Conversion of a conventional building to a green building using GRIHA for Environmental protection using case study in India

[1]Ravi Gupta
Research Scholar, Civil Engineering
Maulana Azad National Institute of Technology, Bhopal India.

Abstract : The comparative analysis of a green building and a conventional building is undertaken to study how green building is a need for today. To protect the future, concept of green building needs to be adopted widely in current times. The green buildings are designed to decrease the overall impact of the built environment on human health & the natural atmosphere by efficient use of energy, water & other resources. It incorporates sustainable materials in their construction. Protecting occupant health & improving employee productivity. It creates a healthy indoor atmosphere with minimal pollutants. It features landscaping that reduces water usage.

Therefore, adopting green building techniques instead of conventional methods are need of today's scenario. The aim is to compare a green (Maruti Solitaire project Chhattisgarh) and conventional building (K Square Nagpur) by following GRIHA rating scale and suggesting some modification & alteration for conventional one.

Maruti Solitaire project by Avinash Builders is Chhattisgarh's 1st residential building designed as a 'green building', located in Shankar nagar, Raipur, registered under GRIHA is taken as a base case. This is an 8-floor lavish building having some smart ideas to save water, electricity, HVAC systems with some lower maintenance and good quality of living. It got a 4 star rating from GRIHA in September 2014. The Maruti Solitaire is one of the rarest residential projects which are going to reduce their water bill up to 40% & electricity bill up to 50% this is a cost effective approach which will further save money, natural energy & surroundings as well.

K-square (study case) Nagpur is a typical 7+1 floor conventional building consists of 2 & 3BHK flats, with stilled parking. There are a total of 82 flats which are made with low embodied building materials, which affects the surrounding less adversely.

IndexTerms - Green building, conventional building, GRIHA, natural energy, residential projects.

With the rapid development of the human race, the environment seems to be the first recipient to all the good and the bad effects. But in most cases; it is evident that the negative effects outweigh the positive ones, suggesting a matter of concern for all. Nowadays construction of every type (building, bridge, road, etc.) takes place everywhere (land or water).

Approximately, 3.5 billion to 7 billion trees are cut down yearly to make space for infrastructure and development. This leads to deforestation and global warming, putting our environment's health at risk. As a result, our environment is much more polluted now. It is righty said "save tree-save life". To address these environmental concerns, smart techniques regarding construction practices should be considered. Urbanization is one of the main contributors to pollution. Urbanization needs to be undertaken and designed in a manner that doesn't harm the environment. Due to modern urbanization, the standard of living of an average individual is now higher than it was before. Each individuals desire is to live in '*pukka makan'* (cement concrete or R.C.C. building), commonly known as Conventional Type of Construction, in which cement, sand, water, steel and bricks form a majority of the raw materials used to build any kind of structure. Moreover, in Modern Conventional Buildings, cement-concrete, reinforced cement-concrete, steel bar, precasting etc. are used.

Due to modernization, construction has increased by leaps & bounds, which has made a lot of progress in the field of human comforts, primary raw material being cement. In ancient constructions there were many problems like safety, leakage, life, retrofication, no vertical construction etc. But in present times, with the invention of cement, these issues are resolved. Nonetheless, even though the drawbacks of the ancient construction have been addressed, the darker side of this progress too has come to light. Cement is a non-biodegradable material which is continuously polluting the environment. Basically, there is almost no use of a sustainable material like cement if is not good for nature as well. A lot of precious energy is wasted in construction works. Using renewable sources of energy in constructions will prevent our surroundings from getting polluted.

