ABSTRACT

Zadran Sekandar, MSCE. Purdue University, May 2018. ESTIMATING LIKELIHOOD OF SEVERE DAMAGE DUE TO EARTHQUAKES IN LOW-RISE RC FRAME BUILDINGS. Major Professor: Ayhan Irfanoglu

Afghanistan has a history of devastating earthquakes claiming many lives and causing extensive damage. It is important to identify buildings vulnerable to ground shaking in an efficient manner and to upgrade or rebuild them to avoid losses during earthquakes expected to happen in the future. 51 reinforced concrete (RC) school buildings with masonry infill walls and no structural walls were surveyed in Kabul, Afghanistan in June 2017. Besides photographic documentation and location information, building dimensions including column dimensions and masonry wall dimensions, as well as wall orientation information, and number of stories above ground were recorded. To rank these buildings in vulnerability and to identify which ones, if any, would need to be upgraded to avoid high likelihood of severe damage at different levels of ground shaking, a method derived from the Priority Index (Hassan and Sozen 1994) was used. Ratios of total cross-sectional areas of ground story columns and masonry walls to total floor area above ground formed two of the key parameters. Peak ground acceleration (PGA) was used as the parameter to indicate the ground shaking. Column-to-total floor area and masonry wall-to-total floor area ratios were divided by PGA to differentiate between different levels of shaking intensity. The method is calibrated and a threshold relationship is established to distinguish whether a building is more likely to sustain severe damage ("more vulnerable") or less likely to do so ("less vulnerable") using data from buildings surveyed following the 2016 Meinong, Taiwan earthquake. In particular, observations and measurements from survey of 72 RC frame buildings with no structural walls but with solid brick infill walls and located near ground motion recording stations were used. Peak ground acceleration recorded by the nearest ground motion recording station (within 5 km of the building) is used to scale the column and infill wall ratio based indices. Various combinations of the indices were studied to find a threshold description. Threshold expression choice was based on 1) the success rate in identifying buildings that sustained severe damage as "more vulnerable" while 2) minimizing the likelihood of identifying buildings that did not sustain severe damage as "more vulnerable." The primary objective is to avoid loss of life while the secondary objective is to avoid establishing a threshold that would be too costly to implement. It has been found that, for a given PGA level, columns contribute 2 to 3 times more to the survivability of the considered RC buildings than solid masonry walls. The indices were then used to rank the school buildings in Kabul in vulnerability with weighted distance to origin as the indicator of vulnerability rank. The threshold relationship was used to estimate possible cases of severe damage under different levels of ground motions expressed in terms of PGA. Results are used to make recommendations for existing buildings and for new construction in Afghanistan, with particular focus on school buildings similar those surveyed in Kabul.