Seismic Analysis of High-Rise Building in Different Zones Using ETABS

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Abstract— **High-rise reinforced concrete (RC) buildings are increasingly vulnerable to seismic forces due to their height and flexibility, making seismic analysis an essential aspect of structural design. This study evaluates the seismic performance of a G+25 RC building using ETABS software in accordance with IS 1893 (Part 1):2016. The building was analysed under Seismic Zones II, III, IV, and V by considering gravity and seismic loads. Key response parameters such as storey displacement, storey drift, base shear, and natural time period were evaluated to understand the structural behaviour under varying earthquake intensities. In addition, the effectiveness of shear walls placed at corner locations was assessed by comparing the structural response of buildings with and without shear walls. The analysis results indicate that seismic response increases with the seismic zone factor, resulting in higher displacement, drift, and base shear in higher seismic zones. The inclusion of corner shear walls significantly reduced storey displacement and drift while improving the lateral stiffness and overall stability of the structure. The study demonstrates that ETABS is an effective tool for seismic analysis and confirms that the provision of shear walls enhances the earthquake resistance of high-rise RC buildings.**

Index Terms—**High-rise building, ETABS, Seismic analysis, Reinforced concrete, Shear wall, Storey drift, Base shear, Earthquake-resistant design.**

I. INTRODUCTION

Urbanization has accelerated rapidly during the last few decades, resulting in an increasing demand for high-rise residential, commercial, and mixed-use buildings. These structures provide efficient utilization of limited urban land while accommodating growing populations. However, increasing building height also increases susceptibility to lateral forces generated by earthquakes and wind. Unlike low-rise buildings, tall buildings possess larger flexibility, longer natural periods, and greater sensitivity to dynamic loading. Therefore, structural safety cannot be evaluated solely based on gravity loads, and comprehensive seismic analysis becomes essential during the design stage.

Earthquakes produce sudden ground motion that induces inertia forces throughout a structure. These forces generate lateral displacement, storey drift, bending moments, shear forces, and axial forces that directly influence structural safety and serviceability. If these seismic effects are not properly accounted for during design, significant structural damage or even progressive collapse may occur. India is divided into different seismic zones based on the expected intensity of earthquake ground motion. Buildings located in Zones IV and V experience considerably larger seismic demands than those situated in Zones II and III. Consequently, engineers must evaluate structural behaviour under varying seismic conditions before finalizing the design.

The present study focuses on the seismic analysis of a G+25 reinforced concrete building model developed in ETABS. The structure is analysed under earthquake loading corresponding to Seismic Zones II, III, IV, and V according to IS 1893 (Part 1):2016. Structural response parameters including storey displacement, storey drift, storey shear, base shear, and natural time period are compared across the different seismic zones. In addition, the effectiveness of corner shear walls in improving structural performance is evaluated by comparing the building behaviour with and without shear wall systems. The study aims to provide a comprehensive understanding of the influence of seismic intensity on tall building behaviour and to demonstrate suitable structural measures for improving earthquake resistance.

