

The drift pushover analysis procedure based on the relative displacement of stories for seismic evaluation of structures

Abstract

With the occurrence of devastating earthquakes, structures deform beyond the elastic range and their accurate evaluation requires the use of nonlinear analysis. For the same purpose, use of nonlinear static/dynamic analysis methods have recently been considered in the new generation of earthquake engineering building codes based on performance based-design criteria. In this study a new method for nonlinear static analysis based on the relative displacements of stories is proposed that is able to be implemented in a single stage analysis and considers the effects of an arbitrary number of higher modes. The method is called the drift pushover analysis procedure (DPA). To define the lateral load pattern, values of the relative displacements of stories are calculated using the elastic modal analysis and the modal combination factors introduced. For determining the combination factors, six different approaches are examined. Buildings evaluated in this study are located in an area with a very high seismic hazard and consisting of four special steel moment-resisting frames with 10 to 30 stories. Responses including relative displacements of stories, story shear forces and rotation of plastic hinges in each story are calculated using the proposed approaches in addition to modal pushover analysis (MPA) and nonlinear dynamic time history analyses. The nonlinear dynamic analysis is implemented using ten consistent earthquake records that have been scaled with regard to ASCE 7-10. Distribution of response errors of story shears and plastic hinge rotations show that a major part of error corresponds to the second half of the buildings studied. Thus, the mentioned responses are corrected systematically. The final results of this study show that implementing the DPA procedure using the third approach of this research is able to effectively overcome the limitations of both the traditional and the modal pushover analyses methods and predict the seismic demands of tall buildings with good accuracy.

Keywords: drift pushover analysis (DPA) procedure, contribution of the higher-mode, seismic demands, tall buildings.