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A Review on Comparative Analysis of Multistorey Buildings Under Various Indian Seismic And Soil Conditions

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Abstract - *Due to India's vulnerability to seismic activity, the paper emphasizes the need for research on the analysis of structures in seismic zones and soil conditions. It highlights how crucial it is to comprehend how various building types react to seismic stress in order to lessen the devastating effects of earthquakes on infrastructure and people. By shedding light on the benefits and drawbacks of different structural systems, the study hopes to improve building practices. It takes into account elements like overall stability, stress distribution, deformation, and seismic performance under various load scenarios. A comparison of high-rise reinforced concrete irregular buildings with and without shear walls is also included in the paper. It evaluates variables like modal period, storey displacement, storey drift, shear force, bending moment, and building torsion using analytical methods and simulations. The investigation also takes into account various structural forms. The overall goal of the research is to offer a thorough understanding of how different structures behave in India's various seismic zones, which will improve building techniques and seismic vulnerability assessments.*

Key Words: *Seismic analysis, Multistorey Buillding, Structural Design, Seismic Load, E-tabs.*

1.INTRODUCTION

India's vast and varied terrain is marked by different degrees of seismic hazard, which makes in-depth study of the evaluation of structures in seismic zones necessary. Structures are more vulnerable in high-seismic-risk areas, such as those near tectonic plate boundaries, necessitating a careful analysis of construction materials and design principles. To determine the unique difficulties brought about by seismic activity and to create resilient construction techniques, research in these areas is crucial. Through examining how distinct structural systems react to seismic strain, scholars can acquire significant understanding of the benefits and drawbacks of different kinds of buildings. By improving a structure's seismic performance, this knowledge helps lessen the effect of earthquakes on surrounding communities.

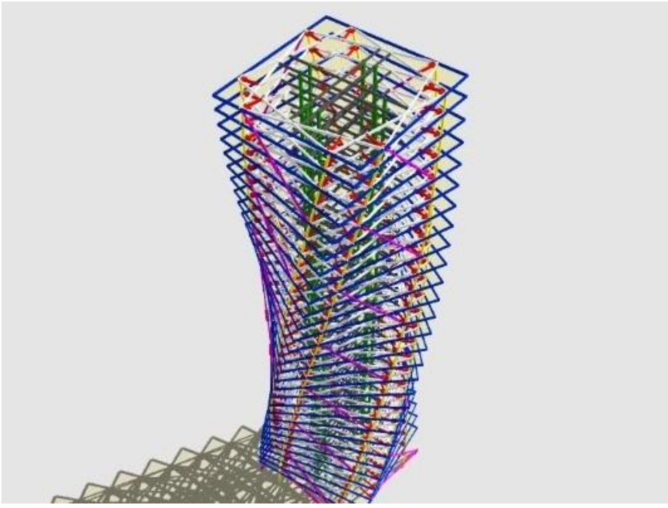

Figure 1: Structural representation

Furthermore, seismic studies provide a basis for the creation of seismic building standards and codes specific to various Indian regions. Strictly based building codes are necessary to guarantee that newly constructed buildings meet the strictest seismic safety requirements. Regulatory bodies can promote an earthquake-resilient culture in the construction industry by establishing guidelines that prioritize the safety of structures and occupants, a practice that is made possible by incorporating the lessons learned from seismic analysis.

In conclusion, studies on the evaluation of Indian seismically vulnerable structures are essential to the preservation of infrastructure and human life. The country's varied seismic risk makes it necessary to take a nuanced approach to comprehending how different regions' buildings behave. These studies provide valuable insights that not only guide the design and construction of new buildings, but also play a major role in the development of robust building codes and retrofitting strategies. The knowledge gained from seismic research will be crucial in developing a built environment that is safer and more resilient as India continues to urbanize and grow. Regulatory bodies can promote an earthquake-resilient culture in the construction industry by establishing guidelines that prioritize the safety of structures and occupants, a practice that is made possible by incorporating the lessons learned from seismic analysis.