In a typical conventional building, daylight problems, heating, ventilation, air-conditioning (HVAC), acoustical and thermal problems are seen. This will further increase the expense and make the occupants uncomfortable. In 2010 United States Environment Protection Agency figures shows that lucrative residential & commercial units are responsible for 11% greenhouse gas release including burning fossil fuel for procedure of product enfolding greenhouse gases & unwanted. U.S. EIA says, in 2011 roughly 41% of total energy consumed was used in buildings only. 50% of global greenhouse emission is due to building (approximately 40 quadrillion BTUs).In the United States, buildings are responsible for 72% of electricity intake, 39% of energy use, 41% of raw material usage, 37% of carbon dioxide discharges, 31% unwanted production and 15% drinkable water intake. (USGBC, 2009) It is estimated that 73% of these buildings will stand for decades to satisfy demand with their negative environmental impact.
That is why green building concept came into existence. The green building is also known as sustainable building, high performance building & eco-friendly buildings, are made up of sustainable, renewable, eco-friendly building material &

techniques, which mitigates the CO_2 released, saves energy, water efficiency maintained and provides an improved & healthy environmental quality for inhabitants. The common objective of green buildings is to reduce the overall impact of the built environment on human health & the natural environment by efficiently using energy water & other resources protecting occupant health & improving employee productivity reducing waste pollution & environment degradations.
World Green Building Council states that a green construction refers to both and application of processes that are environmentally responsible & resources efficient through a building life style. The negative effect aids in achieving positive influence on our climate & natural environment. The quality of life of inhabitants is considered by design, construction & operation.

The scope of this research paper is to take this topic "comparative study of green & conventional building" to the next level, which will discuss how an existing conventional building can be updated to green building.

Tables and Figures

METHODOLOGY

1. In early stage, case study was searched through GRIHA site. Options for case study were taken in Raipur, Nagpur & Pune. All three places were visited. Of the firms visited, one firm agreed to share the essential data. The data related to case studies was collected by site visit.
2. After receiving the required data, it was analyzed to understand the concept and evaluation process of GRIHA...
3. After evaluating the local case study, the guidelines for planning elements of housing projects are compared, and suggestions are made wherever deemed fit.
4. Then a local case study was taken to understand conventional construction condition following local bylaws and was then rated in accordance to GRIHA pre-certification rating system.
5. Suggestions were provided to improve rating of the conventional project.
6. At last a re-evaluation of the conventional case study was done considering all the suggested elements

Literature Survey:

1. A Comparison of Occupants Comforts and Satisfaction between Green Building & Conventional Building. Warren L. Paul, Peter A. Taylor. Building And Environment Vol. 43, Nov. 2008

It has been argued that the "green" building have a better indoor air environmental quality (as measured by the comfort perceptions of occupants) than conventional building and that this translates into a more satisfying work place for the building's occupants &, in turn a more productive workforce. To test this we measured the comfort and satisfaction perceptions of the occupants of green university buildings and to conventional university buildings with a questionnaire that asked occupants to rate their workplace environment in terms of aesthetics serenity, lighting acoustics, ventilations, temp., humidity and overall satisfaction. The university buildings at the center of the study located in Asbury Watonga in inland south east Australia. The green building, which is naturally ventilated is constructed from rammed earth and recycled materials. All other aspects of comfort including aesthetics, serenity, lighting, ventilation, acoustics and humidity were not perceived differently by the occupants of the two types of building.

2. Benchmarking Green Building Attributes To Achieve Cost Effectiveness Using Data Envelopment Analysis. G S Vyas K. N. Jha. Sustainable Cities & Society. Vol. 28, Jan. 2017

Green building construction has been considered to be an essential practice for achieving sustainability.to is achieving sustainable development, greater attention has been paid to environmental, social & economic impacts associated with the construction & operation of buildings. Hence, the importance of a more integrated approach to green building design with cost effectiveness has gained momentum. The present study focuses on developing appropriate constructs to benchmark green building attributes in construction that with limited funds. The sustainable performance of building is improved. In this study Indian green building assessment tools such as green rating integrated habitat assessment (GRIHA), Indian green building council (IGBC), Eco housing and newly developed rating system, are reviewed. Data envelopment analysis (DEA) has been employed to benchmark the green building attributes. Buildings in different climatic conditions, such as hot and dry, warm & humid and composite climates where chosen for benchmarking proposes. The following attributes were observed:

a. Utilization of Bureau of Indian standards (BIS) recommended waste materials in the buildings,
b. Increase in environmental awareness,
c. Dedicated facilities for service staff,
d. Design for universal accessibility,
e. Low impact design
f. Construction management practices & Use of low-volatile organic compound (VOC) paints that contribute to more green points at lower cost.

