

ANALYSIS ON GREEN BUILDING

(Case study: GRIET, Hyderabad, India)

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Abstract: The idea of green building has made an enormous significance in a creating nation like INDIA. The hypothesis suggests of minimizing the wastage and the expense of development. With expansion in urbanization the normal assets were utilized as a part of ill-advised ways which drives us towards the usage of green structures and the idea helps in making ideal utilization of regular assets. The green building is an eco-friendly segment, since it depends on the essential tenet - "REDUCE, REUSE and RECYCLE". In the long run, the green structures manage the cost of an abnormal state of financial and building execution, which drives us to the advancement of future era. The point of a green building configuration is to minimize the interest on non-renewable assets, amplify the use effectiveness of these assets when being used and boost reduce, reusing and usage of renewable assets. It amplifies the utilization of effective building materials and development hones; enhances the utilization of local sources and sinks by bio-climatic design; utilizes least vitality to power itself; utilizes productive gear to meet its lighting, aerating; cooling and different needs; boosts the utilization of renewable wellsprings of vitality; uses proficient waste and water administration hones; gives agreeable and hygienic indoor working conditions. With regards to the expression "Green Buildings," we may simply characterize it as an extraordinary sort of working without knowing the subtle elements and foundation behind it. Really, Green Buildings comprise of a wide range of sorts of material and gear. Their appearances additionally vary from other typical structures. Green structures regularly incorporate measures to lessen vitality use. To expand the productivity of the building envelope (boundary amongst molded and unconditioned space), they may utilize high-proficiency windows and protection in walls, roofs, and floors.

Author keywords: Green Building; Resource efficiency; Energy efficiency; Waste reduction; Passive design; GBC; GRIET

Introduction

These days, people give careful consideration to ecological security, in this manner build up another pattern called Green Buildings. It's not about the shading green, but rather has something to do with another structural idea. The "Green Building" is an interdisciplinary subject, where the green building idea incorporates a large number of components, segments and methodology which veer to a few subtopics that entwined to frame the green building idea. For the most part, the green building is thought to be a natural segment, as the green building materials are produced from neighborhood eco-sources, i.e. ecologically friendly materials, which are then used to make an eco-development subject to an eco-plan that give a solid environment based on the social and compositional legacy in development while guaranteeing protection of characteristic assets. This ensures dismantling the building parts and materials, after a decided building lifetime, to ecologically well disposed materials that can be either re-utilized or recycled.

Green building (otherwise called green development or supportable building) alludes to both a structure and the utilizing of procedures that are earth capable and asset proficient all through a building's life-cycle: from referring to outline, development, operation, upkeep, redesign, and destruction. At the end of the day, green building outline includes finding the harmony amongst homebuilding and the supportable environment. This requires close collaboration of the configuration group; the draftsmen, the specialists, and the customer at all anticipate stages.

Although new advances are always being produced to supplement current practices in making greener structures, the regular goal of green structures is to decrease the general effect of the assembled environment on human wellbeing and the common habitat by:

- Efficiently utilizing energy, water, and different assets
- Protecting tenant wellbeing and enhancing representative profitability
- Reducing waste, contamination and environmental degradation.

The expression "Green" alludes to naturally, neighborly practices from building configuration to the finishing decisions. It additionally hopeful person and Economic vitality use, water utilize, and storm water and waste water reuse.

A Green building is that building which is developed at an all around arranged area with legitimate configuration and reasonable materials fitted and painted with eco agreeable materials. The building ought to provide for its inhabitants solid and agreeable environment in all atmospheres. It stays cool in summer, warm in winter, inside completely shielded from downpour, gives normal contamination free air and light through entryways, windows and ventilators with no simulated means. For specific prerequisites it has sun based, wind power and eco friendly electrical, mechanical and so on gadgets. The expression "Green Building" applies to items, as well as to development systems, building outline and introduction, finishing, building operations, support, and the sky is the limit from there. The less effect a building has on human wellbeing and the earth, the more green it is.