II. LITERATURE REVIEW

1) Shaik Akhil Ahamad et.al (2020), “Dynamic analysis of G + 20 multi storied building by using shear walls in various locations for different seismic zones by using Etabs”. This paper aims to study the usage of Shear walls at different locations in a G + 20 multi storied residential building and to study the nature of the structure exposed to earthquake by adopting Response Spectrum Analysis. The Multi storied building with G + 20 is analysed for storey drift, base shear, maximum allowable displacement and torsional irregularity. It is studied that maximum displacement and storey drift values are found to be higher in seismic zone V for all the cases A, B and C when correlated to zones II,III and IV which indicates that displacement can be reduced by making the structure with uniform stiffness. It is observed that the building with shear walls placed at four ends i.e., Case C , had given better results in terms of maximum displacement, storey drift and base.
2) Md. Foisal Haque et.al (2025), “Seismic performance evaluation of multi-storied RC structures by nonlinear static analysis”. This research proposes various configured multi-storied reinforced concrete (RC) structures for the evaluation of roof displacement, ductility, strength ratio, and response reduction factor under seismic loading by using nonlinear static analysis. Four configured RC structures are used in this research such as flat plate with edge beam, flat plate without edge beam, flat plate with drop panel, and beam-column supported framing system. The displacement of the performance point is gradually increased with the increment of number of stories because of increasing lateral force. This happens due to the increment of the self-weight. The higher storied structure shows the larger self-weight compared to the lower storied structures. This larger self-weight increases the lateral force. The range of average difference in results between previous and present studies is found to be (1.29 to 1.65) %, which may indicate a good accuracy of validation with the nonlinear static analysis by using ETABS.
3) Ajay Namdev et.al (2023), “Study and Seismic Analysis of High-Rise Buildings using Etabs Software”. Loading in high-rise buildings differs from low-rise buildings in several aspects, such as greater accumulation of gravity loads from the top to the bottom floor, increased importance of wind loading and greater importance of dynamic effects. Structural analysis mainly involves discovering the structure behind something that happens. Such behavior may be caused by the weight of objects such as people, furniture, wind and snow, or by other forms of excitation such as earthquakes, ground shaking caused by nearby explosions, etc. A G+10 storey high-rise building subjected to seismic, wind and live loads was analyzed using ETABS software. The behavior of the tall building was clearly shown using graphs and lateral displacements.
4) Mr. Shyam Tukaram Jadhav et.al (2025), “Seismic Performance Analysis of High-Rise Buildings Using ETABS”. In the design of high-rise buildings, one of the most critical structural components is the shear wall. These walls serve as the primary element for resisting lateral forces induced by wind and seismic loads. Shear walls are typically designed to provide a rigid resistance to these forces, and their effectiveness depends significantly on their orientation and the direction of the forces. The purpose of this research study was to evaluate the seismic performance of a high-rise G+20 RCC structure, with an emphasis on the effectiveness of structural upgrades using outrigger and belt truss systems. These systems not only decrease lateral displacements and inter-storey drift, but also improve load redistribution, resulting in increased stability and less damage from seismic loads. Findings provide a good platform for formulating design standards for tall buildings in seismically prone locations.
5) Vijay Kumar et.al (2020), “Seismic Analysis of High-Rise Building (G+10) Using Etabs”. In the present study, analysis of G+10 multi-story building in all seismic zones for wind and earthquake forces is carried out.3D model is prepared for G+10 multi-story building using ETABS. It is found that the lateral displacements or drifts are more in zone 5 when compared to the zones 4&3. It is also found that from the base reactions of structure obtained in zone 5, the story shear is higher in zone 5 than in zone 3. Better

accuracy of the analysis can be obtained by using ETABS software.

III. DESCRIPTION OF BUILDING

The building considered in this study is a G+25 reinforced concrete (RC) high-rise building modelled and analysed using ETABS to evaluate its seismic performance under different earthquake zones as per IS 1893 (Part 1):2016. The structure has a rectangular plan with overall dimensions of 30 m × 42 m and a uniform storey height of 3 m, resulting in a total building height of approximately 80.5 m above ground level. The structural framing system consists of reinforced concrete beams, columns, and slabs designed to resist both gravity and lateral loads..

The structural members were designed using M30 grade concrete and Fe500 grade reinforcement steel. The floor system comprises 150 mm thick reinforced concrete slabs, while the primary beams have cross-sectional dimensions of 300 mm × 600 mm, with secondary beams of 300 mm × 450 mm. The columns are provided with a uniform cross-section of 700 mm × 700 mm throughout the building to ensure adequate strength and stiffness against axial and lateral loading.

The building was analysed by considering all relevant design loads, including dead loads, live loads, wind loads, and seismic loads, in accordance with IS 875 (Parts 1, 2, and 3) and IS 1893 (Part 1):2016. Seismic analysis was performed for Seismic Zones II, III, IV, and V to investigate the influence of increasing earthquake intensity on the structural response. Important seismic parameters such as storey displacement, inter-storey drift, storey shear, base shear, and natural time period were evaluated.

To improve the lateral load-resisting capacity of the structure, reinforced concrete shear walls were provided at the corner locations and their effectiveness was assessed by comparing the structural behaviour of the building with and without shear walls. The comparison enabled a comprehensive evaluation of the influence of shear walls on displacement control, drift reduction, lateral stiffness, and overall seismic stability of the high-rise building.

