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Analysis of a Green Building Structure Under Dynamic Loading Condition using ETABS

Dishant Tiwari[1], Pankaj Agarwal[2]
P.G. Scholar[1], Assistant Professor[2]
Department of Civil Engineering, Eklavya University Damoh, Padriya, Madhya Pradesh, India

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ABSTRACT

Present world is requesting supportable practices in varying backgrounds and development industry isn't unique. The maintainability idea in development industry has made some amazing progress yet there is need for new turns of events and creations.

One of the key aspect of sustainable construction is the concept of green buildings. It is the type of buildings that are environment friendly as well as resource efficient. There are several systems for assessing the green building and rating them accordingly. In India, there exist 3 major rating systems but all of these systems only account for very large buildings or small commercial buildings. This exploration center around attempting to oblige a little existing private structure into the structure of one of the rating frameworks SVAGRIHA (Basic Flexible Reasonable Green Rating for Incorporated Living space Evaluation) for changing over the halfway customary structure into green structure. The structure condition was examined and green structure ideas were suggested. A basic expense investigation for the extra works and frameworks were likewise finished to show the efficient part of transformation to green structure. A bunch of suggestion to better the green structure rating frameworks as well with respect to regulatory level were given.

This research presented comparative analysis of a 17 storey conventional structure and a sustainable structure considering similar loading conditions designed using ETABS. The comparative analysis was conducted on parameters of storey moment, storey diplacmenet, storey drift and storey shear. In this study material replacements were scheduled such as low carbon footprint material replacing a certain percentage of cement in foam 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

India is a fast growing country. Rapid industrialization, increasing population, infrastructure development and destruction of natural resources lead to construction of green building. Green structure is a design that is ecologically mindful and asset effective all through its life cycle. Green structure is likewise known for its maintainability and elite execution.

Warm solace concentrates on conventional private structures of India that is known for its utilization of regular and uninvolved strategies for an agreeable indoor climate, are under progress. Detached techniques for accomplishing warm solace inside the structures are the best answer for give a solid and energy effective indoor climate. This is of preeminent significance for structures in the jungles where mechanical frameworks with high energy utilization are utilized to condition the indoor climate for warm solace. Individuals are compelled to rely upon such frameworks since, larger part of the structures are planned without giving satisfactory significance to detached techniques for controlling the indoor climate. Much of the time, inability to give the expected warm circumstances has brought about distress, chronic sickness and efficiency misfortune. As of now, there is a consistent need to assess the warm states of the indoor conditions to learn further and continue with the exploration in detached plan.

Water is a critical and finite resource. It covers over 71% of the Earth's surface and is essential for life, playing a key role in the production of food, human health and sustaining the natural environment.

However, water, particularly of drinking water quality, is becoming increasingly scarce in most of the populated regions of the planet. The strain is on to lessen water interest by diminishing wastage, to reuse or reuse however much as could reasonably be expected, and to take a gander at different method for limiting our effect on the water climate. Generally we should be more effective with our water usage.

Discarding waste has tremendous ecological effects and can lead to difficult issues. Some waste will ultimately decay, however not all, and in the process it might smell or create methane gas, which is hazardous and adds to the nursery impact. Squander that isn't as expected made due, particularly excreta and other fluid and strong waste from families and the local area, are a serious wellbeing peril and lead to the spread of irresistible infections. Unattended waste lying around draws in flies, rodents, and different animals that thus spread sickness. Typically the wet waste disintegrates and delivers a terrible scent. This prompts unhygienic circumstances and subsequently to an ascent in the medical conditions. Plastic waste is one more reason for weakness. Subsequently unnecessary strong waste that is created ought to be constrained by going to specific preventive lengths.

Concept of Green Building

Construction industry has both negative and positive impacts on the environment, economy and society. According to estimates buildings consume more than 30% of energy utilizing 40% of resources while simultaneously generating 40% of wastes and 35% of harmful green-house gases (Mane 2017). Green structure is the act of making designs and utilizing processes that are naturally capable and asset effective all through a structure's lifecycle from siting to plan, development, activity, upkeep, redesign and deconstruction. This training grows and supplements the traditional structure configuration worries of economy, utility, strength, and solace. Green structure is otherwise called a manageable or elite execution building (Choudhary, 2018).Green structures safeguard valuable regular assets and work on our personal satisfaction. There are various highlights which can make a structure 'green'. These include:

- Effective utilization of energy, water and different assets
- Utilization of sustainable power, like sun based energy
- Contamination and waste decrease measures, and the empowering of re-use and reusing
- Great indoor natural air quality
- Utilization of materials that are non-poisonous, moral and practical
- Thought of the climate in plan, development and activity
- Thought of the personal satisfaction of tenants in plan, development and activity
- A plan that empowers variation to a changing climate

II. Review of Literature Summary

Svetlana Pushkar et.al (2022) in the exploration paper, a five-story supported concrete private structure was retrofitted with: Case 1: substantial wall reinforcing (CWS)- customary cement + ordinary green rooftop; Case 2: CWS-squander included concrete + squander based green rooftop; Case 3: seismic seclusion segments (SIC)- regular cement + traditional green rooftop; and Case 4: SIC-squander included concrete + squander based green rooftop. Palekastro, Nuweiba, Tabas, and Erzincan ground movements were utilized for an underlying unique time-history examination of the retrofitted structures. Life cycle appraisals of cases 1-4 were performed utilizing ReCiPe 2016 midpoint and endpoint assessments. A two-stage investigation of fluctuation (ANOVA) was utilized to break down the ReCiPe endpoint results.

Results expressed that Case 3 and Case 4 were significantly more desirable over Case 1 and Case 2, though as per the ecological assessments, Case 4 was the most desirable over different cases.

Wakale Yogesh Namdev et.al (2022) research paper introduced plan and examination of G+26 story place of business utilizing ETABS programming. While planning every one of the powers that actuate on the structure were thought of and in Post examination of the design, greatest shear powers, twisting minutes, most extreme story dislodging, conduct of working to seismic power, story solidness, story float and different responses was figured.

Results expressed that the highest level of removal is expanding from first story to last one. End expressed that construction was protected in stacking like dead burden, live burden, wind load and seismic burden. Part aspects (Shaft, Section, Chunk, Balance) are changed by working out the heap type and it's amount applied on it CSi Detail gives min. width of bars, thickness of piece and same for segment, balance.

Xiao-guang Zhao and Chun-Ping Gao (2022) research paper explained the meaning of energy-saving plan components from the parts of demonstrating programming choice, envelope energy-saving plan, and lighting energy-saving plan. Appropriately, the attributes and interaction of building energy proficiency investigation in light of BIM were proposed. At long last, the energy-saving impact assessment technique for green structure in view of BIM was given, and a model showed that the energy-saving plan strategy for green structure in light of BIM proposed in the examination work had great plausibility and viability.

You energy-saving plan of green structures in view of BIM innovation proposed in this paper can not just give a reference to the top to bottom examination of BIM innovation yet additionally offer specialized help for the wide application in the field of green structures.

III.Objectives of the Research

a) To understand the concept of Green building or sustainable high rise structure.
b) To study the seismic behavior of G+16 green building by using IS 1893:2002.
c) To design the earthquake resistant structure and present comparative analysis between a conventional stucture and sustainable strcuture for zone III and soft soil.
d) To compare the results of story drift, shear force, bending moment, building torsion, base shear.
e) To study the multi story buildings in ETABS software.
f) Conduct cost analysis between a sustainable structure and conventional structure.