Related Literature

A study done by Boyd and Kimmet (2006), took a gander at the Triple Bottom Line (TBL) way to deal with the budgetary execution of speculation properties, concentrating particularly on ecological and social attributes of green structures. The likely effect of improved natural qualities on venture sort property is appeared in Figure 1.

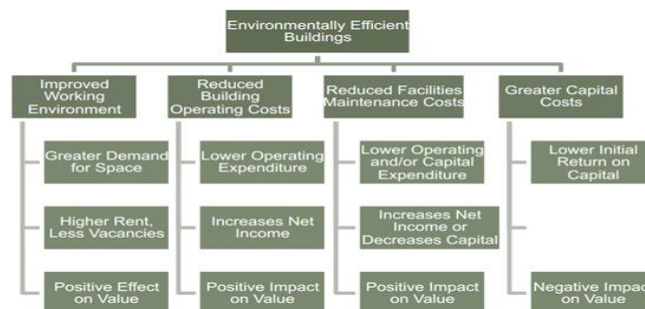


Figure 1: Value Impact of Environmentally Efficient Buildings

The figure shows four expected outcomes from greater environmental efficiency, i.e. improved working environment, reduced building operating costs, reduced facilities maintenance (FM) costs and increased capital costs. All characteristics, with exception to the latter had positive impacts on the capital value of property.

A study started by the Building Construction Authority (BCA) and the Department of Real Estate, National University of Singapore (NUS) in 2011 examined 23 business properties that were refurbished. Key components considered incorporated the residency, period of property, area, size, Green Mark honor rating and year of recompense and vitality utilization figures (prior and then afterward retrofit) and capital use for the retrofit venture. The study inferred that retrofitting can prompt an expansion in the property estimation of around 2%, with a normal expected investment funds in working costs of 10%.

Research has also been done primarily by Lorenz and Lutzkendorf, Sayce et al., Boyd and Kimmert in proposing to modify valuation theory and methodologies to incorporate sustainability features in valuation. Generally they proposed that sustainability issues would affect major risk factors in computing the asset value. Thus, valuers can attach a risk premium to each of these factors or group the risk factors to adjust other parameters used in traditional valuation methods.

As compared to conventional projects, green projects tend to cost more to construct. Some green materials cost significantly more than their conventional counterparts, compressed wheat board costs about ten times more than ordinary plywood as stated by Shristi and Singh. Green materials costs from 3 to 4% more than conventional construction materials and also conclude that higher costs are due to design complexity and the modeling costs needed to integrate green practices into projects which was proposed by Zhang et al. Hwang and Tan proposed that higher costs are associated with green materials and also by using green construction technologies. According to an estimate by Tagaza and Wilson, capital costs for green projects range from 1 to 25% higher than conventional projects.

Peng and Sui Pheng expressed that green structures, frequently characterized as those including regular ventilation capacities, i.e. low-vitality or free-running structures are presently at the bleeding edge of building examination and environmental change alleviation situations.

Chatterjee characterized the "Green building hone" as a procedure to make structures and framework in a manner that minimize the utilization of assets, decrease hurtful impacts on the nature, and make better situations for tenants. Xing et al. expressed that structures represent half of vitality utilizations in European nations and vitality request in building keeps on becoming around the world.

Horman et al. have exhibited that procedure assumes a key part in effectively conveying a superior green office inside spending plan and on time. The hypothesis supporting elite venture conveyance is that decreased procedure waste can upgrade both reasonable results and the business case for maintainability.

Essential Concepts of Green Buildings

A green building is one whose development and lifetime of operation guarantees the most beneficial conceivable environment while speaking to the most productive and slightest problematic utilization of land, water, vitality, and different assets. Makers, developers, originators, and buyers are making a growing business sector for lodging and home items that dirty less and are more asset proficient. By utilizing green items and practices, our homes can be solid and agreeable additionally earth well disposed and cost proficient. Here are 10 rules with a couple of case to consider for everyone.

