

Analysis of a 3-Dimensional Building Frame Considering Green Building and Energy Efficient Technique using Analysis Tool ETABS

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ABSTRACT

Minimizing energy consumption in buildings has become an important goal in architecture and urban planning in recent years. Guidelines were developed for each climatic zone aiming at increasing solar exposure for buildings in cold climates and at reducing solar exposure for buildings in hot climates. This approach usually plans for the season with the harshest weather; often forgetting that temperatures in cities at latitude 25° can drop below thermal comfort limits in winter and that temperatures in cities at latitude 48° often rise above thermal comfort limits in summer. This paper argues that a holistic approach to energy efficient building forms is needed. It demonstrates a generic energy efficient building form derived by glass walls at exterior and composite wall at the interior.

In this study material replacements were scheduled such as low carbon footprint material replacing a certain percentage of cement in concrete for R.C.C. members. In this research work for modelling and dynamic analysis ETABS tool is considered.

Keywords: ETABS, Structural Analysis, Energy Efficiency, Low Carbon, Building, Environment.

I. INTRODUCTION

Energy conservation in the built environment has become one of the most important topics on both political and scientific agendas. The rising global population, decreasing fossil-based energy resources, rising emissions of harmful gases have emerged as the main motivators for energy efficiency in buildings. In addition, cost efficiency, safety and the need to reduce carbon emissions are fundamental reasons for energy conservation. In the last century, the incredible increase in the amount of energy usage and the increasing dependence on energy resources have forced human beings to consume energy in the most efficient way in every area. The world is dominated by buildings with about 40% energy

consumption. For this reason, the construction sector is affected by global energy issues, and the traces of these effects are manifested in the design, construction and usage processes of the buildings. In this context, energy efficient design systems related to the production of the buildings that draw so much of the world's energy consumption have been put forward. This Study scrutinizes approaches to energy efficiency in the buildings of the last century.

- Low energy buildings have attracted lots of attention in recent years. Most of the research is focused on the building construction or alternative energy sources.

- In contrary, this Study presents a comparative study on a bare frame and low energy emission frame. general methodology of minimizing energy consumption using current energy sources and minimal retrofitting, but instead making use of advanced control techniques.
- We focus on the analysis of energy savings that can be achieved in a building heating system by applying **model predictive control** (MPC) and using weather predictions.

REVIEW OF ENERGY + GREEN HOME PROJECT AS A CASE STUDY

- Location – Bhopal Seismic Zone II
- Geographical Location Latitude 37.28 (N), Longitude 127.22 (E)
- Climate Mean air temperature for January: 23 oC
- Mean air temperature for August: 26oC
- Building Type- multistory
- Low carbon material- Fly-ash cement
- Exterior walls- Glass
- Interior walls- Composite section

Flyash Cement

Flyash is defined in Cement and Concrete Terminology as “the finely divided residue resulting from the combustion of ground or powdered coal, which is transported from the firebox through the boiler by flue gases.” Flyash is a by-product of coal-fired electric generating plants. Flyash is one of three general types of coal combustion byproducts (CCBP’s). The use of these byproducts offers environmental advantages by diverting the material from the wastestream, reducing the energy investment in processing virgin materials, conserving virgin materials, and allaying pollution. Thirteen million tons of coal ash are produced in Texas each year. Eleven percent of this ash is used which is below the national average of 30 %. About 60 – 70% of central Texas suppliers offer flyash in ready-mix products. They will substitute flyash for 20 – 35% of

the portland cement used to make their products. Although flyash offers environmental advantages, it also improves the performance and quality of concrete.



Fig 1: flyash cement

II. LITERATURE REVIEW

Singh et. al. (2018) Contemplated that idea of Green working, in more extensive terms, includes a building, enhance representative efficiency, utilize admirably regular assets and diminish the ecological effect. As it were, the green building process joins ecological contemplations into each phase of the building development. This procedure centers around the plan, development, task and upkeep stages and considers the part outline and advancement productivity, vitality and water proficiency, asset effectiveness, indoor ecological quality, building-proprietor support and the building's general effect on the earth. Careful determination of eco-accommodating feasible building materials might be the quickest route for developers to begin coordinating manageable outline ideas in structures.

Klarin et. al. (2018) Examined that the seismic execution of a fly-ash solid space surrounded working with two distinct kinds of workmanship infills, in particular, clay block stonework and flyash block brickwork utilizing pushover investigation. The displaying and investigation of casings are done utilizing the software application SAP 2000. The horizontal burdens are computed according to Indian

Seismic code IS 1893:2002. The aftereffects of this examination would urge the end clients to change over to the utilization of flyash prompting a maintainable and greener condition.

