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RESEARCH ARTICLE OPEN ACCESS

Adaptation of an existing building into a green building

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ABSTRACT
Buildings consume about 40% of the total energy of the world and hence it is essential to adopt the practice of sustainable buildings. This paper aims to redesign an existing building according to the green building norms. It also focuses on the energy efficiency and economic feasibility while redesigning the same. The hotel's natural resource utilization and energy consumption is immense and this also has an impact on the environment. This study stresses on the benefits that would be obtained like reduced energy consumption and reduced wastage of water along with other materials thereby leading to cost savings later on. The redesigning of hotel is done using the benchmarks provided by GRIHA for subsequent analysis. The costing and relevant savings calculations for the business is also conducted to check the economic feasibility of the research.

Keywords – Green buildings, Renewable energy, GRIHA, Natural Ventilation, Wastage

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I. INTRODUCTION

Renewable energy is essential part of sustainable development. Today civil and environmentalengineeringprofessionalsareworking side by side to understand new construction methods which allows the buildings to use less energy than before. Earlier the conventional methods of constructionswereusedwhetheritwastorecreatean existing building or to start a new building from ground up. With the advent of technological advancements, it is now possible to construct buildings which are superior in quality and they also use less energy. [1] One such modification was done on the building in Jaipur, it is a hotel building and these buildings are known to use more energy than a residential building. Hotel management wanted to modifythecurrentbuildinginordertomakeitenergy efficient, it is an initiative taken by the management of hotel to have a GRIHA rating. GRIHA has a star rating system and it is necessary for the building to comply with certain group of norms stated by GRIHAtobeastarratedbuilding.Toachievethestar rating some technologically advanced methods of modificationswereusedwhichhadreducedtheusage of energy in the building.[2]

1.1. Certification System

In India, the Indian business council (IBC) administersLeadershipinEnergyandEnvironmental Design(LEED).AndtheGreenRatingforIntegrated Habitat Assessment (GRIHA) was developed by Ministry of New and Renewable Energy (MNRE) and The Energy and Resources Institute (TERI). [3] TheratingsysteminLEEDprogramisvoluntaryand is based on rewarding points on the basis of evaluation on water savings, material selection, energy efficiency, sustainable site development and environmental quality indoors. There are various steps involved like registration of the GB, credit interpretation followed by certification and documentation of the same and lastly, certification award. The certification is provided under 4different levels i.e. Certified, Silver, Gold or Platinum. So, to obtain a LEED certificate can be worth millions of rupees but the cost of operational savings may be worth it. GRIHA was adopted to control the drawbacks of the LEED program in India to make it suitable here [4]. There is a rating system which involves parameters like consumption of water and power/energy, generation of water and integration of renewable energy; and awards a rating between 1-5 following the evaluation. This is also voluntary in nature but the MNRE has directed the government buildings to be constructed according to GRIHA standards to obtain support for funding. GRIHA has now more preferred green certification program and is mandated for public entities. The rating systemin

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GRIHAisona100-pointratingsystemandthepoints are awarded on mandatory and optional criteria for a GB.Toacquirethecertification,theminimumpoints required is 25. The buildings that score in the range 25-40, 41-55, 56-70, 71-85, 86-100 obtain1,2,3,4 and 5 stars respectively with the maximum being a five-star green building.

II. CASESTUDY

The Unique Stay Hotel in Jaipur is a 4-story building with a total of 7 rooms and one basement, it was concerned with their energy utilisation and they wanted to reduce the energy consumption of their building. The management was concerned by the utilisation because of the problems of scarce resources has been rising in the society, Jaipur is a part of Rajasthan which has been facing problems of low water supply. Being a concerned business and adopting to change with the changing consumption needs of the society the management wanted to upgrade their premises for low energy consumption which included less use of electricity and water resources.Themanagementwantedtounderstandthe budgetary requirement for the upgradation of the facility. For facilitating their requirement there wasa research conducted to understand the ways of reducing these challenges, the research included a research review of all the available products which could be essential for green building initiative and suits the need ofresearch.

III. METHODOLOGY

The hotel's current structure along with other energy consuming devices were tested. Then appropriate replacement was decided as per the requirement of hotel. The major problems of higher resource consumption were water consumption and air ventilation which required attention as it was costing the hotel more on a regular basis. We needed equipment whose energy consumption can be monitored and subsequently wastage can be reduced [5].

For ventilation the choice of mix that is natural and mechanical ventilation process is used, this wasdone toimproveindoorenvironmentalairqualityandsave electricity. We provided windows on east and north walls as a part ofreconstruction.

IV. ANALYSIS

We used fundamental approach for calculation of rate of Ventilation due to action of wind The analysis was done in the months of March, April and May. The wind flow direction was from easttowest, the speeds on an average in three months were 9km/hr,9.15km/hrand10.9km/hr respectively. The building is a north facing building. There were openings given in different directions which allowed a better air flow into the building. For estimating the magnitude of air over the three months we measured the air flow speed weekly.

