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Analysis of a Low Carbon Emission Green Building Using ETABS

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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.

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.

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 structure and sustainable structure 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.

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.

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.

Steps of Modelling and Analysis

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.

Step 3: The Quick Template option in ETABS makes it simple to construct a structure with grids that may be configured in the X, Y, and Z directions. The model is symmetrical in this example since 5 bays are taken into account in both the X and Y directions, with a fixed spacing of 4m. With normal storey heights of 3.2 metres and 3.2 metres for the bottom storey, a G+8 storey green structure is taken into consideration.

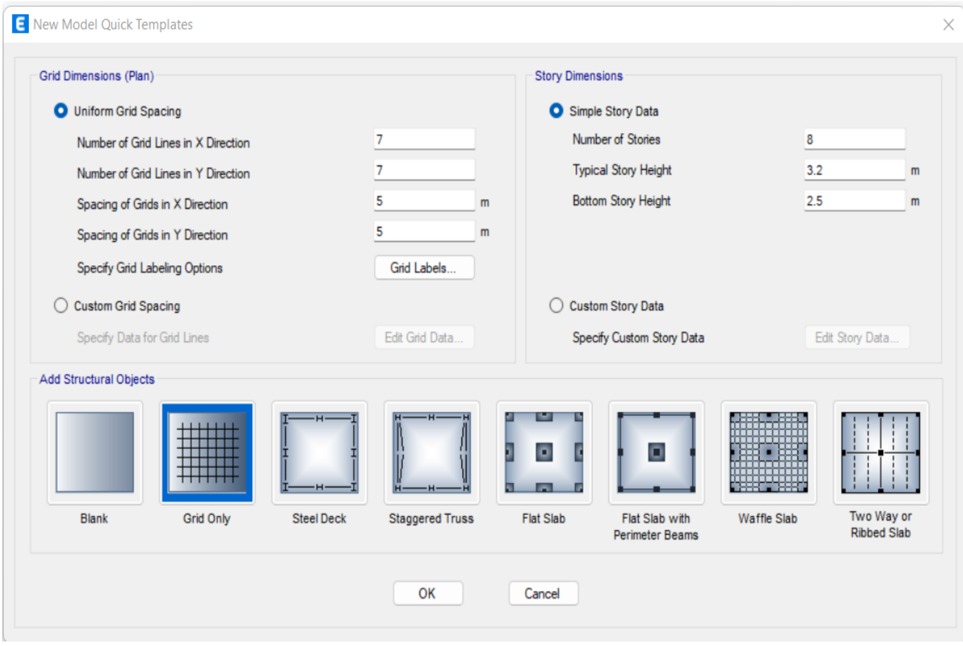


Fig 1 New Model Quick Template

Step 4: Defining the material characteristics of steel and concrete is the following stage. In this case study, green concrete and rebar HYSD 415 is taken into consideration, and the ETABS programme has access to its predefined features.

