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Software Simulation Modelling Based Approach in Building Envelope Optimization

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Abstract— *In the present scenario, there is a huge difference between energy demand and production. The building sector consumes 30% of global energy and is responsible for 36% of total carbon dioxide emissions. In recent years,high emphasis has been given to the reduction of energy consumption and the carbon footprint by optimizing the performance and resource utilization of buildings to achieve sustainable development.The design of building in the future will be performance-based, So the different components of building according to their contribution to energy consumption can be optimized. Building envelopes (roof, wall, and glazing) contributiontoHeating ventilation and air conditioning(HVAC) load is around 28 % of the total electricity consumption in a building. This is further reduced by the right balance between the different types of envelope according to the dynamics of building, size, scale, climate zone, occupants, and operation. Optimization can be applied to decision variables like material properties (such as U and V value) and design strategy (passive and active design).This will help in identifying the option toward better wall, roof, and glass performance specific to the Indian climate zone. Software simulationsfor modeling the energy performance also give the cost information and life cycle cost analysis and an alternate option for the building envelope which would respond to Indian climatic conditions in a better way.*

Keywords— *Energy Efficiency, Energy Simulation, Modellingthe Energy Performance, Building Envelope, HVA C*

I. INTRODUCTION

Building science is not a new subject; it has been optimized for many years.Many researchers have tried to optimize building performance by trial and error to achieve the present level of advancements information about building construction maintenance and performance.Modern building technologyhas been developedin 1000years of learning and optimization. In the present scenario,building prototype can models can be optimized and evaluated for their performancein a few minutes andclimate conscious building design can be proposed. Many energy modellingsoftware are available. These can optimize the proposed building, so thishelps in the upcoming building improving the performance as compared to the present building. Energy efficiency is an integral part of the sustainable development era. Optimization makes building energy efficient and additionally compliance to ECBC & ASHRAErequirementsin accordance with theIndian climatic conditions and locally available construction material can further reduce the carbon footprint of humanity

II. AIM & METHODOLOGY

The current study optimizes building envelope according toIndian climate zones using traditional construction practices. The study throws light on alternative materials used for the building envelope such as roof, wall, and glazing. The size of windows and glazing defined by wall window ratio (WWR) has also been considered as a parameter in this study. Optimization increases the envelope performance which helps in design and operationof buildings that end up using less energy and provide an improved building environment.There are two approaches to determine the energy use of buildings: performance pathway and outcome based [4] approach.

TABLE I INPUT DATA

Building			
	Units	**Base Case**	**Proposed Case**
Building		Tagore Hall NITTTR	Tagore Hall NITTTR
Location		Chandigarh	Chandigarh
Weather File		India Hissar 421310 (ISHRAE)	India Hissar 421310 (ISHRAE)
Building Type		Residential (hostel)	Residential (hostel)

Layout and Zones		As per plan	As per plan
Gross Floor Area	Sq.m.	2241.42	2241.42
Total Conditioned Floor Area	Sq.m.	2241.42	2241.42
No. of Floors-Above	No.	3	3
No. of Floors-Below Grade	No.	0	0
Floor to Floor Height	m.	3.5	3.5
Construction			
Roof- U value	W/sq.m.K	2.668	0.3
Wall-U value	W/sq.m. K	1.829	0.37
Openings			
Glass U value	W/sq.m.K	5.832	2.2
Glass SHGC		0.251	0.25
Glass VLT		0.560	0.56
WWR	%	40	60
Shading	Local Shading	No	0.5m overhang

Theformer uses software modeling for optimization whereas the later meters the exiting building data. In the current scenario, the building is designed to achieve maximum energy performance of the building.

Building energy optimization by performance simulation is widelyused to help design energy efficient buildings. This is done with the help of analytical tools for whole-building energy modeling purpose. To achieve this, different software, based on the building energy modelling (BEM) approach are available. Some of these areasDesignBuilder, DOE2, EnergyPlus, eQUEST, HAP, IDA-ICE, EcoNiwastool, OpenStudio, Simergy, Trace700, TRNSYS, Visual DOE [2]. Design Builder has been used for model simulationsin this study. The building was based on compliance of energy conservation code (ECBC) with respect to energy performance and various associated parameters.

III. THE OVERVIEW OF COMPUTER BASED OPTIMIZATION

TagoreHall hostel building of National Institute of Technical Teachers Training & Research (NITTTR) Chandigarh hasmodelled for simulations using DesignBuilder. First, we input the geometry of building for performance modelling. Geometry layout is further assigned site location, activity schedule, construction material, roof, wall, and HVAC [15]. After checking compliance to ECBC requirement value for the base case and proposed case simulation program run is given in Table I.

IV. SIMULATION RESULTSAND DISCUSSION

Software simulation providedan analysisof temperature heat gain and energy consumption data. This simulation runprovides data,and chartsor scenarios based on different energy usage variables. This data is given in Table II. Correlatedifferentinfluencing variables for their effect on building heat gain. These influencing parameters optimize by Software simulationbased on alternativeinput and their effect.Analysis result has further used in proposed case optimization based on alternative input in the base case. Proposed case buildingenergy consumption lower down by change building parameters like building material, orientation, envelope, typesof occupancy, surrounding, and design.

TABLE III OUTPUT PARAMETER ANNUAL ENERGY CONSUMPTION

Combination of Energy Conservation Measures(ECM)		**Energy Consumption**	**Energy Performance Index(EPI)**	**Energy Savings**
		(kWh)	**(kWh/m^2/yr)**	**%**
Base case		**787042.42**	**351.14**	**0.00%**
ECM 1	Roof	719400.32	320.96	**8.50%**
ECM 1+ECM 2	Wall	679589.68	303.20	**14.03%**
ECM 1 +ECM 2+ ECM 3	Glass	675252.78	301.26	**14.67%**
ECM 1+ ECM 2+ ECM 3+ ECM 4	Glass	637598.16	284.46	**14.72%**

ECM 1+ECM 2 +ECM 3+ ECM 4+ ECM 5	WWR	616124.50	274.88	**23.74%**
ECM 1+ECM 2 +ECM 3+ ECM 4+ ECM 5 +ECM 6	Orientation	608978.35	271.69	**24.90%**
ECM 1+ECM 2 +ECM 3+ ECM 4+ ECM 5 +ECM 6+ ECM 7	Shading	596299.44	266.04	**26.98%**

V. CONCLUSIONS

In the current studyof different energy conservation parametersrelated to building have been investigated to improve the energyand thermal performance of the whole building.Standard codes like NBC2016, ECBC2017, and ASHRAE90.1has been enforced after proper study. This research provides a methodology to optimize the building envelope fora residential hostel building in Chandigarh. The paper provides an overview of research development forsoftware simulation modeling based approach in building envelope optimization. To identify the energy saving difference between base case and proposed case building onbases Energy Performance Index (EPI). Whole building energy simulation by software simulation approach diagnostics the effect of energy conservation measure and improve efficiency. Energy simulation modeling gives benchmarking tools to evaluate building envelope components.

VI. FUTURE SCOPE OF THE STUDY

In future studies, different types of buildingoccupants schedule with different influential design variablesin five different climate zones of India.

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