Tavares et. al. (2017) A case-study of a public building is presented as an example of the adequacy of timely analyses of building performance, based on a preliminary architectural design. A virtuous combination of a receptive building owner and a multidisciplinary design team, allowed a systematic methodology to be used, providing the opportunity for the consideration of several options for each class of constructive element and the possibility of choosing among the options for each case, based on quantitative results on the expected performance of the building. The options were created and analysed with the help of the VisualDOE™ building simulation tool, aiming at a comfortable and energy efficient building. Several parameters were used for enabling the sensitivity analyses, namely relating to wall structure and materials, window frames, HVAC system, etc

Kaushik and Basha (2015) Examined that fly ash blocks are gentler and weaker in correlation with consumed clay blocks and mortar by and large utilized nearby. Results demonstrated that the edge gave sensibly great outcomes regarding sidelong quality, firmness, disfigurement, and vitality dispersal. Utilizing a scientific model created from the trial results a parametric report was completed to think about the impact of utilizing both fly fiery debris and consumed clay block workmanship as infill in RC outlines. three sorts of examinations were completed to assess their synthetic and mineralogical sythesis: X-beam fluorescence investigation, filtering electron magnifying instrument related with vitality dispersive spectrometer, and powder X-beam diffraction procedure. It was inferred that due to the deficient pozzolanic response, fly ash blocks showed feeble and delicate nature.

Problem Identification:

No detailed study on suitability of GREEN BUILDING and related technique has been done in past researches were conducted on different materials including RCC, flyash cement concrete and panels (glass and aluminium) however information on techno-economic feasibility of materials to be used in green building is lacking.

This study will be a base or datum for all developing high rise buildings where Utility of energy efficiency is required.

This study is meant to develop a concept of structural designing with considering Concept of low carbon footprint building.

Objectives:

The main objective of this study is to determine the following:

- To differentiate a simple building and a energy efficient building.
- To determine the effectiveness of energy efficient building.
- To justify its effect on structure stability.
- To determine that glass as a exterior wall is capable of resisting total building load.
- To determine the cost effectiveness of the structure.
- To determine the stability of RC members after replacing cement by fly-ash cement.

III. METHODOLOGY

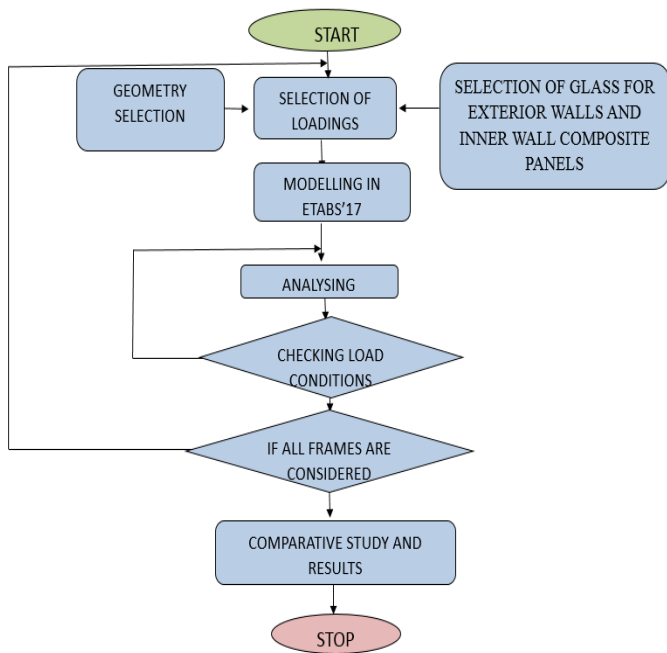


Fig 2: Flow chart of methodology

Table 1: Material property

S.NO	Description	Value
1	Fly-ash cement	-
2	Young's modulus of steel, Es	2.17x10 ⁴ N/mm ²
3	Poisson ratio	0.17
4	Tensile Strength, Ultimate Steel	505 MPa
5	Tensile Strength, Yield Steel	215 MPa
6	Elongation at Break Steel	70 %
7	GLASS	12 mm