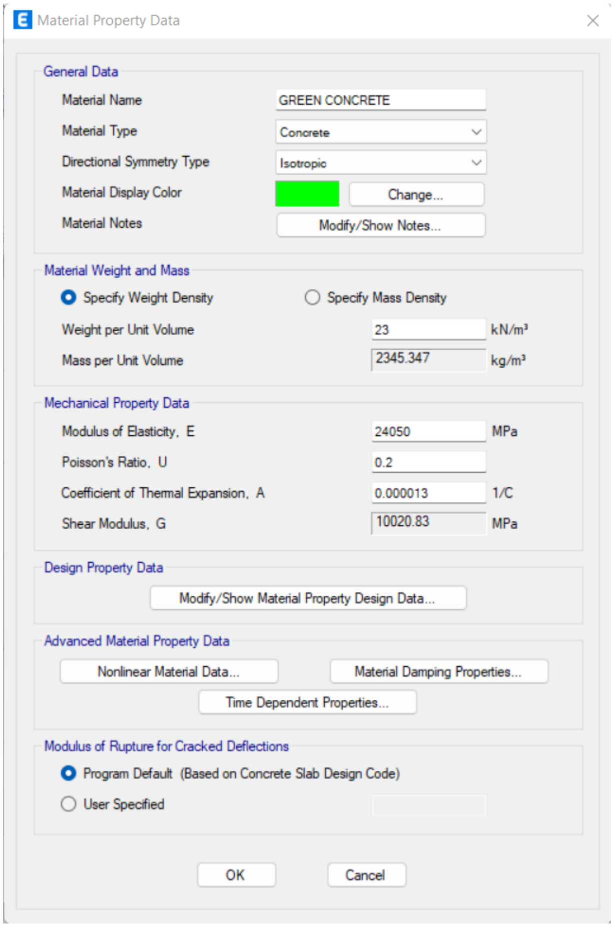


Fig 2 Defining Properties of Concrete M30

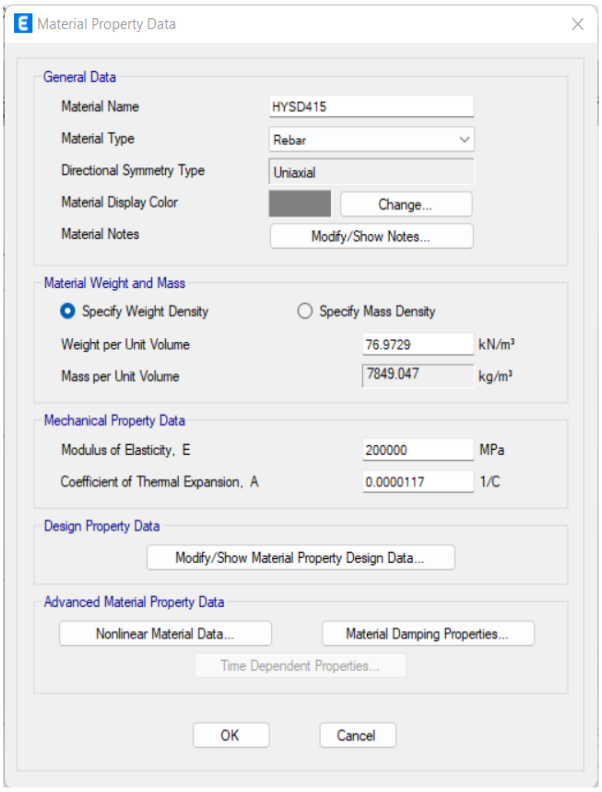


Fig 3 Defining Properties of Rebar HYSD 415

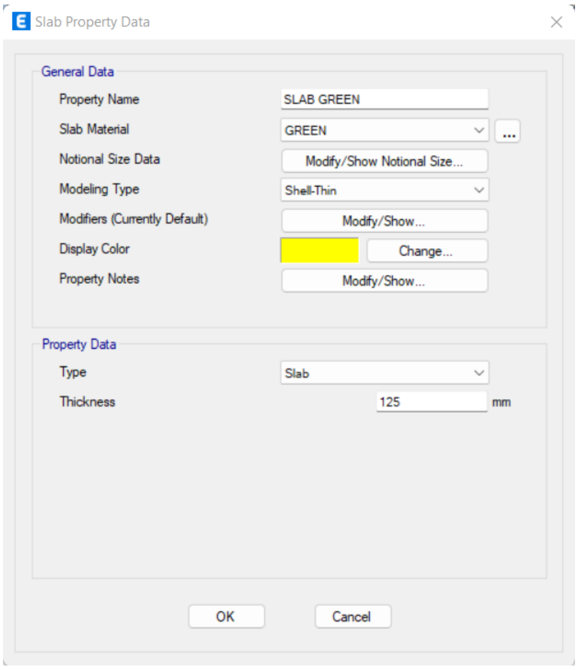


Fig 4 Properties of Green Slab

Step 5: Setting up the section's beam and column attributes. The analysis takes into account slab sizes of 125 mm, 450x450mm columns, and 400x300mm beams.

