like energy consumption reduction, conservation of resources, low carbon footprint etc.

The three most prevailing rating system in India are LEED, IGBC and GRIHA. Existing Buildings can even be retrofitted and obtain the certificate from Rating Agencies of the World. By applying IGBC inexperienced homes criteria, homes that are feasible over the life cycle of the building is created. This rating programme could be a tool that allows the designer to use inexperienced ideas and criteria, therefore on cut back environmental impact, that are measurable. IGBC Green Homes is that the initial rating programme developed in Asian country, completely for the residential sector. IGBC green new buildings system could be a voluntary and consensus-based programme. The system has been developed supported materials and technologies that are presently obtainable. The target of IGBC green new buildings grading system is to facilitate a holistic approach to make environment-friendly buildings, through architecture design, water potency, effective handling of waste, energy potency, feasible buildings, and specialise in dweller comfort & well-being. The rating system evaluates bound necessary needs & credit points employing a prescriptive approach and others on a performance primarily based approach. The system is evolved therefore on be comprehensive and at an equivalent easily operating.

1.2 Scope and Significance of Study

- This typical case is selected in the project would be useful while considering the cases for residential sites.
- This project will be identical for person who are associated with this type of work, who would be integrate and analyses information

at construction stage and beneficial for the person who construct green building rather than constructing conventional building.

- This will be beneficial for the people who are really conscious about the environmental impact of the building and believe in energy conservation.

- The another future scope for this project is while achieving IGBC rating system, it can be increased if the remaining credits are attempted.

1.3 Objectives

- Planning and Modelling of G+10 residential conventional as well as green building by using Revit.

- Energy analysis of green building and conventional building by using Green Building Studio and comparison of their results.

- To plan the Scheduling of project and determine the cost and estimating of G+10 Residential conventional and green building and compare their results.

- To achieve highest rating available as per IGBC rating system.

2. LITERATURE REVIEW

Builiding Information Modeling (BIM) for green building : A criticle review and future directions. Yujie Llu, Zhilei Wu, Ruidong Chang, Yongkui Li. 2017, Automation in construction.

In this study, BIM was used as an enabling technology for cloud-based building data services that integrated building data in the operational phase with a focus on energy management. Three main facts of green BIM are critically examined, namely the contributions and applications of BIM in the life cycle of green buildings, the various functions of environmental sustainability analyses provided by BIM programs, and the integration of green building assessment (GBA) with BIM. Also BIM functions for green analyses were identified and critically reviewed, including energy performance analyses and evaluations, natural ventilation system analyses, solar radiation and lighting analyses, water usage analyses and thermal comfort analyses. This study reveals that green BIM applications might bring varied edges for GBA, like estimating GBA scores, managing application documents, and enhance the potency of GBA method.

Building information modelling (BIM) for sustainable building design. Fan, Kam-din Wong and Qing. 3/4, Hong Kong, China : Emerald Group Publishing Limited, 2013, Vol. 31.

In this paper Implementation of BIM is able to eliminate the extra cost of design changes during the subsequent phases of construction process. BIM is also capable of enhancing the project delivery culture in future. BIM enabled sustainable design and to explore that BIM can potentially facilitate and benefit sustainable design. Inspection of the BIM contributions to sustainable building design. Analysis of the benefits and obstacles of using BIM to support sustainable design “Green” strategies using the inherent BIM software such as Revit include selection of the best building orientation and the appropriate degree of massing.

Integrating BIM with green building Certification System, Eneergy Analysis and Cost Estimating Tools to conceptually Design Sustainable Building. Jrade, Farzad Jalaei and Ahmad. Ottawa : s.n., 2014.

This paper presented a method to partially automate the procedures of implementing sustainable design for building projects at their conceptual stage by integrating BIM, energy analysis and cost estimation tools. Energy analysis, in order to have an accurate energy analysis of the proposed building, the 3D physical model should be converted into an analytical model by transferring all the spaces into rooms. Building Information Modelling tools help users do complete energy analysis and explore different energy saving alternatives during the design stage. This would help owners and designers make energy related decisions that have high impact on the proposed building life cycle cost.