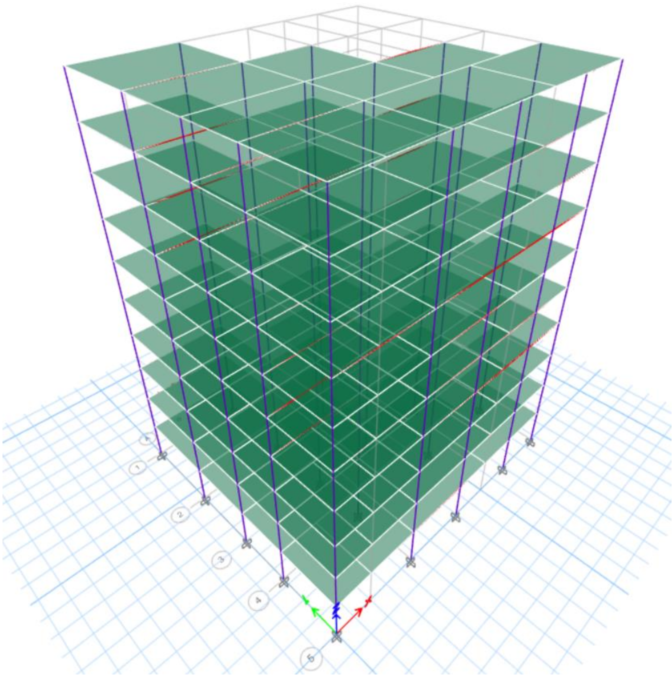

Figure 2: E-tabs Structural model

1.2 Objective

- To compare the susceptibility of different structures in different seismic zones of India, conduct an assessment of seismic vulnerability.
- To compare the performance of different buildings under different soil conditions.
- Examine how India's seismic zoning map affects structural performance, taking into account the various features of each zone.
- Utilizing analytical techniques and simulations, assess and contrast the deformation, stress distribution, and overall stability of various structures.
- To analyze different buildings using E-tabs software.

2. Literature Review

[1] Md. Sabbir Hossain, S.K. Singh, "Comparative analysis of irregular RCC buildings in different zones" IOP Conf. Series: Earth and Environmental Science (2023)

This research paper compares and contrasts two irregularly designed Reinforced Cement Concrete (RCC) building plans that are intended to withstand seismic loads and gravity in different seismic zones. The extended three-dimensional analysis of building systems (ETABS) and the response spectrum method (RSM) are both used in the study to evaluate the earthquake performance of these structures. Important factors like earthquake resistance, serviceability, and design considerations are all included in the evaluation, with a focus on how the system responds to seismic and gravitational forces.

There were two distinct irregular RCC building plans for G+9 and G+25, and they were exposed to four distinct zones—Zones 2, 3, 4, and 5—for a total of eight models. Notable results are obtained from the analysis, which was carried out using the Indian Standard (IS) 1893 for earthquake load. When it comes to base shear, maximum story displacement, and maximum story drifts, the models located in lower seismic zones perform better. This implies that these buildings are more resilient to the dynamic forces brought on by seismic activity. A thorough grasp of the structural behavior under various loading scenarios is provided by the application of the response spectrum method and extended three-dimensional analysis.