Table 2: Geometrical data

S.NO	Description	Value
1	Area	16 X 24 m
2	Number of bays in X direction	4

3	Number of bays in Z direction	5
4	Height of Floors	3.0 m
5	Overall height	36 m

Table 3: Loading conditions

S.No.	Load Type	As per I.S.
1	Dead Load	I.S. 875-PART-1
2	Superimposed Load	I.S. 875-PART-2
3	Seismic (dynamic) response reduction	I.S. 1893-PART-1
4	Load Combinations	I.S. 875-PART-5

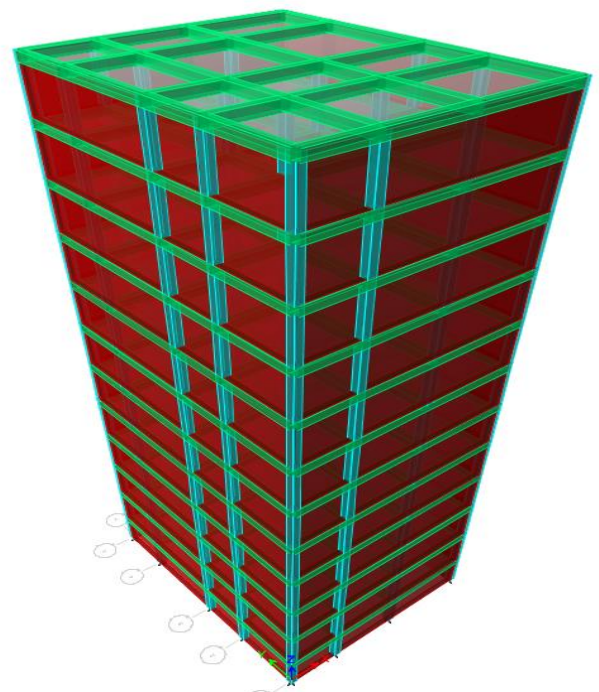


Fig 3: Modelling in analysis tool

IV. ANALYSIS RESULTS

Moment in each storey:

Table 4: Moment kN-m

Moment in kN-m		
	Bare frame	Green sustainable frame
storey12	387.03	363.45
storey11	325.85	318.4
storey10	317.83	310.64
storey9	309.81	302.88
storey8	301.79	295.12
storey7	293.77	287.36
storey6	285.75	279.6
storey5	277.73	271.84
storey4	269.71	264.08
storey3	261.69	256.32
storey2	253.67	248.56
storey1	245.65	240.8

Table 5 : Shear force kN

Shear force in kN-m		
Storeys	Frame with light weight concrete	Bare frame
storey12	563.32	570.12
storey11	558.65	568.54
storey10	552.85	553.65
storey9	537.05	551.46
storey8	521.25	533.9
storey7	505.45	516.34
storey6	489.65	498.78
storey5	473.85	481.22
storey4	458.05	463.66
storey3	442.25	446.1
storey2	426.45	428.54
storey1	410.65	410.98

Table 6 : Storey displacement mm

Storey Displacement (mm)		
Stories	Bare frame	Green sustainable frame
Story12	37.85	30.95
Story11	34.635	28.32
Story10	31.42	25.69
Story9	28.205	23.06
Story8	24.99	20.43
Story7	21.775	17.8
Story6	18.56	15.17
Story5	15.345	12.54
Story4	12.13	9.91
Story3	8.79	7.28
Story2	5.95	4.65
Story1	2.36	2.02
Base	0	0

Table 6 : Cost analysis of rebar

S.No.	Frame type	Reinforcement in kg	Rate of Rebar kg as per S.O.R.	Cost of Rebar in INR (Rupees)
1	green sustainable frame	9454.23	72.75	6,87,795.23
2	Bare frame	9552.87	72.75	6,94,971.30

Table 7 : Cost Analysis of concrete

S.No.	Frame type	Concrete cu.m	Rate of concrete (m ³) as per S.O.R.	Cost of concrete in INR (Rupees)
1	green sustainable frame	92.6	5757	5,33,098.00
2	Bare frame	94.5	5757	5,44,036.50

V. CONCLUSION

For this research work following outcomes are observed:

- It is observed in above results that bending moment is comparatively more in bare frame, thus green sustainable frame case results in stable structure with less reinforcement requirement.
- As bending moment is higher in bare frame results thus heavy section is required which will result in less unbalance (shear) force.
- In the above chapter results shows that green sustainable structure is comparatively economical than bare frame by 8.4%.

VI. SUMMARY

Here it can be concluded that green sustainable building results in stable building with more stiffness than bare frame case. Whereas it terms of cost analysis it will be

costlier by 8.4 % than bare frame case.

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