Comparative Seismic Design and Analysis of G+27 Building

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Abstract — This study presents a comparative seismic analysis of a G+27 high-rise building using Conventional RCC structural systems and RCC–Steel Composite structural systems across India's four seismic zones (II, III, IV, and V). Using ETABS 16.0.3, eight 3-D models were developed and analyzed through the Response Spectrum Method as per IS 1893:2002 provisions. Key structural parameters—storey displacement, storey shear, storey drift, stiffness, and overturning moment—will evaluate to understand the influence of seismic intensity and structural configuration.

Keywords: RCC, E-Tabs,Seismic Zone,Drift, IS Code

I. Introduction

In rapidly expanding cities, high rise structures are the answer to the growing population needs. Vertical development in High-rise buildings offers facilities for those who are trying to make their lives easier since as horizontal expansion increases, problems with the electricity supply, water supply, sewage system, and transportation needs will also increase.

Investments in high-rise buildings are a symbol of the country's edge and a component of its economic strength. Many nations have aimed to advance by promoting the creation of thorough plans for the construction of high-rise investment projects in order to demonstrate their economic might and prestige in places like Hong Kong, Malaysia, the United Arab Emirates, and Qatar, among others.

A popular alternative to pure steel and pure concrete building around the world is steel- concrete composite construction. This strategy is a novel idea for the building sector, nevertheless. Because of their hazardous formwork and high dead load, R.C.C. are no longer viable.

Due to their many benefits, such as greater lateral load resisting behavior, faster erection, lower weight, better quality control, and shorter building times, composite construction has gained widespread adoption. The current study compares reinforced concrete, steel, and composite structures when static and dynamic loads are present.

II. Objectives

The primary goal of the project is to create an understanding of the behavior of three- dimensional structures by substituting structural steel members for conventional RCC construction in order to sustain the applied loads on the structure while being subject to seismic loads in various seismic regions of our nation.

The objectives of the study are:

- To examine how the country's four seismic zones affect the behavior of the country's columns and core wall structures.
- To evaluate the seismic performance of traditional RCC structural members and structural steel members when combined with RCC core walls during the course of the structure's service life.
- To use the dynamic analysis (Response spectrum) approach to test the behavior of the vertical members, such as columns and core walls, utilizing the ETABS16.0.3 commercial software

III. Methodology

Fig. 1: Flow Chart

A. Model Description

Eight structures—two models for each of the seismic zones of Zone II, Zone III, Zone IV, and Zone V—are modeled in this research. In the analysis, there are 8 models total, all of which are G+27 stories tall and have the same floor height, deck slab or slab thickness, floor finishes, wall load, and living load.

Regardless of the seismic zone, this project just deals with the soil type of being Medium for all of its constructions. Additionally, analysis is performed using a reference plan and taking into account a fixed support at the base of the building.

The usual floor design comprises of 112 plots totaling 4 BHK residential plots with 4 units per level. The structure has four lifts in total, all of which are protected by RC shear walls.

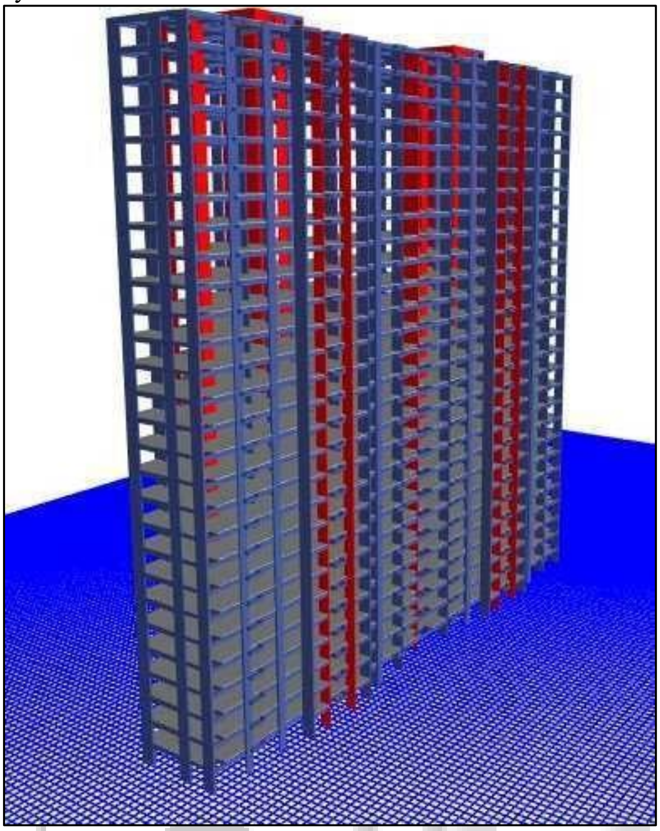
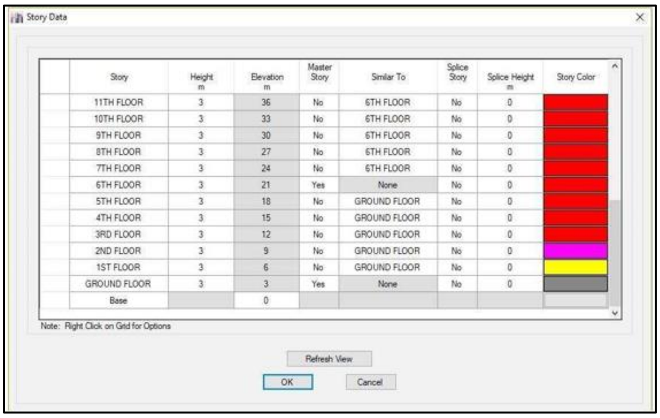


