World Academy of Science, Engineering and Technology
International Journal of Structural and Construction Engineering
Vol:9, No:03, 2015

Damages of Highway Bridges in Thailand during the 2014-Chiang Rai Earthquake

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Abstract : On May 5, 2014, an earthquake of magnitude 6.3 Richter hit the Northern part of Thailand. The epicenter was in Phan District, Chiang Rai Province. This earthquake or the so-called 2014-Chiang Rai Earthquake is the strongest ground shaking that Thailand has ever been experienced in her modern history. The 2014-Chiang Rai Earthquake confirms the geological evidence, which has previously been ignored by most engineers, that earthquakes of considerable magnitudes 6 to 7 Richter can occurr within the country. This promptly stimulates authorized agencies to pay more attention at the safety of their assets and promotes the comprehensive review of seismic resistance design of their building structures. The focus of this paper is to summarize the damages of highway bridges as a result of the 2014-Chiang Rai ground shaking, the remedy actions, and the research needs. The 2014-Chiang Rai Earthquake caused considerable damages to nearby structures such as houses, schools, and temples. The ground shaking, however, caused damage to only one highway bridge, Mae Laos Bridge, located several kilometers away from the epicenter. The damage of Mae Laos Bridge was in the form of concrete spalling caused by pounding of cap beam on the deck structure. The damage occurred only at the end or abutment span. The damage caused by pounding is not a surprise, but the pounding by only one bridge requires further investigation and discussion. Mae Laos Bridge is a river crossing bridge with relatively large approach structure. In as much, the approach structure is confined by strong retaining walls. This results in a rigid-like approach structure which vibrates at the acceleration approximately equal to the ground acceleration during the earthquake and exerts a huge force to the abutment causing the pounding of cap beam on the deck structure. Other bridges nearby have relatively small approach structures, and therefore have no capability to generate pounding. The effect of mass of the approach structure on pounding of cap beam on the deck structure is also evident by the damage of one pedestrian bridge in front of Thanthong Wittaya School located 50 meters from Mae Laos Bridge. The width of the approach stair of this bridge is wider than the typical one to accommodate the stream of students during pre- and post-school times. This results in a relatively large mass of the approach stair which in turn exerts a huge force to the pier causing pounding of cap beam on the deck structure during ground shaking. No sign of pounding was observed for a typical pedestrian bridge located at another end of Mae Laos Bridge. Although pounding of cap beam on the deck structure of the above mentioned bridges does not cause serious damage to bridge structure, this incident promotes the comprehensive review of seismic resistance design of highway bridges in Thailand. Given a proper mass and confinement of the approach structure, the pounding of cap beam on the deck structure can be easily excited even at the low to moderate ground shaking. In as much, if the ground shaking becomes stronger, the pounding is certainly more powerful. This may cause the deck structure to be unseated and fall off in the case of unrestrained bridge. For the bridge with restrainer between cap beam and the deck structure, the restrainer may prevent the deck structure from falling off. However, preventing free movement of the pier by the restrainer may damage the pier itself. Most highway bridges in Thailand have dowel bars embedded connecting cap beam and the deck structure. The purpose of the existence of dowel bars is, however, not intended for any seismic resistance. Their ability to prevent the deck structure from unseating and their effect on the potential damage of the pier should be evaluated. In response to this expected situation, Thailand Department of Highways (DOH) has set up a team to revise the standard practices for the seismic resistance design of highway bridges in Thailand. In addition, DOH has also funded the research project 'Seismic Resistance Evaluation of Pre- and Post-Design Modifications of DOH's Bridges' with the scope of full-scale tests of single span bridges under reversed cyclic static loadings for both longitudinal and transverse directions and computer simulations to evaluate the seismic performance of the existing bridges and the design modification bridges. The research is expected to start in October, 2015.

Keywords : earthquake, highway bridge, Thailand, damage, pounding, seismic resistance
Conference Title : ICCSEE 2015 : International Conference on Civil, Structural and Earthquake Engineering
Conference Location : Istanbul, Türkiye
Conference Dates : March 23-24, 2015

Open Science Index, Structural and Construction Engineering Vol:9, No:03, 2015 publications.waset.org/abstracts/16730.pdf