1. Create outline gets ready for the building itself.
2. Situate and outline working to site needs, atmosphere, and neighborhood conditions.
3. Augment the utilization of normal sunlight.
4. Research building materials.
5. Reuse existing materials, use less materials, and use building materials that are thought to be naturally cordial.
6. Plan for solid indoor air quality.
7. Set high lighting-effectiveness measures.
8. Select machines that are vitality productive and save money on water use.
9. Plan for simplicity of upkeep and utilization of earth neighborly cleaning items.
10. Keep up basic and building frameworks for most extreme vitality and ecological adequacy.

Principles of Green Architecture and Sustainability

Passive features shape an irreplaceable piece of Green Building Design that is the most essential and imperative stride to be accomplished with a specific end goal to make a reasonable and Green environment. Passive components of a Green Building are the configuration includes that are to be fused in a building with the goal that it requires utilization of lesser energy assets by the clients of the building furthermore keep up an agreeable way of life.

Dynamic elements of Green Architecture infer on the utilization of gear that chips away at Renewable assets and help in the protection of regular and non-renewable assets which includes:

1. Site and its environment
2. Energy Efficiency
3. Water Efficiency
4. Material Efficiency and Waste Reduction
5. Indoor Air Quality

CASE STUDY:

Gokaraju Rangaraju Institute of Engineering and Technology (GRIET) is established in 1997 by Dr.Gokaraju Gangaraju as a self financed institute under the aegis of Gokaraju Rangaraju Educational Society. GRIET is approved by AICTE, New Delhi permanently affiliated to and autonomous under JNTUH, Hyderabad. GRIET is committed to quality education and is known for its innovative teaching practices Table 1 gives complete information of GRIET.

Table 1: Details of GRIET Campus

Project name	Gokaraju Rangaraju Institute of Engineering and Technology (GRIET)
Building type	Educational Institution
Investor / Owner	Gokaraju Gangaraju
Project built date	Started in the year 1997.
Location	Survey no. 288, GRIET College Road, Nizampet, Hyderabad, Telangana 500090
Purpose	To provide quality education for engineers and technologists with attitudes, skills and knowledge
Size	18 acres(72843.4156 m ²) (total site area) 8695m ² (total built up area)

Features of GRIET:

1. Large area for landscape to enhance micro climate and for visual delight
2. One of the top Engineering colleges in the state providing quality education to the students.
3. GRIET quality policy is to provide an integrated learning environment to enable students to grow towards their full potential and meet the high expectations of the Industry and the Society.

Location:

Gokaraju Rangaraju Institute of Engineering and Technology

Survey no. 288, GRIET College Road, Nizampet, Hyderabad, Telangana 500090

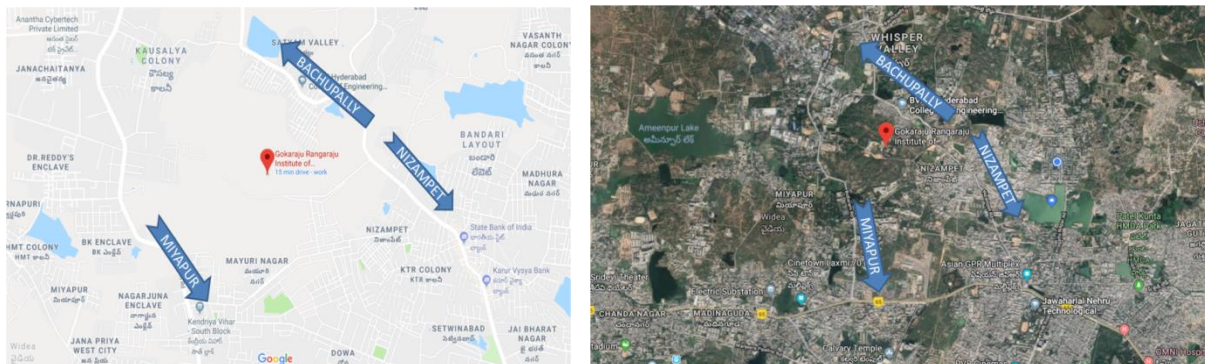


Figure 2: Location map of GRIET

Source: Google map

Surroundings:

1. The building was designed to have minimum disturbance to the surrounding ecological environment.
2. This has preserved the majority of the existing flora and fauna and natural micro – biological organism around the building.
3. Extensive erosion and sedimentation control measures to prevent topsoil erosion have all been taken at the site.

