Extended Abstract DOI: https://doi.org/10.64862/ajeg.2025.2sp.44.148 Open Access

# Local Peak Ground Acceleration from Probabilistic Seismic Hazard Assessment: Methodology and Application for Engineering Design in Bangladesh

Md. Mahmood Hossain Khan[1*], Aida Azari Sisi[2], Manuel Hobiger[2], Mohammad Anisur Rahman[1] and Sarwat Jabeen[1]

[1]Geological Survey of Bangladesh (GSB), Segunbagicha, Dhaka, Bangladesh
[2]Federal Institute for Geosciences and Natural Resources (BGR), Hannover, Germany

(*Corresponding E-mail: mahmood.khan@gsb.gov.bd)

*Received: September 18, 2025, Accepted: October 17, 2025*

**Abstract: Probabilistic Seismic Hazard Assessment (PSHA) deals with a framework for determining seismic ground motion by combining seismic source zonation, earthquake recurrence and ground motion prediction and taking the respective uncertainties into account. This study converts regional PSHA results into local Peak Ground Acceleration (PGA) values, which are essential for earthquake-resistant structural design, for eight cities in Bangladesh – Barishal, Cumilla, Faridpur, Gopalganj, Khulna, Kushtia, Satkhira and Sirajganj. This procedure incorporates PSHA-derived engineering bedrock level hazard estimates and soil shear-wave velocity measurements from the top 30 meters (Vs30) to account for site amplification factors, enabling the calculation of local PGA values. The results are compared with the seismic design provisions of the Bangladesh National Building Code (BNBC, 2020), indicating differences between local Uniform Hazard Spectrum (UHS) and BNBC design spectra. The results emphasize the necessity of site-specific hazard assessments for safe and earthquake-resilient infrastructure planning in Bangladesh.**

**Keywords:** ***Probabilistic Seismic Hazard Assessment, Peak ground acceleration, Site amplification, Vs30, Uniform hazard spectra.***

## Introduction

Bangladesh is located in the vicinity of one of the tectonically most active regions in the world where the Indian, Eurasian, and Burma plates meet. The country's seismic risk is enhanced by high population density, rapid urbanization, and poorly designed infrastructure. Previous hazard assessments of the country provide a reasonably fair understanding of seismic hazard, but do not fully describe local amplification effects caused by local near-surface soil conditions. One important factor to consider in the construction of earthquake-resistant structures is the local peak ground acceleration (PGA). Both site-specific effects controlled by local soil characteristics and regional seismic hazard (calculated from PSHA) are necessary for reliable local PGA calculations. Local site amplification is not precisely included in the Bangladesh National Building Code (BNBC, 2020), in spite of its extensive seismic zonation and design guidelines. Therefore, for engineering design and disaster risk reduction, a methodology that combines PSHA findings with seismic site characterization is crucial. In order to assess the present code standards, this study intends to (a) obtain local seismic hazard values by combining regional PSHA with site amplification factors based on Vs30, (b) apply this framework to eight cities in Bangladesh, and (c) compare the results with the BNBC design spectrum.

## Methodology

The PSHA process begins with the seismic source zonation, identifying areal source zones and active faults in and around Bangladesh. Earthquake recurrence parameters are characterized by the Gutenberg-Richter relation, as detailed in Azari Sisi et al. (2021). For exceedance probabilities of 10% and 2% in 50 years, PGA and Spectral Acceleration (SA) are calculated at the engineering bedrock level using regionally calibrated Ground Motion Prediction Equations (GMPEs). Hazard maps and curves are created by probabilistic integration of all sources, which gives PGA values for design return times of 475 and 2475 years.

Local site effects are evaluated by classifying cities according to Vs30 values derived from Multichannel Analysis of Surface Waves (MASW) and Downhole Seismic testing. Period-dependent site amplification factors are calculated using the two empirical models of Seyhan and Stewart (2014) and Hashash et al. (2020), which depend on Vs30 and bedrock-level PGA. These amplification factors are then multiplied by the bedrock PGA estimations to determine the local PGA. The results are then compared with the BNBC (2020) provisions, in terms of design spectral accelerations, Uniform Hazard Spectra (UHS), and seismic site classes.

## Results and discussion

The PGA values at engineering bedrock across Bangladesh for the 10% and 2% exceedance probability in 50 years are obtained from the regional PSHA data. The PGA distribution for Bangladesh with a 10% exceedance probability is shown in Figure 1. Without taking the soil amplification into consideration, these values represent the baseline hazard level.

The Vs30 data indicate that most of the study sites fall within the stiff soil (SC) or soft soil (SD) classes, with significant potential for amplification. By applying empirical amplification models, the local hazard values at the surface are significantly greater than the bedrock estimates. Discrepancies are observed between local UHS and BNBC design spectra. In several study sites, the BNBC design spectra underestimate local spectral accelerations relative to site-specific UHS results, as shown in Figure 2.