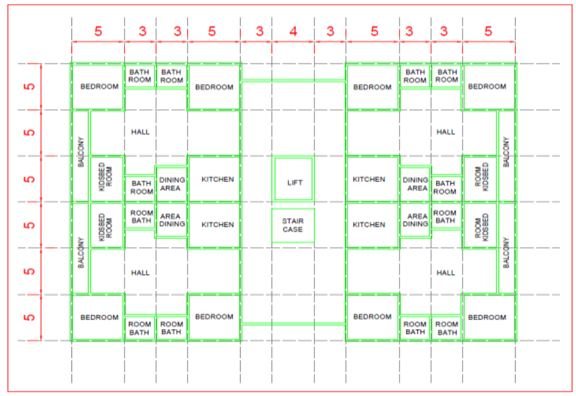

Fig.1 Building Plan

IV. MODELING AND ANALYSIS

The structural analysis and modelling of the proposed G+25 reinforced concrete (RC) high-rise building were carried out using ETABS (Extended Three-Dimensional Analysis of Building Systems). ETABS is a specialized structural analysis and design software widely used for the analysis of multi-storey buildings because of its ability to accurately simulate structural behaviour under gravity and lateral loading conditions. The software facilitates efficient three-dimensional modelling, automatic load generation, code-based seismic analysis, and detailed evaluation of structural response parameters.After developing the three-dimensional structural model, appropriate support conditions were assigned at the foundation level to represent fixed-base behaviour. Gravity loads, including self-weight, floor finishes, wall loads, and live loads, were applied in accordance with IS 875 (Parts 1 and 2). Wind loads were defined following the provisions of IS 875 (Part 3), while seismic loads were assigned according to IS 1893 (Part 1):2016 for Seismic Zones II, III, IV, and V. Load combinations for both ultimate and serviceability limit states were generated as per the relevant Indian Standard codes to evaluate the structural response under critical loading conditions.

The seismic analysis was performed using the Response Spectrum Method, considering an importance factor of 1.2, response reduction factor of 5, medium soil condition, and 5% damping ratio. The corresponding seismic zone factors of 0.10, 0.16, 0.24, and 0.36 were assigned for Zones II, III, IV, and V, respectively. The analysis enabled the determination of key structural response parameters such as storey displacement, inter-storey drift, storey shear, base shear, natural time period, bending moments, shear forces, and support reactions, which were subsequently used to assess the seismic performance of the building.

To investigate the effectiveness of lateral load-resisting systems, the building was analysed under two different configurations: without shear walls and with reinforced concrete shear walls provided at the corner locations. The comparison between these two models provided a comprehensive evaluation of the influence of shear walls on structural stiffness, displacement control, drift reduction, and overall seismic stability. The results obtained from ETABS formed the basis for the subsequent discussion on the seismic behaviour and performance of the high-rise building under different earthquake intensities.

