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Modelling and Computational issues in Seismic Progressive Collapse Assessment of RC Moment Resisting Buildings with Eccentricity in Plan

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Abstract

Margin of safety against potential of progressive collapse is an important property of a structural system. Often eccentricity in plan of a building causes concentration of damage, thus adversely affects progressive collapse safety margin of that building. In this paper some modeling and computational issues in seismic progressive collapse assessment of reinforced concrete moment resisting buildings with eccentricity in plan are studied. The building models are symmetric and asymmetric 3, 6 and 9-story reinforced concrete ordinary moment resisting frame buildings subjected to earthquake ground motions. The asymmetric buildings have 5%, 15% and 25% mass eccentricity. The distribution of damage and spread of collapse is investigated using nonlinear time history analyses. An important modeling issue is selecting the type of nonlinear element capable of reliably identifying collapse of a building. Results show concentrated plasticity approach is a more appropriate tool for such studies compare with other available techniques such as fiber modeling. Using such models show that increase in potential of progressive collapse at both flexible and stiff edges of buildings with increase in level of asymmetry in buildings. It is also demonstrated that “drift”, as a more easily available global response parameter of frame, is a good measure for a much difficult to calculate local response parameter of “number of post collapse plastic hinges”.
Among other important issues in progressive collapse behavior of a building is tracking down the type and location of the damaged elements. This paper also deals with identifying the effects of computational strategies for deriving distribution of collapse from the first element to the entire of the structure due to earthquake loads. Here, 3D collapse propagations in symmetric and asymmetric reinforced concrete buildings are compared using nonlinear time history analyses. The variables of such analyses are modeling techniques, computational strategy, earthquake load intensity and level of mass eccentricity. Results show that collapse distribution is dependent on the degree of asymmetry in building. Some patterns to predict progressive collapse scenarios in similar symmetric and asymmetric buildings are also determined. One main pattern shows that propagation of collapse is horizontal through the stories not vertical through the height of the buildings. Spread of the collapse is independent of the earthquake records. According to the results, probability of collapse initiation from the columns increases when mass eccentricity increases. Generally, collapse in asymmetric buildings initiates mainly on the flexible edge of the building.

Key words: Asymmetric buildings, Progressive collapse, Mass eccentricity, Reinforced concrete ordinary moment resisting frame building, Nonlinear time history analysis.