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Seismic Fragility Assessment of Strongback Steel Braced Frames Subjected to Near-Field Earthquakes

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Abstract : In this paper, seismic fragility assessment of a recently developed hybrid structural system, known as the strongback system (SBS) is investigated. In this system, to mitigate the occurrence of the soft-story mechanism and improve the distribution of story drifts over the height of the structure, an elastic vertical truss is formed. The strengthened members of the braced span are designed to remain substantially elastic during levels of excitation where soft-story mechanisms are likely to occur and impose a nearly uniform story drift distribution. Due to the distinctive characteristics of near-field ground motions, it seems to be necessary to study the effect of these records on seismic performance of the SBS. To this end, a set of 56 near-field ground motion records suggested by FEMA P695 methodology is used. For fragility assessment, nonlinear dynamic analyses are carried out in OpenSEES based on the recommended procedure in HAZUS technical manual. Four damage states including slight, moderate, extensive, and complete damage (collapse) are considered. To evaluate each damage state, inter-story drift ratio and floor acceleration are implemented as engineering demand parameters. Further, to extend the evaluation of the collapse state of the system, a different collapse criterion suggested in FEMA P695 is applied. It is concluded that SBS can significantly increase the collapse capacity and consequently decrease the collapse risk of the structure during its life time. Comparing the observing mean annual frequency (MAF) of exceedance of each damage state against the allowable values presented in performance-based design methods, it is found that using the elastic vertical truss, improves the structural response effectively.

Keywords : IDA, near-fault, probabilistic performance assessment, seismic fragility, strongback system, uncertainty
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