Development of fragility functions for low- to mid-rise reinforced concrete buildings in Chiang Mai, Thailand

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ABSTRACT

In northern Thailand, Chiang Mai is one of the largest provinces, hosting an urban area with over 40,000 buildings. Typically, these buildings are constructed as low- to mid-rise reinforced concrete (RC) structures with structural systems consisting of RC beam-column frames and masonry infill walls. Given that this province is surrounded by several active faults, the safety and serviceability of these buildings during earthquakes are significant concerns for both residents and city officials. In general, the safety and serviceability of a group of buildings are determined by the fragility function, which represents the relationship between the seismic intensity measure and the level of damage that a group of buildings may experience during an earthquake. In this study, our focus is on developing fragility functions for low- to mid-rise RC buildings located in Chiang Mai. The overall procedure begins with a survey of the characteristics of actual buildings in the study area, including dimensions, material properties, and vulnerability factors. This data is then utilized to select representative buildings, typically numbering between 20 and 30 structures, to serve as representations for a group of buildings during seismic evaluation. While Nonlinear Response History Analysis (NLRHA) is widely acknowledged as the most accurate seismic evaluation procedure, it cannot be employed in this study due to its high cost and time-consuming work. NLRHA is more appropriate for specific applications, especially when precision and reliability in the evaluation results are crucial, and when only a few buildings need to undergo evaluation. Consequently, we employ the uncoupled modal response history analysis (UMRHA) procedure, a simplified version of the NLRHA procedure, to assess the seismic performance of the representative buildings. This method allows us to evaluate the seismic performance of numerous buildings in significantly less time compared to NLRHA while still delivering reasonable accuracy. Subsequently, the seismic responses of these representative buildings were evaluated under various potential earthquakes, ranging from low to high seismic intensity, in order to determine the damage levels of these structures. These damage levels, along with the earthquake intensity, can then be used to develop fragility functions for groups of buildings. These developed fragility functions can be further utilized to estimate seismic losses for a city in the event of an earthquake scenario or to determine risk-based premiums for earthquake insurance.

Keywords: Fragility Function, Low-rise to Mid-rise building, UMRHA

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