Sustainable BIM-based Evaluation of Buildings. Ibrahim Motawa, Kate Carter. Edinburgh : Elsevier Ltd., 2013.

In this study BIM applications for energy analysis have been introduced to improve the process at the design stage. This paper introduces a conceptual BIM-based model that can improve th evaluation process and meet the industry requirements for sustainable buildings. The required sets of data to analyse energy consumption in building is quite complex and includes data about the external environment, the shape and configuration of the building, equipment loads, lighting mechanical systems and air distribution. Therefore, for accurate prediction of energy consumption, integrated simulation tools should be used. This study shows a BIM model of a building includes design features, Building type, construction materials, System types (Heating/Cooling), Room type (Zone management), Project location (weather files), etc. which can be exported to a building simulation tool.

Green Building Based on BIM. Neelam Sharma, Bhupinder Kaur and Amit Goel. Mohali, Punjab, India : s.n., 2018, Vol. 11

The study shows various factors which affect the energy use of a building which include building location, size and shape and its parts, in internal spaces heat and light occurred which reduces need for energy use. It results to improve efficiency and reduce energy use with reducing heating and lighting units. In the energy simulation process, BIM is considered important factor used to create a high potential in sustainable building design. Thus, calculate the energy performance effectively before construct the building on site. In this study autodesk Revit software is used to analyze energy performance by adopted different building location.

BIM application to building energy performance visualisation and management: Challenges and potential. Tristan Gerrish, Kirti Ruikar, Malcolm Cook, Mark Johnson, Mark Phillip, Christine Lowry. United Kingdom : Elsevier B.V., 2017.

The present study describes the definition of BIM. The definition adopted here it is as a systematic process of the management and wide information generated throughout building design development and operation. In this study the much efforts are targeted for reducing the gap between predicted and actual building performance. This study shows that accurate recreation of the entire building would have taken significant time, therefore a simplified representation of spaces and systems was chosen as a demonstrative BIM environment to which building performance data could be attributed and utilized. In that space and system data describing performance characteristics such as the maximum expected lighting, heating, cooling and small power loads for each space were taken from the simulated performance model and attributed to their respective spatial objects.

3. METHODOLOGY

- The first step contains literature review relevant to the study. In that BIM and energy analysis software and factors affecting building energy use, are reviewed. This is accustomed understanding the relation between building energy location and energy use.

- Second step consist of selection of site and planning of G+10 residential building with the help of AutoCAD. The same plan can be used for conventional and green building.

- Third step consist of modelling of G+10 plan in Revit software for conventional as well as green building. The green building is replaced by using certain green materials which are energy and cost efficient.

- In fourth step energy model is created and energy analysis is done which is used for model to recognized information. The data required for energy model is location of site, latitude and longitude of building etc.

Solar panels are given in this building to store energy use which is the best practices for green building.

Also the provision of rainwater harvesting is given in the revit model. Rainwater harvesting is that the assortment and storage of rain, instead of permitting it to escape. Rainwater is collected from a roof-like surface and redirected to a tank, cistern, deep pit, aquifer or a reservoir with percolation. This provision can improve the sustainability of building.

