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Simulation Study on Building Energy Management in HVAC Control System for House Building

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Abstract: **House buildings usually consume high energy and the operation efficiency of air conditioning system in house buildings is still far from agreeable. Thus, it is important to break down the data and suggest recommendations on energy usage. In the current work, an energy simulating instrument termed e-Quest was applied to model the thermal, ventilation and different energy in taking processes in a three storeyed building to predict its energy performance. In order to precisely compute the energy usages in building, the instrument considered the outer climate of the building, warmness resources within the building and the use of structure materials. This building energy imitating approach was arguably established as an influential practice for observing energy pattern of building, evaluating architectural design, decide upon proper structural resources and system demanded as well.**

Index Terms: **House building, e-QUEST, HVAC (Heating, Ventilation and Air-Conditioning) and Energy usage**

I. Introduction

Main objective of this work is to analyze the different parameters which affect the power consumption using HVAC (Heating, Ventilation and Air-Conditioning) system before constructing the building because reconstruction is a long and hard process.

Buildings are complicated physical things. They interact with their instant surroundings while trying to supply a comfortable living and working out environment to the residents. The way a building behaves and performs is affected by the attachments framed in taking building materials and factors while aiming the building envelope (fences, windows, ceilings), and other systems (lighting, HVAC,etc.). Buildings deliver easy inner atmosphere provisions like thermal, visual, and auricular by devouring energy.

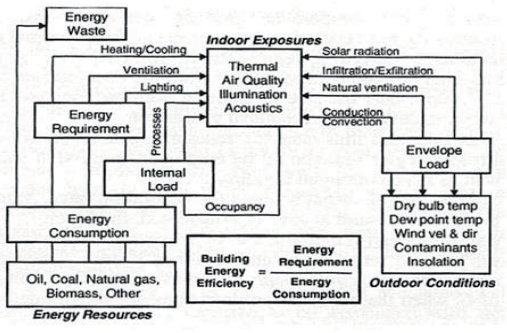

Figure 1. Energy Flow and Concepts in Buildings.

Fig .1 shows the Energy flow and concepts in Building.

An energy simulation implement models are thermal, visual, ventilation and different energy consuming procedures taking place within a building to forecast its energy and environmental performance. During its computation process, it takes the outside climatic factors, inner heat sources, building materials and systems into consideration to exactly model the building. Building energy simulation is an important method to acquire knowledge about energy performance of buildings and to assess architectural design opinions as well as to find options in construction materials and methods. Moreover, the sophisticated design effects also can be questioned, and their performance can be quantified and estimated.

A. About e-QUEST

e-QUEST is a simple employment building energy deconstruction instrument which provides high grade developments by joining a building creation charmer, an energy effectiveness measure wizard and pictorial results display module with a perfected DOE-2.2 decided building energy simulation program. Within-QUEST, DOE-2.2 performs an hourly simulation of the building predicated on fences, windows, glass, people, pack loads, and ventilation.

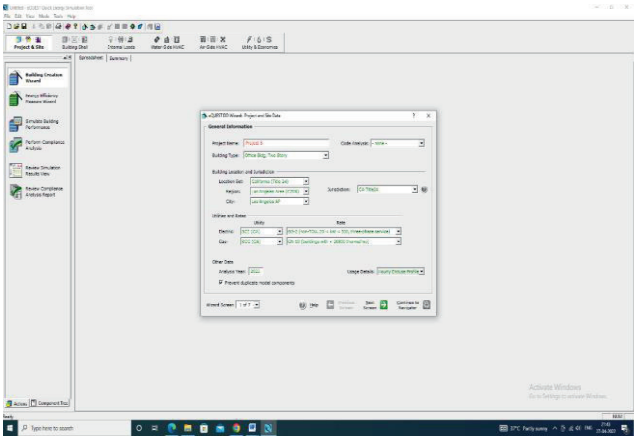

Figure 2. e-QUEST Software Interface.

