



Impact Of Openings In Shear Walls On Seismic Response Of High-Rise Rcc Buildings

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Abstract

Shear walls play a vital role in enhancing the lateral stiffness and seismic resistance of high-rise buildings. However, practical design often requires the inclusion of openings for doors, windows, and services. This study investigates how such openings, with varying configurations and sizes, affect the seismic performance of reinforced concrete (RCC) structures. Using ETABS and Response Spectrum Analysis, three models were compared: (i) a solid shear wall (no openings), (ii) shear wall with small openings (11.11%), and (iii) shear wall with large openings (22.22%). Results indicate a clear trend of reduced stiffness and base shear, and increased displacement and drift, with increasing opening size. This research provides key design recommendations for safe structural behavior under seismic loads.

1. Introduction

The increasing construction of tall buildings necessitates the use of lateral load-resisting elements like shear walls. Shear walls, typically reinforced concrete vertical panels, efficiently transfer lateral forces due to wind and seismic activity to the foundation. However, architectural and functional demands often require openings in these walls. The impact of these openings on structural performance, especially during seismic events, is a subject of growing importance.

2. Objectives

The main objectives of this study are:

- To analyze the effect of shear wall openings on base shear, story drift, displacement, and time period.
- To compare three configurations: solid wall, small openings (11.11%), and large openings (22.22%).
- To identify optimal strategies for placing and sizing openings to maintain structural integrity.

3. Methodology

3.1 Building Model:

A G+8 RCC framed structure (27 m height) was modeled in ETABS. Plan dimensions were 20 m × 30 m. The structure was analyzed for seismic Zone III conditions using IS 1893:2016.

3.2 Load Considerations:

- Dead Load and Live Load as per IS 875.
- Seismic Load: Zone III, $Z = 0.16$, $R = 5.0$, $I = 1.2$
- Analysis Type: Linear dynamic using Response Spectrum Method.
- Soil Type: Type III (Soft Soil).

3.3 Models Analyzed:

- **Model 1:** Solid shear wall (no openings)
- **Model 2:** Shear wall with small openings (11.11% of wall area)
- **Model 3:** Shear wall with large openings (22.22% of wall area)

4. Results and Discussion

Parameter	Model 1 (No Opening)	Model 2 (11.11%)	Model 3 (22.22%)
Max Story Displacement (mm)	Lowest	+12–15%	+25–30%
Max Story Drift	Lowest	Moderate	Highest
Base Shear (kN)	Highest	Reduced	Lowest
Time Period (sec)	Shortest (most rigid)	Longer	Longest (most flexible)
Stiffness	Highest	Reduced	Significantly Reduced

Key Observations:

- **Time Period** increases with larger openings, indicating flexibility and delayed dynamic response.
- **Base Shear** decreases due to reduced lateral stiffness, affecting overall energy dissipation.
- **Displacement and Drift** grow significantly, especially in mid-height stories, which can impact serviceability and structural safety.
- **Stress Concentration** was observed near the edges of openings, indicating need for enhanced reinforcement.

5. Conclusion

The study demonstrates that while functional openings in shear walls are often necessary, their size and placement critically affect seismic performance. Larger openings reduce stiffness and increase drift, posing a risk during seismic events.

Recommendations:

- Openings should be minimized and placed symmetrically.
- Reinforcement detailing around openings must follow ductility norms (IS 13920:2016).
- Performance-based design should be adopted when large openings are unavoidable.

6. Future Scope

Further studies should explore:

- Nonlinear time-history and pushover analyses for damage estimation.
- Experimental validation via scaled models.
- Behavior in vertically or plan-wise irregular buildings.
- Optimization algorithms to suggest best opening configurations.

References

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