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Comparative Energy Analysis and Cost Estimation of HVAC System between Conventional and Green Building

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I. INTRODUCTION

In modern world, due to the growth of population many of the problems are being faced, one of them is space required for living, as a result more and more buildings are being made both in residential and commercial sector but they generally built normal or conventional buildings in which energy consumption and energy wastage is more which is not desirable for environment.

As a reaction to this, from the development side numerous executions are being done and by using Green building techniques we can control or atleast decrease the harmful effect on environment. Air conditioning systems are clearly one of the key elements of building energy utilization, as it constitutes over 50% of energy utilization. Incorrect and poor design of HVAC system can cause negative impacts on environment, occupancy, indoor air quality, reduce comfort level, increase in electric bills, dangerous to health. As a result we can say that HVAC System plays an important role in the overall functionality of a green building.

The solution to the stated environment damage problem is constructing green buildings and by implementing them we can reduce the energy consumption by replacing conventional methods, and so by reducing energy wastage and also pollution. In this project an analysis is going to be done by comparing a Normal building and a Green building.

Green building is part of the larger concept of "sustainable development," In general to build a green building we have to consider the parameters such as sustainable site and design, water resources, energy & atmosphere, materials & resources of construction, maintenance and operation. But the key objective of this project is to show the benefits of a sustainable building over conventional building with respect to HVAC system only, which will compare cooling loads, indoor quality, energy consumption and cost estimation. The results are significant because HVAC is the major source of energy consumption.

Minimizing negative environment impact and ultimately increasing indoor air quality (IAQ) and comfort conditions is also one challenging factor thus this project will also consider conservation strategies of HVAC systems to provide the best of green rating for this specific commercial building.

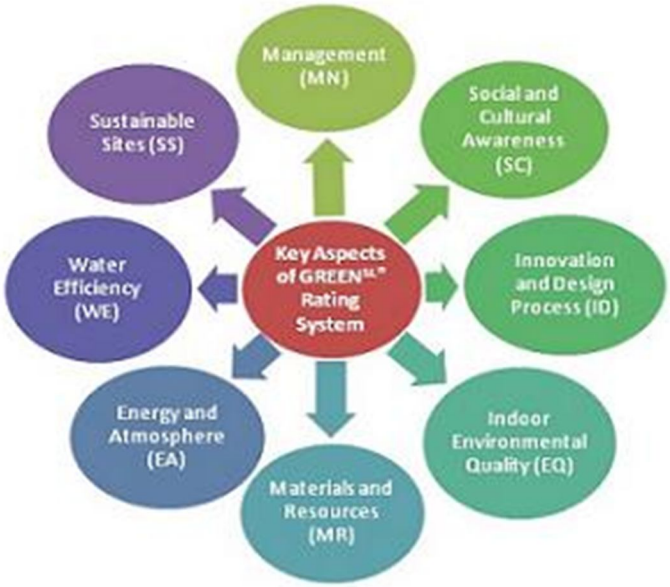

Fig.1 Green building project cycle

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II. STATEMENT OF PROBLEM

The buildings are very big part of the world's social and economic development. High energy usage means to create a significant negative environmental impact. HVAC System significant role in this field is to promote more alternatives to conventional design and equipments. This Project study guides in the direction of energy efficiency and green HVAC design use in buildings, will make an important part in reducing the environmental impact of consumption of energy, indeed making buildings healthier and more productive places to stay and work.

Green buildings have become common due to the realization of the mistakes done in the past by the building industry. HVAC can create benefits in costs of energy in the buildings, with operation and maintenance impacts keeping in consideration while designing. The introduction of "Green Building" has brought with it a trend in HVAC design, where the new technologies and strategies are being developed to achieve higher performance.

MEP is the incorporation of mechanical, electrical design, public health engineering, general wellbeing building, and different systems which all works together inside a building. Green building creates effective performance and is an advantage:

1) Because of reduction in energy consumption and effective utilization of resources even of land, materials and water, healthy environment is formed.
2) Gas emissions, Acid rain, global warming and ozone layer depletion will be reduced and environment can be saved.
3) During the life cycle and even at the end or demolition of building, harmful solid or liquid waste can be avoided, because building is already made from eco friendly materials.
4) Maximum indoor air quality, ventilation, lighting, noise reduction and comfort temperature with illumination and visual aspects can be maintained.