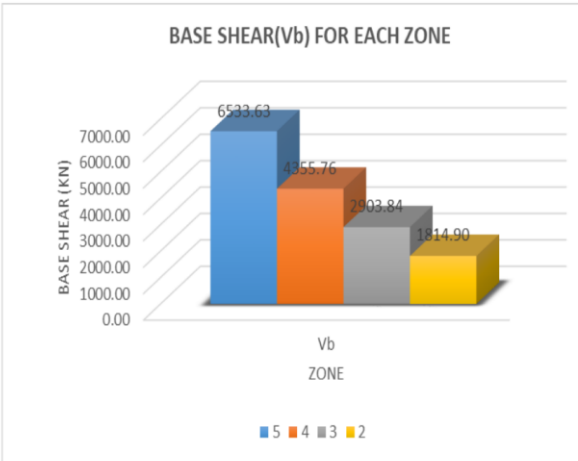

Figure 3 Base shear for G+25

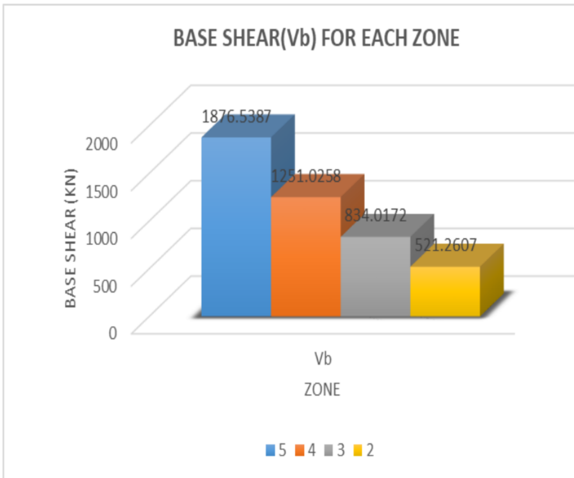

Figure 4 Base shear for G+9

[2] Deepali Vasudev, Anjali Rai, "Comparative Study on Seismic Analysis of Multi Storied RC Framed Structure with and without Diaphragm Discontinuity" International Journal for Research in Applied Science & Engineering Technology (IJRASET), (2021)

This study delves deeply into the topic of seismic analysis as it relates to multi-story reinforced concrete (RC) framed buildings. The study's main focus is on how diaphragm discontinuity—more especially, architectural openings or structural cutouts—affects how these buildings behave under seismic stress. The term "diaphragm discontinuity" describes breaks in a building's horizontal components, like its floors or roofs, which may have an impact on how seismic loads are distributed.

A building plan measuring 25 meters by 25 meters was taken into consideration for the structural analysis, and the structure is regarded as a residential building for the purposes of the load applications. The structure has been examined with a generic storey height of 3 meters in mind. To look into how seismic forces affect the structure with the diaphragm discontinuity, different percentages of the openings have been provided in the structure. The percentage of gross area occupied by the openings has been provided. We have four models: 0%, 5%, 10%, and 17%, with increasing opening percentages.

The analysis's conclusions provide important new information about how the structure's openings affect its seismic behavior. The research has revealed that the introduction of architectural openings or cutouts has altered the load transfer path within the building, which is one significant outcome. It is clear from this that diaphragm discontinuity must be taken into account in seismic design and analysis since it significantly affects the structure's overall response to seismic forces. For engineers and architects involved in the planning and construction of buildings in seismically active areas, this information has important practical implications for seismic design procedures.