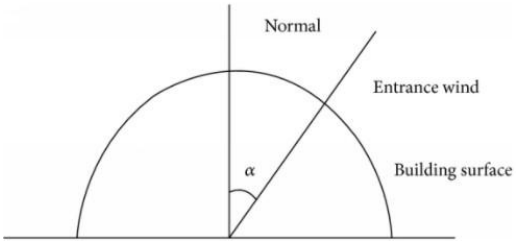

Fig 1: wind direction angle

- Alpha is assumed to be zero here as the air is assumed to be flowing perpendicular to theopening.

Thereadingsofairspeedforthethreemonthsandthe pattern is shown below.

TABLE 1: Wind speed over three months

Week	**March**	**April**	**May**
1	9	8.8	10.4
2	8.7	9.1	10.8
3	8.9	9.5	11.9
4	9.4	9.2	10.5
Average Speed (Km/hr)	9.00	9.15	10.90

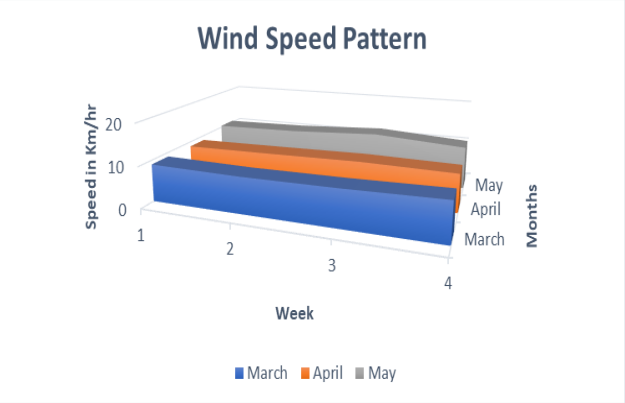

Fig 2: wind speed pattern over three months

After taking the readings on a regular basis the rate of ventilation due to action of wind was calculated. [6].

$$\boldsymbol{Q=KAV}\ (1)$$

Q = The rate of flow of air

K = it's the effectiveness coefficient, this is relative

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to the wind direction, it also depends on the areas of two openings. It's also the ratio of areas of two openings.
A = Free area available at inlet opening V = Speed of Wind in m/hr**Calculations**
Area of inlet window at each floor A1 (m^2) = 0.189
Area of outlet window at each floor (m^2) A2 = 0.283
Coefficient of Effectiveness (K) = 0.668 (ratio of areas)
Calculations for rate of ventilation due to action of wind:
The calculations in the table below are according to equation (1) above;

TABLE 2: Rate of Ventilation due to wind action over the months as per speed of wind. The calculations are in m^3 per hour

Week	March	April	May
1	1141.51	1116.14	1319.07
2	1103.46	1154.19	1369.81
3	1128.82	1204.92	1509.33
4	1192.24	1166.87	1331.76
Average rate of Ventilation due to action of wind m^3/hr	1141.51	1160.53	1382.49

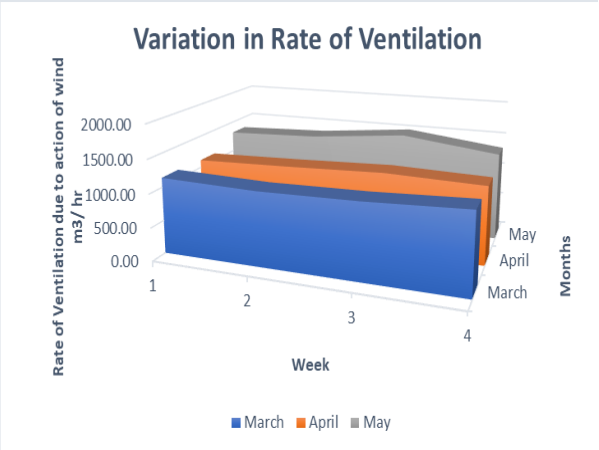

Fig 3: pattern of variation in rate of ventilation

- The pattern of air speed and ventilation rate is similar, the ups and downs visible in the graph which states that even though the airflow rate change is similar to change in the rate ofventilation.
- We used this data for implementing mixed ventilation techniques. There were small windows and the maximum area available for fitting new windows was A1 = 2.03 sq.feet for inlet that is windows situated on the east walls and A2 = 3.046 sq. feet for the windows placed at the north side, due to limitations there was no possibility of having a window on either a south or awest wall.
- Quality of the indoor environment must be ensured by maximising the natural light. Environment friendly and biodegradable materials can be used indoors in the construction phase. The materials that release residue or harmful gases must be avoided and there must be a provision for the ventilation such as advanced and cross- ventilation system etc. Also, to maintain indoor air quality, proper ventilation methods was employed along with air filtrations.