III. OBJECTIVE OF STUDY

A. To promote and advise improvement in energy efficient sustainable Buildings which leads to the reduction in Carbon foot print and fuel dependency.
B. To encourage energy efficient HVAC System design practices in Building Sector, so that it increase the performance of the building, Operation and Maintenance cost, Comfort, Health and the productivity of the occupants.
C. Create awareness amongst the Building Owners, HVAC System Designers, builders and constructors, Occupants about Energy Conservation.
D. Explore Opportunities for savings, cost reduction during operation and to improve energy efficiency of buildings by identifying major Energy and Environment issues related significantly to HVAC System.
E. Examine and use Energy proficiency measure in all types of Buildings and reduce energy consumed by HVAC systems.
F. To make sure HVAC design meets the standard and codes of energy saving departments like ASHRAE, ECBC and LEED.
G. Promote suitable sustainable energy policies that help to avoid the harmful gases to form, by maintaining a healthy climate and surroundings.
H. To promote green technologies and designs, to secure the future generations and fuels exhaustion, increasing energy conservation and reducing carbon emissions meanwhile maintaining a good living environment.

IV. GREEN BUILDING

A green building comes under sustainable designing and is designed to consume less energy which is not possible with conventional designing of the buildings.

The benefits of green building will get to the owner and builders both in financial and market and is not hard to understand. By establishing suitable strategies a perfect green building can be made. High energy efficient green buildings have lower operating costs than that of the normal buildings. Sustainable buildings are so good that they reduce the raw material, fuel, electricity and water consumption all together. Moreover, the workers and occupants are more productive and happy in a green environment.

The green building should interact with its systems, activities and surrounding environment all together. As a critical part of green building criteria are Energy- execution related, the energy issues are normally a key factor in deciding the natural execution or responsiveness.

The use of energy building codes reduces energy consumption by 30% to 40%.

Fig.2 Green building

V. METHODOLOGY

This section describes the methodology of how Load calculations was doneand step by step procedure adopted by which project has been performed with building as normal building (case 1) and green building (case 2).
All the data is gathered according to the stated points and project was completed in the following steps:

A. The scope and objectives of the comparative study was discussed.
B. Gathering data and information about the building, its environment (whether and ambient conditions), orientation. This progression likewise includes taking data information from building designs, assessing building utilization, HVAC needs.
C. Measuring spaces with material data of roof, doors, walls, partitions and windows.
D. Making schedules for lighting, people, equipments etc.
E. Enter into HAP software weather properties, Space data and Plant data.
F. Generate design reports for load and energy of both normal building as (case 1) and green building as (case 2).
G. The heating loads obtained from Hourly Analysis Program (HAP) software for the normal building case 1 was compared to that of green building case 2.
H. Results show energy saving, which in turn leads to sustainable and eco- friendly environment.
I. Estimate the cost difference of HVAC system in both the cases of conventional and green building.

The HAP software program performs the following tasks:
1) Calculates configuration cooling and heating loads for spaces and zones.
2) Calculates air rates for spaces and systems.
3) Calculates energy utilization by HVAC systems.
4) Calculates the electric and fuel cost utilization by the framework.
a) Conventional Building Material Technical Description
i) *Normal Roof:* Air space, HW concrete, built up roofing.
ii) *Normal Wall:* Gypsum board, stucco, face brick, plaster.
iii) *Normal Window:* Double glazed glass.
iv) *Doors:* Main door is of Glass and internal doors are wooden door
b) Conventional Building Material Technical Description
i) *Normal Roof:* HW concrete, insulation, cement screed, asphalt, water proofing, space, soil.
ii) *Green Wall:* LW concrete block, wood cladding panel, stucco, air space.
iii) *Green Window:* Blue-Green reflective glass outer and inner with gap of Argon
iv) *Door:* Main door is of Teak wood and internal doors are skin molded paneled door