Fig 2 shows the interface of e-QUEST software.

e-QUEST allows users to bring many simulations and review the indispensable results in side- by side graphics. It offers energy charge estimating, day lighting and lighting system regulator, and mechanic perpetration of energy effectiveness expedients (e-QUEST, 2008).

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II. Literature Survey

Yamin Zhu et al [1] conducted a case study on pertaining computer- based simulation to do energy auditing. They finished the task by associating the power of the portfolio manager which is elaborated by the Environmental Protection Agency and eQuest DOE2.com. The stimulation has broken down the job of an existing facility in setup to express methods for attaining the Energy Start designation.

R. Pacheco et al [2] written a review on energy efficient design of building energy and concluded that energy consumption in the domestic building sector makes it compulsory not only to convey out fundamental examination on the thermodynamic detail of the colorful systems but also allows to deliver energy. Still, it's also compulsory to express project grades associated with the sustainability of these buildings.

M. Santamouris et al [3] conducted trial on ceiling system inducted in a nursery academy structure. The simulations were carried out for the building in both non-insulated and insulated structures. Consisting to the effects, the investment of the green ceiling system significantly contributed to the structure energy efficiency.

Florides et al [4] modelled and analyzed on new businesses of cyprus and energy consumption and concluded that that the fence isolation pays back in a twenty- span period whereas the ceiling isolation has significant profitable advantage with life round savings up to EUR 22,374 turning on the place temperature and the isolation consistence.

Yi Zhitong et al [5] conducted analysis on crystalline radiative cooling flick for structures with ceiling glazing and concluded that when the T- RC flick is appertained on a1.0 m ×0.6 m ×1.2 m (L × W × H) model box with ceiling glazing, the inner side air temperature of the model box was demoted by an utmost valuation of 21.6 °C.

Hee et al [6] has conducted analysis on window glazing on daylighting and energy delivering in structures and concluded that both glazing kinds; it involves offerings on some sides to open occasion for different sides in setup to give the ideal equilibrium among the accounted features while minimizing the paradox.

Zhaosong Fang et al [7] has conducted experiment on constructing envelope isolation on refrigerating energy consumption in summer and concluded that during devouring the same quantum of refrigerating energy, the inner temperature of the energy effective room was significantly less than the introductory room. This means refrigerating energy has been wasted and it also could route to thermal discomforting.

III. Energy Modelling

A. Building Details

In this present work, the building which is taken for analysis is located in Hyderabad, India. It is a three storeyed house building with a total floor area of 1800 sft.

The floor height is 12’ with a floor to ceiling clear space of 9’. The Walls are of the type of insulated concrete block with interior finish of lay-In acoustic tile with no batt insulation. The Ground Floor consists of a Parking Place, Garden, Kitchen, 2 Bedrooms, 2 Rest Rooms, Living Space and one Guest Room. The Ground Floor consists of a Parking Place, Garden, Kitchen, 2 Bedrooms, 2 Rest Rooms, Living Space and one Guest Room.

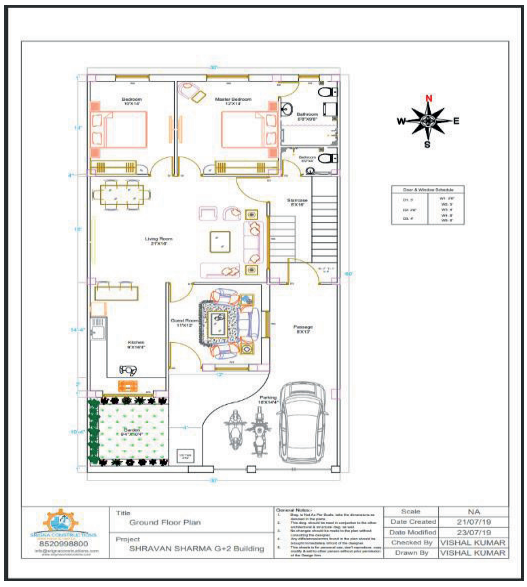

Figure 3. Ground Floor layout

First Floor consists of Balcony, Kitchen, 2 Bedrooms, 2 Rest Rooms, Guest Room, and Living Room is shown in Fig.3