IV.Methodology

Step 1- the research papers from different authors were summarized to understand the behaviour of connected towers and the research done till date.
Step 2: In order to initiate the modelling of the case study, firstly their's need to initialize the model on the basis of defining display units on metric SI on region India as ETABS supports the building codes of different nations. The steel code was considered as per IS 800:2007 and concrete design code as per IS 456:2000.

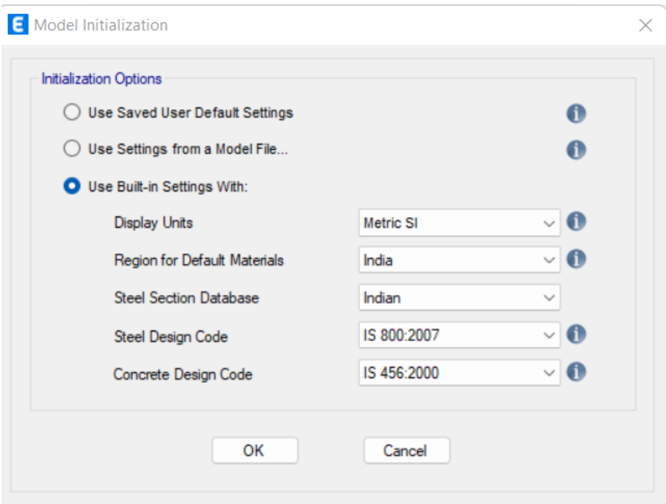


Fig 3.1 Model Initialization

Step 3: ETABS provides the option of modelling the structure with an easy option of Quick Template where the grids can be defined in X, Y and Z direction. Here in this case, 5 bays in considered in both X and Y direction with a constant spacing of 5m making the model symmetrical in nature. G+16 storey structure is considered with typical storey height of 3m.

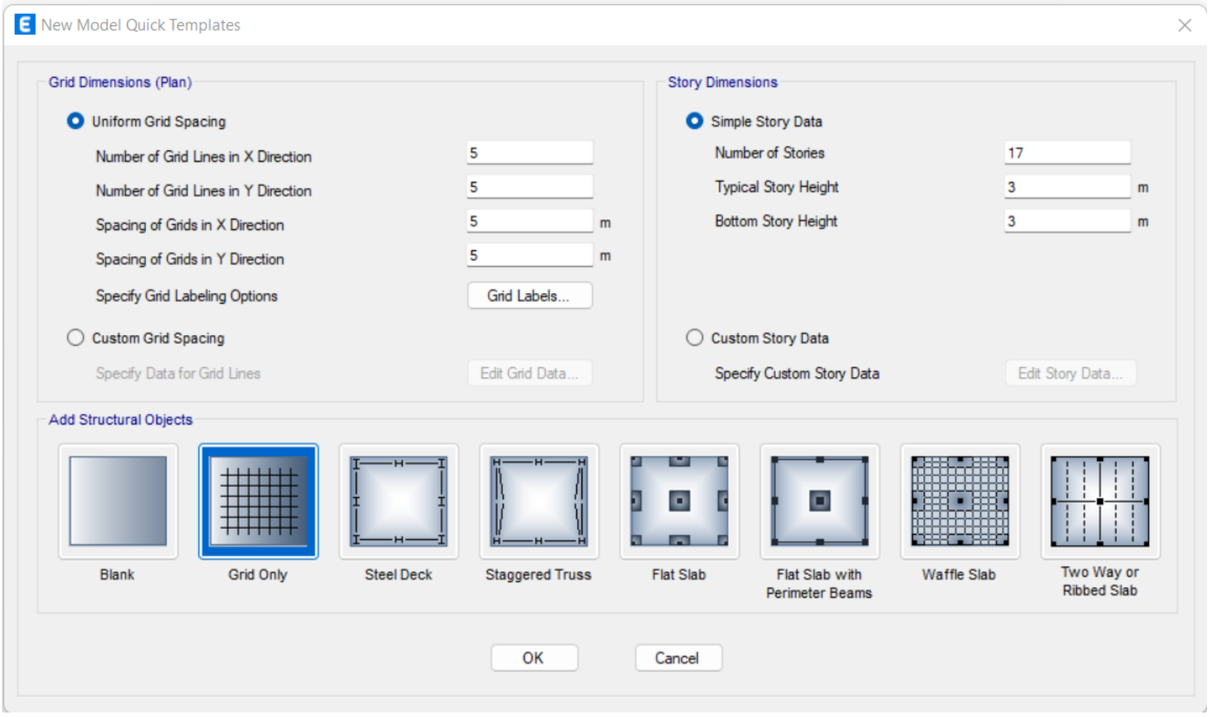


Fig 3.2 New Model Quick Template

Step 4: Next step is to define material properties for concrete and steel. Here in this case study, M30 concrete and rebar HYSD 500 is considered and its predefined properties are available in the ETABS application.

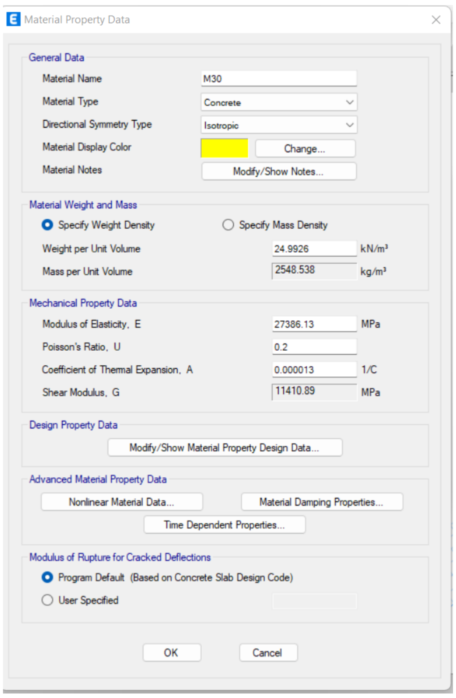


Fig 3.3 Defining Properties of Concrete M30.