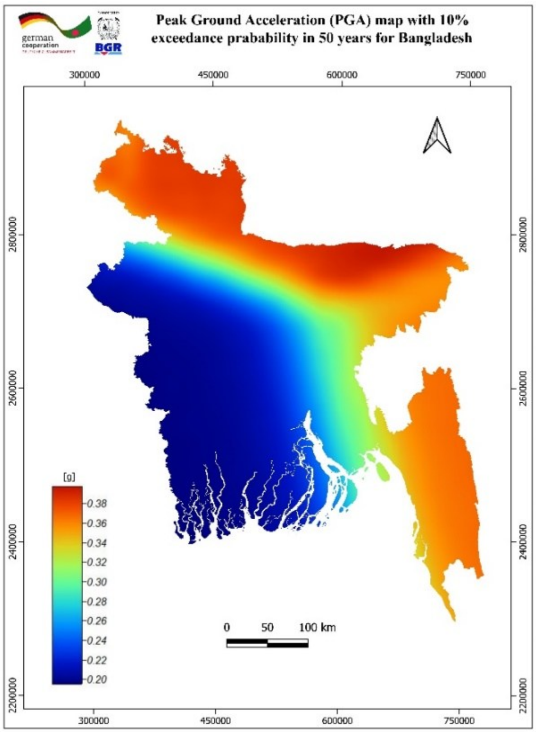


*Figure 1, PGA map with 10 % exceedance probability in 50 years for Bangladesh.*

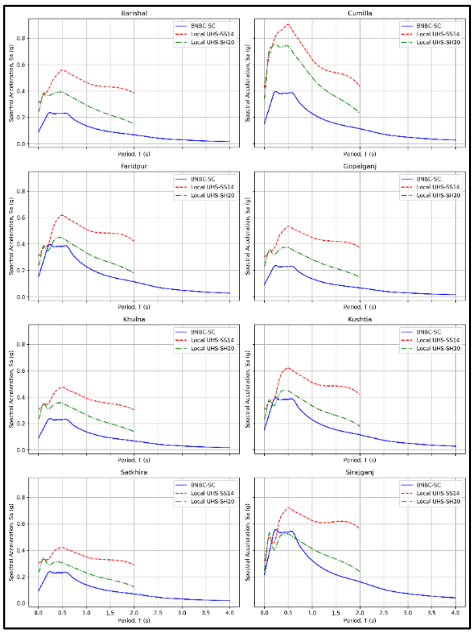


*Figure 2, Comparison of BNBC design spectral acceleration with local UHS curves for site class SC in the different project cities.*

## Conclusion

This study describes a methodology to combine site-specific amplification factors with regional PSHA to derive local seismic hazard values. The implications of including site effects in seismic design are demonstrated by the application to eight cities in Bangladesh, showing that local hazard values often exceed those suggested by BNBC (2020). The results justify the need for site-specific seismic hazard studies to improve infrastructure planning, reduce vulnerability and promote earthquake-resilient development activities in Bangladesh.

## Acknowledgement

The authors are grateful to the German–Bangladesh technical cooperation project Geo-information for the Implementation of a Climate-Change-Resilient Urbanization (GICU), funded by the Government of the Federal Republic of Germany through its commissioning Federal Ministry for Economic Cooperation and Development (BMZ) and by the Government of the People's Republic of Bangladesh through the Ministry of Power, Energy and Mineral Resources (MPEMR), and implemented jointly by the Federal Institute for Geosciences and Natural Resources (BGR) and the Geological Survey of Bangladesh (GSB).

## References

Azari Sisi, A., Hobiger, M., Kaiser, D., Spies, T., and Schlittenhardt, J. (2021). Regional seismic hazard assessment in Bangladesh. Project: Geo-information for Urban Planning and Adaptation to Climate Change (GPAC). Bangladesh-German Technical Cooperation.

BNBC. (2020). Bangladesh National Building Code. Government of the People's Republic of Bangladesh, Ministry of Housing and Public Works. Available at: https://mccibd.org/wp-content/uploads/2021/09/Bangladesh-National-Building-Code-2020.pdf

Hashash, Y. M. A., Ilhan, O., Harmon, J. A., Parker, G. A., Stewart, J. P., Rathje, E. M., Campbell, K. W., and Silva, W. J. (2020). Nonlinear site amplification model for ergodic seismic hazard analysis in Central and Eastern North America. Earthquake Spectra, 36 (1), 69–86. https://doi.org/10.1177/8755293019878193

Seyhan, E., and Stewart, J. P. (2014). Semi-empirical nonlinear site amplification from NGA-West2 data and simulations. Earthquake Spectra, 30(3), 1241–1256. https://doi.org/10.1193/063013eqs181m