Evaluation of ASCE-41 Nonlinear Static Procedure Using Recorded Motions of Reinforced-Concrete Buildings

By

Rakesh K. Goel, F. ASCE
Department of Civil & Environmental Engineering
California Polytechnic State University
San Luis Obispo, CA 93407
Phone: (805) 756-2052; Fax: (805) 756-6330; Email: rgoel@calpoly.edu

Motivated by a unique opportunity provided by recorded motions of buildings that were strongly shaken during recent earthquakes, the principal objective of the investigation reported in this paper is to evaluate the ASCE-41 nonlinear static procedures (NSP) for seismic analysis and evaluation of building structures using strong-motion records of reinforced concrete buildings. The NSP in ASCE-41 includes the improvements suggested by the ATC-55 project, reported in FEMA-440 document, to the NSP method in the FEMA-356 document. The pushover curve, needed in the NSP method is developed from three-dimensional models of the buildings. The beams, columns, and shear walls (when present in the building) are modeled with nonlinear beam-column elements with fiber section. Particular attention is paid to modeling techniques that would enable the pushover curve to exhibit failure because one the of the building being investigated suffered significant damage, was near collapse, and had to be demolished after the earthquake. The “accuracy” of the NSP procedure is evaluated by comparing the seismic demands – maximum floor and roof displacements and inter-story drifts – predicted from the NSP method and those “derived” directly from recorded motions. This investigation generated ten data points, one in each direction for each of the five selected buildings, for evaluation of the ASCE-41 NSP method. Although such a small number of data points may appear to be very limited for drawing widely applicable conclusions, they provide useful information. It is shown that the ASCE-41 NSP, as well other currently used NSP, may lead to errors, either on the un-conservative or conservative side, by up to 20 percent when compared to the data from recorded motions.