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# Comparison of Time History Analysis of Regular and Irregular Shape Buildings

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**ABSTRACT:** This study compares the seismic performance of regular and irregular-shaped multi-storey buildings using time history analysis in ETABS. The buildings are modeled using the finite element method and subjected to real earthquake ground motions. The analysis focuses on comparing maximum displacement, acceleration, and inter-story drift between the two building types.

Sensitivity and statistical analyses are performed to understand the impact of different parameters on structural response. The main goal is to gain insights into how geometric irregularities affect seismic behavior and to support the design of earthquake-resistant buildings.

**KEYWORDS:** Multi-Storey Building, Non-Linear Seismic Analysis, Time History Method and ETABS

## I. INTRODUCTION

**Time History Analysis** is a dynamic method used in structural engineering to study how buildings respond to time-varying loads such as earthquakes, wind, and blasts. Unlike static methods, it simulates real-life conditions using recorded ground motion data to evaluate displacements, accelerations, stresses, and inter-story drifts.

This research delves into the seismic performance of multistorey buildings with diverse geometric configurations, specifically analyzing the influence of various shear wall placements on structural responses. Employing the Time History Analysis (THA) method, the study utilizes ETABS 2019 software to simulate realistic seismic loading conditions. The aim is to provide an in-depth comparative assessment of structural parameters such as displacement, drift, time period, base shear, and stiffness for buildings with and without shear walls.

## II. OBJECTIVE

The primary goal of this investigation is to examine the effectiveness of different shear wall configurations in controlling seismic responses in irregular buildings. Key objectives include:

- Assessing storey displacement and drift across different configurations.
- Evaluating structural stiffness and dynamic characteristics through time period analysis.
- Analyzing base shear forces to understand force distribution mechanisms.
- Drawing comparative insights for optimizing shear wall placement in seismic design.

## III. METHODOLOGY

- Software Used: ETABS 2019
- Analysis Type: Linear Time History Analysis (LTHA)
- Seismic Input: Real earthquake ground motion data

- Model Variants:
  - Model I: Irregular building without any shear walls (base case)
  - Model II: Straight shear wall placed at external face
  - Model III: L-type shear wall at external face
  - Model IV: Plus-type shear wall at the building's center

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- Model V: Shear wall positioned at core
- Model VI: Straight shear wall at inner external face
- Model VII: Straight shear wall at inner internal face

- Common Building Parameters:
- Plan Dimension: 24m x 24m
- Total Height: 32.9m (10 Storeys + 1m parapet)
- Floor-to-Floor Height: 3.1m
- Beam Size: 300 mm x 450 mm
- Column Size: 500 mm x 500 mm
- Slab Thickness: 125 mm
- Shear Wall Thickness: 230 mm
- Grade of Concrete: M25
- Grade of Steel: Fe500
- Seismic Zone: IV (India)
- Soil Type: Hard
- Live Load: 3 kN/m²
- Floor Finish Load: 1.5 kN/m²

## IV. RESULTS AND DISCUSSION

4.1 Storey Displacement Model I, without shear walls, shows the highest displacement (42.1 mm at top storey), highlighting vulnerability to seismic forces. In contrast, Model V with core shear walls significantly limits displacement to just 5.3 mm.

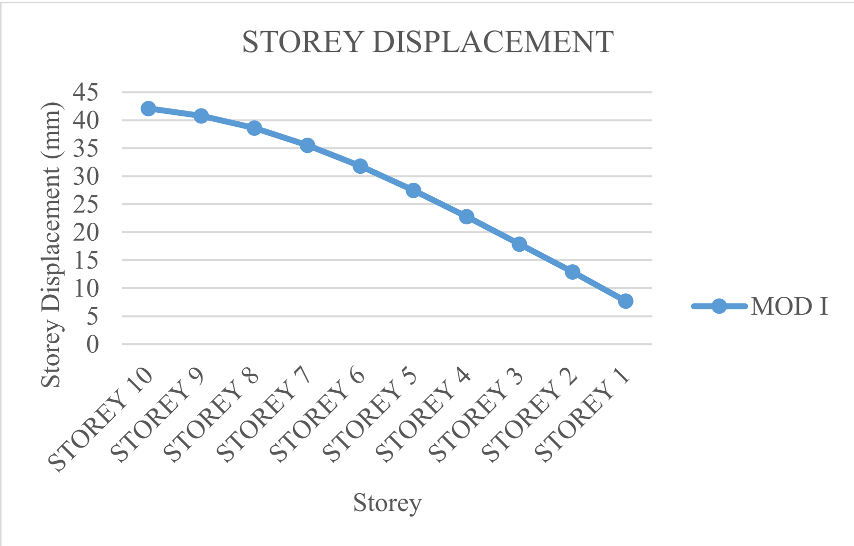


Figure: Storey Displacement for Model-I

4.2 Storey Drift Storey drift trends mirror the displacement behavior. Model I records peak drift (5.2 mm at storey 2), while Model V restricts it to 0.4 mm, ensuring better occupant safety and structural control.

