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DEVELOPMENT OF FRAGILITY CURVES FOR LOW RISE BRACED STEEL BUILDINGS WITH ROCKING MOTION

Masoumeh FARSHBAF
Ph.D. Candidate, IIEES, Tehran, Iran
masumeh.farshbaf@stu.iiees.ac.ir

Abdolreza S. MOGHADAM
Associate Professor, IIEES, Tehran, Iran
moghadam@iiees.ac.ir

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Residual drifts after severe earthquakes interrupt serviceability of buildings. Retrofitting of such buildings are in many cases very difficult and need lots of time and money to perform. Recently there are some attempts to develop such seismic design procedures to not only satisfy life safety criteria, but also lead to a more economical building. One of these modern methods of improving seismic performance of steel structures is using systems with ability of rocking. The main features of these new systems are to concentrate the damages in specific and easily repairable locations of structures, to dissipate more energy and to reduce and limit the residual deformations.

The purpose of this study is to develop fragility curves for low rise braced steel buildings with rocking motion and compare them with the corresponding fragility curves for fix based buildings. The buildings with rocking motion are considered for two cases with viscous and yielding dampers.

The base model in this study is a 3-story building with rocking motion based on a prototype building of the SAC project configuration (Eatherton, 2010). Figure 1 shows a 3D view of the model. To consider the effect of dampers and their specification on building performance, two different types of dampers, viscous and yielding are used in column foundation connection to control the rocking motion in different models. In total 13 building models are considered for this study. Vertical post tensioning strands provide self-centering forces. The strands are initially stressed to %70 Fy. Plans, loading and other information details are provided elsewhere (Farshbaf et al., 2016). To model the possibility of uplift at column base in SAP2000, gap elements are used. The gap elements have zero stiffness in tension but very large stiffness in compression. The value of opening is considered zero.

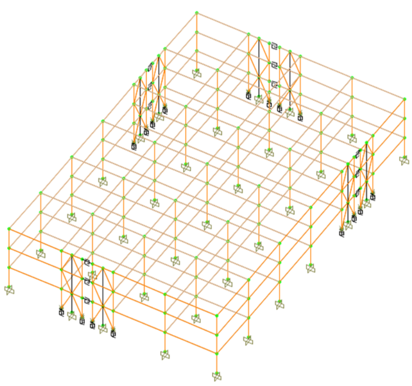
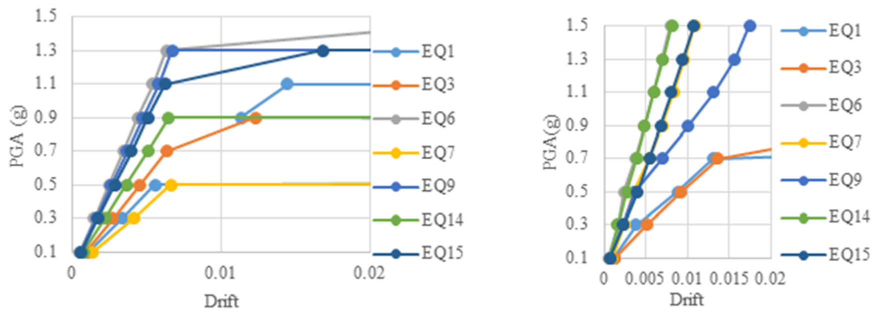


Figure 1. Three dimensional view of studied model.

This study used seven far field records from appendix A of FEMA P695. To drive the fragility curves. For each ground motion record its horizontal component with maximum acceleration is used. For driving fragility curves, Incremental

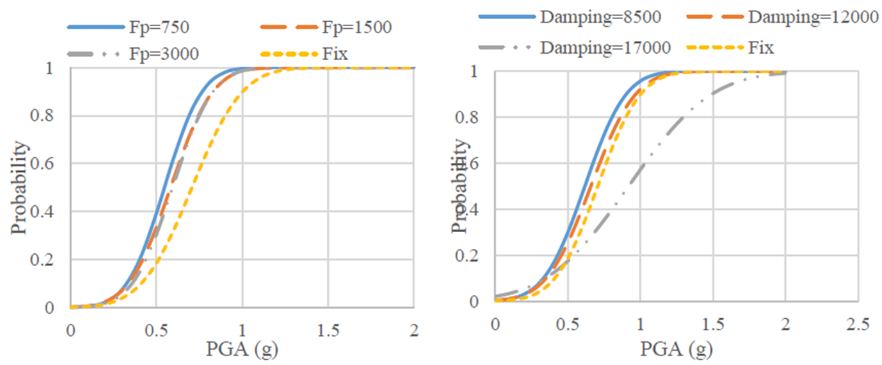
Dynamic Analysis (IDA) is performed by using nonlinear time history analyses from 0.1 g to 1.5 g with 0.2 g increment for every of the 13 building models, each subjected to the seven ground motion records. In this study, Immediate Occupancy (IO), Life Safety (LS), Collapse Prevention (CP) performance levels are considered equivalent to 0.5%, 1.5% and 2% drift respectively.



(a) (b)

Figure 2. Drift IDA curves, a) Fixed based building, b) Rocking building.

In this curves vertical and horizontal axis indicate PGA and Drift ratio respectively and each curve on the Figure 2 show the responses subjected to one of the ground motions.



(a) (b)

Figure 3. Drift fragility curves in IO performance level. a) buildings with yielding dampers with different damper strenthgs, b) buildings with viscous dampers with different damping coefficients.

Some of the conculutions based on fragility curve developed here (one of them is shown in Figure 3) are as following. With increase in viscous damping, the drift decreases. In models with yielding dampers, increase in damper strength causes decrease in the drift values. In general, although rocking motion did not decrease the maximum drift in the building; howerer, it should be noted that larger part of the drift in the rocking buildings is due to rigid body rotation and is not destractive.

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