ABSTRACT

Skok, Nicholas R. M.S.C.E., Purdue University, December 2014. Evaluation of Collapse Indicators for Seismically Vulnerable Reinforced Concrete Buildings. Major Professor: Santiago Pujol.

Older reinforced concrete buildings can be prone to shear and compression column failures during earthquakes because of inadequate transverse reinforcement. Cities in seismic areas still have large inventories of older and potentially deficient buildings. To analyze every building and estimate its vulnerability in detail is costly for engineers. A simple method to rank quickly older buildings according to their seismic vulnerability is needed to help engineers prioritize the use of resources for rehabilitating the most vulnerable buildings.

Four indicators of building damage or collapse were evaluated using numerical analysis and prior data from building surveys: column index (Hassan and Sozen, 1997), R factor, ratio of column shear capacity to plastic shear demand, and ratio of column moment capacity to beam moment capacity. Idealized building frames were studied using nonlinear numerical analysis. Numerical models of these building frames with different spans, column sizes, numbers of floors, and transverse reinforcement ratios were analyzed with 44 ground motion records. Each numerical analysis used an algorithm to estimate whether a numerical model representing a hypothetical building was likely to be severely damaged.

Among the four indicators studied, the column index was observed to be 1) the simplest and 2) the one with the best correlation with estimates of vulnerability to damage. Approximately 3/5 of the numerical models representing hypothetical building frames with column indices not exceeding 0.20% were classified as buildings likely to be severely damaged and were 4 times more likely to be classified as severely damaged than those with column indices exceeding 0.20% during ground motions

with PGVs between 40 cm/s and 120 cm/s. The prior building survey data also had approximately 3/5 of buildings with column indices not exceeding 0.20% classified as severely damaged and were twice as likely to be classified as severely damaged than those with column indices exceeding 0.20%.