An overview of earthquake engineering research activities in Thailand

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ABSTRACT

Before the 1990s, awareness of earthquake risk in Thailand was low, earthquake research was at a primitive stage, and there were no requirements for earthquake safety of buildings and structures. In the early 1990s, several papers on Probabilistic Seismic Hazard Analysis (PSHA) became available, allowing comparison of the hazard level in Thailand with that of many other countries. Maps from PSHA, showing that the northwestern and northern regions of Thailand are at moderate to moderately high seismic hazard, provided a compelling rationale for the introduction of the first ministerial regulation for earthquake-resistant construction in 1997. Improved PSHA maps became available in the late 2000s and provided the key parameters for design-basis ground motions in the first national standard for earthquake-resistant design of buildings and structures, designated DPT -1302, issued in 2009.

In 2004, a magnitude 9 megathrust earthquake occurred in the Andaman Sea, triggering a series of destructive tsunami waves that hit the coastal areas of many countries in the Indian Ocean. The tsunami disaster claimed more than 8,000 lives in Thailand. Many high-rise buildings in the capital city Bangkok were also strongly shaken by seismic waves from this distant source. This event greatly increased public interest and awareness of earthquake disasters with low probability but potentially large impacts. This led to the establishment of the National Disaster Warning Center (NDWC) and seismic design requirements for high-rise buildings in Bangkok and four surrounding provinces in the late 2000s. Now that a tsunami warning system has been established, current research is focused on improving the tsunami evacuation process at various risk sites through the use of agent-based simulations. The effectiveness of various measures, such as vertical evacuation shelters, is being studied.

On the effect of distant large earthquakes on high-rise buildings in Bangkok, several studies have been conducted on the amplification of seismic motions by the Bangkok soil basin. In the most recent study, we used an array microtremor measurement technique to determine the shear wave velocity profile down to 1000 m below the ground surface at various locations throughout the basin. Based on this work and the work of PSHA, a set of amplified ground motion spectra for 10 different microzones in the Bangkok basin was produced and included in the revised version of the DPT -1302 standard in 2019. The spectra clearly show that the extreme ground motions are long-period motions that have a greater impact on long-period structures such as high-rise buildings. For such structures, the response of the structures to ground motions is usually determined using a method called Response Spectrum Analysis (RSA). This method was carefully reviewed and compared to a more advanced and reliable method called nonlinear response history analysis (NLRHA). It was found that the RSA method significantly underestimated some important responses, particularly seismically induced shear forces. As a result, a new method called Modified Response Spectrum Analysis (MRSA) was proposed and recommended in the 2019 DPT -1302 standard.

In 2014, a magnitude 6.3 earthquake occurred in Chiang Rai, a northern province of Thailand, damaging more than 10,000 low-rise buildings and some infrastructure in the rural region. The impact clearly raised public awareness of earthquake risk and encouraged the implementation of earthquake-resistant designs. As most of the buildings were reinforced concrete frames with masonry infill walls, the observed damage demonstrated the importance of nonstructural masonry walls in modifying the structural response to seismic loading. However, in design practice, such effects of masonry walls were generally ignored. This led to several extensive studies on the effects of masonry infill walls on RC concrete frame buildings. In addition, there have also been many studies on various seismic retrofit measures for low-rise concrete buildings, such as column jacketing, buckling restrained braces, fiber-reinforced-polymer wrapping on columns, base isolation, etc. Some demonstration projects were carried out in Chiang Rai and Chiang Mai provinces, focusing on seismic retrofitting of school buildings with the first soft story. More intensive activities and studies on seismic retrofitting of existing vulnerable structures are expected in the near future.

Finally, we would like to point out that there are many ongoing research activities that are not mentioned in this presentation. These include, for example, the development of a regional tectonic model, the paleoseismic investigation of active faults, the assessment of liquefaction hazards, the development of catastrophe models for the cities of Chiang Mai and Chiang Rai, the seismic performance of precast concrete elements, the structural health monitoring of high-rise buildings, etc. With a better understanding of earthquake risk through all this research, we hope to be able to save more lives in future earthquake disasters in Thailand.

Pennung Warnitchai has D. Eng. in Civil Engineering from University of Tokyo, Japan and is currently the Professor in Structural Engineering Field of Study, School of Engineering and Technology, Asian Institute of Technology (AIT), Thailand. Prof. Warnitchai is also actively involved with the Disaster Preparedness, Mitigation, and Management Field of Study at AIT. Besides, Prof. Warnitchai association with AIT, he has been part of various significant elective and appointed offices both in Thailand as well as in the region. Some of Prof. Warnitchai current professional affiliations include: Scientific Board Member, The Global Earthquake Model; Member, National Earthquake Committee of Thailand; Chair, Chapter on the Effects of Earthquakes and Wind Loads, Engineering Institute of Thailand under H.M. the King's Patronage; Member, Civil Engineering Chapter, Engineering Institute of Thailand under H.M. the King's Patronage.