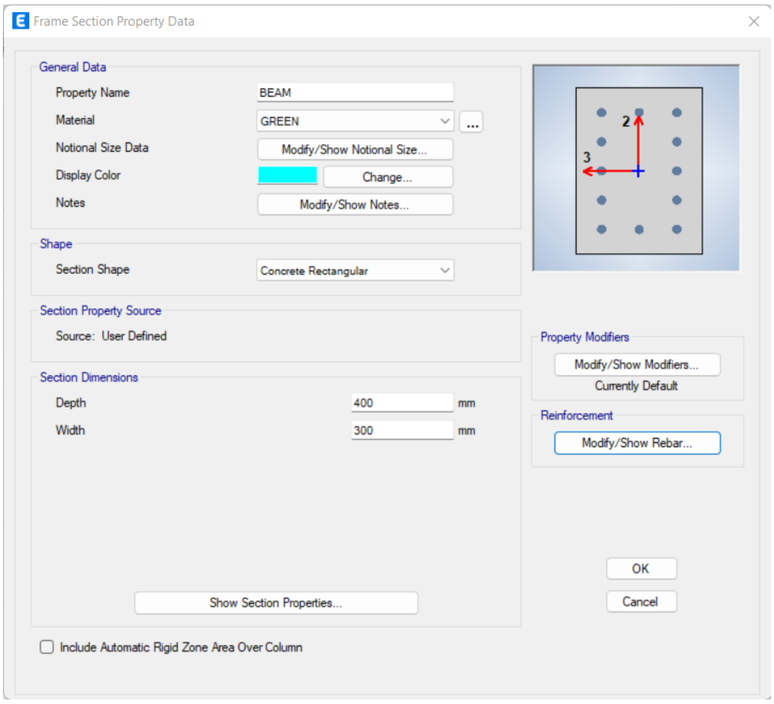


Fig 5 Defining the section properties of Beam

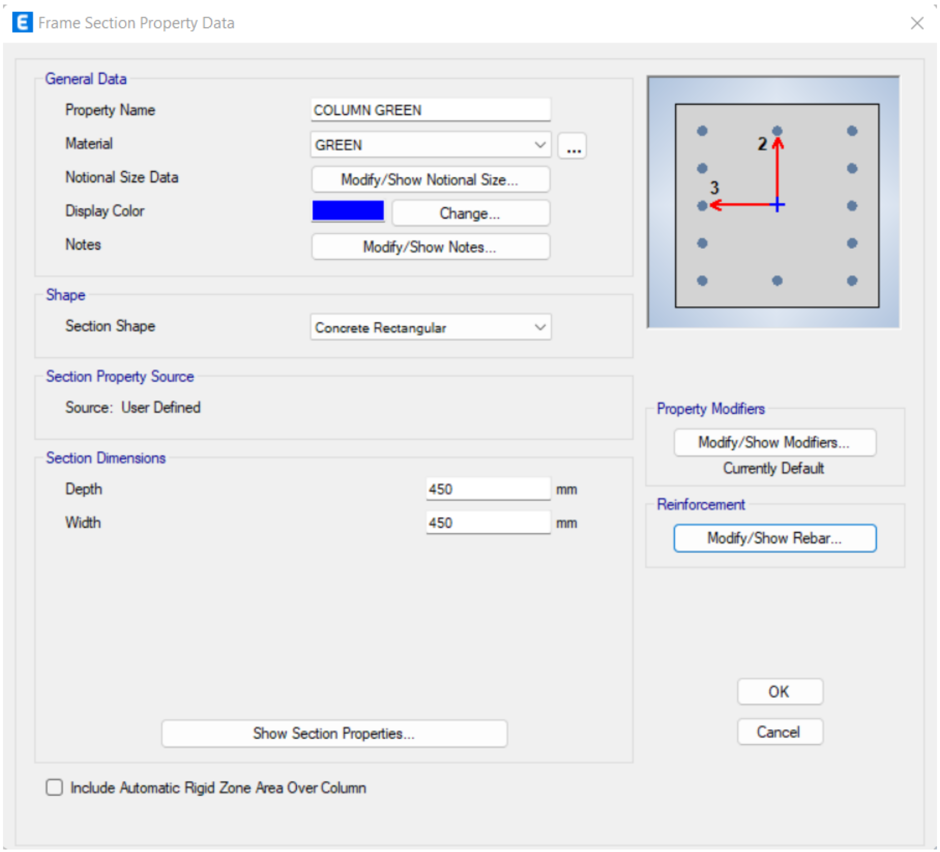


Fig 6 Defining Properties of Column

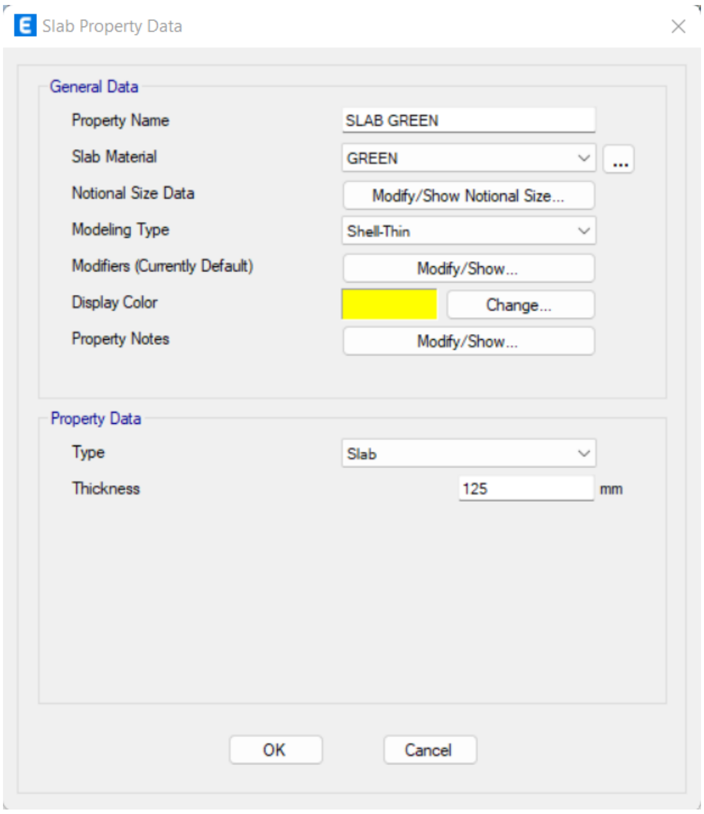


Fig 7 Defining the Properties of Green Shell-thin slab

Step 6: In both scenarios taken into consideration, assigning Fixed Support to the structure's base in the X, Y, and Z directions.

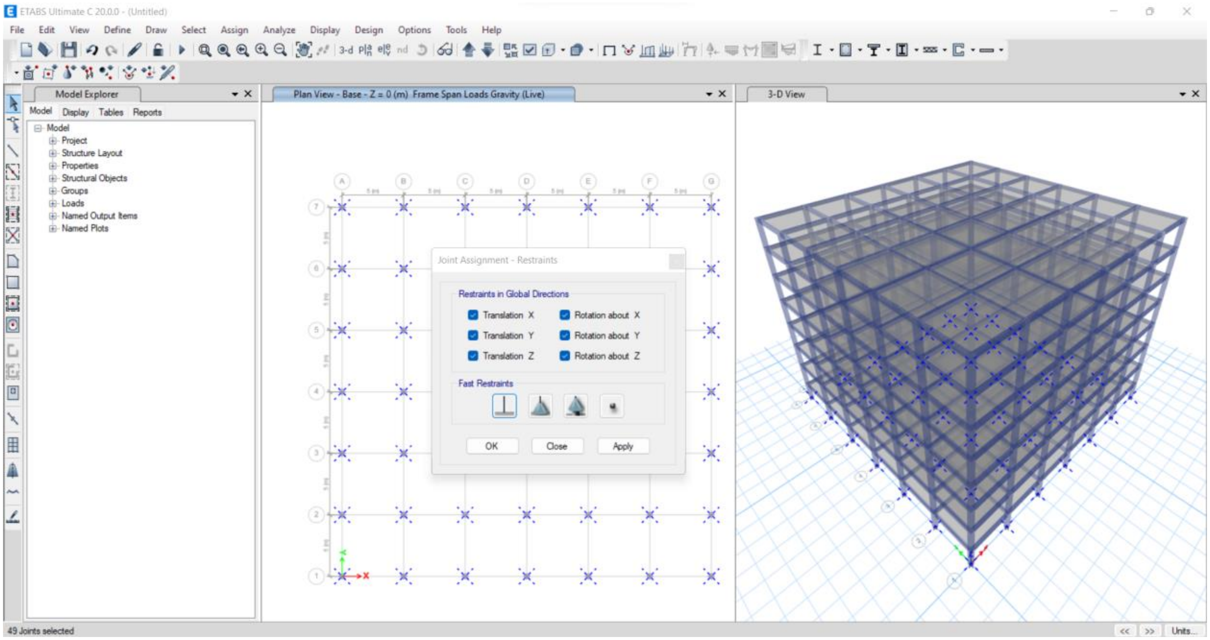


Fig 8 Assigning Fixed Support

Step 7: defining load instances for seismic analysis for the X and Y directions under dead load, live load, and other conditions.