GRIET Center:

Figure 3 represents the top view of GRIET which clearly shows the presence of various green building techniques such as vegetation, topography, solar panels etc.,



Figure 3: Top view of GRIET

Green Features incorporated in GRIET:

1. Bio-climatic Architecture
2. Occupancy to the natural elements of water flow, air quality, vegetation, and topography.
3. The built form responds to the rocky site.
4. Large vegetative open spaces
5. Open space in the site exceed the local requirements

Criteria Priority in the Rating System:

The overall sequence of criteria, and the appraisals contained within them, has been changed in 2015. The new sequence is segregated into specific sections and previous criteria have been modified accordingly. At present there are only 31 criteria in the rating system

It is also important to know which criteria pertain to which aspect of environmental friendliness. The following table thus throws some light on which aspects are given priority in the rating system..

Table 2: Total Points allocated to Different Aspects of Sustainability (As per LEED)

Priority order	ASPECT OF GREEN BUILDING	POINTS
1	Energy	20
2	Water	17
3	Sustainable building materials	14
4	Occupant comfort and well being	12
5	Performance monitoring and validation	12
6	Construction management	9
7	Sustainable site planning	8
8	Solid waste management	6
9	Socio economic strategies	6

It can be seen from above distribution of points that extreme importance is given to Energy optimization, issues like site planning, water conservation, building materials and health and well being have more or less equal weight-age. Waste management does not receive much importance as municipal waste disposal issues are still not critical in the operations of human settlements in India, though this may have long term detrimental effects.

Energy Efficiency

Arguably, the most impressive feature of the GRIET is its energy efficiency. The building boasts of lighting energy with maximum savings as compared to an electrically light building of the same size.

Climate:

- It remains fairly warm most of the year and receives less rainfall in the monsoon.
- Temperatures come down in the months of December and January and the nights become quite cool in and around the Hyderabad city.
- During the summer months, the mercury goes as high as 42° C while in winters the minimum temperature may come down to as low as 12° C.

Relative Humidity:

Humidity in the morning is very high exceeding 80 per cent from July to September. In the dry months of March, April and May, humidity is generally low with an average of 25 to 30 percent and decreases to 20 percent at individual stations.

Temperature:

During the summer months, temperature goes as high as 42° C , while in winters the minimum temperature may come down to as low as 12° C and the average temperatures recorded in Hyderabad is as shown in Table 3

Table 3: Average Temperatures recorded in Hyderabad

Annual Mean Temperature	Monthly Mean Temperature	Max Temp. Ever Recorded	Min Temp. Ever Recorded
26° C	21 - 32° C	45.5° C	8° C

Source: <http://www.accuweather.com/en/in/hyderabad>.

Shape of building:

GRIET is designed in such way that to control the following factors

- Unrestricted circulation of air
- Limitless flexibility in design layout
- Stronger than conventional square building
- Best architecture aspect.

Natural light:

Natural light deflection systems can direct light deep into the room and ensure better natural lighting provisions as shown in Figure 4.



Figure 4: Natural light in GRIET

Table 4: Net Savings of Energy in terms of KWh/day for GRIET

Description	Energy Consumption (KWh/day)
GRIET (if it is Green Building)	1252.530
GRIET (if it is normal Building)	1328.037
Net Savings	75.507

Water Efficiency

Table 5: GRIET Population data

Description	Population
B.Tech	4855
M.Tech	182
Employees	655
Grand Total	5692

Table 6: Rainfall data of Quthubullapur mandal

Year	June	July	August	September	October	November	December	January	February	March	April	May	Annual Rainfall
2012-13	167	288	138.8	81.6	74.4	16.6	0	0	23	0	42.8	6.8	839
2013-14	166.4	252.4	145.6	183.6	143.4	10.4	0	0	0	50.2	9.2	20.8	982
2014-15	47.8	146.4	127.4	82.4	14.8	15	0	8.2	0	54.8	81.4	45.4	623.6
2015-16	180	40.4	61.4	147.4	43	0	0	0	0	0	0	0	472.2
2016-17	148.2	146.6	66	795.8	106.6	0	0	0	0	8.8	1	13.8	1286.8
Average Annual Rainfall (mm/year)													840.72