Table-1

Input of Roof properties for Normal Building

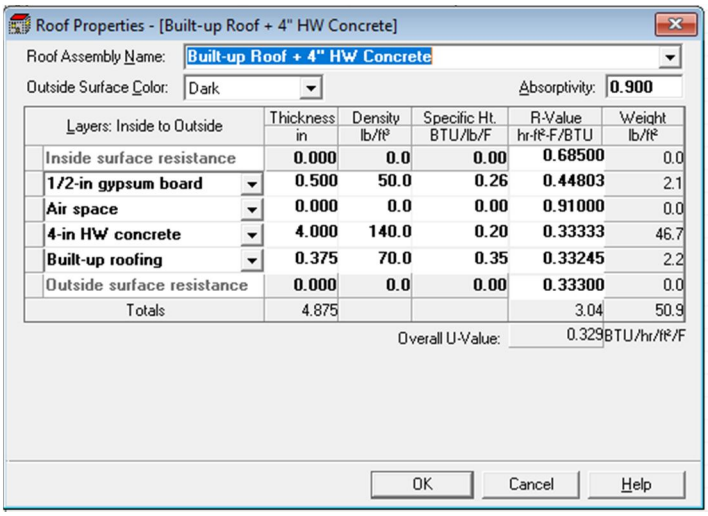


Table-2

Input of wall properties for Normal Buildling

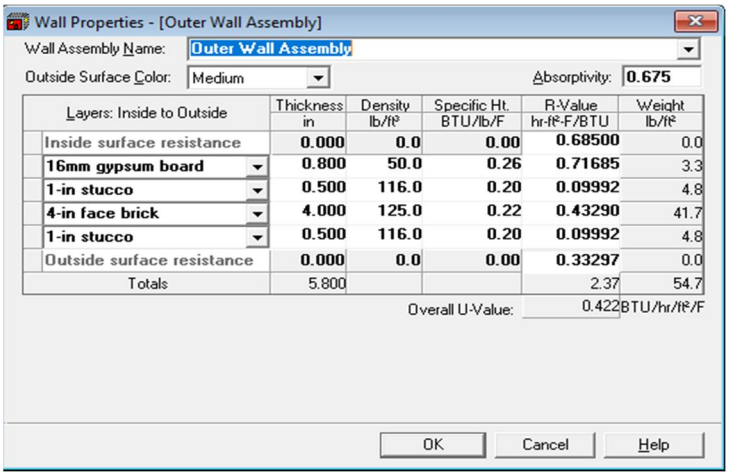


Table-3

Input of Roof properties for Green Building

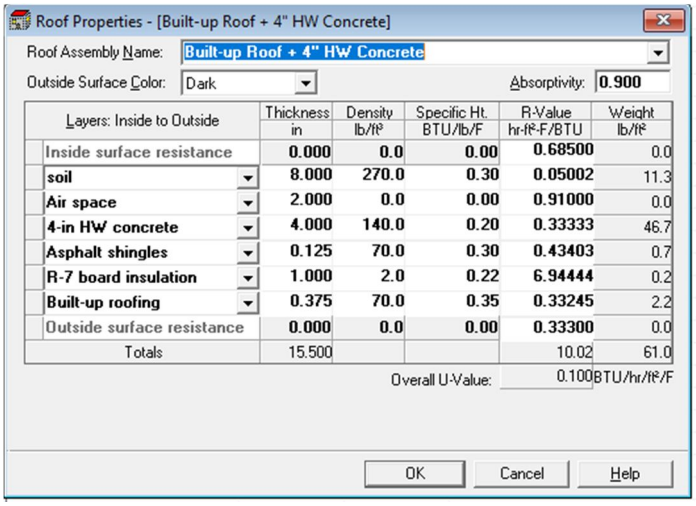
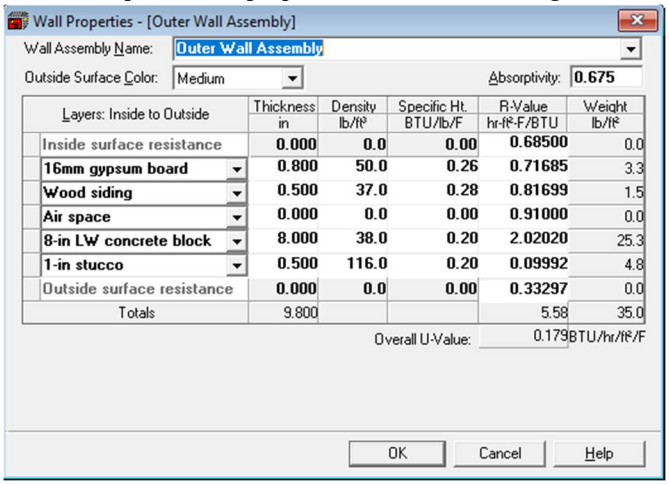


Table-4
Input of wall properties for Green Building



VI. GREEN BUILDING HVAC SYSTEM DESIGN

Depending on various factors like discussion from client and architecture, available areas for equipment placement, zoning of the common and rental areas, different air conditioning systems have been selected.