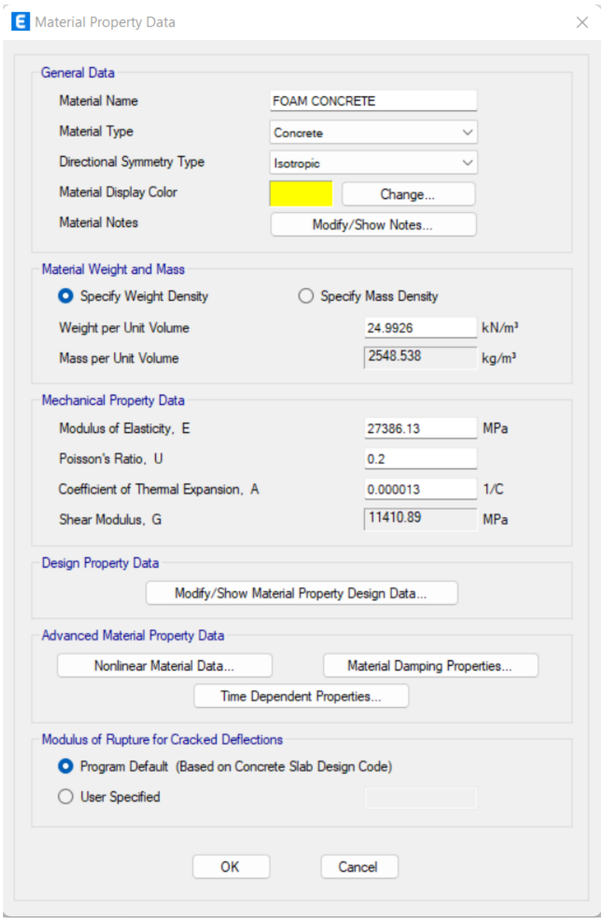


Fig Properties of Foam Concrete

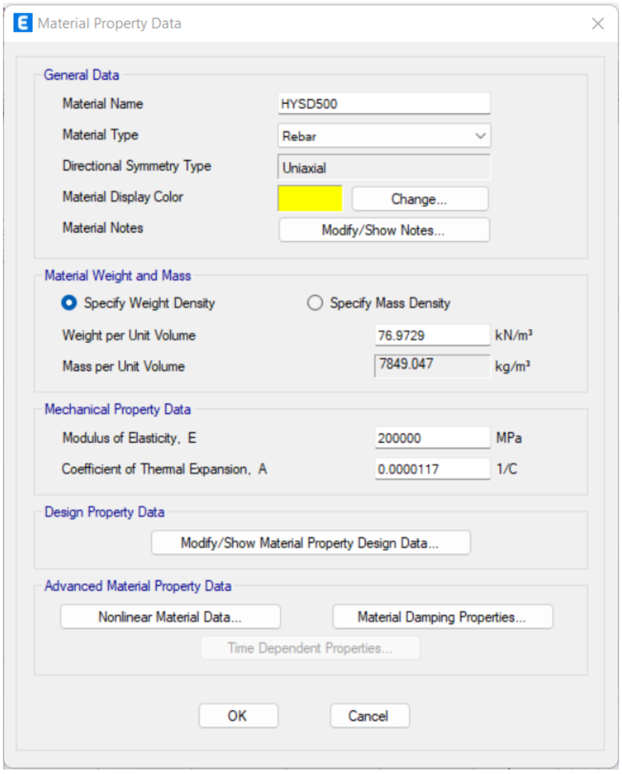


Fig 3.4 Defining Properties of Rebar HYSD 500

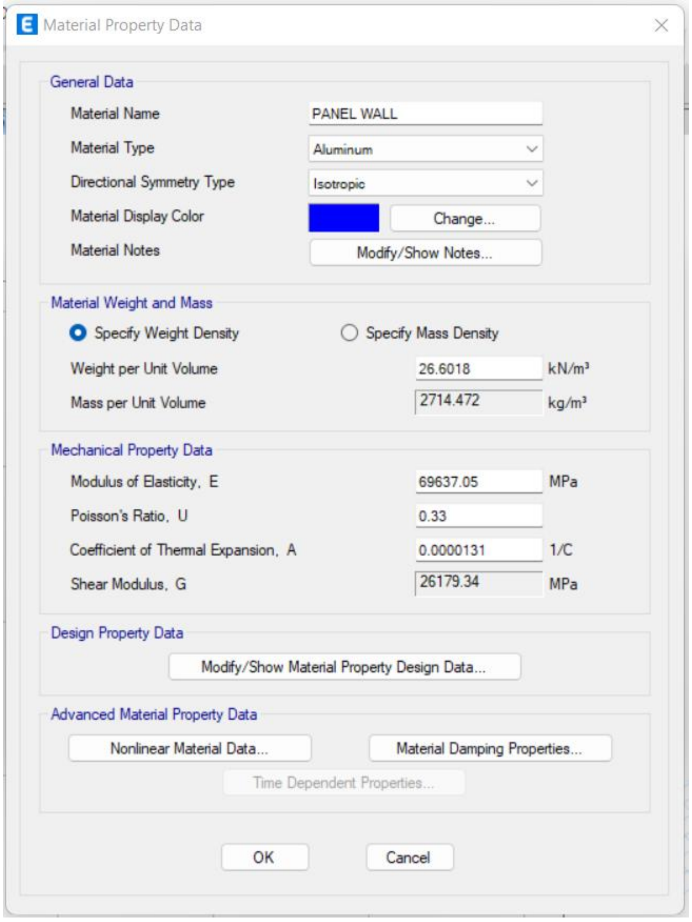


Fig Properties of Pannel Wall

Step 5: Defining section properties for Beam, Column. Beam size of 500x350mm, Column size of 500x500mm and Slab size of 150 mm is considered in the study.