3. An Overview of the Benefits and Risk Factors of Going Green in Existing Buildings. Alev Durmus-Pedini. International Journal of Facility Management. Vol. 1,April 2010

This paper tries to emphasis one more time that green building benefits are real, and also shows the decision maker that even though there are risks factors involved of going green, these can be managed. The purpose of this paper is to develop a framework for benefits and risks of retrofitting existing buildings to green standards. Using the comprehensive literature review methodology, this paper tries to contribute to the new organization and framework of risk & benefits factors with number of risk strategy suggestions and tries to consolidate the information for subsequent research help. A growing world population combined with the rapid growth in the economies of countries such as China and India will make so many more new buildings necessary in the near future that their collective negative effects could become catastrophic for the environment.

4. **Cost Effectiveness Of Active And Passive Design Strategies For Existing Building Retrofitting In Tropical Countries. Xiaonuan Sun, Z Gou. Journal of cleaner production. Vol. 183, 10 May 2018**

This research investigated the 1st Zero Energy Building (ZEB) in south East Asia which was retrofitted from an existing building and incorporated diverse passive and active design strategies for the tropical climate. The study disclosed the efficiency improvement through each individual design strategy and also compared with the cost effectiveness of active and passive categories. The most cost effective active strategy was efficient lighting; and the 2nd was efficient air conditioning systems. The most cost effective passive strategy was lighting pies; and the 2nd was lightning controls. Generally, passive strategies might have longer period of payback. It should be noted that ZEB was a test – bedding project; there for, the finding on passive design cost effectiveness should be cautiously interpreted considering the scale of applications. The research suggests the active & passive strategies should be integrated into building design to optimize the energy performance. Particularly passive design shall be applied in a large scale to have significant energy improvements.

5. **Green Building Construction for Sustainable Future. H.S. Mehta, Vishal Porwal Civil and Environment Research. Vol. 3, July 2013**

Green building construction is relatively new phenomenon in Indian construction industry with increasing awareness about global warming and climate change movement for sustainable development is gaining force. India govt. also realizes the need for sustainable construction as its economies growing at fast pace (7 to 8% annually) & that needs a rapid and vast infrastructure development. This paper provides a state-of-the-art literature review on green building construction movement in India. This study provides an overview of green building rating systems, cost & benefits, green design strategies and discusses their implications for future of sustainable development of India. A need for wide spread awareness about sustainable development & capacity building for design, construction & operations of green building is realized.

6. **"Green" Building in India: A Comparative and Spatial analysis Of the LEED-India & GRIHA Rating System. Russell M. Smith Asian Geographer. Vol. 32, 2015**

With an urban population exceeding that of the entire USA, India has two systems for encouraging environmentally sustainable growth for its rapidly growing urban population. Leadership in Energy & Environmental Design (LEED) India is associated with the internationally known LEED programme, which is administrated in India by the India green business council. Meanwhile, the Ministry of new and renewable energy (MNRE) and The Energy & Resource Institute (TERI) developed GRIHA (Green Rating for Integrated Habitat Assessment). This indigenous green building standard is similar to the LEED system in recognizing development that meets certain environmental and sustainable development practices. This paper seeks to provide an overview of the LEED-India and GRIHA programme and examine the special dynamics of projects developed under LEED-India and GRIHA requirements. In the end, this analysis will provide important insight into these two competing urban sustainability programme in India and begin a discussion of the merits of each.

Literature Case Study on Maruti Solitaire (base case) Raipur:

Maruti Solitaire project by Avinash Builders is Chhattisgarh's 1st residential building designed as a 'green building', located in Shankar nagar, Raipur, registered under GRIHA. This is an 8 floor lavish building having some smart ideas to save water, electricity, HVAC systems with some lower maintenance and good quality of living. After completion of the building, it got a 4 star rating from GRIHA in September 2014. The Maruti Solitaire is one of the rarest residential projects which are going to reduce their water bill up to 40% & electricity bill up to 50% this is a cost effective approach which will further save money, natural energy & surroundings as well.

Basically the 8 floor building is divided in to 2 major parts. 1st is apartment style building & 2nd one is row-house type building. Further the apartment style building can also be divided in to 2 types.