A. VRF (variable refrigerant flow) system is used at 2,3,4,5,6 floors.
B. Individual cassette and hi wall split ac's are used at Ground floor receptions and Terrace staff rooms.
C. Ducted Evaporative air coolers are used at 1 and ground floor food court as these areas are open to environment. As the above floors are open areas.
D. Both lower and upper basement are provided with exhaust ducts and also ventilation exhaust ducts are provided enclosed as an envelope, for corridors Fresh air units have been placed.

VII. RESULTS

In this project, a commercial Building at kachiguda, Hyderabad, Telangana was selected for the study. It has 2 basements, ground plus six levels with two roofs and each level of the building has a different purpose i.e, it is a multifunctional commercial complex with overall area 81,689 sq.fts. HVAC heat load calculations were done using the Hourly Analysis Program (HAP) software.

A comparative study was done for the calculation of HVAC loads for two cases. First the building was assumed to be of normal construction, and then the calculations were done for the green building. Different inputs were given to the software for the parameters like roofs, walls, windows and lighting systems.

The results obtained for the project are as follows

S.no	Description	Normal Bldg	Green Bldg	Savings
1	Total cooling load	126 TR	102 TR	24 TR
2	Cost for HVAC system	1,20,61,325 INR	1,07,70,600 INR	12,90,725 INR
3	Energy consumption by HVAC system annually	1,86,196 Kwh	1,65,182 Kwh	21,000 Kwh
4	Annual electric cost for HVAC system	15,34,600 INR	13,61,000 INR	1,73,000 INR

A. The result obtained for green building is 102 TR it is less than that of Normal building which is 126 TR for the whole building having ground plus six floors. The comparative study of results as shown in above tables can be clearly seen. The saving in energy and cost can be compared. There is a difference of 24 TR for Green Building, which approximately gives a difference of 20% less cooling load for the whole Green building in comparison with normal building. which in turn leads to less carbon foot print making the environment sustainable and eco-friendly.

B. As for the costing, the cost for supply and installation of HVAC equipments shows that, due to less Load, the equipments also gets decrease and by the estimation it is clear that for this project green building HVAC system costs 1,07,70,600 INR and conventional building costs 1,20,61,325 INR. Hence we can save 12, 90,725 INR from the point of view from HVAC system. Anyhow, due to the addition of other green building materials, from point of view of building structure and architectural materials cost will be increased.

VIII. CONCLUSION

This study has led to the following conclusion

1) The rising demand of fuel and energy had raised problems of supplying of different resources, global warming, acidic rain, atmosphere change and many more.

2) The consumption of energy contribution in Building sector have steadily increased reaching to 50%. Population growth, rising demand for comfort and building services level, increase in time of staying indoors due to the changing economic factors have predicted more and more energy demand in the future. Thus, energy efficiency in buildings has become a main subject nationally and globally.

3) HVAC system among building services are significant as 40 -50 % of building energy consumption relates with it and which is around 20-30% of energy taken in many of the main developed countries.

4) Green structures are elite building; rehearse for productivity and limit ecological effects by using entire building life cycle idea is necessary. Green revolution enables owners to reduce energy consumption, increases occupant's productivity by improving work environment and saves environment.

a) LEED Certification reduces both money and energy over the duration of the building, through increased building performance, lower operating costs and lower rents.

b) LEED Certified Buildings uses main resources more conveniently, making healthier and good living environments results in higher productivity.

c) Reducing fuel and electric wastage benefits owners and occupants, environment and society as a whole.

5) The HVAC designer role is to lower the energy consumption by high- performance green design through lowering HVAC system size and reduces operational cost. An integrated design process is required to optimize the HVAC design, operation, maintenance for green buildings.

6) The result obtained in our comparative study clearly records saving of energy in case of Green Building which in turn leads to less carbon foot print making the environment sustainable and eco-friendly.