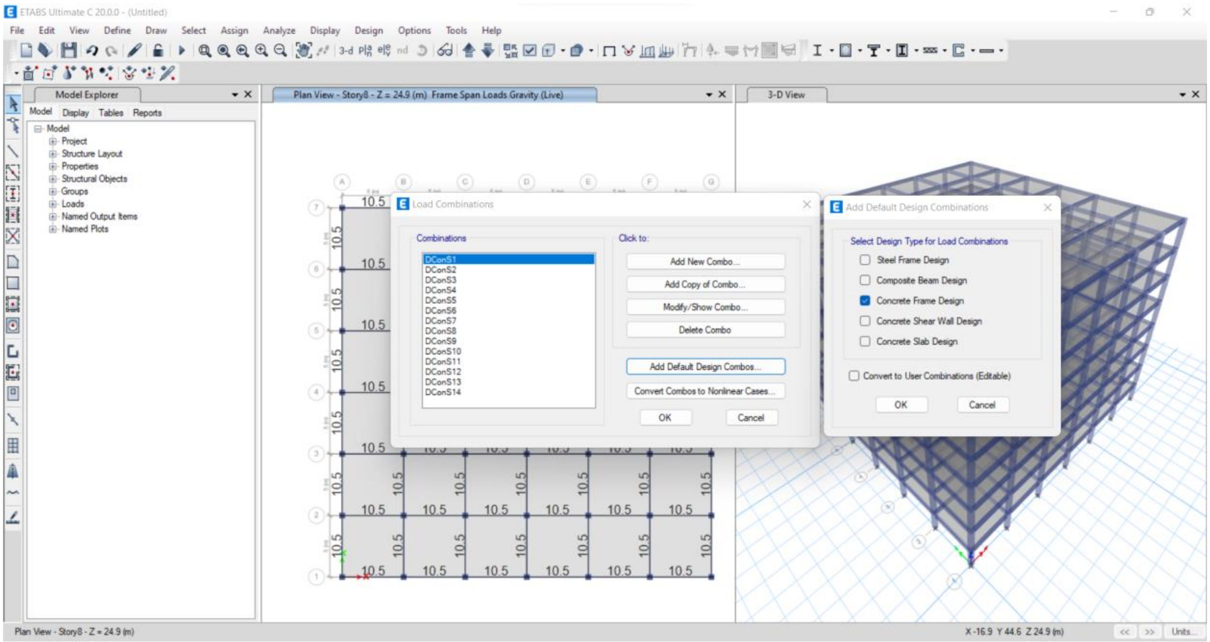


Fig 9 Defining Load Cases

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

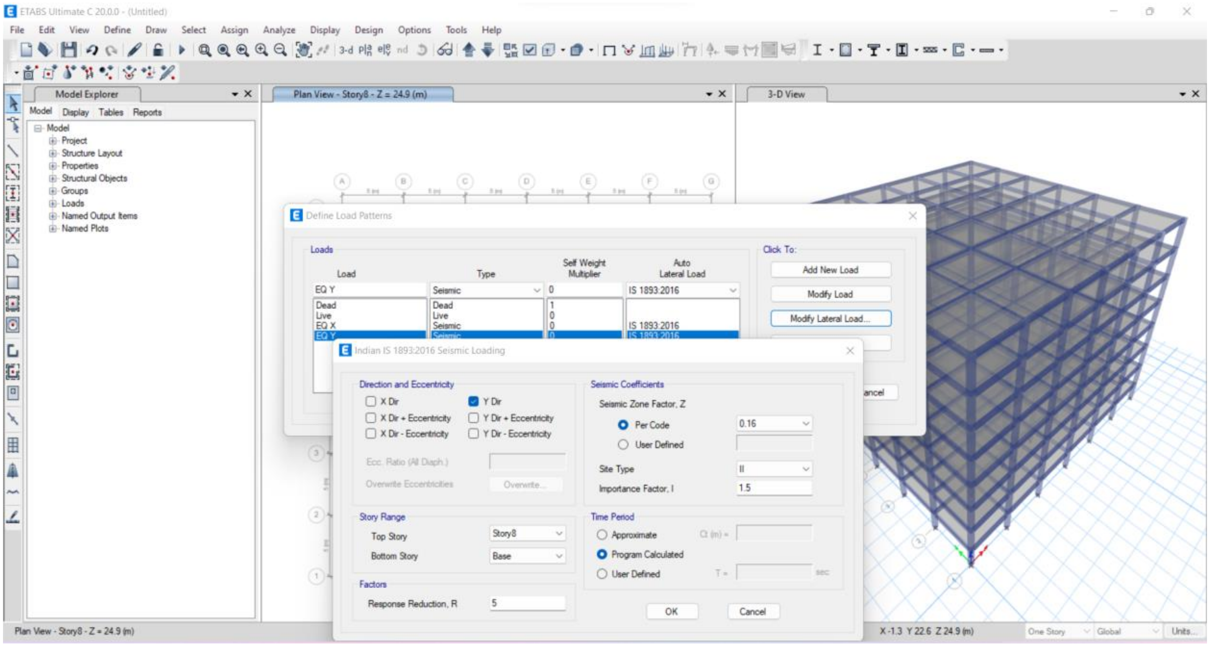


Fig 10 Seismic Loading for Soil Type I

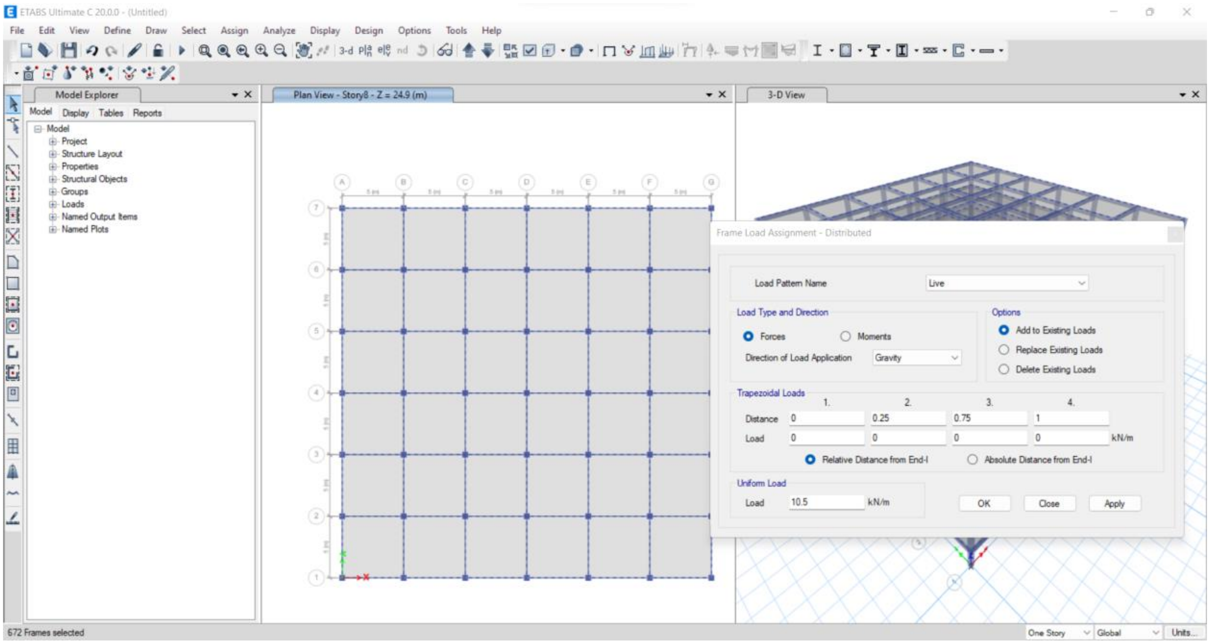


Fig 11 Assignment of frame load