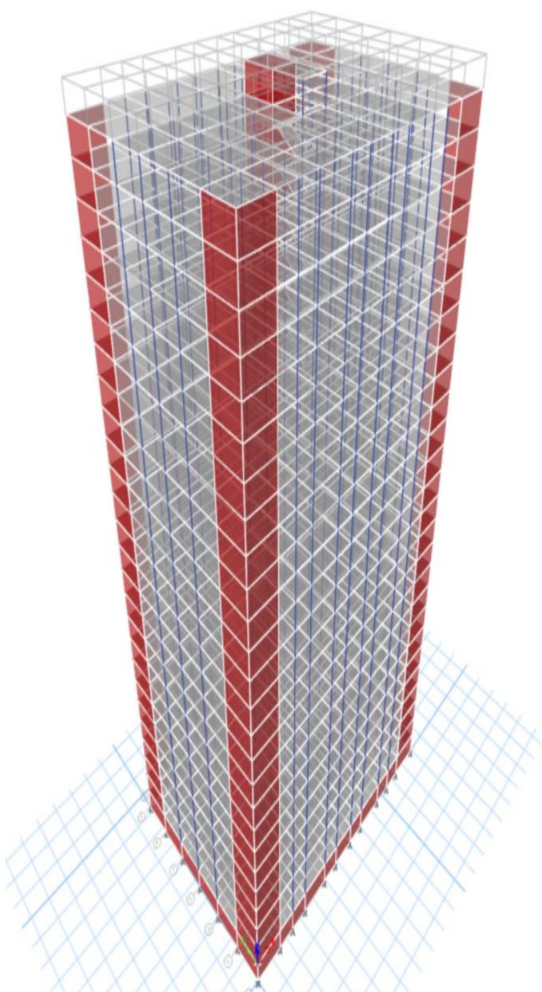

Fig.2 3D Rendering View

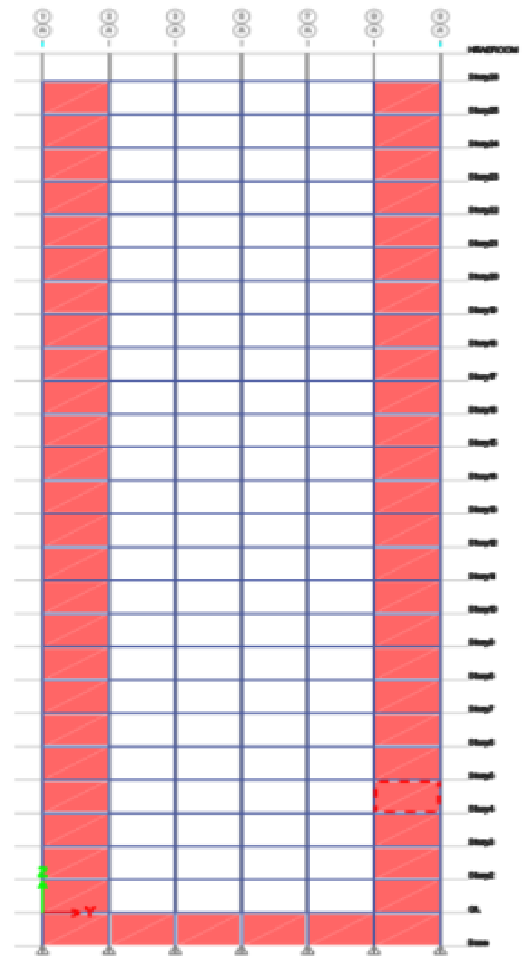

Fig.3 Elevation

V.RESULTS AND DISCUSSION

The seismic analysis of the G+25 reinforced concrete high-rise building was carried out using ETABS software for different seismic zones according to IS 1893:2016. The structural response of the building was studied based on important parameters such as storey displacement, storey drift, storey shear, and base shear.The analysis results obtained from ETABS were compared for Zone II, Zone III, Zone IV, and Zone V to evaluate the effect of seismic intensity on the behavior of the structure. The seismic response increased progressively with increase in zone factor.

5.1. STOREY DISPLACEMENT

Storey displacement refers to the lateral movement of each floor level due to earthquake forces. In high-rise buildings, displacement generally increases from the base to the top storey because of the cumulative effect of lateral loads. The maximum displacement was observed at the terrace level for all seismic zones. The displacement values obtained from ETABS indicate that the structure experiences larger lateral movement as the seismic intensity increases.

Table 1- Maximum storey displacement values

Seismic Zone	Maximum Top Storey Displacement (mm)
Zone II	42
Zone III	68
Zone IV	102
Zone V	148

Table 2- Storey wise displacement for zone V

Storey	Displacement (mm)
Storey 25	148
Storey 20	124
Storey 15	96
Storey 10	63
Storey 5	28
Base	0

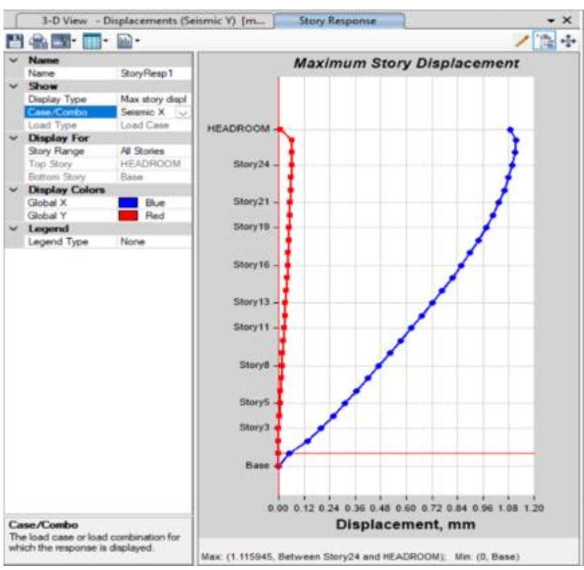

Fig.4 Storey Displacement

5.2 STOREY DRIFT

Storey drift is defined as the relative displacement between two consecutive floors. It is one of the most important parameters in seismic analysis because excessive drift may cause structural and non-structural damage.The permissible storey drift limit according to IS 1893:2016 is 0.004 times the storey height.