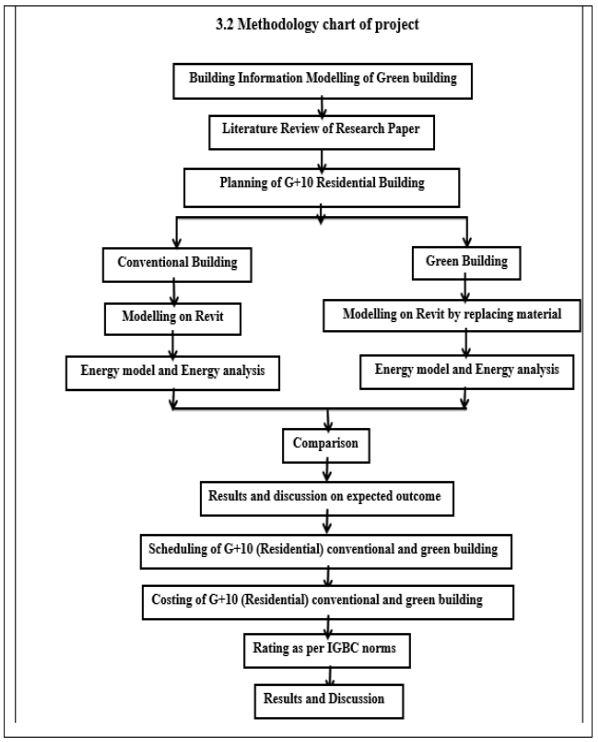


Fig.1 Flow Chart of Methodology

- In fifth step the calculated energy analysis result for conventional as well as green building is compared. Energy analysis using BIM tools (Revit and Green Building studio) and Energy plus. These tools were used to study the thermal and energy performance of a well-insulated test cell and to study the impact of a change of thermal mass and insulation thickness to figure out the advantage and disadvantage of each tool.

- In sixth step Predicting, Planning, and controlling the schedule for G+10 building project are critical requirements for effective project implementation in the construction industry. The scheduling of the construction process is subjected to many variables and unpredictable factors, such as the resource availability, environmental conditions,

involvement of other parties and contractual relations, so planning the schedule is one of the main tasks of the contractor.

- In seventh step Costing of G+10 building is done. A cost estimate is the main type of target data to obtain at the outset of any project, which enables the project manager to define the project budget. Cost planning of the construction project can be performed through several steps using software. The 3D model can be formed in multiple formats such as Revit, ArchiCAD.

- In eighth step The Indian Green Building Council (IGBC) has launched 'IGBC Green Residential societies Rating System to implement measures that will reduce the consumption of natural resources. The main objective to launch IGBC Green Residential Societies Rating System is to develop as many green societies as possible. Benefits of IGBC Rating System, 20-30% reduction in Energy cost, 30-50% reduction in Water requirement and improved health & wellbeing of occupants.

- In ninth step calculated Result and Discussion for conventional as well as green building on expected outcomes.

3.1 Work of the Project

- **AutoCAD Plan of G+10 Residential Building**

Fig. 2 AutoCAD plan of G+10 Residential Building.

- **Revit Modelling Of G+10 Residential Building**

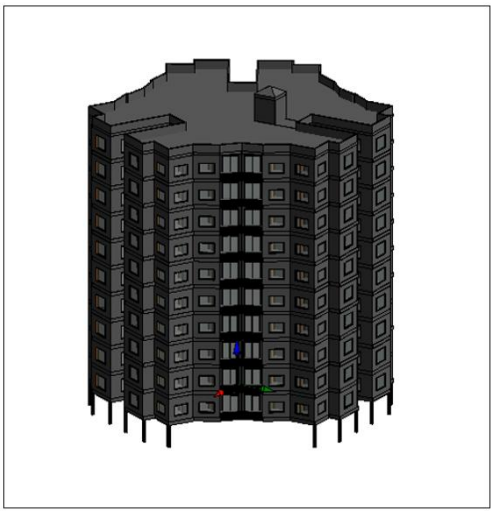


Fig. 3 Revit modeling of Conventional Building.

Fig. 4 Revit Modeling of Green Building.

- **Analytical Model of G+10 Residential Building**

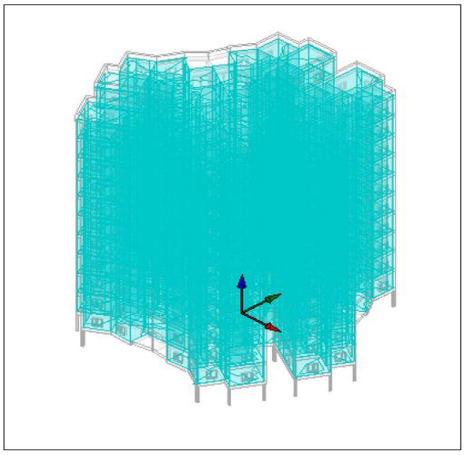


Fig. 5 Analytical model of G+10 residential building

- **Rating as Per IGBC Norms**

The Indian Green Building Council (IGBC), part of the Confederation of Indian Industry (CII) was formed in the year 2001. The vision of the council is, "To enable a sustainable built environment for all and facilitate India to be one of the global leaders in the sustainable built environment by 2025".The council offers a wide array of services which include developing new green building rating programmes, certification services and green building training programmes.

