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Analysis of RCC Buildings Under Seismic and Wind Forces: A Study on Flat and Sloped Grounds

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Abstract

The structural behavior of multistory RCC buildings under seismic and wind forces is complex and critical, especially when constructed on sloping terrains. This study investigates the performance of a G+9 RCC building using different models on flat and sloped grounds (0° to 20°) under Zone III, IV, and V seismic intensities. STAAD.Pro and ETABS software were employed for linear and nonlinear analyses, following IS 1893:2002 and IS 456:2000 guidelines. Parameters such as base shear, story drift, lateral displacement, overturning moment, and internal forces were evaluated. Results indicated that terrain slope and seismic zone significantly influence structural response, with higher slopes and zones leading to increased displacements, drift, and overturning moments. The findings underline the necessity of careful structural planning in seismic-prone, uneven terrains.

Keywords

RCC Buildings; Seismic Analysis; Wind Forces; Sloped Ground; Base Shear; Story Drift; STAAD.Pro; ETABS.

1. Introduction

The performance of reinforced concrete structures subjected to lateral forces such as earthquake and wind loads has been an area of crucial research. Building response during seismic events is influenced not only by structural configuration but also by the underlying terrain slope. This study focuses on evaluating the seismic and wind response of RCC multistory buildings constructed on both flat and sloped terrains using structural analysis software. The objective is to understand the variations in base shear, displacement, drift, and internal stresses across different seismic zones and ground conditions.

2. Literature Review

Numerous studies (Kumar et al., 2016; Gudur et al., 2016; Santhosh et al., 2016) have emphasized the importance of shear walls, bracing systems, and terrain inclination in the seismic response of buildings. Structures with shear walls show reduced story displacement and drift. Sloped ground structures experience irregular base shear distributions and torsional effects (Arjun et al., 2016; Halkude et al., 2013). Additionally, Belgaonkar et al. (2016) reported that deep beams enhance ground stiffness, and Yarnal et al. (2015) highlighted the detrimental effects of openings in shear walls.

3. Research Methodology

A ten-story RCC building (base dimensions 40 m × 30 m, story height 3 m) was modeled in STAAD.Pro and ETABS. Analysis was conducted for both flat and sloped terrains (0°, 10°, 15°, 20°) in seismic Zones III, IV, and V. Dead loads and live loads were assigned as per IS 875 (Part 1 & 2). Seismic parameters adhered to IS 1893:2002 specifications.

Structural elements varied in size according to seismic demand, ranging from 400 mm × 400 mm to 800 mm × 800 mm for columns.

4. Results and Discussions

4.1 Base Shear

The variation of base shear for different models is shown in Figure 1.

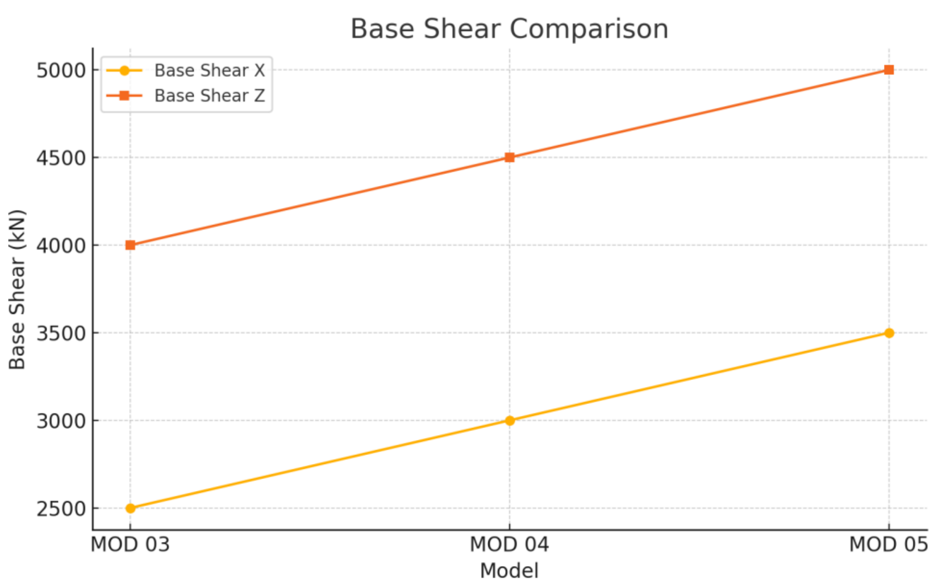

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Figure 1: Base Shear Comparison for Different Models

4.2 Maximum Displacement

The maximum displacement observed under critical loading conditions is presented in Figure 2.