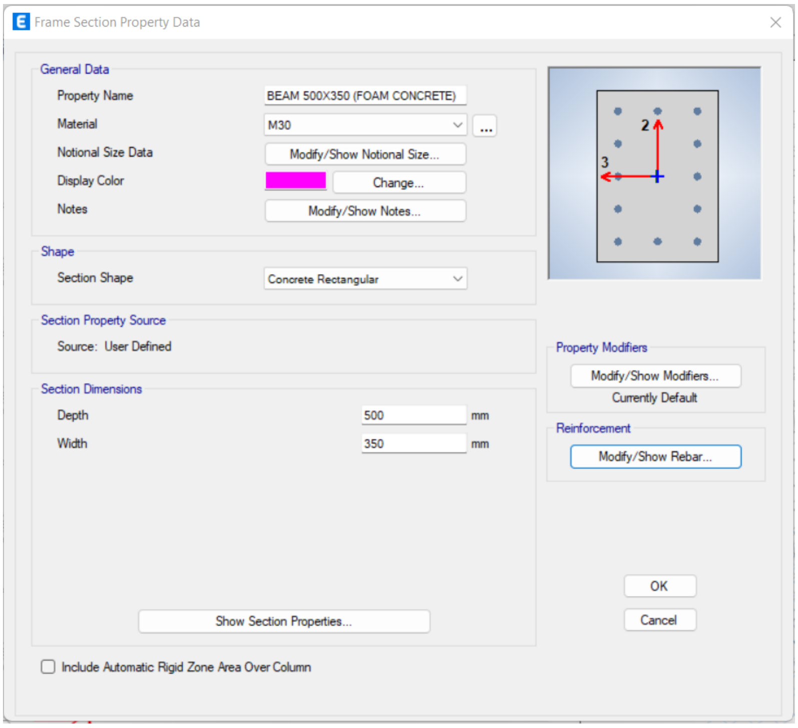


Fig 3.5 Defining the section properties of Beam

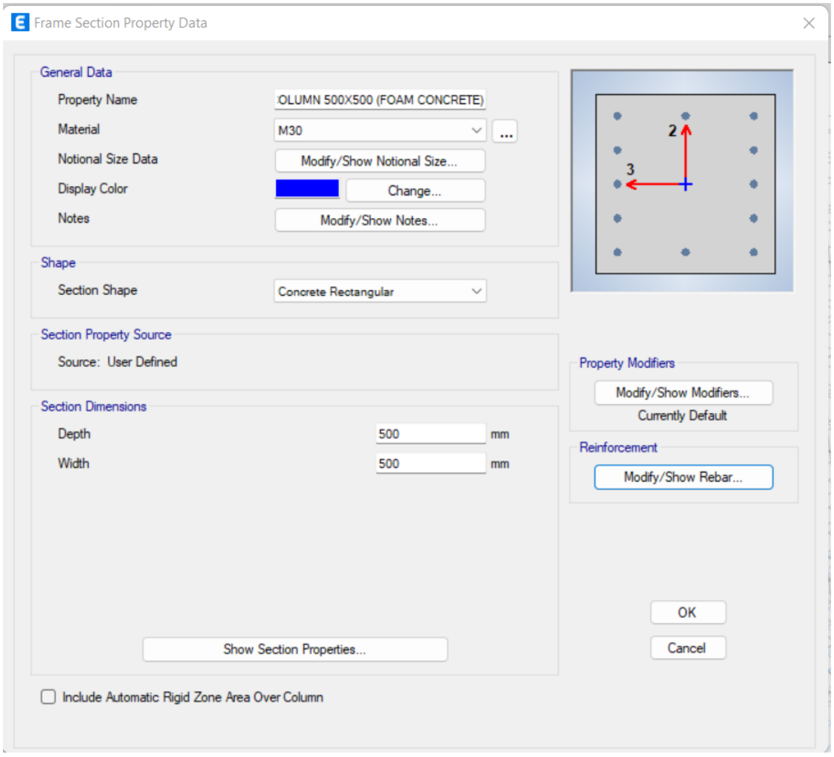


Fig 3.6 Defining Properties of Column

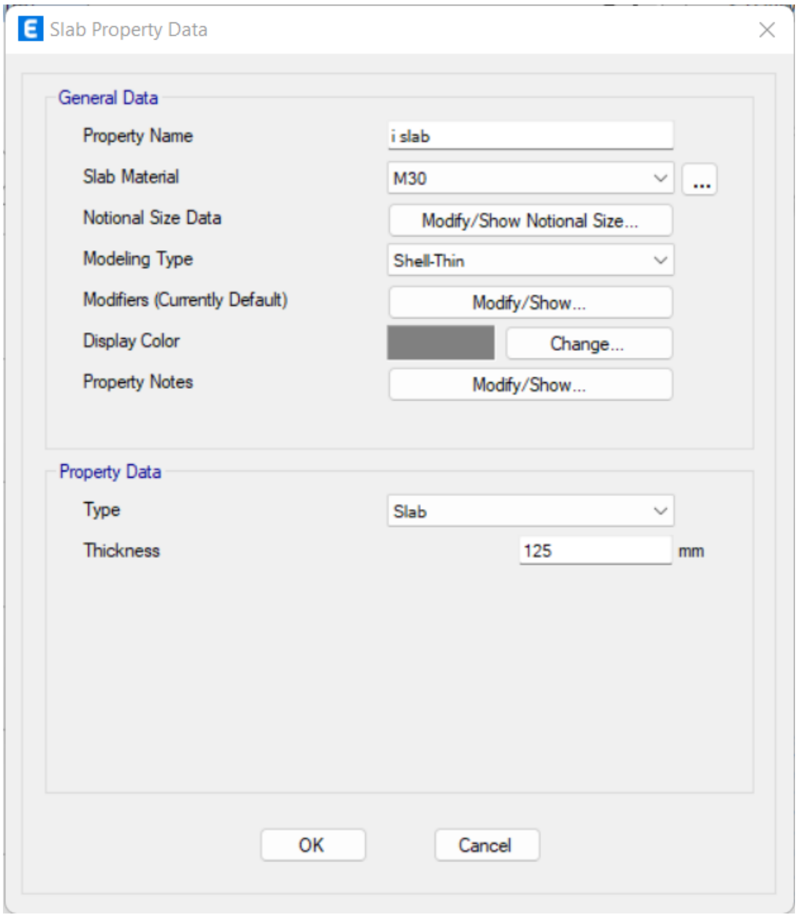


Fig 3.7 Defining the Properties of Shell-thin slab

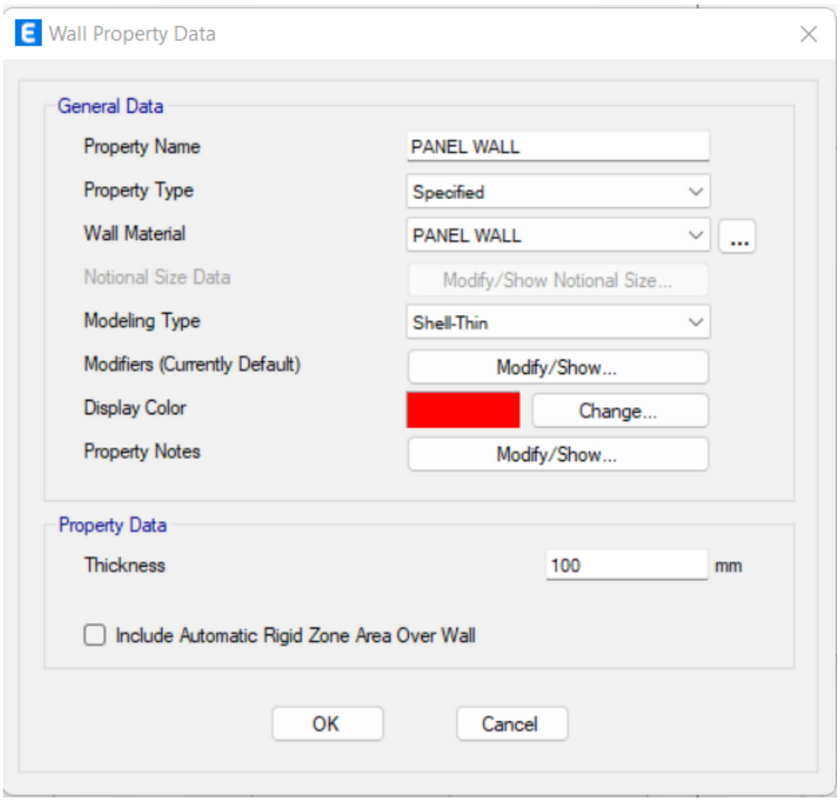


Fig Pannel Wall

Step 6: Assigning Fixed Support at bottom of the structure in X, Y and Z direction in both the considered cases.