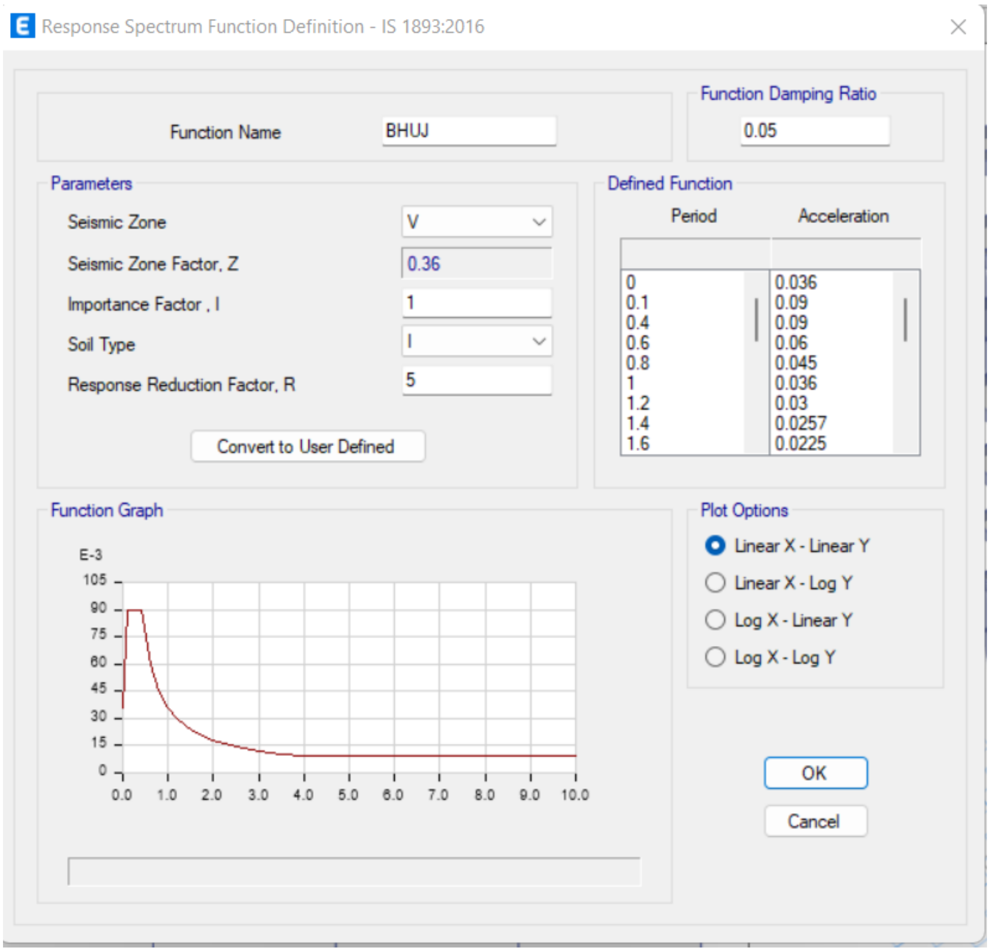


Fig 12 Defining Response Spectrum Analysis as per IS 1893-2016.

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

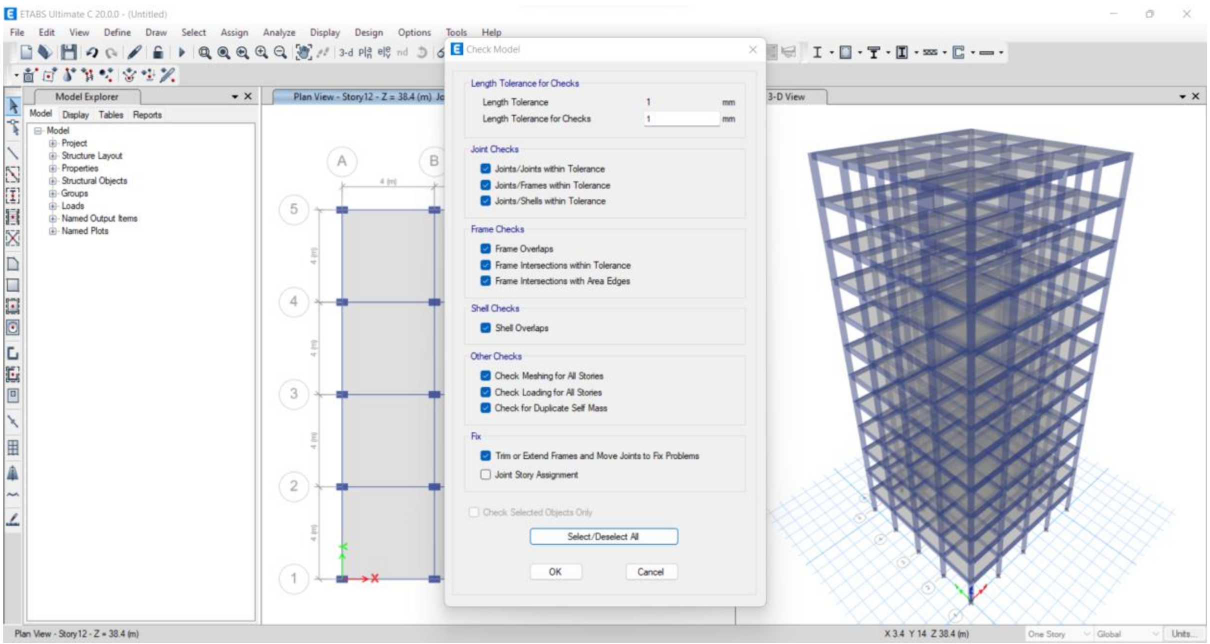


Fig 13 Model Check

Step 10: Static load, stress, and displacement analysis of the structure.