Source : Mandal Revenue Office Quthubullapur mandal

Table 7: Catchment Area of GRIET

Particulars	Roof Top Area (m ²)
Block-I	1719
Block-II	1537
Block-III	2533
Block-IV	2906
Concrete paved area	10089
Total Catchment area	18784

Peak Water Demand:

From Table 5 Total population of GRIET = 5692

Consumptions of water in Litres per capita demand (lpcd) is 45 Litres/day

Total water demand = 5692*45=256140 Litres/day = 0.25614 MLD (Million Litres / Day)

Rain water harvesting:

From Table 6: Average Rainfall in Quthubullapur mandal = 840.72 mm/year = 2.335 mm/day

Run off coefficient for Roof Top areas in Hyderabad = 0.80

(Source: <http://www.hmda.gov.in/EBGH/the%20guidelines/pdfs/Sto%20Bg%202.pdf>)

From Table 7: Area of roof top is 18784 m²

Quantity of Rain water harvesting = Rainfall (m/day) × Area of catchment (m²) × Run off coefficient

$$\begin{aligned}
 &= 0.002335 \times 18784 \times 0.80 \\
 &= 35.088512 \text{ m}^3 / \text{day} \text{ [since } 1 \text{ m}^3 = 1000 \text{ Litres]} \\
 &= 35088.512 \text{ Lit} / \text{day} = 0.035088 \text{ MLD (Million Litres / Day)}
 \end{aligned}$$

Extra water required after effective Rain water Harvesting Technique

$$= 0.25614 \text{ MLD} - 0.0035088 \text{ MLD}$$

$$= 0.221051488 \text{ MLD}$$

From the above Water conservation data, we can simply say that amount of water which can be available through Rain Water harvesting is 13.66 % of the Peak Water Demand of GRIET.

Table 8: Net Savings of Water Demand for GRIET

Description	Units	Quantity
Peak Water Demand	MLD	0.25614
Water Collected through Rain Water Harvesting	MLD	0.033587 (13.66%)
Net Water Demand after effective utilization of Rain Water Harvesting	MLD	0.25278

Achievements of Gokaraju Rangaraju Institute of Engineering and Technology :

1. Building footprint: Only 11.9% of site is used for the construction purposes
2. Minimum disturbance to the existing site features
3. Large area for landscape to enhance micro climate and for visual delight
4. The building boasts of lighting energy with maximum savings as compared to an electrically light building of the same size.
5. Vegetation that was lost to the built area was replaced by gardens

6. The building achieves recycling capacity of nearly 80% of waste water generated from it.
7. By considering all these aspects Gokaraju Rangaraju Institute of Engineering and Technology has achieved 38 credits

LEED Certification Process for GRIET

Table 9: Rating System of GRIET

Parameters	Maximum Credits	Obtained Credits
Sustainable Architecture and Design	5	3
Site Selection and Planning	14	7.5
Water Conservation	18	6.5
Energy Efficiency	28	12.5
Building Materials and Resources	16	0.5
Indoor Environmental Quality	12	4.5
Innovation and Development	7	3.5
Total Credits	100	38

GRIET has attained 38 points as per LEED certification level with our data analysis which means GRIET approaches nearer to the Certification levels, which itself a great task to reach such credits among the Educational Institutional aspects.

