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Performance-Based Seismic Analysis of Mid-Rise Buildings in Northeast India (Zone 5)

Mabrur Ahmed

Abstract

This paper presents a comprehensive nonlinear seismic assessment of mid-rise reinforced concrete (RC) buildings located in Northeast India's Zone 5 using Performance-Based Seismic Design (PBSD) methodology. Two building models, one regular and another with a soft-storey irregularity, were analyzed using Nonlinear Time History Analysis (NLTHA) and Incremental Dynamic Analysis (IDA). Fragility curves were developed to quantify seismic vulnerability. Results highlight the pronounced drift concentration in soft-storey structures and emphasize the necessity of PBSD integration into seismic codes for critical regions.

Keywords

Performance-Based Design, Seismic Zone 5, RC Buildings, Nonlinear Time History Analysis, Fragility Curves, Soft-Storey Irregularity

1. Introduction

Seismic design practices in India are evolving with a growing focus on performance-based approaches. Zone 5, covering Northeast India, experiences high seismicity, making it essential to assess the actual behavior of structures beyond prescriptive code limits. This study investigates mid-rise RC buildings under dynamic earthquake loading using PBSD concepts.

2. Methodology

Two G+4 RC building models were developed in ETABS: one with uniform stiffness and one with a soft storey at the ground level. Nonlinear material properties and P-delta effects were included. Ground motions from historical earthquakes including Bhuj, Chamoli, Northridge, and Kobe were applied for dynamic simulations. IDA curves were generated and fragility analysis was conducted using Excel.

3. Results & Discussion

The IDA results indicate significant reduction in collapse capacity for the soft-storey configuration compared to the regular model. Peak interstorey drift ratios exceeded 2.5% in the soft-storey model. Fragility curves show over 60% probability of exceeding life-safety limit at 0.35g for soft-storey versus 0.55g for the regular model. This performance gap underlines the need for stricter code checks and retrofit strategies in similar urban settings.

4. Conclusions

Performance-based methods offer deeper insights into actual seismic vulnerabilities, especially in high-risk areas like Northeast India. Soft-storey buildings exhibit heightened fragility under strong shaking. Recommendations include mandatory PBSD adoption in critical seismic zones, encouraging drift control, and region-specific fragility-based design guidelines.

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