V. RESULTS AND RECOMMENDATIONs

After analysing the ventilation of the building, some other installations were done whichreducedtheamountofenergythebuilding was consuming. The parameters which were used to save energy were ratings of the equipment. These equipmentwere selected basis the requirement of building. Aboveanalysis
shows that the air change rate is adequate which is less than 1.
The research was done on a building which was built without the norms of a green building. The earlier plans of the building were traditional and afterwards the renovation of the building was done according to the specifications of a green building. The list of items which were used are listed below:

TABLE 3: *Products and their energy rating*

Item	Number of Units	Energy Rating of each item in Units
Air conditioning 1 ton	12	598
Air Conditioning 1.5 ton	9	898
Air Conditioning 2 ton	1	1198
LEDs 4Ws	36	4
LEDs 18Ws	22	12
Wall Fans	7	42
Key Tags	20	-

Net Present Value (NPV) Calculations

- The total cost of these and construction was Rs 9,46,776.
- The free cash flows of the hotel at 50% occupancy is Rs8,70,500.
- The NPV(Net present value calculations for this project is shown below:

***TABLE 4**: Net Present Value calculations*

Calculations for Net Present Value	**Values of Cash Flows in Respective Years**	**Present Values of Future CashFlows**
Initial Investment for green Building Project	-946776	-946776
1St Year	348200	348200
2nd Year	383020	364780.9524
3rd Year	421322	382151.4739
4th Year	463454.2	400349.1632
5th Year	509799.62	419413.409
NPV	**8,35,174.78**	**9,68,118.99**
Discount Rate	5%	

- The adjustments in the locations of windows and air conditioners reduced the usage of electricity by 46% which was a significant reduction in the electricity. The amount saved could benefit the management in any kind of business expansion.
- The required area by one AC to be cooledis about 150 sq. ft and that is used to calculate the available space for cooling, though the space required for cooling was greater than served by the installed air conditioning but the positioning was done in such a way to reduce the unnecessary requirement of Air Conditioning.
- In the basement the ventilation of air is circulated not linear so, the ventilation is reduced by about 15%, but that reduction in the natural ventilationis compensated by the mechanical ventilation.
- Though the electricity charge of the commercial building is greater than the regular building hence the amount paid for electricity is higher.
- There was a single RO attached on each floor and that was used to serve water onall rooms on each floor, the implementation of a centralised RO system was proposed and implemented, the waste water of the RO is used for dishwashing and cleaning purpose in the hotel.
- The fixtures were changed to new technology low flow fixtures which allow less discharge of water resulting in water savings.
- We have proposed a painting in each room which will focus of water conservation, this allows a person to consciously think about the issue and ultimately save water.

Wastage Disposal System (Proposal)

- It was proposed to the management of the hotel that the waste needs to be collected into three containers and those containers must be kept on each floor.
- There are three types of waste that can be collected from the rooms, dry dust, organic waste, polyethene or plastic, wet waste and hazardouswaste.
- The dust which is dry and filtered must be reused as plants and gardening mud. It will create a healthy culture of preserving the usablewaste.
- Organic waste should be transferred to the places which are equipped with proper machines to dispose-off thiswaste.
- Hazardous material, though it is not a site wherethereisanextensiveuseofhazardous materials, but there should be some waste management measures for thesepurposes.
- Plastic should always be thrown in to the place where it is sent for cleaning and recycling, this has to happen in order to contain the unnecessary waste plastic from oursurrounding.

GRIHA Points achieved

TABLE 5: GRIHA Points Achieved

Section No.	Section Title	Maximum Points	Points achieved
1	Parameter of Site	2	1
		2	1
2	Housekeeping and Maintenance Parameter	7	5
		10	8
3	Energy	20	15
		15	8
4	Water	15	6
		10	8
5	Human health and comfort	8	4
		4	2
6	Social Aspects	5	2
		4	0

The building was easily able to achieve a total of 60 points which is a 3 star GRIHA rating at a very less cost.

VI. CONCLUSION

Just as mankind clears a lot of trees for the purpose of constructing buildings. Similarly, a lot of treesmustbeplantedbytheminordertobalancethis and save the earth from their practices. A lot of activities are taking place that are quite alarming and it is stated that building construction accounts is among the main reasons for environmental degradation.Buildingsaccountfor40%energyusage out of which 60% is electricity usage, 40% waste generation and 40% material resource usage on a globalscale.Buildingsoccupyabout50%areaofthe land in cities. This also shows that they are responsible not only for high usage but also high wastage as well. In India, the GBs are found to be costly as people look at the initial cost rather than looking at the savings in the long-term. Theadoption of green buildings would prove to be useful in the conservation of energy and resources on a national basis. The materials and resources are available easily in the markets locally that could make the adoption simpler. This movement towards GB from traditional buildings is not only for the advantage of the individuals but it is also for the betterment of the society and the country as well. The cost savings can be calculated through the quantification of the resources saved like energy, which is the easiest to compute. Hence, it is required to use the discussed practices in the report for providing the benefits (social, financial, economic and environmental). Also, operational savings and lower maintenance costs could be an attractive option that GBs offer through the usage of highly efficient materials that are environment friendly and cost effective aswell.

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