Seismic Site Amplification Assessment in Bangladesh from Regional and Teleseismic Earthquake Records

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Abstract: Seismic ground motion in Bangladesh is strongly affected by local soil conditions, leading to seismic site amplification. This study estimates amplification effects from regional and teleseismic earthquakes (0.1–20 Hz) at 11 seismic stations across the Bengal Basin. Using earthquake data (M 6.0–7.5; depth 8–112 km; distance 333–1450 km) recorded from 2008–2015, peak ground acceleration (PGA), spectral acceleration (SA), and Fourier amplitude spectrum (FAS) were analyzed. Results show significant amplification at long periods (0.06–2.6 Hz), posing risks to tall buildings. These findings provide essential insights for seismic hazard assessment and infrastructure design in Bangladesh.

Keywords: ***Site amplification, Earthquake ground motion, Peak ground acceleration, Spectral acceleration, Earthquake seismogram.***

Introduction

The seismic ground motion experienced at a site is largely governed by local soil and geological conditions, a process referred to as seismic site amplification (Kawase, 2003). Bangladesh has previously recorded higher-than-expected ground motions during large distant earthquakes, highlighting its potential vulnerability to seismic hazards (Furumura et al., 2011). Understanding the frequency-dependent amplification behavior of the Bengal Basin's soft sedimentary layers is crucial for assessing earthquake risk to high-rise and critical infrastructures (Farazi et al., 2023a). The primary objective of this study is to estimate site amplification due to regional and teleseismic earthquakes at lower frequencies, a topic not previously studied in Bangladesh.

Study Area

The research focuses on the deep basin portion of the Bengal Basin, Bangladesh, characterized by thick layers of unconsolidated sediments. These soft alluvial and deltaic deposits have high potential for amplifying seismic waves. Eleven seismic stations across the region were selected for detailed analysis to capture spatial variations in amplification caused by differing local geology and soil profiles.

Methodology

Sixteen regional and teleseismic earthquakes (M 6.0–7.5; depth 8–112 km; distance 333–1450 km) recorded between 2008 and 2015 were analyzed. Peak ground acceleration (PGA) was first calculated from earthquake seismograms. The 5% damped spectral acceleration (SA) for periods of 0.1–20 s was computed using the Newmark-beta method to develop SA curves (Newmark and Hall, 1982). Fourier amplitude spectra (FAS) were obtained through fast Fourier transform (FFT) of recorded S-wave data. SA and FAS results were compared across components to verify amplification frequencies and assess consistency.

Results and discussion

All stations exhibited amplification peaks at different dominant frequencies, reflecting site-specific soil and geological variations (Hossain et al. 2025). The PGA values were relatively low due to the long epicentral distances. However, significant amplification was observed in longer periods (0.06–2.6 Hz), which correspond to the natural frequencies of medium to tall buildings. This suggests that thick sedimentary sequences in the Bengal Basin selectively amplify low-frequency waves from distant large earthquakes. Consequently, multistory buildings in these areas face elevated seismic risks due to long-period ground motions.

Conclusion

This study presents a detailed spectral characterization of long-period seismic amplification across the Bengal Basin. The findings highlight the vulnerability of tall structures to distant large earthquakes and provide essential data for seismic hazard assessment and resilient infrastructure design. Spatial mapping of ground motion parameters developed in this research contributes a novel framework for future earthquake risk mitigation in Bangladesh.

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