Fig. 2: 3D Model of ETABS

Column Dimension	Storey Level	Concrete Grade
1600 × 300	Ground floor to 5th storey	M60
1750 × 300	Ground floor to 5th storey	M60
1900 × 300	Ground floor to 5th storey	M60
1600 × 200	6th to 27th storey	M60
1750 × 200	6th to 27th storey	M60
1900 × 200	6th to 27th storey	M60
L – Shape 1600 × 300	Ground floor to 5th storey	M60
L – Shape 1600 × 200	6th to 27th storey	M60

Table 1 Column Dimensions in Conventional RCC Structure.

The basic model is constructed in the ETABS software in accordance with the aforementioned approach, and loads are applied as indicated below.By drawing the center line layout of the architectural plan and importing the DXF file with the storey data as input in "Storey Data," as shown below,



Story Data

Story	Height m	Elevation m	Master Story	Similar To	Splice Story	Splice Height m	Story Color
11TH FLOOR	3	36	No	6TH FLOOR	No	0	
10TH FLOOR	3	33	No	6TH FLOOR	No	0	
9TH FLOOR	3	30	No	6TH FLOOR	No	0	
8TH FLOOR	3	27	No	6TH FLOOR	No	0	
7TH FLOOR	3	24	No	6TH FLOOR	No	0	
6TH FLOOR	3	21	Yes	None	No	0	
5TH FLOOR	3	18	No	GROUND FLOOR	No	0	
4TH FLOOR	3	15	No	GROUND FLOOR	No	0	
3RD FLOOR	3	12	No	GROUND FLOOR	No	0	
2ND FLOOR	3	9	No	GROUND FLOOR	No	0	
1ST FLOOR	3	6	No	GROUND FLOOR	No	0	
GROUND FLOOR	3	3	Yes	None	No	0	
Base		0					

Note: Right Click on Grid for Options

Refresh View

OK Cancel

Fig. 3: Storey data from ETABS

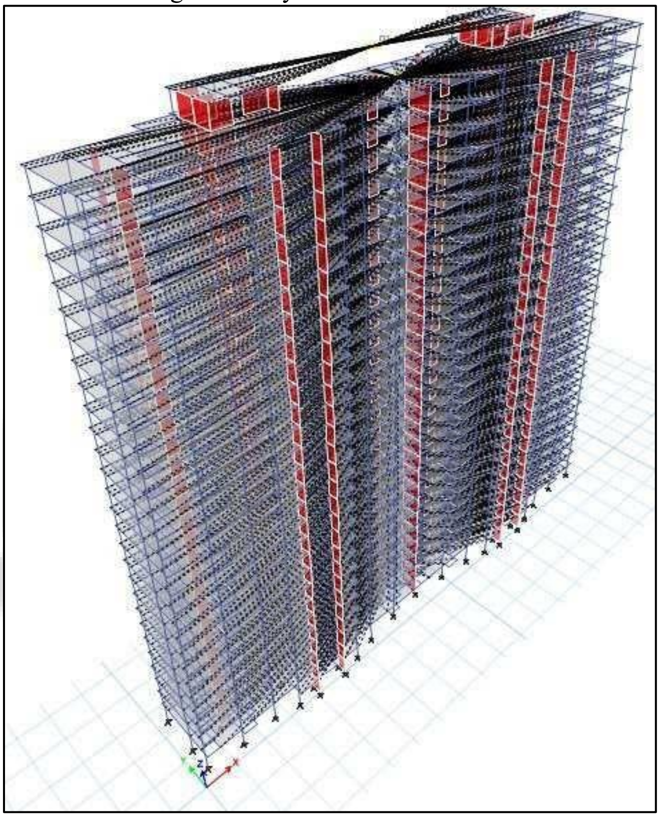


Fig.4: Diaphragm is an ETABS.

