Effect of Uncertainty in RC Walls on Seismic Responses of Buildings with Force-limiting Connections

C. Franco Mayorga* and Georgios Tsampras
University of California San Diego, La Jolla CA, United States

Corresponding Author: cfmayorg@ucsd.edu

ABSTRACT

The uncertainty in the reinforced concrete (RC) wall model parameters is propagated to the seismic responses of a 12-story building with force-limiting deformable connections between the floor system and the structural RC walls. Preliminary analysis showed that the seismic response of the longitudinal reinforcing steel in flexure-dominant base-mechanism RC walls significantly influences the seismic response of the walls. Therefore, the reinforcing steel bar behavior is explicitly modeled through a fiber-based modeling approach, in which the response of the steel fibers is simulated using the Giuffrè-Menegotto-Pinto (GMP) uniaxial steel constitutive law in OpenSees. A joint probability density function of the parameters of the GMP material model for the ASTM A615 Grade 60 reinforcing steel available in the literature is used to perform an uncertainty propagation analysis, generating 4000 samples in the steel model parameter space through Monte Carlo simulation. The building is evaluated at each steel model parameter sample and subjected to 18 design-basis level ground motions. Hence, 72000 nonlinear dynamic analyses are performed using parallel computing in Python. The uncertainty propagation analysis is also performed for a conventional building modeled with high-stiffness connections to evaluate the effects of the inclusion of force-limiting connections on the distribution of the structural responses. The histograms of the base shear, base moment, story-drift, floor acceleration, and strain peak mean value responses are presented. The use of force-limiting deformable connections reduces the peak mean values of the base shear, base moment, story-drift, floor acceleration, and strain responses, and the dispersion of the peak mean values of the base shear and acceleration responses. This results in higher confidence in the prediction of the seismic responses of the building with force-limiting deformable connections compared to that obtained for the conventional building.