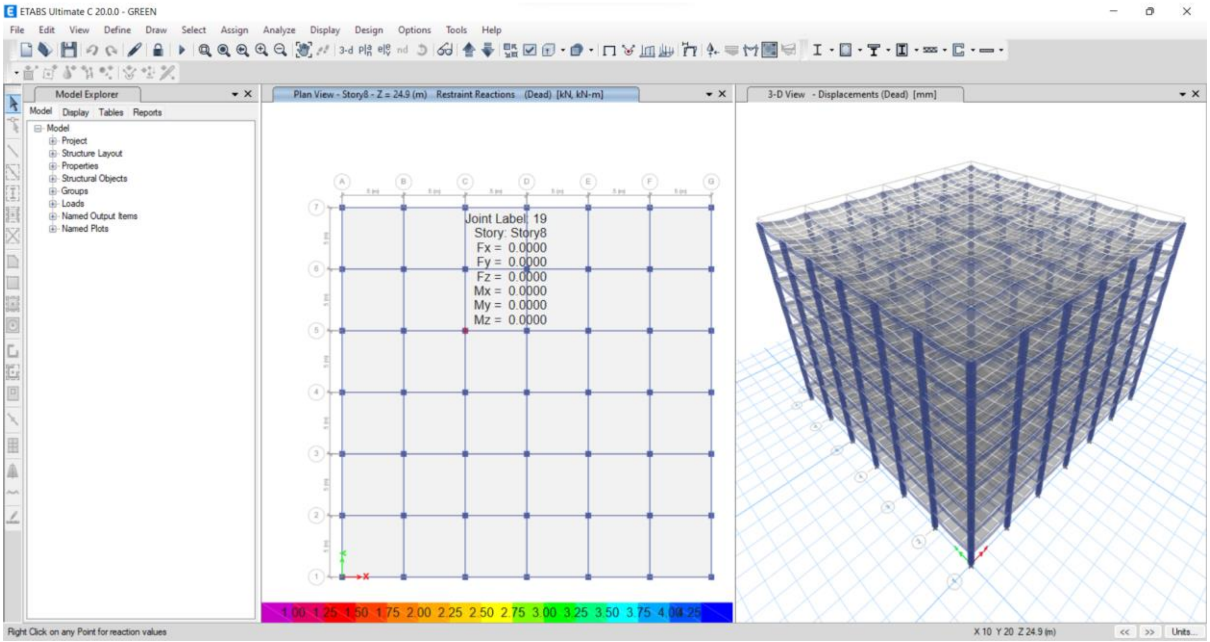


Fig 14 Stress Analysis for Dead Load

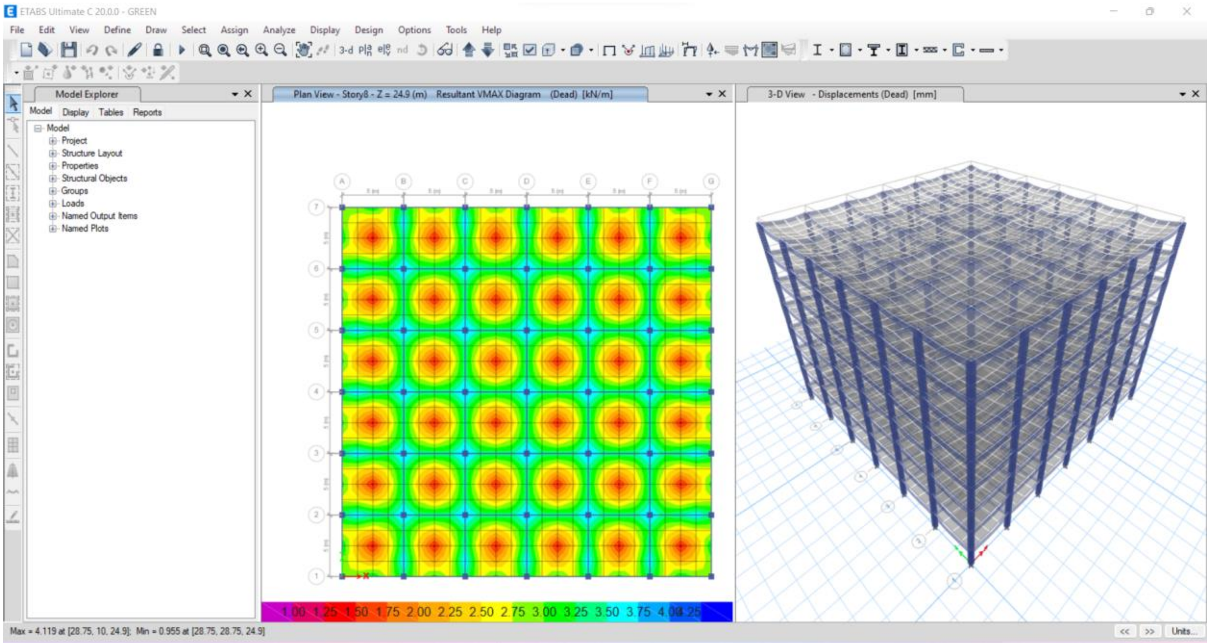