1. Block A is a T shaped building from top view,
2. Block B is a Y shaped building from top view.

Both the building floors are distributed into even & odd number, and the floor plan of odd number floors like 1, 3, 5, and 7 are same. Similarly the floor plan of even number floor like 2, 4, 6 floor are same. Every floor has 6 flats. The 8th floor is also like even number floor plan but the staircase is providing which connects the terrace. 2nd floor is pent house.

There are 2, 3, & 4 BHK type apartments followed by type A, B, C, D, E, and F.

Why the building is rated as a green building?

1. Zero garbage system.
2. Waste water treatment (STP tank) for flushing & gardening.
3. Universal accessibility & toilets for handicapped.
4. Solar paneled street lights.
5. Heat repellent coating in terrace to reduce UHIE.
6. Rain Water Harvesting- 11 tanks of 7-8 feet deep 200 lit. Capacity.
7. Water softer plant of 1.5lacks lit.
8. Solar power energy.
9. Worm compost machine.
10. Low embodied energy building materials are used as composite light cement (CLC) blocks, fly ash cement/ brick, low volatile organic compound (VOC) material in punning. Wood, fire doors & windows.

Specifications:

- Flooring: (1m*1m) double charged vitrified tiles in living, dining & kitchen. Wooden flooring in drawing & master bedrooms. Interior based tiles (2ft *2ft) in other rooms. 2ft*2ft wooden finished tiles in balconies & wash areas.
- Doors: Veneer finished main door with decorative paneling & polish with antique finish mortise lock.
- Windows: Aluminum dome section 3 track sliding window with mosquito net.
- Toilets: 3ft*2ft rustic tile in toilets up to lintel level on wall. Granite flooring in dry area, anti-skid tiles in wet area. Large size wash basin.
- Plumbing fitting: Single liver diverter in shower area, metro pole flush in dual flow (jaguar or equivalent). Wall hangs EWC, wash basin-platform size (Roca/ American STD.). Electrical points for geyser exhaust fans (Havel's or equivalent) & mirror lights.
- Kitchens: Quartz granite platform, compatible for modular kitchen. Steel sink with sink mixture. Wall tile up to 4ft above platform. Electrical points for refrigerators, chimney, water purifier, oven, and mixer.
- Painting: Cement based wall putty is finished all the Interior walls. POP punning finish wall. Weather proof texture paints in exterior walls.
- Electrical: Providing electrical points as per furniture layout. Telephones, T.V. & AC points are in all bedrooms & living rooms. Fire retardant cables & modular switches of reputed brand & provided.

Common Amenities:

- Well-equipped club with swimming pool, gym, squash & many indoor games, small community hall, guest rooms & society office, temple, garden places, separate kids play zone with modern equipment.
- Fire fitting- Providing all necessary provisions for fire fitting as per norms of National Building Code like clear movement space for fire engine, separate water tank & pipe lines, refuge area on 6th floor, fire scape stair with fire door & power backup for firefighting instruments.
- L.P.G. Bank- Gas bank for metered LPG supply to all flats with all safety checks as per norms
- Sewage Treatment Plant- Treating sewage water and recycling for flushing & gardening. It will reduce daily water demand of the society.
- Web free project- No overhead cables, provision for underground cabling for electricity, telephone & other services.
- Road- Concrete road in heavy vehicular movement and paved path ways in low vehicular movement.
- Electricity- LED lights for common areas, power backup for all common areas, provisions for power backup for flats.
- Parking- Min. 2 car parks for each flat with ample parking for visitors. Sensor based lighting system for basement. Security features- Gated community living with safety features like 24 hrs. Security, CCTV camera. Alarm for flats, intercom etc.

ANALYSIS OF CONVENTIONAL CASE STUDY

COMPARISON OF BOTH BUILDING

K-square (study case) Nagpur:

This is a typical 7+1 floor conventional building consists of 2 & 3BHK flats, with stilled parking. There are a total of 82 flats which are made with low embodied building materials, which affects the surrounding less adversely. K-square is 5.6 km away from Nagpur railway station &2 km away from Nagpur airport (Dr. Babasaheb Ambedkar International Airport). It is located in a prime location in Nagpur. The site is easily approachable. Nearest landmark for reference is the 3 star hotels, Radisson Blue.

