ABSTRACT

Hesam, Pedram. Ph.D., Purdue University, May 2016. Estimating Effective Viscous Damping and Restoring Force in Reinforced Concrete Structures. Major Professors: Ayhan Irfanoglu and Thomas J. Hacker

In seismic design, buildings are designed to respond to strong earthquake ground motions inelastically. The engineering norm followed in design and analysis is to use constant modal viscous damping ratios to account for all energy dissipation aside from that arising from material nonlinearity. In general, equivalent linear models which aim to capture primarily the peak response with typically 2% to 5% of critical damping are employed. In this research study, it is shown that the effective viscous damping ratio can be estimated from the dynamic response of actual building structural systems without linearization of the load-deformation characteristics. The presented empirical method, which estimates the effective viscous damping ratios of structures, has been tested using numerical simulations, and applied to twenty-three small-scale laboratory test specimens in addition to an actual full-scale reinforced concrete (RC) building. It is observed that the effective viscous damping ratio in a low to mid-rise RC building responding at its dominant mode (equivalent of fundamental mode in linear elastic systems) varies linearly with the change in the effective period of its dominant mode. Fundamental mode envelopes of hysteretic responses for the structures are estimated by excluding higher mode effects from the measured responses.