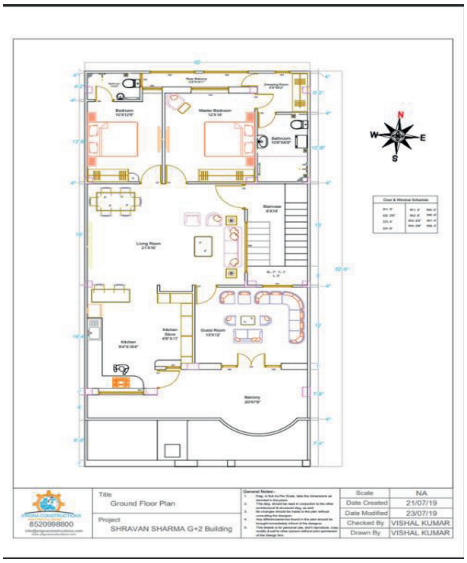

Figure 4. First Floor layout

Second Floor Consists of Staff Room, CEO Office, Meeting Room, Reception Area, 2 Bathrooms and Balconyis shown in Fig.4

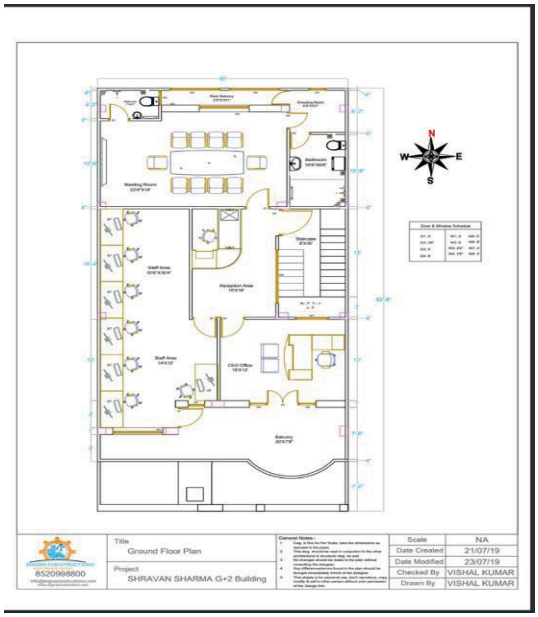

Figure 5. Second Floor layout

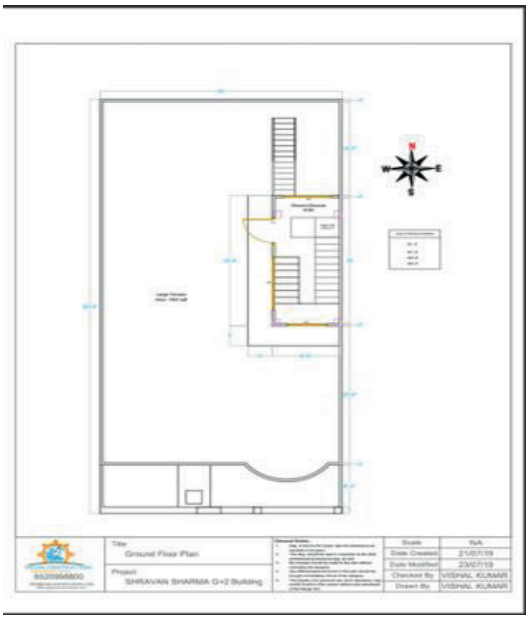

Figure 6. Terrace layout

Fig 5 and Fig.6 show Second and Terrace layout.

IV. E-QUEST PROJECT

A. Steps for building 3D Model

The first step is to open e-Quest and choose "Create New Project via the Wizard."