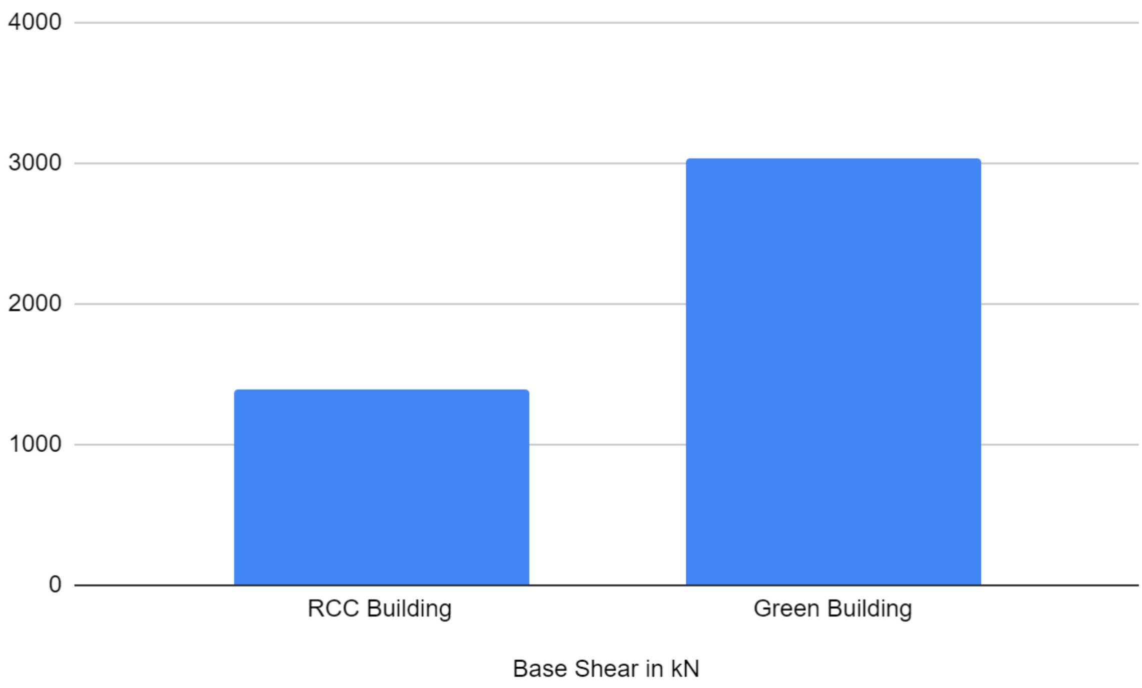
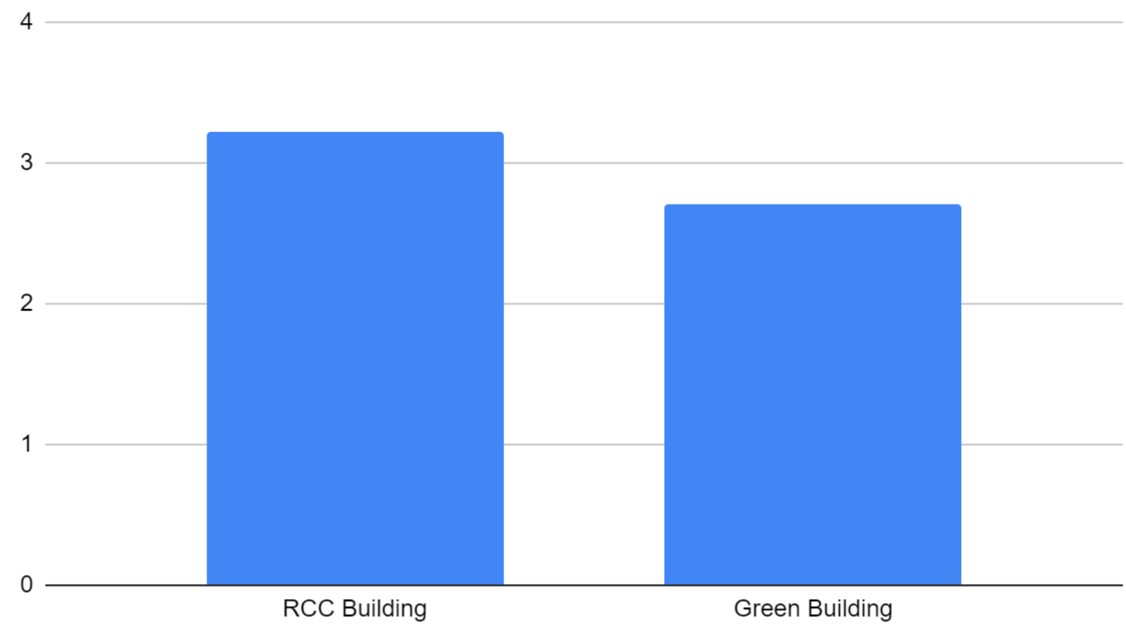