The building floors are distributed in to even & odd numbers such that the floor plan of odd number floors like 3, 5, and 7 are same. Similarly the floor plan of even number floors like 2, 4, 6 floor are same. The floor plan of 1st floor plan is different. There are 10 flats in 1st floor and rests of the floors have 24 flat of 2BHK & 12 flats 3BHK each. Inner to inner flats are 2 BHK and outer to outer flats are 3 BHK.

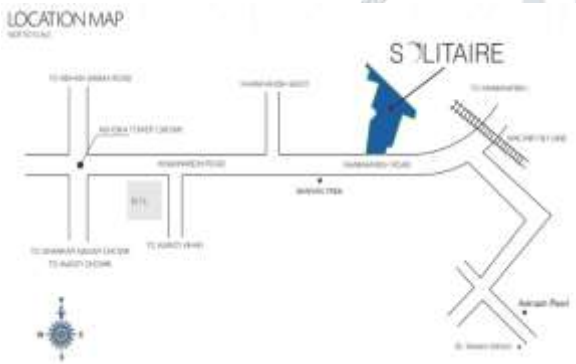
Evaluation And Comparison Of Base Case & Study Case As Per GRIHA Manual:

The comparative analysis of both the cases have been explained in the form of tables as stated below for easy understanding of the same.

Criteria			Maruti solitaires		K-Square	
S. N.	Clause	Points	Applicable	Committed	Applicable	Allotted
1. Site Selection	Partial Compulsory	1	1	1	1	1
2. Low-Impact Strategy	-	4	4	3	4	1
3. Approach To Decrease UHIE	-	2	2	2	2	1
4. Site Impermeable Factor	-	1	1	1	1	0
5. Air & Water Pollution Management	Partial Compulsory	1	1	1	1	0
6. Conserve & Look after Landscape During Construction	Partial Compulsory, if applicable	4	4	1	2	2
7. Construction Management Practices	-	4	4	3	4	2
8. Energy Efficiency	Partial Compulsory, if applicable	13	13	3	13	0
9. Renewable Energy Consumption	Partial Compulsory	7	7	0	7	0
10. Zero Ozone Depletion Potential Ingredients	Compulsory	0	0	0	0	0
11. Attaining Indoor Comfort Necessities (Visual/Thermal/Acoustic)	Partial Compulsory	6	6	6	6	2
12. Preserving Appropriate Indoor Air Quality (IAQ)	If applicable	4	2	4	2	0
13. Usage Of Low-VOC Paints And Other Compounds In Building Interiors	-	2	2	2	2	0
14. Use Of Low-Flow Fixtures And Arrangements	Partial Compulsory, if applicable	4	4	4	4	2
15. Reducing Countryside Water Requirement	-	4	4	4	4	2
16. Maintaining Water Quality (solid-waste treatment plant)	Partial Compulsory, if applicable	2	2	2	2	0
17. On-Site Water Reuse	-	5	5	5	5	1
18. Rainfall Restoration	If applicable	2	2	2	2	2
19. Application Of Bureau of Indian Standard Endorsed Waste Materials In Building	-	6	6	6	6	3
20. Reduction In Embodied Energy Of Building Assembly	-	4	4	0	4	0
21. Practice Of Low-Environmental Effect Materials In Building Interiors	-	4	4	2	4	0
22. Evaded Post-Construction Landfill	-	4	4	4	4	0
23. Deal with Organic Waste On Site	If applicable	2	2	2	2	0
24. Worker protection and sanitation	Partial Compulsory, if applicable	1	1	1	1	1
25. Scheme For Universal Approachability	-	2	2	2	2	2
26. Dedicated Facilities For Service Staff	-	2	2	2	2	1
27. Growth In Environmental Alertness	-	1	1	1	1	0
28. Smart Metering And Observing	Partial Compulsory	8	8	8	8	2
29. Operation, Upkeep Protocols	Compulsory	0	0	0	0	0
30. Performance Valuation For Finishing Rating	Compulsory	0	0	0	0	0
31. Innovation	-	4		2		0
TOTAL		104	104	73	100	24