Green building rating brings together a host of sustainable practices and solutions to reduce the environmental impacts. Green building design provides an integrated approach considering life cycle impacts of the resources used.

Benefits of Green Residential Societies Rating System

- 20-30% reduction in Energy cost
- 30-50% reduction in Water requirement
- Improved health & wellbeing of occupants

The guidelines detailed under each credit enables the design and construction of green Residential Societies of all sizes and types. Different levels of green building certification are awarded based on the total credits earned.

Table No.1 Criteria for Certification Level

Certification Level	Points	Recognition
Certified	30 – 39	Best Practices
Silver	40 – 49	Outstanding Performance
Gold	50 – 64	National Excellence
Platinum	65 & above	Global Leadership

Table No.2 IGBC Green Residential Societies Rating System – CHECKLIST

Sr. No.	Credits	Point
1	No Smoking in Common Areas	3
2	Maintenance of Facility	4
3	Basic Amenities	2
4	Green Housekeeping in common areas	1
5	Green Education for Occupants	1
6	Minimize Heat Exposure – Roof: 30, 40, …… 80%	6
7	Covered External Lighting Fixtures : 50, 75, 95%	3
8	Design for Differently Abled	3
9	Facilities for Health & Wellbeing	2
10	Rain Water Harvesting : 10, 20, ……100%	10
11	Landscape Areas: 20, 25, …… 40%	5
12	Water Sub Metering	4
13	Water Efficient Fixtures : 40, 50, …… 90%	6
14	On-Site STP: 50, 75, 95%	3
15	Automatic water level controllers	1
16	CFC Free Appliances	3
17	Efficient Lighting Fixtures: 25, 50, 75, 95%	4
18	Solar power for street & Common Area Lighting: 20, 30 ……. 80%	7
19	Energy metering	2
20	Solar Water Heating Systems: 20, 30. …… 70%	6
21	Waste Segregation	4
22	Organic Waste Management - 20, 40, 60, 80, 90%	5
23	E-waste Management	1
24	Water Meters for Dwelling units (50, 75, 100%)	3
25	Reuse of treated waste water for landscaping	1
26	Fresh water treatment plant	1
27	Electric charging points for vehicles in common areas (2.5%, 5%)	2
28	LPG/CNG Gas geysers for water heating (20, 40%)	2
29	Day-Light / Motion Sensors in common areas	1
30	IGBC Accredited Professional	1
31	Other Innovative practices	3

4. RESULT AND DISCUSSION

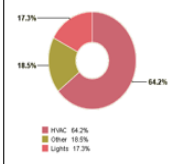
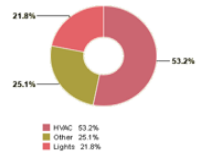
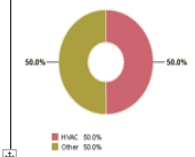
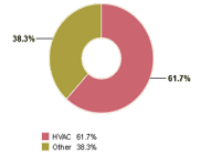
- **COMPARISON BETWEEN CONVENTIONAL BUILDING AND GREEN BUILDING**