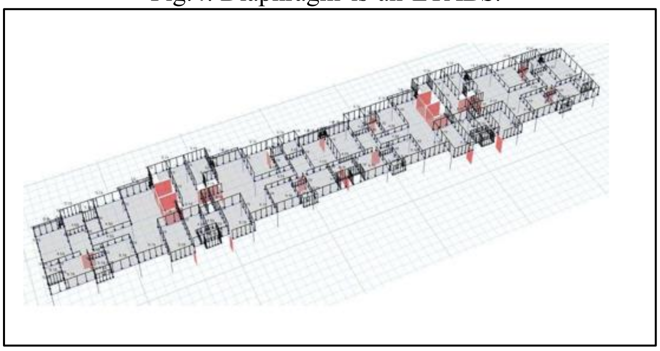


Fig. 5: Wall loads are applied using ETABS.

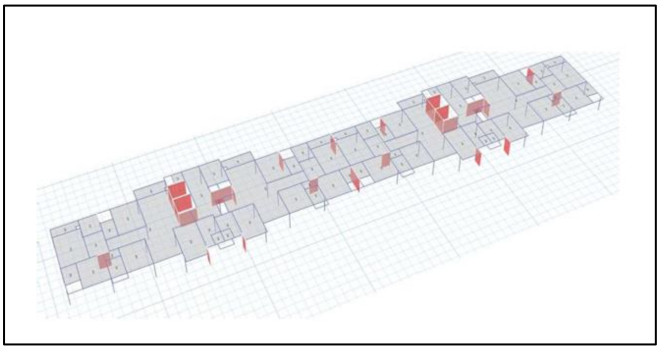


Fig. 6: Application of Live Loads (ETABS).

IV. RESULTS & DISCUSSION

The structures are being created for the dynamic analysis, which uses the ETABS 16.2.0 mention version program, which was stated in the previous chapter, to analyze the response spectrum.

Storey displacements, storey shear, storey drift, storey stiffness, and the structure's overturning moment are the structural factors taken into account in this project. Structural parameters are used to present the results in this chapter.

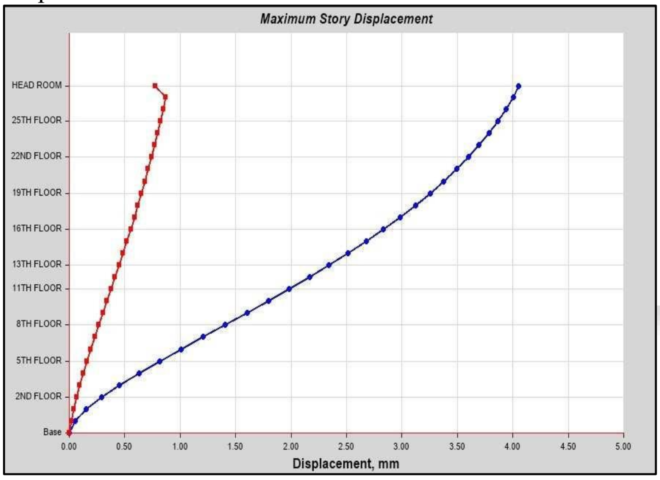


Fig. 7: RCC Wall-Frame Structure, Max. Storey Displacement, Zone-II in X-direction.

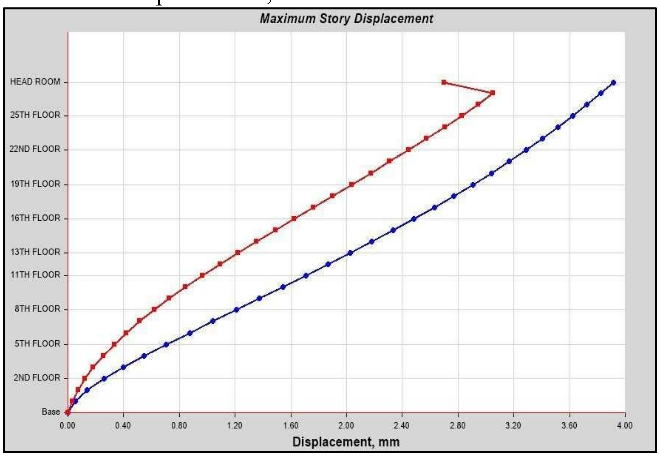


Fig. 8: Zone-II top storey displacement in X-direction for composites

Fig. 9: Max. Composite Structure with Storey Displacement Along the Zone-II Y Direction.