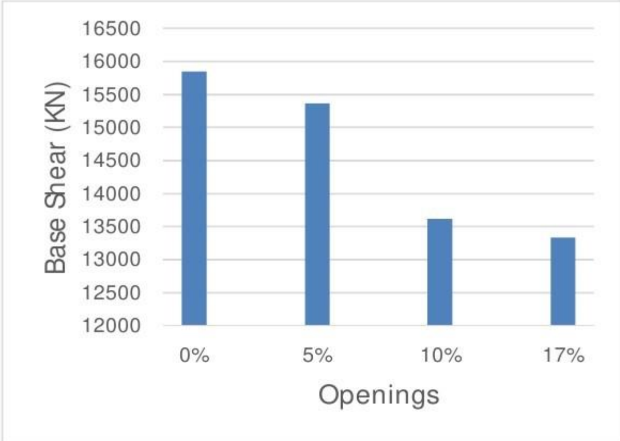

Figure 5 Base shear of all models

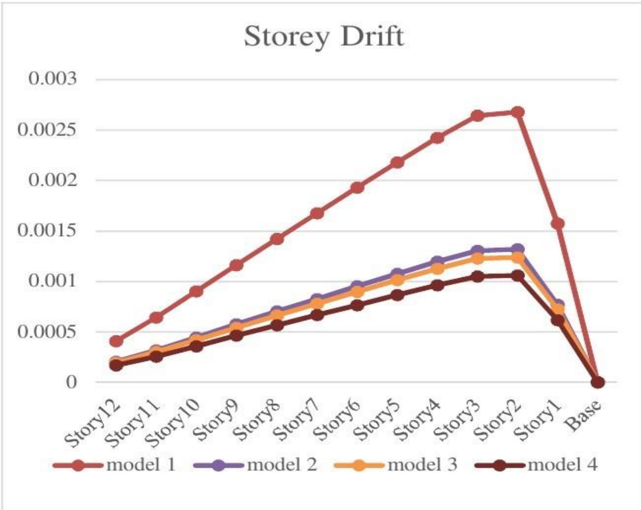

Figure 6 Storey drift of all models

[3] Suraj D. Vasave, Ganesh N. Vhankade, Aniket S. Kumbhar,Akshay R. Damse, V.P. Bhusare, Dr. N.V. Khadake "Comparative study of dynamic behavior of g+4 building with different configurations in seismic zone iii using Etabs software." International Research Journal of Modernization in Engineering Technology and Science (2023)

The study under review offers a thorough comparative analysis with an emphasis on the dynamic behavior of G+4 buildings in seismic zone III. With the use of the ETABS software, the study focuses on structures that have two different spatial configurations: rectangular, H-shape, C-shape and hollow shape with non-parallel x and y coordinates. The effect of slenderness ratio on these structures is one of the main issues the study addresses. This study is important because it may provide important new information about how mid-rise structures with different geometric features behave during earthquakes.

A crucial component of the study is the analysis of various structural parameters. The study looks into the reaction moment, story drift, and base shear among these. The researchers obtain a sophisticated understanding of how various building configurations react to seismic ground motion by closely examining these parameters. The conclusions regarding the seismic resilience of G+4 structures are based on this thorough analysis, which offers crucial information to structural engineers and urban planners working in earthquake-prone areas.

The study's main conclusions include the realization of how significantly building shape affects a structure's ability to withstand seismic forces. The choice of spatial arrangement, whether square or rectangular, can have a big impact on how well a building can absorb and release seismic energy, as the conclusion makes clear. This realization is crucial for directing future building procedures and design choices in seismically vulnerable areas.