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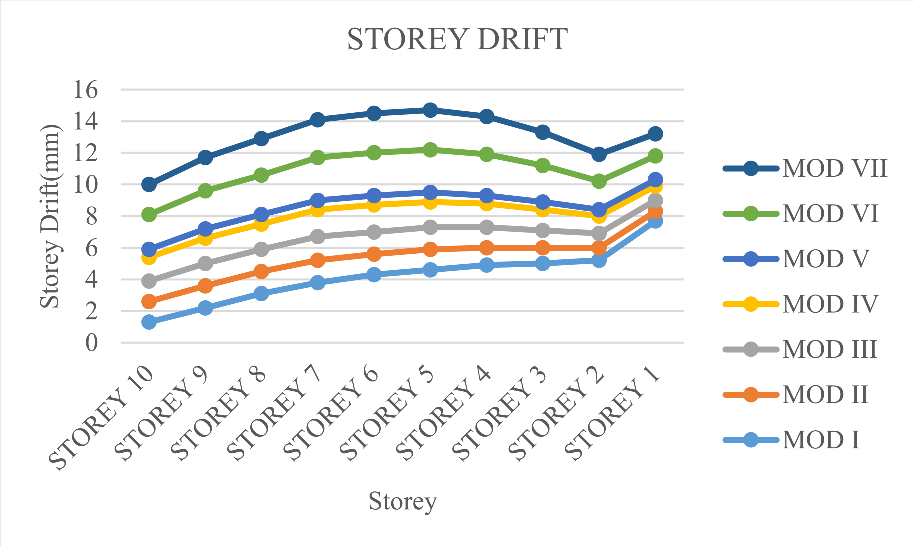


Figure **Fehler! Kein Text mit angegebener Formatvorlage im Dokument.:** Storey Drift for all the models

4.3 Time Period Model I's fundamental time period (1.571s) reflects greater flexibility and susceptibility to seismic oscillations. Model V shows the shortest period (0.49s), indicating a stiffer structure with quick vibrational response.

| MODE | MOD I | MOD II | MOD III | MOD IV | MOD V | MOD VI | MOD VII |
|---|---|---|---|---|---|---|---|
| MODE 1 | 1.571 | 0.712 | 0.812 | 1.492 | 0.49 | 1.512 | 1.5 |
| MODE 2 | 1.571 | 0.712 | 0.748 | 0.813 | 0.49 | 1.044 | 1.007 |
| MODE 3 | 1.495 | 0.431 | 0.748 | 0.813 | 0.374 | 1.044 | 1.007 |
| MODE 4 | 0.506 | 0.157 | 0.213 | 0.48 | 0.126 | 0.486 | 0.483 |
| MODE 5 | 0.506 | 0.157 | 0.177 | 0.268 | 0.126 | 0.27 | 0.269 |
| MODE 6 | 0.481 | 0.089 | 0.177 | 0.201 | 0.125 | 0.264 | 0.259 |
| MODE 7 | 0.282 | 0.07 | 0.102 | 0.201 | 0.075 | 0.264 | 0.259 |
| MODE 8 | 0.282 | 0.07 | 0.079 | 0.178 | 0.062 | 0.178 | 0.178 |
| MODE 9 | 0.269 | 0.044 | 0.079 | 0.128 | 0.062 | 0.128 | 0.128 |
| MODE 10 | 0.188 | 0.044 | 0.065 | 0.097 | 0.054 | 0.118 | 0.117 |
| MODE 11 | 0.188 | 0.039 | 0.049 | 0.093 | 0.043 | 0.118 | 0.117 |
| MODE 12 | 0.178 | 0.033 | 0.049 | 0.093 | 0.041 | 0.096 | 0.097 |

Table: Time Period for all the models

4.4 Storey Shear Model V consistently exhibits the highest storey shear values (up to 1928.1 kN), demonstrating robust lateral force resistance due to centrally located shear walls. Model I registers the lowest, compromising structural safety.