Parameter	Conventional Building	Green Building
Building Summary: Location:	Pune, MH	Pune, MH
Building Type:	Multi Family	Multi Family
Floor Area:	2,314 m²	2,314 m²
Number of People:	1,030 people	1,030 people
Roof:	Concrete Roof	Green Roof
Wall:	Brick Wall	Cavity Wall
Door:	Door Material without Glazing	Door Material with Glazing
Window:	Standard Dimension Window Material without Glazing	Change in Dimension Window Material with Glazing
Solar Panel	Not Applied	Area: 459m² Panel Cost: $1.21per Watt
Time Occupancy	58%	58%
Electric Cost:	$0.08 / kWh	$0.08 / kWh
Fuel Cost:	$0.01 / MJ	$0.01 / MJ
Water Cost:	$0.69/ m³	$0.69/m³
Rainwater Harvesting:	No	Yes
Native Vegetation Landscaping:	No	Yes
Greywater Reclamation:	No	Yes
Weather Station: Distance to your project: Latitude = Longitude =	GBS_04R20_266136 12357.8 km 42.4509 -71.0785	GBS_04R20_266136 12357.8 km 42.4509 -71.0785

Table No.3 Comparison Between Conventional Building And Green Building

- **Result:**

Table No.4 Result

Parameter	Conventional Building	Green Building
Annual Energy		
Energy Use Intensity (EUI)	2,929 MJ / m² / year	1,591 MJ / m² / year
Electric	500,989 kWh	495,211 kWh
Fuel	4,975,579 MJ	3,119,425 MJ
Annual Peak Demand	134.2 kW	146.6 kW
Annual Energy Cost	$77,045	$62,793
Lifecycle Energy		
Electric	15,029,661 kW	14,856,318 kW
Fuel	149,267,370 MJ	93,582,750 MJ
Lifecycle Cost	$1,049,353	$855,234
Annual Electric End Use		
Annual Fuel End Use		
LEED Daylight	Percentage of building area with glazing factor over 2%: 36.7%	Percentage of building area with glazing factor over 2%: 43.4%
LEED Water Efficiency Indoor: Outdoor: Total Total Efficiency savings:	 29,436,355 L/yr $32438 815,782 L/yr $589/yr 30,253,137 L/yr $33027/yr	 17,597,454 L/yr $27,403/yr 293,032 L/yr $126/yr 17,890,486 L/yr $27,529/yr
Percent of Indoor Usage (%) Gallons per Year Annual Cost Savings ($) Total Net-Zero Savings:		15.1% 3,127,507 $5,035 522750L/yr $463/yr
Photovoltaic Potential Annual Energy Savings: Total Installed Panel Cost: Potential Cost savings per year Annual Energy Production (kWh) Nominal Rated Power: Total Panel Area: Maximum Payback Period:		71,202 kWh $76,706 $5,696.19 71,202 63 kW 459 m² 12 years @ $0.08 / kWh

- **Results of Estimation and Costing**

Table No.5 Results of estimation and costing

Parameter	Conventional Building	Green Building
Roof	$19466.37	$58836.68
Wall	$54587.27	$148195.06
Door	$30165.48	$33709.34
Window	$20872.08	$32877.1
Total	$125091.2	$273618.18

- **IGBC Green Residential Building Credit**

Table No.6 IGBC Green Residential Building Credit

Sr. No.	Credits	Point
1	No Smoking in Common Areas	3
2	Maintenance of Facility	4
3	Basic Amenities	2

4	Green Housekeeping in common areas	1
5	Green Education for Occupants	1
6	Minimize Heat Exposure – Roof: 30, 40, …… 80%	5
7	Design for Differently Abled	3
8	Rain Water Harvesting : 10, 20, ……100%	8
9	Landscape Areas: 20, 25, …… 40%	5
Total credit points		**32**

Table No.7 Credit Obtained

Certification Level	Points	Recognition
Certified	30-39	Best Practices

By the following method,

The total credit points=32

So, project is under category of certified and with recognition of Best Practices.

5. CONCLUSION

- From the above report we concluded that Green building reduces energy consumptions in numerous ways. Decrease embodies energy of the building through well-organized design, use of recycled and local materials and recycling construction waste.
- Green building design reduces energy consumption over its lifespan.
- Strategically placing windows and skylight can terminate the need for electrical lighting during the day. High quality insulation shrink temperature regulation costs in both summer and winter.
- Green building consumes minimum water as compared to conventional building.
- A rating system is very important to identify the green features of the building and also in guiding the building to be sustainable.
- The total credit points obtained is 32 so, this work is under category of certified and with recognition of Best Practices.

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