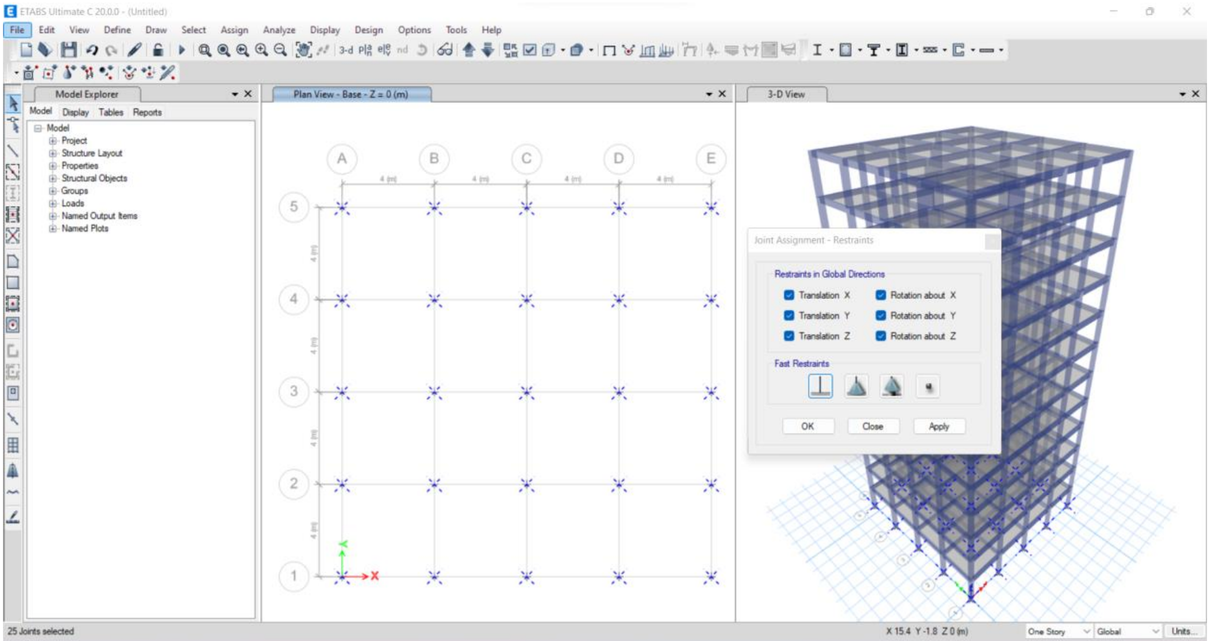


Fig 3.10 Assigning Fixed Support

Step 7: Defining Load cases for dead load, live load and seismic analysis for X and Y Direction.

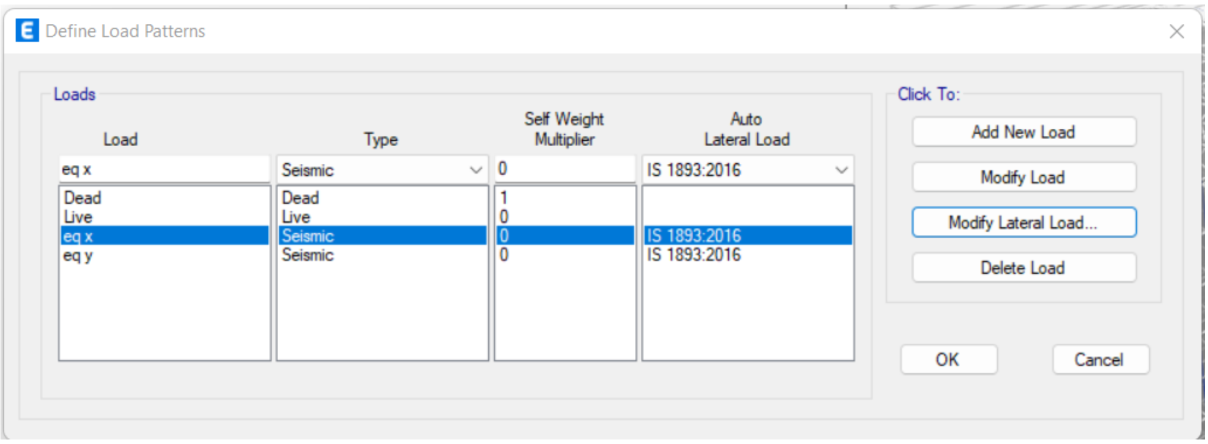


Fig 3.11 Defining Load Pattern

Step 8 Defining Seismic Loading as per IS 1893: 2016 Part I.