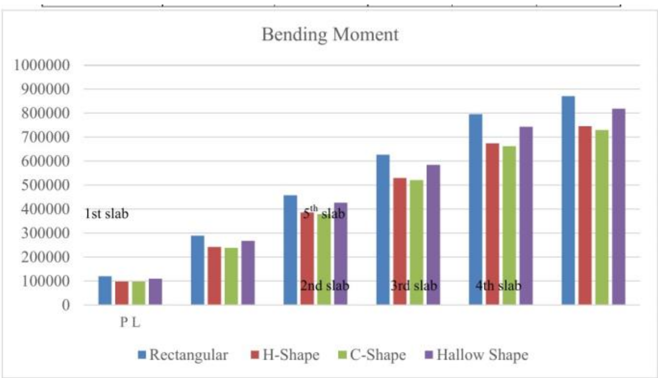

Figure 7 Bending Moment graph

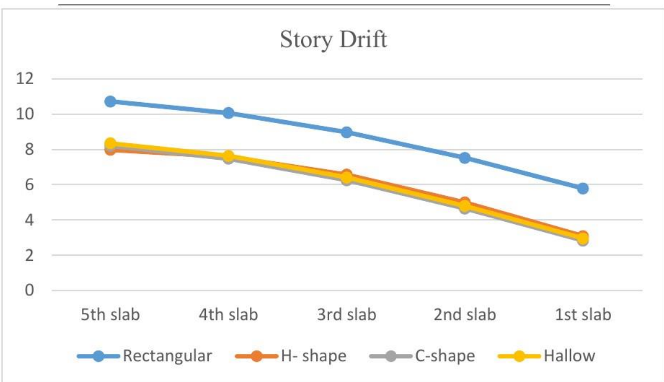

Figure 8 Story drift graph

[4] G.Vamshi Prathap ,D.Radha "Comparative analysis of behaviour of horizontal and vertical irregular buildings with and without using shear walls by etabs software." Journal of Engineering Sciences (2023)

The current paper investigates the structural buildings having vertical and horizontal irregularities with and without the provision of shear wall. The analysis of the G+12 multi-story commercial building in zone 2 is taken into consideration in the current study using ETABS. Shear walls are essential for improving high-rise reinforced concrete buildings' seismic performance, especially during earthquakes. When compared to buildings without shear walls, these vertical structures significantly lessen the displacement of building stories, showing a reduction of 50–70%. This significant advancement in displacement control is essential to the structure's overall stability and seismic event safety.

Building structures with irregularities, particularly those with vertical irregularities, are significantly more likely to fail during earthquakes. Variations in mass and stiffness along a building's height are examples of vertical irregularities that significantly affect seismic performance. In order to overcome these difficulties, shear walls increase resistance to lateral loads, lessen the negative effects of irregularities, and improve the building's overall structural integrity.

The presence of shear walls is not the only factor that determines their effectiveness; other factors include their design. In structures with shear walls, the resistance to lateral loads rises linearly with the shear wall's thickness. But the shear wall's width has an even more noticeable impact on how well it performs. This emphasizes how crucial it is to take into account both width and thickness when designing structures with shear walls in earthquake-prone areas.

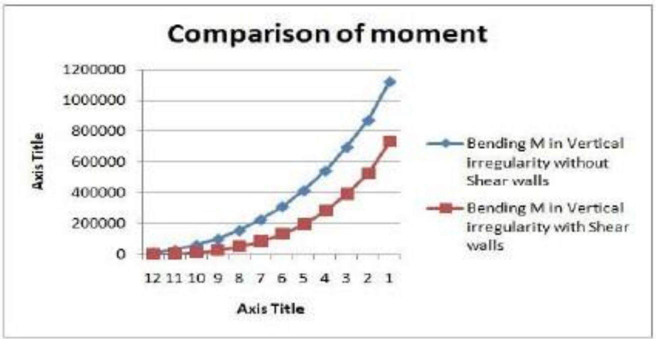

Figure 9 Moment graph

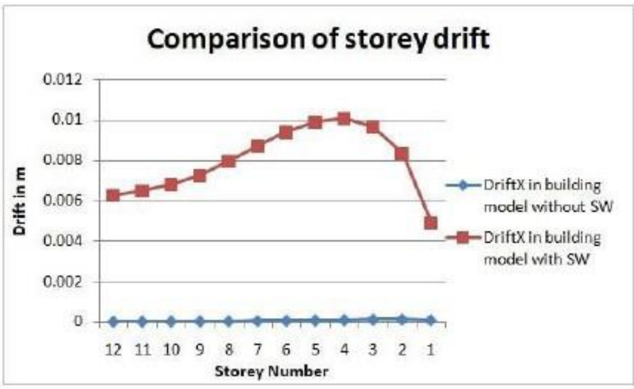

Figure 10 Storey drift graph

[5] Kiran Devi, Subhankar Petal "A Comparative Study on Seismic Analysis of Multistorey Buildings in Different Seismic Zones" Journal of Smart Buildings and Construction Technology (2023)

The study offers a thorough examination of how multistory buildings behave seismically in different seismic zones. This study examines the performance of a reinforced concrete (RC) structure with a maximum height of eight stories in seismic zones III, IV, and V. This study's main goal is to use the ETABS analytical model to compare the percentage of longitudinal steel, reinforcement details, and design base shear of a single G + 8 story reinforced concrete (RC) structure in three distinct seismic zones—India's III, IV, and V. The analysis takes into account a number of important variables, such as the building's inherent frequency, damping factor, base type, structural significance, and ductility.

