ABSTRACT

The tectonic ensemble of Bengal Basin, Central India, and Koyna-Warna region reveals prolific seismicity attributed to interplate, intraplate, and reservoir-triggered activities. The Bengal Basin, situated at the junction of the Indian, Eurasian, and Burmese plates, has experienced major events such as the 1885 Bengal (M_W 6.8) and 1918 Srimangal (M_W 7.6) earthquakes; Central India, on the other hand, is characterized by intraplate seismicity within the Precambrian rift systems and deep-seated shear zones, exemplified by the 1997 Jabalpur earthquake (M_W 5.8); whereas the Koyna-Warna region located in the south-western part of the Deccan Volcanic Province exhibits both reservoir-induced and intraplate activities, marked by the 1967 Koyna (M_W 6.3) and 1993 Latur (M_W 6.2) earthquakes, with maximum Modified Mercalli Intensities ranging from VII to IX across these tectonic domains. Field and laboratory investigations facilitated the derivation of spatially distributed effective shear-wave velocity (V_S^{30}) maps and site classifications, delineating predominant classes of D4 ($180<V_S^{30}(m/s)\leq240$) for the Bengal Basin, C3 ($440<V_S^{30}(m/s)\leq520$) for Central India and C4 ($360<V_S^{30}(m/s)\leq440$) for Koyna-Warna. Site response analysis performed using PLAXIS-2D revealed absolute site amplification factors ranging from 1.3-4.6, 1.24-2.84, and 1.09-3.70, respectively, for these blocks. Both areal and tectonic sources in three hypocentral depth ranges of 0-25km, 25-70km and 70-180km along with a host of Ground Motion Prediction Equations including Next Generation Spectral Attenuation models have been incorporated to deliver probabilistic hazard in terms of Peak Ground Acceleration (PGA) of the region at firm-rock condition varying from 0.03-0.58g and 0.09-0.78g for 10% and 2% probability of exceedance in 50 years, respectively. Incorporating site amplification resulted in surface-consistent PGA values in the ranges of 0.09-1.40g, 0.05-0.61g, and 0.17-1.17g, respectively, for the Bengal Basin, Central India, and Koyna-Warna, for a 475-year return period. Liquefaction hazard analysis under probabilistic scenario categorizes Dhaka, Sylhet, and Mymensingh as "Severe", while Jabalpur and Koynanagar exhibit "High-to-Severe" potential. Random Forest-based Landslide Susceptibility Zonation delineates the landslide-prone zones along the Chittagong Hill Tracts and the Western Ghats. Seismic Hazard Microzonation for nine representative urban centres integrates multi-thematic hazard parameters using the Analytic Hierarchy Process. SELENA-based structural damage potential modelling predicts "extensive-to-complete" damage for non-engineered unreinforced masonry structures, with casualty level estimations across diurnal scenarios. This seismic hazard assessment establishes a framework that captures tectonic diversity, site response, and induced hazard interactions, providing a robust scientific basis for earthquake risk mitigation and resilient urban planning across east to west-central peninsular India.

Keywords: Bengal Basin, Central India, Koyna-Warna, Site Characterization, Surface-consistent Probabilistic PGA, SELENA, Microzonation, Liquefaction, Landslide Susceptibility