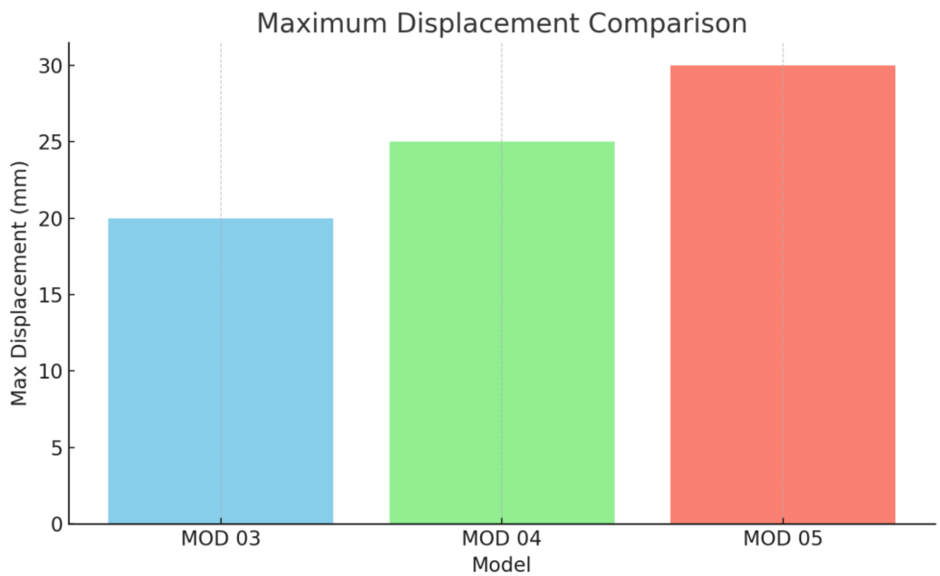

Figure 2: Maximum Displacement for Different Models

4.3 Story Drift

Story drift increases with height, as shown in Figure 3.

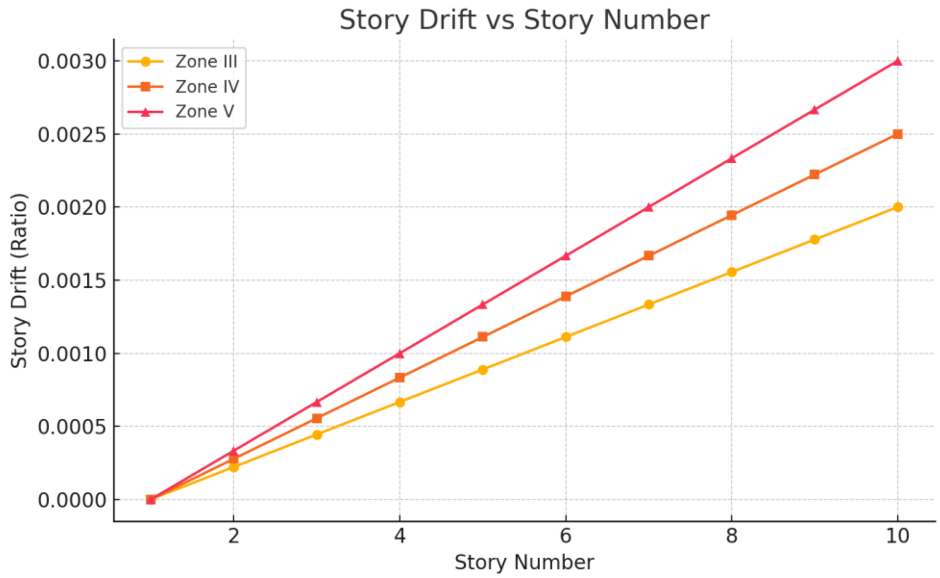

Figure 3: Story Drift vs Story Number for Different Zones

4.4 Overturning Moment

The overturning moment increased with the seismic zone severity, as shown in Figure 4.

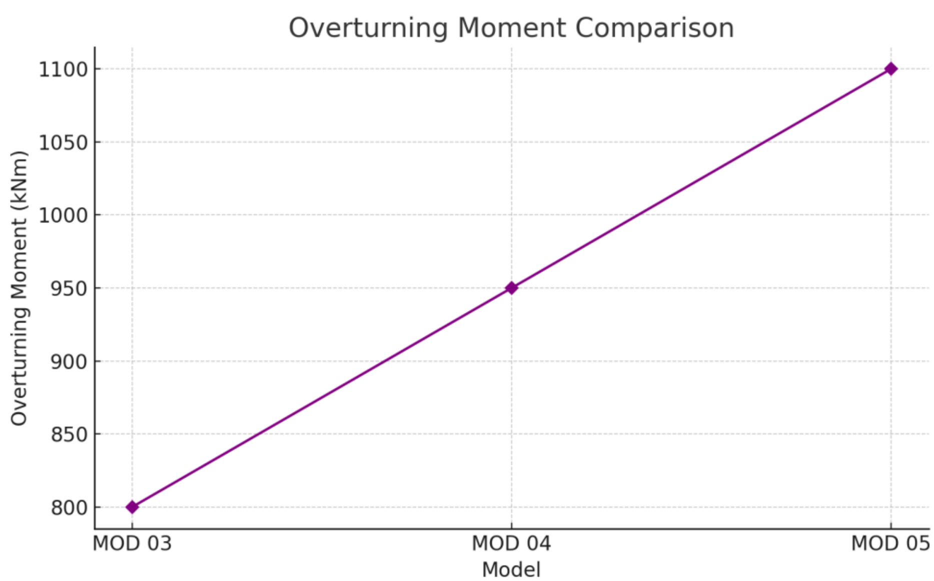

Figure 4: Overturning Moment for Different Models

5. Conclusion

Base shear, displacement, and story drift increase with higher seismic zones and terrain slope. Structures on sloping ground experience amplified lateral responses compared to flat ground. Structural members must be proportioned adequately, with larger sections and stiffer frames required for high seismic zones and steeper slopes. Incorporation of shear walls, deep beams, and bracing systems is essential for mitigating seismic effects.

Future Scope: Time history analysis using site-specific ground motions and experimental validations are recommended for further research.

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