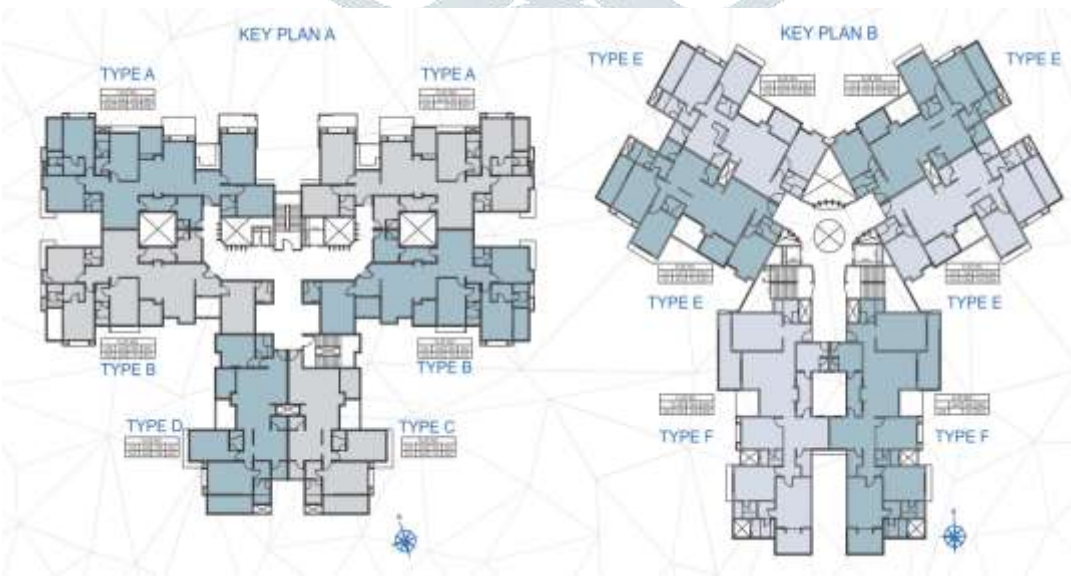
Suggestions for Conventional Building According To GRIHA MANUAL:

1. Reduce the UHIE by increasing vegetation pergolas, green paved areas, High SRI Paints & more plantations.
2. All the HVAC are CFC/HCFC free, fire-fighting equipment are halogen free, all the fans, AC, refrigerators, lighting fixtures & other electric appliances must be BEE star rated- **Compulsory**
3. To maintain healthy indoor air quality Smoking must be strictly banned within building premises. If allowed, the air from smoking area must be isolated from non-smoking areas-**Compulsory.** For fulfillment of the suggestion smoke detectors should be fixed in the building premises & building rule should be very strict.
4. Promote on-site recycle and reuse of waste water.
5. Reduce water consumptions by using STP tank & any other smart methods like timer based controls for lawn sprinklers.
6. Use renewable energy on site such as solar photo-voltaic power panel system, solar water heater.
7. Installation of smart meters & sensors & need to monitor them.
8. Use of low VOC adhesives, sealants, paints & other materials.
9. Energy audit of the building and smart work to reduce the EPI should be below the GRIHA benchmark.
10. Avoid post-construction landfill to save the land pollution form solid wastes.
11. Use of low environmental impact materials with recycled contents in building interiors.
12. Indoor comfort requirements followed as NBC 2005, ASHRAE 55 & SP-41 norms.
13. Adopt some innovative strategies like zero garbage system, net-zero-water-discharge, urban farming, geothermal systems, wind tower & GRIHA Professionals on site during the construction etc.
14. Universal accessibility.
15. Increase environmental awareness among the users & visitors.



Site Location Map of the building

Ant Eye View of the building



Building plan of Maruti Solitaire

Zero Garbage system

Automatic Solar street light

STP Tank

Fire-fighting Safety & beautiful fenestration

Centralized water purification system

GRIHA Pre-certification to Maruti Solitaire (Base Case)

View of K Square building

Interior Building Site (K Square)

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