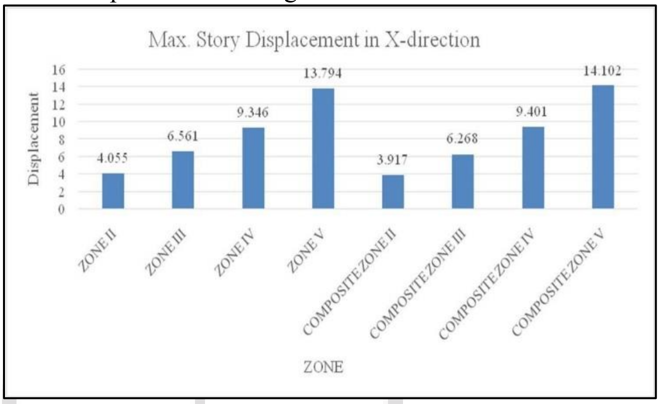


Fig. 10: maximum X-directional storey displacement comparison.

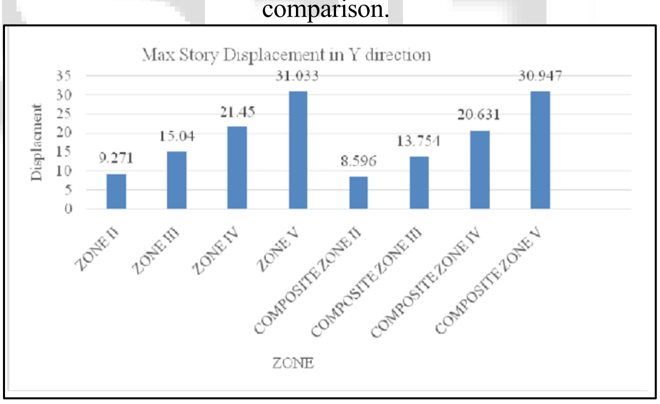


Fig. 11: X-direction Max. Storey Displacement comparison.

The following elements of this project can be inferred from the results above:

– The acceptable Since the overall height of the construction is 84.00 m and the maximum displacement value is H/250 as per IS 1893:2002, the maximum displacement should not be greater than 336 mm, and all the structures are well within the limit.
– Regardless of the kind of structure, the highest Storey displacement can be found in all seismic zones along the longer direction of the structural orientation.
– It was discovered that the conventional RCC structure offered more displacement in the absence of L-shaped columns and shear walls, therefore these features were added to reduce displacement and seismic drift and keep them within acceptable bounds.

- Compared to conventional rectangular or square RCC columns, L-shaped columns and shear walls have a higher moment of inertia, which significantly reduces displacement.
- Because of the decreased displacement values caused by the L-shape Column and shear walls, the displacement values were quite similar to those of the conventional RCC construction.
- Compared to conventional RCC structures, the displacement values of the RCC and steel composite structures were found to be 5 to 10% lower.

V. Conclusion

The following was concluded based on the studies conducted in the current work, which aimed to explore the seismic behavior of RCC and steel composite structures with RCC wall frame structures:

- The greatest option for high-rise buildings and towers in lower seismic zones like Zones II and III is composite structures. It was quite similar to the numbers for the two buildings because the L-shaped concrete columns' encouragement played a significant part in lowering displacement and raising stiffness of the structure in higher seismic zones like Zone IV and Zone V.
- It has been discovered that Composite structures have lower dead weights than Traditional RCC structures, which results in a higher reduction in lateral seismic forces in seismic Zones II and III.
- Concrete provides great resistance to compressive loads, while steel structural members have excellent tensile loading resistance but are subject to buckling. In composite structures, steel can be utilized to create the necessary ductility, while concrete can be used to prevent corrosion and fires.
- Because the conventional RCC structure mimics composite structures in higher seismic zones by using L-shaped columns and shear walls, seismic values returned from the analytical engine were remarkably comparable to those reported in the preceding chapter.
- When compared to the conventional RCC constructions, Composite structures will be significantly cheaper in terms of economic criteria. However, drift and displacement are significantly reduced by moment-resistant components like shear walls. In addition, as compared to composite buildings, traditional constructions will take more time and have a bigger impact on the project's budget.

Finally, it can be said that the choice of structure type depends on the loads that the structure must endure. The designer can rely on numerous studies, such as the one in this project, to obtain the most optimal, economical, and environmentally friendly construction for society.

Acknowledgement

Simply to acknowledge the help verbally is not the complete way of expressing the feelings. Even though the words, if brought from bottom of the heart, can serve the purpose to a considerable extent. this is also a small effort for the same. First of all, I am humbly expressing thanks to my respected guide Prof. Nirmal S. Mehta (Assistant Professor, Department of Civil Engineering, Ganapat University) for his valuable time and constant help given to me. He encourages me to express my ideas freely and gave valuable suggestion during the implementation of project work. It was a great learning experience right from searching for the topic for my dissertation phase-1.

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