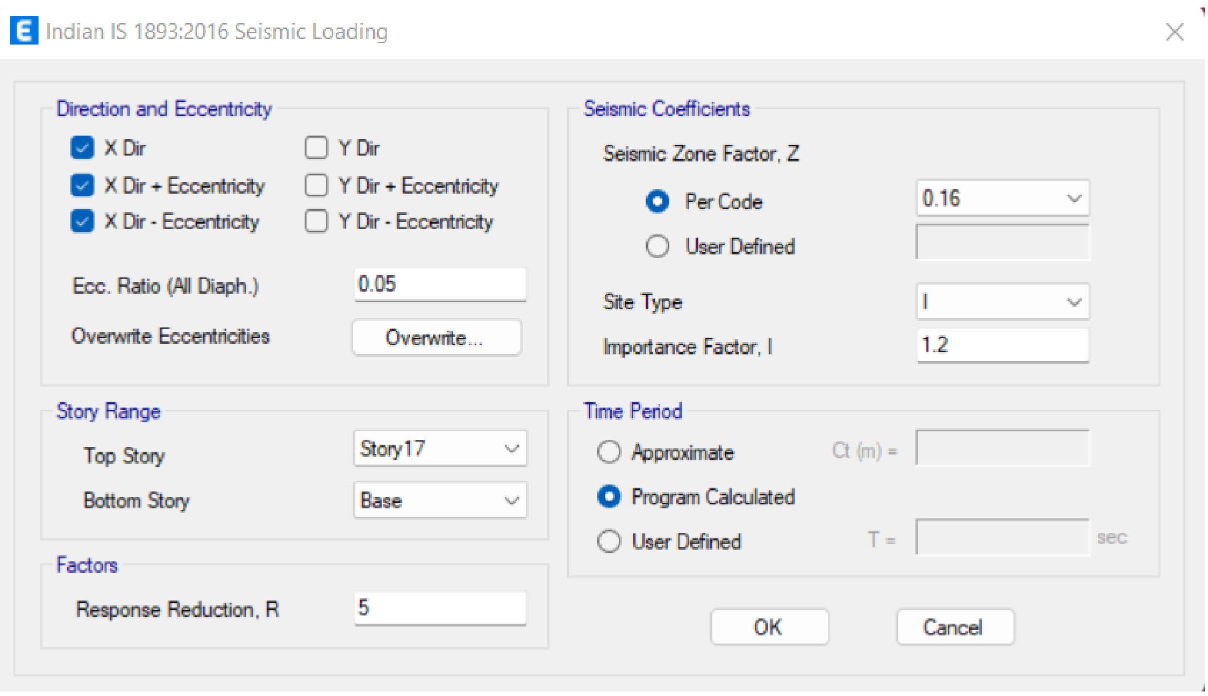


Fig 3.12 Seismic Loading

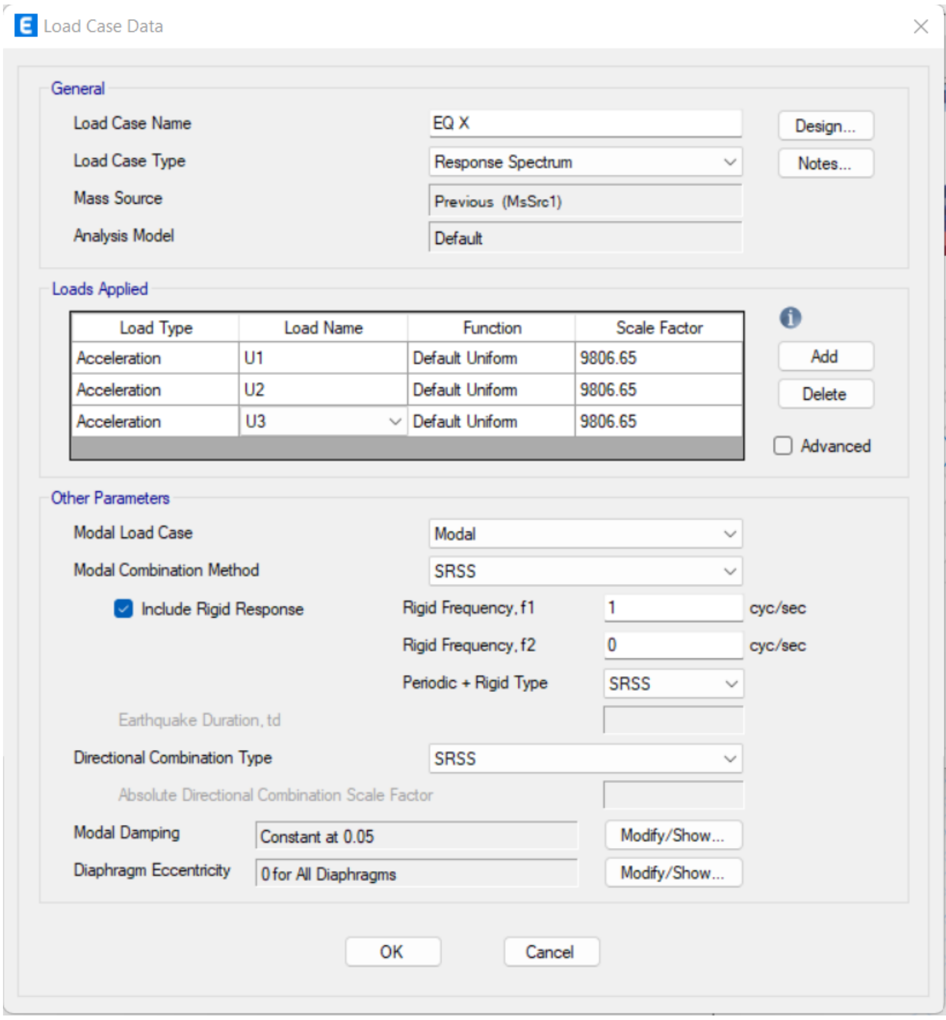


Fig 3.13 Load Case Data

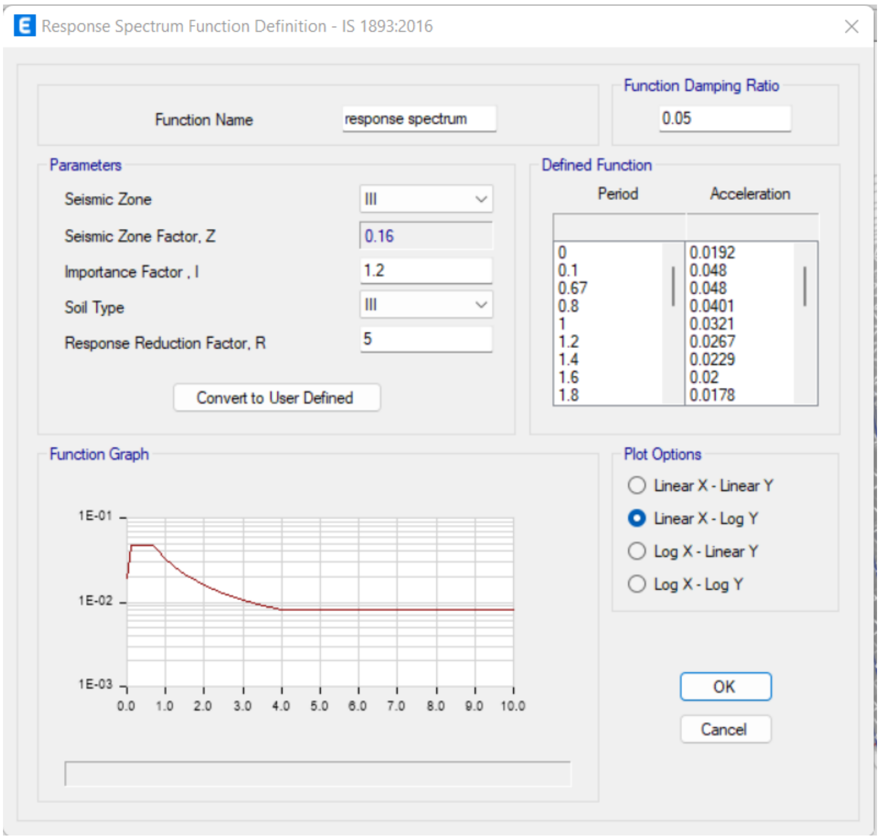


Fig 3.14 Defining Response Spectrum Analysis as per IS 1893-2016.

Step 9: Conducting the model check for both the cases in ETABS

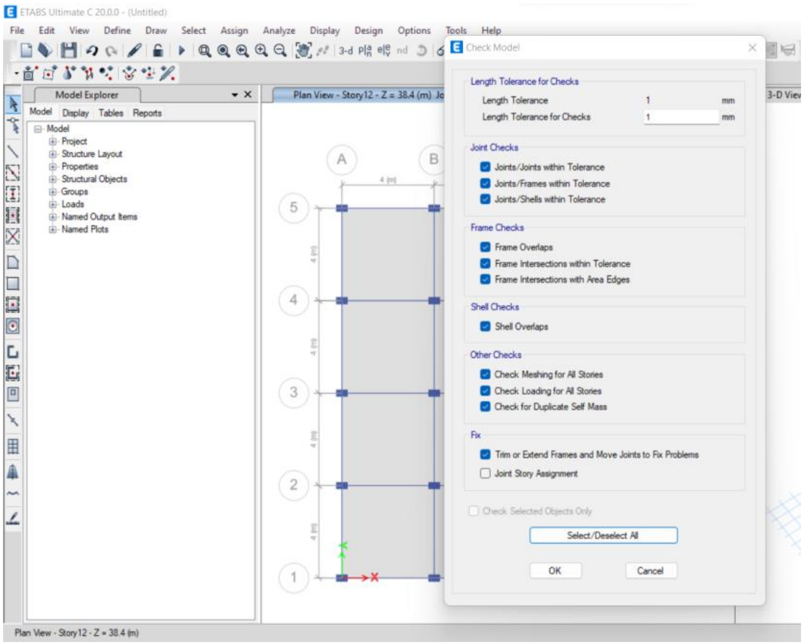


Fig 3.15 Model Check

Step 10: Analyzing the structure for dead load, stress analysis and displacement.