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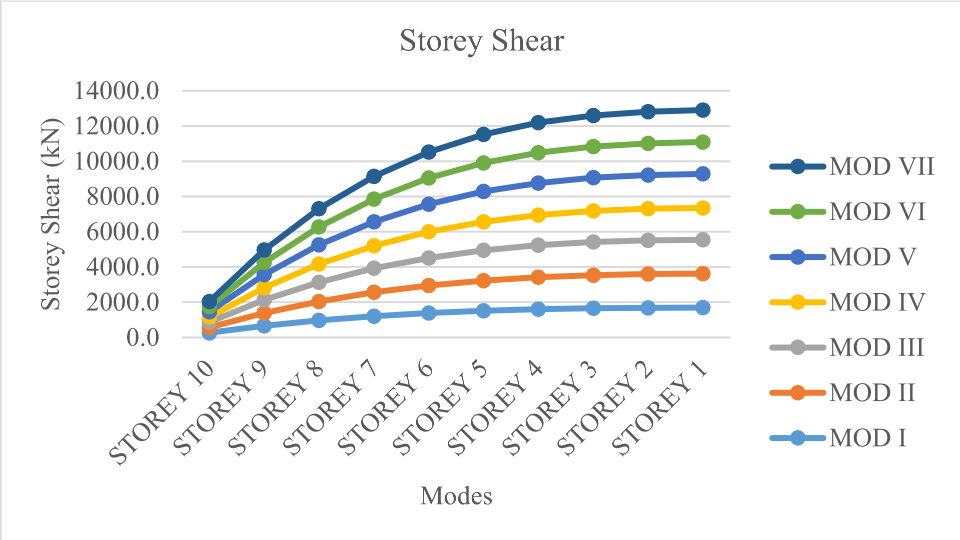


Figure: Storey Shear

4.5 Storey Stiffness Model V again dominates, particularly at lower storeys (e.g., 5.12 MN/m at storey 1), proving the importance of core shear walls. Model VI, although enhanced over Model I, reflects comparatively lower stiffness due to less optimal wall placement.

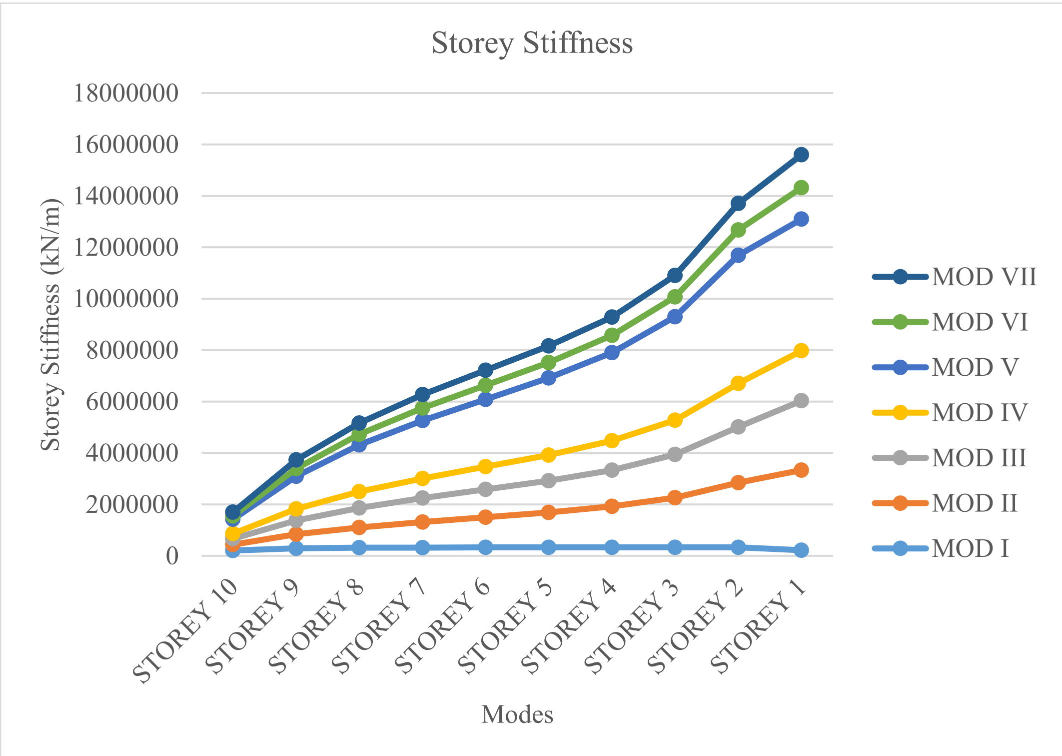


Figure: Storey Stiffness for all the models

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## V. CONCLUSION

The comprehensive analysis leads to the following conclusions

- Core shear walls (Model V) provide the most effective seismic resistance, minimizing drift, displacement, and maximizing stiffness.
- Buildings without lateral load-resisting elements (Model I) exhibit poor seismic performance.
- Shear wall location plays a vital role—central placement offers better symmetry and load distribution.
- Reduced time periods in shear-wall models result in faster structural response, reducing resonance risks.
- Optimal placement of lateral load-resisting elements is critical for designing earthquake-resilient structures.

## VI. FUTURE SCOPE FURTHER RESEARCH MAY INCLUDE

- Nonlinear Time History and Pushover Analysis to evaluate performance beyond elastic limits.
- Incorporating dynamic soil-structure interaction effects.
- Experimentation through shake table models for real-time validation.
- Integration of energy dissipation devices (TMDs, base isolators) for hybrid resilience systems.

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