Table 3- Maximum Storey Drift Values

Seismic Zone	Maximum Storey Drift
Zone II	0.0012
Zone III	0.0019
Zone IV	0.0028
Zone V	0.0039

5.3 STOREY SHEAR

Storey shear represents the total lateral force acting at a particular storey level due to earthquake effects. The storey shear values were maximum at the base and gradually reduced towards the top storey. Base Shear Values

Table 4- Storey Shear Values for Zone V

Storey	Storey Shear (kN)
Storey 25	420
Storey 20	980
Storey 15	1760
Storey 10	2840
Storey 5	4210
Base	10260

5.5 BASE SHEAR

Base shear is the total horizontal seismic force acting at the base of the structure. It depends on building weight, seismic zone factor, importance factor, and response reduction factor.

Table 5- Base Shear Values

Seismic Zone	Base Shear (kN)
Zone II	2850
Zone III	4560
Zone IV	6840
Zone V	10260

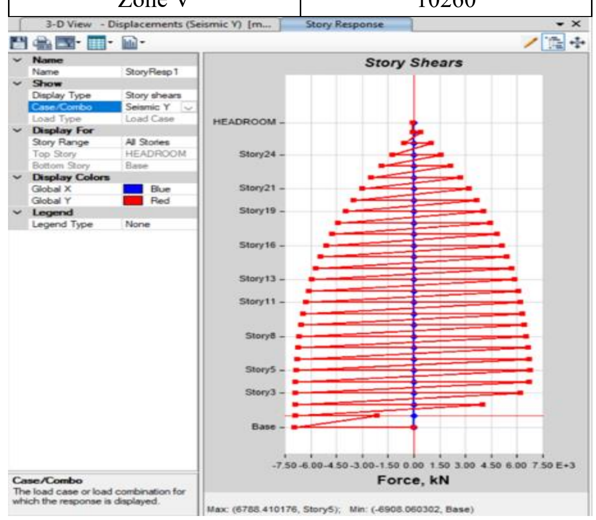

Fig.5 Base shear

5.6 OVERALL PERFORMANCE COMPARISON

Table 6- Overall Comparison

Parameter	Without Shear Wall	With Shear Wall
Lateral Stiffness	Moderate	High
Storey Displacement	High	Reduced
Storey Drift	High	Reduced
Base Shear	Lower	Higher
Earthquake Resistance	Moderate	Improved
Structural Stability	Moderate	Better

VI.CONCLUSION

The seismic analysis of the G+25 reinforced concrete high-rise building was successfully carried out using ETABS for different seismic zones as per IS 1893:2016. The study evaluated the structural behaviour of the building under earthquake loading conditions for two cases: building without shear wall and building with shear wall at corner locations.
From the analysis results, it was observed that storey displacement, storey drift, and base shear increased progressively from Zone II to Zone V due to increase in seismic intensity. The building without shear walls showed higher lateral displacement and drift values, indicating lower lateral stiffness and reduced earthquake resistance.

The provision of shear walls at corner locations significantly improved the seismic performance of the structure. The shear walls reduced storey displacement and drift values, improved structural stiffness, and enhanced overall stability of the building during earthquake loading. Although the base shear increased because of higher stiffness, the structure became more efficient in resisting seismic forces.

The study concludes that shear walls are highly effective structural elements for improving the earthquake resistance of high-rise buildings, especially in higher seismic zones. Proper seismic analysis and suitable shear wall arrangement are essential to ensure structural safety, serviceability, and stability of tall buildings. ETABS proved to be an efficient and reliable software for modelling and seismic analysis of multi-storey structures.

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