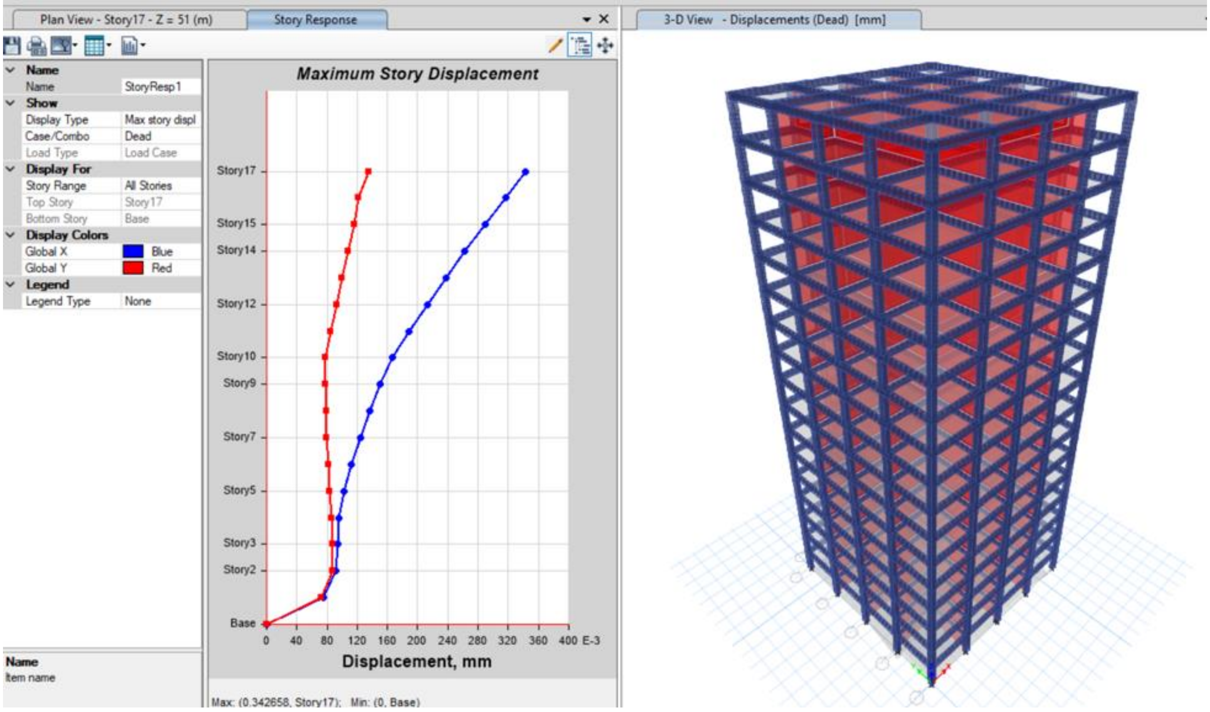


Fig 3.14 Storey Displacement

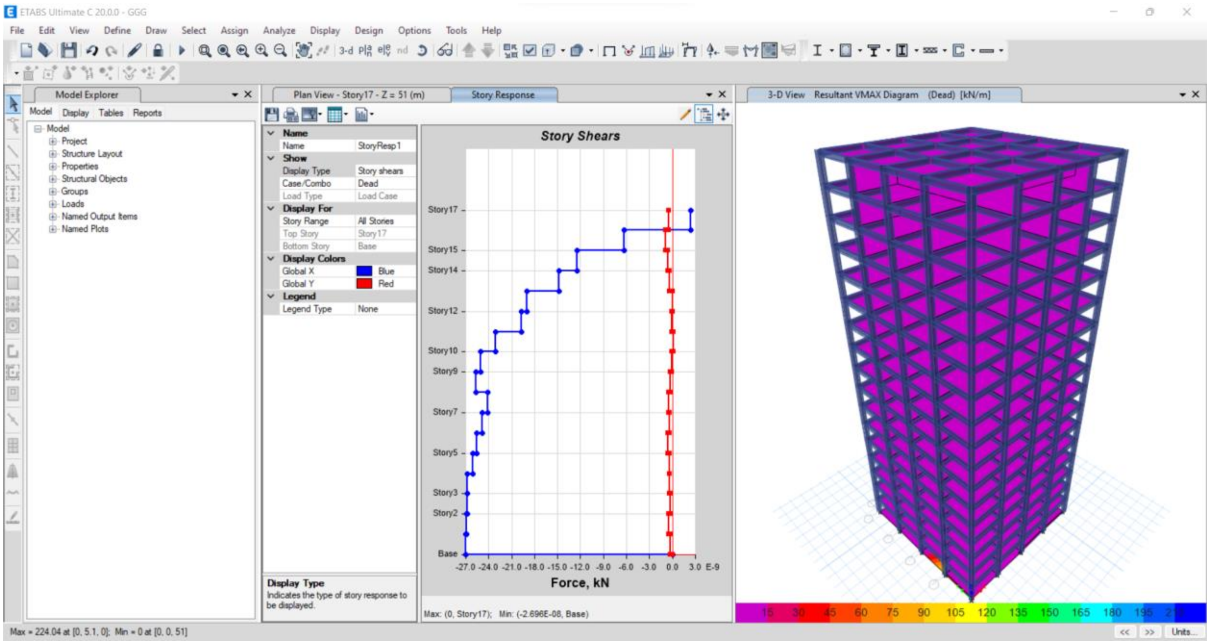


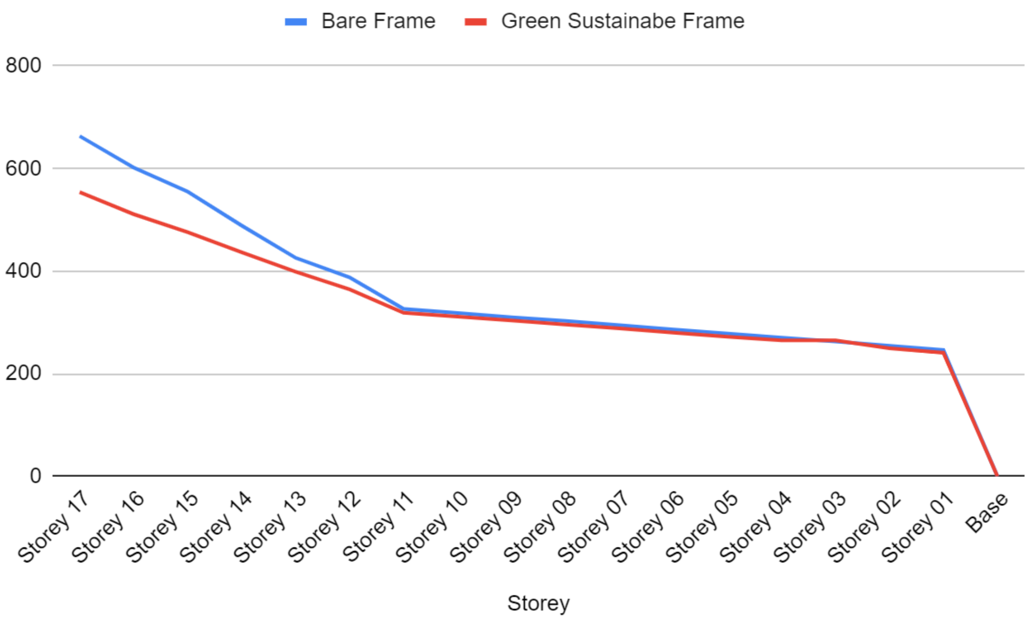
Fig 3.15 Storey Shear

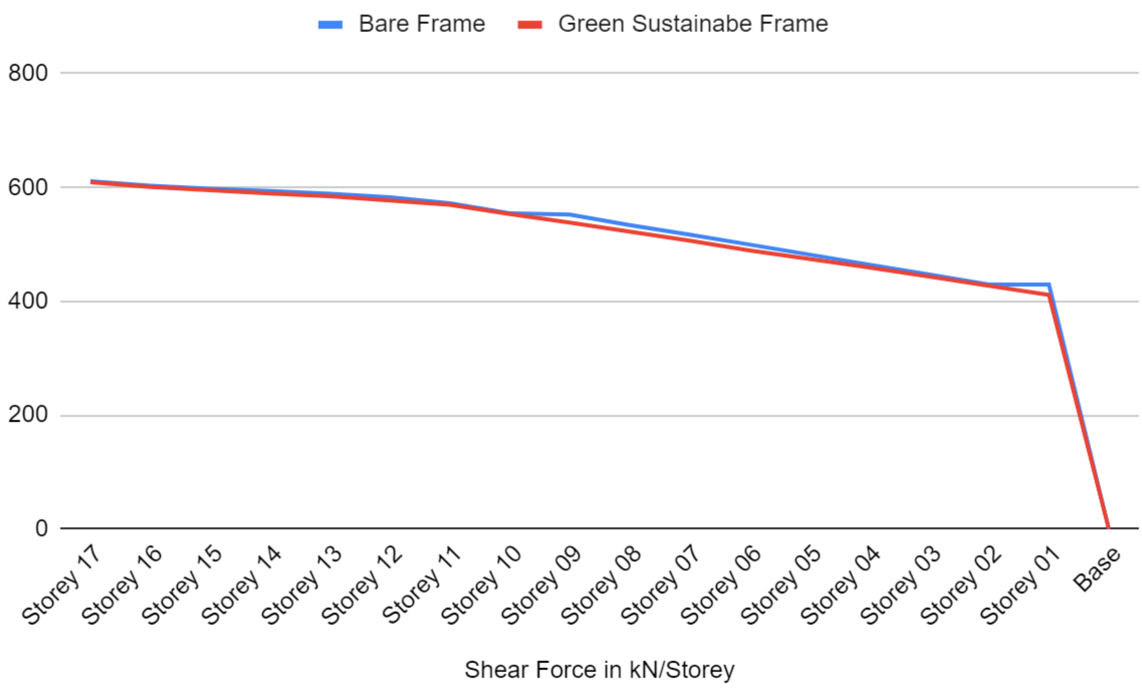
Building Description

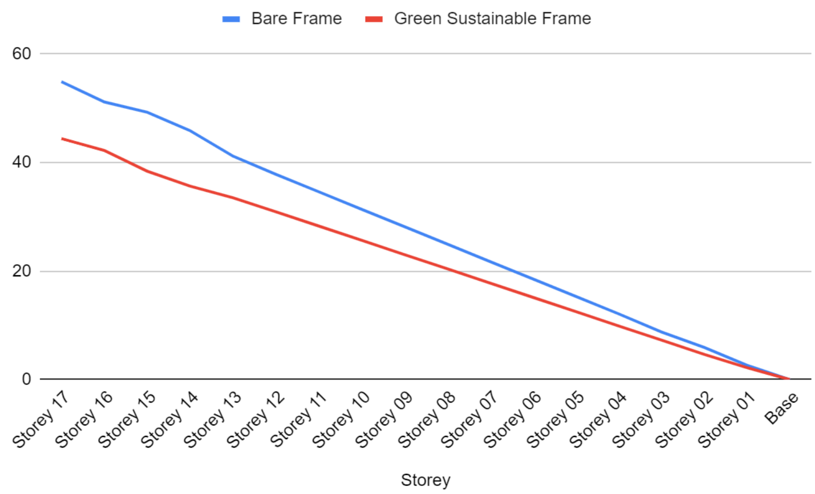
Building Description	
Plan dimension	25mx25m
Number of storey	17
Typical Storey height	3m

Bottom Storey Height	3m
Building Height	63m
Number of Grid in X Direction	5
Number of Grid in Y Direction	5
Spacing of Grids in X direction	5m
Spacing of Grids in Y direction	5m
Beam Size	500x350mm
Column Size	500x500mm
Slab Thickness	125mm
Panel Wall Thickness	100mm
Soil Profile Type	Soft

Analysis Result




Bare Frame
Green Sustainabe Frame
800
600
400
200
0
Storey 17
Storey 16
Storey 15
Storey 14
Storey 13
Storey 12
Storey 11
Storey 10
Storey 09
Storey 08
Storey 07
Storey 06
Storey 05
Storey 04
Storey 03
Storey 02
Storey 01
Base
Shear Force in kN/Storey


Bare Frame
Green Sustainable Frame
60
40
20
0
Storey 17
Storey 16
Storey 15
Storey 14
Storey 13
Storey 12
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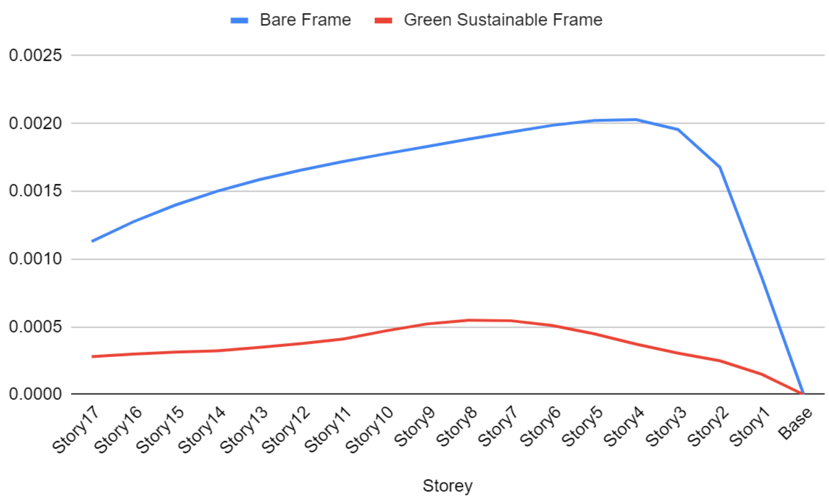
Base
Storey



V. CONCLUSION

This research presented comparative analysis of a 17 storey conventional structure and a sustainable structure considering similar loading conditions designed using ETABS. The comparative analysis was conducted on parameters of storey moment, storey diplacmenet, storey drift and storey shear. In this study material replacements were scheduled such as low carbon footprint material replacing a certain percentage of cement in foam concrete for R.C.C. members. In this research work for modelling and dynamic analysis ETABS tool is considered.

For this research work following outcomes are observed: •

Storey Moment

The general formula to evaluate storey moment is Storey moment = Storey shear x storey height/3. Storey moment was found to be quite similar to storey 11 with minimal difference whereas gap of 2.9% was more visible with increase in storey height. Green structure was found to be lightweight and was able to resist imposed loads considering seismic zone III.

Storey Shear

Storey shear factor is the ratio of the story shear force when story collapse occurs to the story shear force when total collapse occurs. Through a series of dynamic analyses, simple equations are provisionally proposed to calculate the necessary story shear safety factor that can be used to prevent story collapse. Shear force showed minimal difference in comparison to both the cases and constant rise was visible with increase in height of the structure.

Storey Displacement

Story displacement is the deflection of a single story relative to the base or ground level of the structure. Intuitively, we can expect higher total displacement values as we move up the structure. So, a graph showing the story displacement vs. the height of the structure looks exactly like the deflected shape. Storey displacement was found to rise with each storey height and was maximum in case of bare frame structure when compared to green building.

Storey Drift

Storey drift is the lateral displacement of a floor relative to the floor below, and the storey drift ratio is the storey drift divided by the storey height. Storey drift was maximum at storey 1 in case of conventional structure whereas the green structure was able to contain the drift even at first storey whereas relatively the drift decreases with increase in height with a mean difference of 6.89% was visible in the comparison.

Cost Analysis

The cost comparison was made as aluminium panels and foam concrete were used in case of green structure which was found to be more economical and eco friendly when compared to conventional structure. The green structure was found to be 8.4% more economical in comparison to conventional structure making it a feasible option for new structures.

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