Assessment of seismic site effects in Chiang Mai basin from microtremor observation and 1D site response analysis

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ABSTRACT

Chiang Mai, the largest city in northern Thailand and the second largest in the country after Bangkok. The city is located on a flood plain composed of unconsolidated sediments. The city is occasionally threatened by tremors originating from nearby faults in Thailand and neighboring countries. Although ground motion amplifications have been observed, limited research studies have been conducted to comprehensively understand the seismic mitigation measures required for the area, particularly regarding site effects. This study aims to investigate seismic site effects in Chiang Mai basin and analyze site response using a 1-dimensional (1D) soil model. Approximately 50 sites distributed across the basin in Muang Chiang Mai area, covering an area of approximately 100 sq.km, were investigated by microtremor observations and site response analysis. The first part, microtremor observations using the Centerless Circular Array (CCA) method was conducted to determine phase velocity dispersion curves and derive shear wave velocities (VS) profile through inversion analysis. The findings from this part provide information of average VS from the surface to 30-m depth (VS30) and estimated Quaternary sediment thickness. The second part, site response analysis using 1D soil model was involved to examine site amplification. Ground motions obtained from Probabilistic Seismic Hazard Assessment were input as rock outcrop acceleration, and their propagation through the 1D soil model was analyzed using an equivalent linear analysis. From the strong motion database, motions with the same mechanism of occurrence were selected and scaled to match response spectra with the conditional mean spectrum (CMS) at periods of 0.2, 0.5, 1.0, 2.0, and 3.0 seconds, corresponding to a return period of 2475 years. The average spectral accelerations were then used to evaluate the Maximum Credible Earthquake (MCE) design spectrum for each site. Finally, this study presents a site amplification from 1D soil model and provides recommendations for site response analysis in the study area. This study is expected to significantly contribute to enhancing our understanding of seismic site effects in the Chiang Mai basin. Furthermore, it would provide invaluable insights that can guide the implementation of appropriate measures to effectively mitigate earthquake hazards in the region.

Keywords: Site Amplification, Site Response Analysis, 1D and 2D Soil Models, Array Microtremor, Chiang Mai, Thailand

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