Results and Discussions

Energy

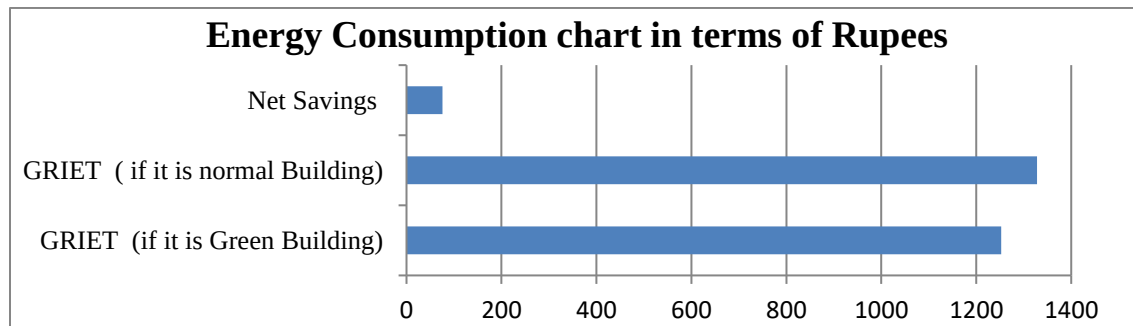


Figure 5: Energy Consumption chart in GRIET

From Table 4 , Figure 5 has been developed and it can be clearly say that Net savings of Energy in GRIET is 75.507 Kwh/day. So by inculcating Green Building designing parameters (By using sunlight effectively we can save electricity up to 5.68% of total consumption in a day).

Water

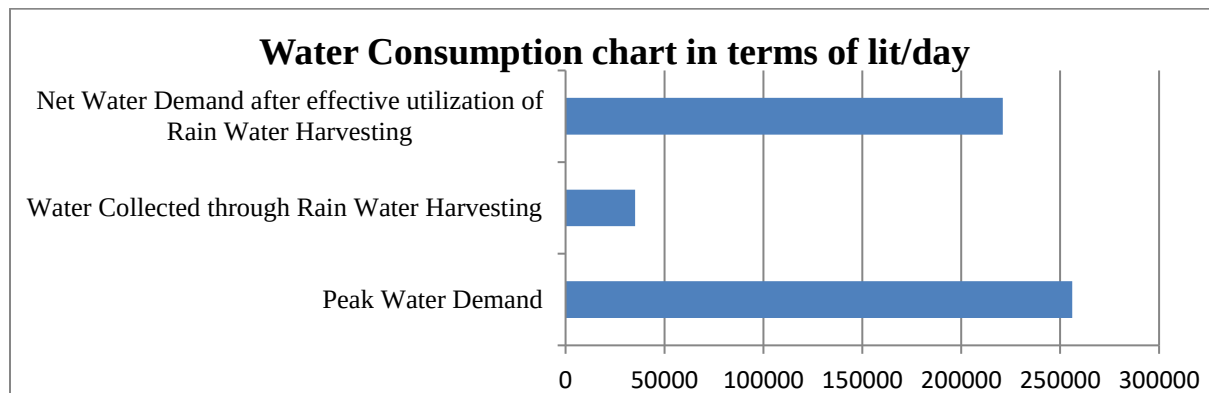


Figure 6: Water Consumption chart in GRIET

From Table 8, Figure 6 has been developed and it can be clearly say that Net savings of water collected through Rain water harvesting accounts for 13.66% of Peak Water Demand. By inculcating Green Building designing parameters (By using Runoff water efficiently by installing Rain water harvesting pits we can save water up to 0.033587 MLD of water).

Conclusions

The following conclusions have been made based on the thesis work done.

1. From the study it can be clearly say that Net Energy Consumption of GRIET can be decreased by 5.68% by using sunlight effectively.
2. From the study we can say that Net savings of water collected through Rain water harvesting accounts for 13.66% of Peak Water Demand.
3. From the study Installation of solar panels helps in increasing the net saving power.
4. Based on physical observations following suggestions are made to improve the certification level of GRIET.
 - a) Use of low emitting vehicles like battery charged vehicles, CNG cars etc helps in reducing indoor air pollution, Heat island reduction in GRIET can be done by Green Roof technique.
 - b) Waste water collected has to be recycled and reused for flushers, gardening, thereby we can use water efficiently. This can be done by imparting water fixtures and by improving recycling quality. Recycling of waste material generated in the college has to be done.
5. By inculcating all the calculations as mentioned above we can increase the Green Building standard level of GRIET.

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