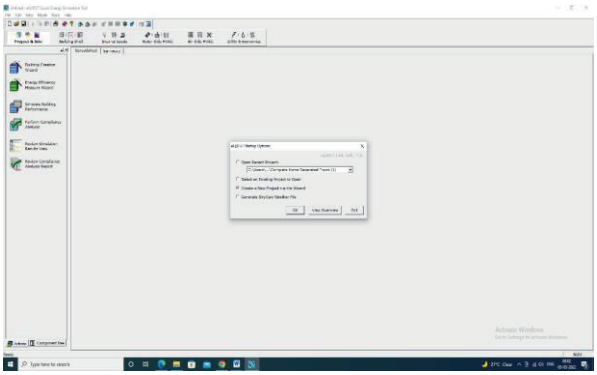

Figure 7. Create New Project Wizard

Fig 7 shows, how create a new project wizard in e-QUEST Software

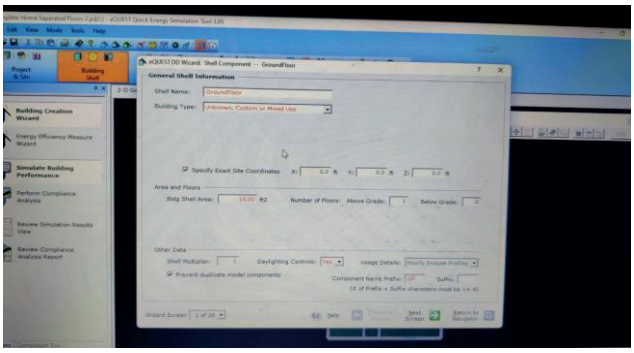

Figure 8. General Information of Building Wizard

This screen will collect general information about building such as size, location, etc shown in Fig.8

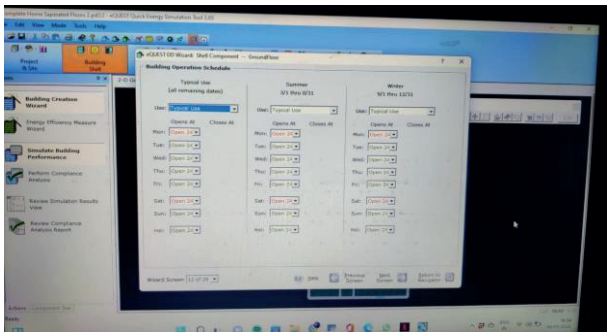

Figure 9. Building Operational Schedule Wizard

This step gathers information about operation timings of the building which is shown in Fig.9

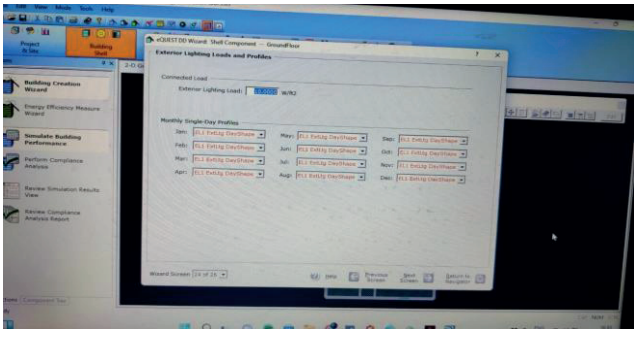

Figure 10. Exterior Lighting Loads

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Fig 10 shows the collecting information about exterior lighting loads.

V. About HVAC

Heating [1], ventilation, and air conditioning is the usage of different technologies to constrain the temperature and moisture of the air in a boxed place. Its goal is to provide thermal consolation and adequate inner air quality.

Heating devices generally include boaster motors which move the air throughout the range. An HVAC network usually contains an A.C or Heat pump [2] as a cooling equipment. An AC only cools but H.P can cool and heat the air. The main goal of HVAC [5] system is to circulate air throughout the room according to human comfort. An A.C, Heat pump and furnace absorbs heat or creates it and circulates through the passages called ducts inside the room. A boaster motor and ductwork assist to grease the motion of the air. Duct work directly connects to heating and cooling system.

Fig 11 shows the air-side HVAC system layout.