It is observed that when the seismic zone shifts from III to V, the amount of bottom midspan reinforcement in the beams increases significantly, ranging from 13% to 35%. This suggests that in response to the increased seismic forces, there is a greater need for reinforcing elements in the beams, especially at the lower levels of the structure. Furthermore, the total amount of steel needed for the structure increases gradually from seismic Zone III to V by about 35%. This emphasizes how crucial it is to give material qualities and structural design significant thought in areas with greater seismic activity.

The differences in base shear, reinforcement details, and overall steel demand observed in the G + 8 storey RC structure across seismic zones III, IV, and V highlight the need for increased attention to earthquake-resistant construction practices, especially in higher seismic zones.

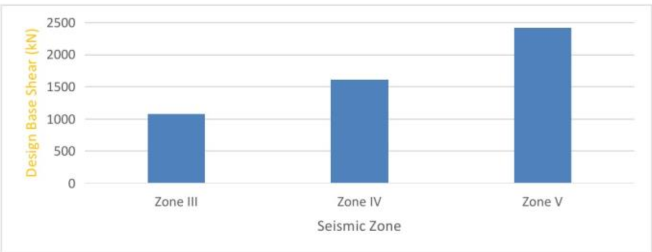

Figure 11 Design base shear

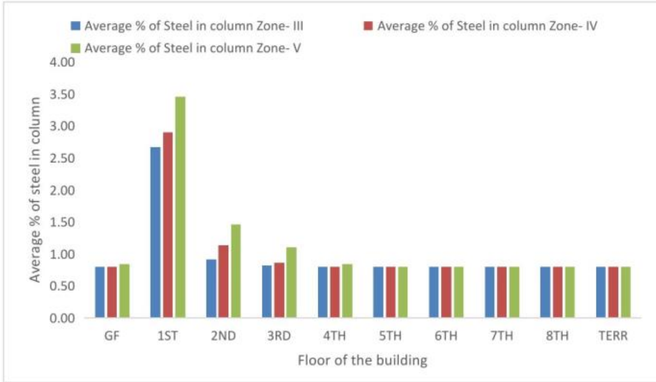

Figure 12 % steel in column

3. CONCLUSIONS

Studies on the evaluation of Indian seismically vulnerable structures are essential to the preservation of infrastructure and human life. The country's varied seismic risk makes it necessary to take a nuanced approach to comprehending how different regions' buildings behave. These studies provide valuable insights based on the research of various buildings having various irregularities as stated above. Some of them are as below:

- Maximum displacement and the number of storeys have an inverse relationship with the seismic zone coefficient.
- There is an inverse relationship between base shear and seismic zone coefficient increase.
- The structural performance against earthquake load is significantly influenced by the length and width of the structure.
- The load transfer path and the behavior of a multistory building under seismic forces can be greatly impacted by the presence of architectural openings or discontinuities.
- Reducing the storey drift indicates less lateral displacement, which is correlated with increasing the percentage of openings in the structure.
- The base shear, which represents the maximum expected lateral force, also decreases as the percentage of openings increases.
- The way a structure is designed for its shape can have a big impact on how it responds structurally to ground motion caused by earthquakes.
- The base shear, which represents the maximum expected lateral force, also decreases as the percentage of openings increases.

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- As seismic zones increased, the quantity of top longitudinal steel at support sections in beams varied from approximately 0.23 to 0.46, while the quantity of bottom longitudinal steel at support sections in beams varied from approximately 0.23 to 0.36.

- Between seismic Zone III and V, the quantity of bottom midspan reinforcement in beams increased by roughly 13 to 35, and the total amount of steel required increased gradually by about 35.

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