7) Green building benefits both building occupants and building owners. As a result more owners want Green Buildings as a part of the economy to gain a business advantage. HVAC engineers, consultants, building designers, architectures have a responsibility to make green building technologies as common as possible in the society

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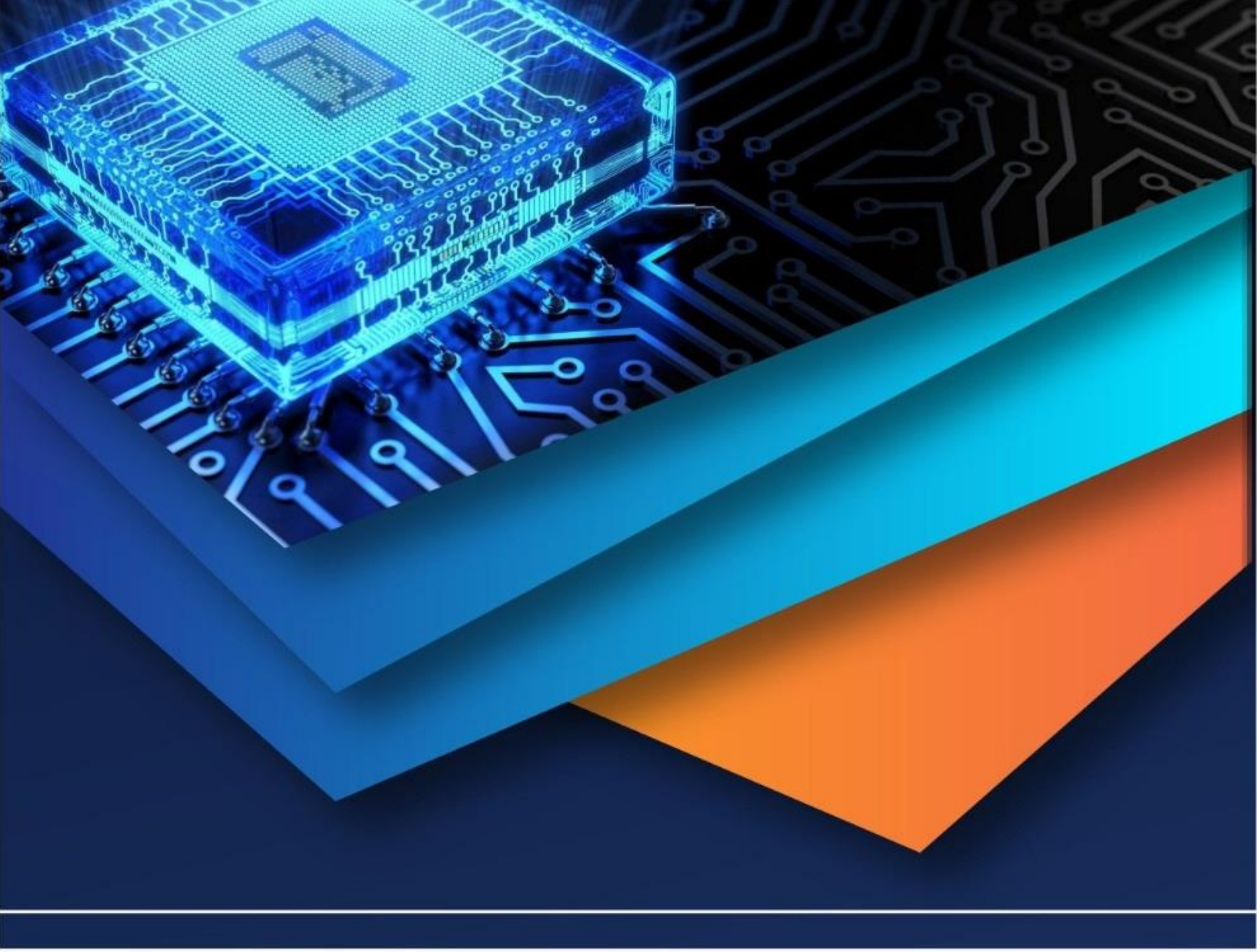
[2] Ashrae handbook, 2001 fundamentals applications.
[3] Hvac design manualby james e.brombaugh.
[4] Refrigeration and air-conditioning
[5] Smacna design manual
[6] Leed sustainable nuilding systems



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