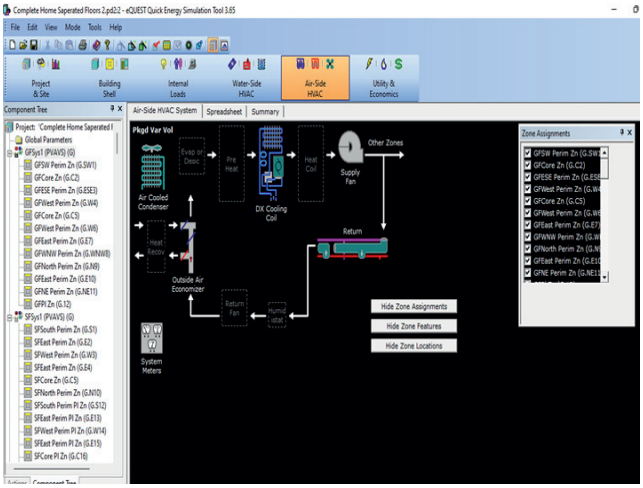

Figure 11. Air side HVAC system Layout

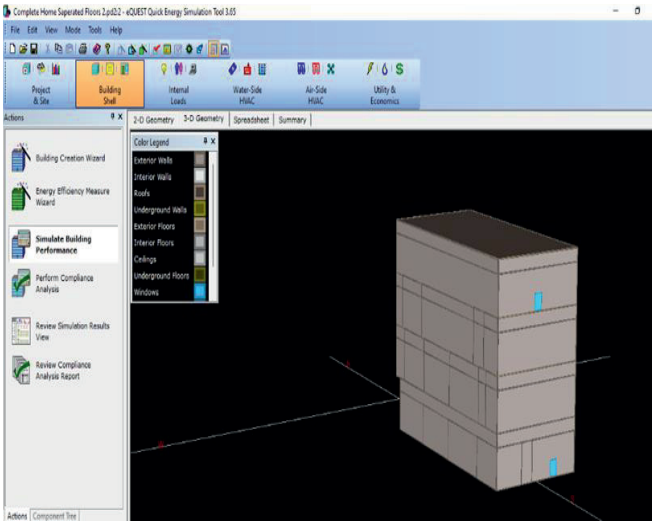

Figure 12. Side view of Building 3D Model

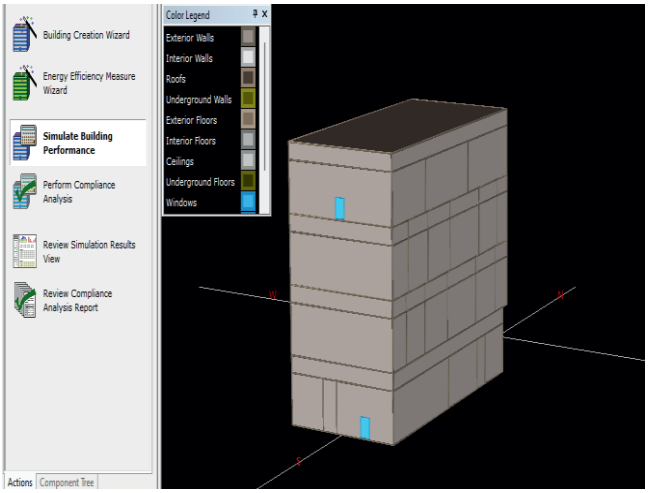

Figure 13. Front view of Building 3D Model

After successfully executing all the building creation and HVAC system steps, it will get a 3D model [3][4] of this building layout which is shown in Fig.12 and 13.

VI. Results and Discussions

During summer based on the setting parameters in the building creation steps, the simulation conclusions are displayed in Fig 14 and Fig 15. It gives results that more power [6][7] is up to 10080Kw-h that was consumed in the month of May. However, the lowest power is consumed in the month of January was only 6130Kwh, which was almost 40% less than the total power consumption in May.

Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	1.80	2.14	3.62	4.65	5.24	4.27	3.59	3.47	3.44	3.23	2.16	1.83	39.44
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	0.01	-	-	-	-	-	-	-	-	-	-	-	0.01
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	0.43	0.50	0.69	0.78	0.85	0.72	0.64	0.63	0.61	0.61	0.50	0.45	7.42
Pumps & Aux.	0.29	0.26	0.29	0.28	0.29	0.28	0.29	0.29	0.28	0.29	0.28	0.29	3.39
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	2.24	2.11	2.52	2.32	2.34	2.42	2.24	2.52	2.33	2.24	2.23	2.34	27.87
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	1.37	1.32	1.51	1.37	1.36	1.38	1.27	1.45	1.34	1.33	1.36	1.43	16.48
Total	6.13	6.34	8.63	9.40	10.08	9.06	8.03	8.36	8.00	7.71	6.53	6.33	94.60

Figure 14. Electric consumption with respect to different months

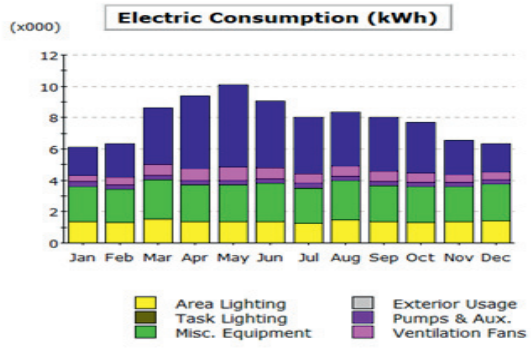

Figure 15. Electric consumption rate

During winter season, especially in Hyderabad region, the ambient air and temperature conditions are usually favorable to human comfort. So, the energy used for circulation of hot air outside is reduced amicably such that the total energy consumption rate is reduced drastically in January and also February. In May, the building payload increases with open-air temperature, so air conditioning power consumption reaches the greatest number. computed by the entire building region of 1800 square feet, the yearly energy consumption of per unit region is52.55 Kw h/(ft2).

VII. Conclusions

From these results, it is concluded that the energy consumption in summer is very high. Therefore, in this present work, it is focused on different parameters affecting energy consumption and tried to optimize it to the best of its ability by using different HVAC systems such as the following.

- Lighting device design: - To use this device, the variety of building shouldn't surpass the defined value. Corresponding to the simulation conclusions, it is recommended that 0.57W/ft2 (6.5W/m2) is more reasonable.
- In summer, the influence of stock air temperature on building electricity consumption is higher than the inner program temperature. For this purpose, DX cooling coils are suggested to improve energy optimization conditions and human comfort.

References

[1] Yimin Zhu. “Applying computer-based simulation to energy auditing: A case study”. Energy and Buildings, 38: 421—428, 2006.

[2] R. Pacheco, J. Ordónez, G. Martínez, “Energy efficient design of building”. A review, Renewable and Sustainable Energy Reviews - 2012.

[3] M. Santamouris, C. Pavlou, P. Doukas, G. Mihalakakou, A. Synnefa, A. Hatzibiros, “Investigating and analyzing the energy and environmental performance of an experimental green roof system installed in a nursery school building in Athens”, Energy -(2007)

[4] G.A. Florides, S.A. Kalogirou, S.A. Tassou, L.C. Wrobel, “Modeling of the mod-ern houses of Cyprus and energy consumption analysis”, Energy-(2000).

[5] Yi Zhitong, lv Yingyan , Xu Dikai , Xu Jingtao , Qian Hua, Zhao Dongliang , Yang Ronggui “Energy saving analysis of a transparent radiative cooling film for buildings with roof glazing” Energy and Built Environment Volume 2, Issue 2, April 2021, Pages 214-222.

[6] W.J. Hee, M.A. Alghoul, B. Bakhtyar, OmKalthum Elayeb , M.A. Shameri , M.S. Alrubaih , K. Sopian “The role of window glazing on daylighting and energy saving in buildings”, Renewable and Sustainable Energy Reviews Volume 42, February 2015, Pages 323-343.

[7] Zhaosong Fang, Nan, Baizhan Li, Guozhi Luo and Yanqi Huang “The effect of building envelope insulation on cooling energy consumption in summer”, Energy and Buildings Volume 77, July 2014, Pages 197-205.