Fig 15 Displacement

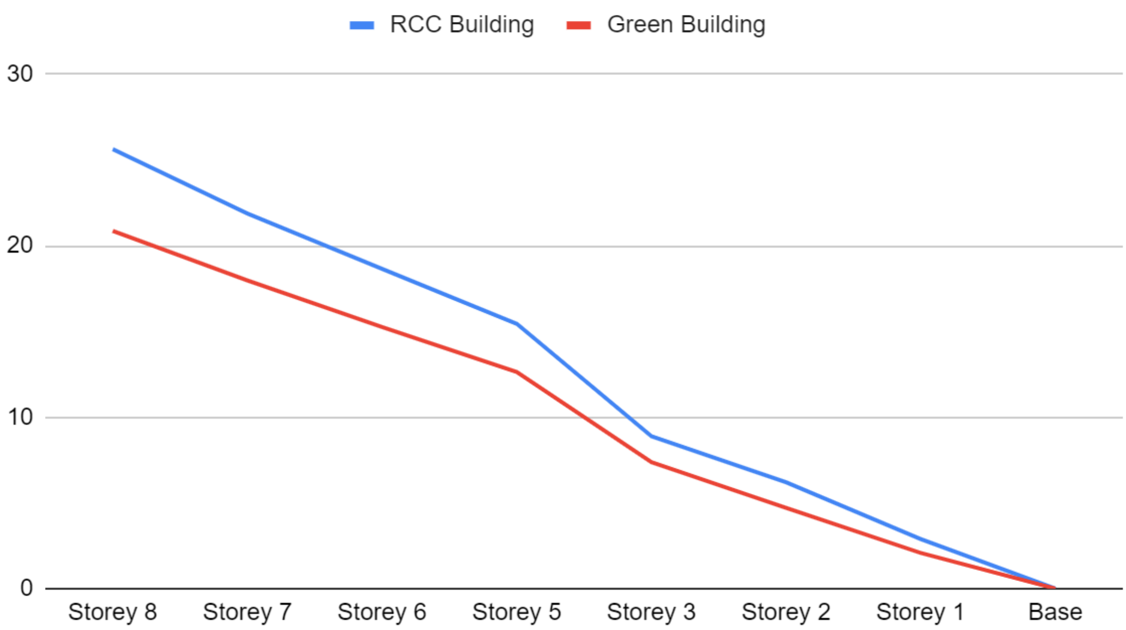
Geometrical Specification	
Particulars of Item	Properties
Number of Storey	G+8
Typical Storey height	3.2m
Bottom Storey Height	3.2m
Floor Diaphragm	Rigid
Number of Grid Lines in X-direction	6
Number of Grid Lines in Y-direction	6
Beam Size	400x300mm
Beam Shape	Rectangular
Column Size	400x400mm
Column Shape	Rectangular
Slab Depth	125mm
Slab Type	Thin Shell

II. ANALYSIS RESULTS

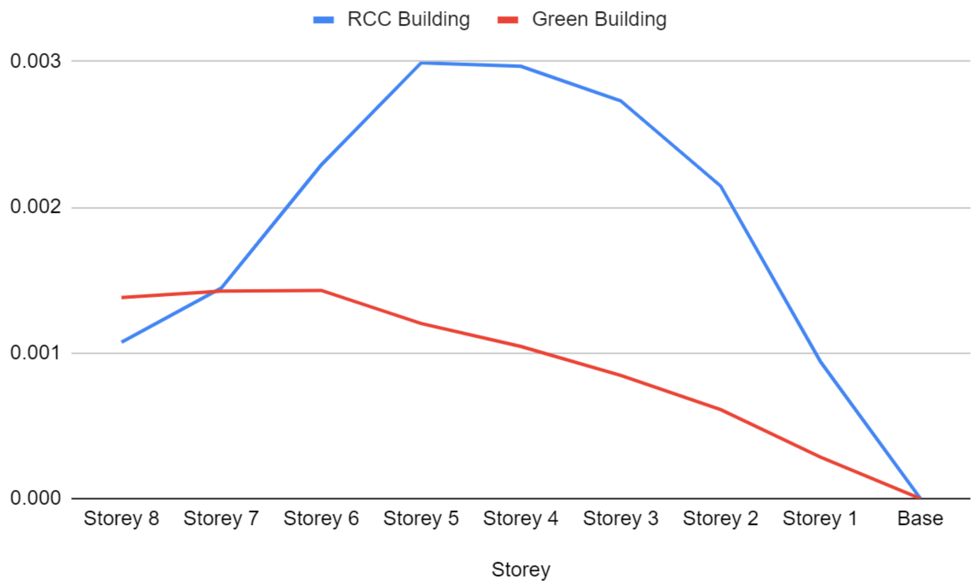




Natural Period in sec



Storey



III.CONCLUSION

Conclusion

The design process of a green building requires several stages such as the architectural design and structural design stages. In addition, a cost analysis is important to compare the cost of a conventional building to the cost of a LEED certified green to show how a green alternative is beneficial in the long run. In the structural design, several green features are added to the building such as solar panels, rain barrels, and vegetation on the roof. The green features are added to minimize the waste of vital resources such as water and electricity. Although the LEED-certified building is a costly alternative, the building's cost will be paid off in eight years and about three thousand dollars will be saved annually after the cost is paid off. Therefore, the green building design is an excellent choice for future projects because the design not only saves vital resources and helps in saving the environment, but also gets paid off in the long run.

Base Shear

It is an estimate of the maximum expected lateral force on the base of the structure due to seismic activity. It is calculated using the seismic zone, soil material, and building code lateral force equations. Results stated that the base shear is more for green building in comparison to RCC structure. The base shear of RCC structure is 9% less in comparison to green building since its mass and stiffness are less.

Time Period

Natural Period Tn of a building is the time taken by it to undergo one complete cycle of oscillation. It is an inherent property of a building controlled by its mass m and stiffness k. These three quantities are related by its units are seconds (s). $T_n = 2\pi\sqrt{(m/k)}$. The period was found maximum for RCC structure and least for Green Building.

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. The percentage decrease of storey displacement for green building was 2.21% compared to RCC structure along x-direction and y-direction. The maximum storey shear was visible for bare frame structure proving to be 12% higher which used to increase with height of each storey.

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. The percentage decrease of storey drift for green building is 36.11% compared to RCC structure along the x-direction.

Shear Force

Storey Shear is the lateral force acting on a storey due to the forces such as seismic and wind force. Buildings having lesser stiffness attract lesser storey shear and vice versa. The percentage decrease of storey shear for Green building was 7.50% compared to RCC Building along x-direction.

Storey Displacement

Storey Moment was on the higher side by 4.1 % in RCC structure and increased to 8% with the increase in height when compared to green building.

Cost Analysis

Cost analysis, also known as cost-benefit analysis, is the process of calculating the potential earnings from a situation or project and subtracting the total cost associated with completing it. It predicts the profit gained from a project and compares the project's cost to its estimated financial benefits. Green Building has proved o be a sustainable and cost-effective option which reduces the quantity of rebar and concrete reduced in the project. The current rates were considered as per SOR, INR. Green sustainable structure is comparatively more economical than bare frame by 8.4%.

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