

Evaluation of Modal Pushover Analysis: SAC Buildings Excluding Gravity Loads

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Introduction

Recently, a modal pushover analysis (MPA) procedure has been developed that includes the contributions of several modes of vibration (Chopra and Goel, 2001). This paper demonstrates the accuracy of the modal pushover analysis (MPA) procedure in estimating the seismic demands for SAC buildings without considering gravity loads or P-delta effects, and compares these results with those obtained for the same buildings by pushover analysis using three force distributions in FEMA-273.

SAC Buildings and Ground Motions

SAC commissioned three consulting firms to design 3-, 9-, and 20-story model buildings according to the local code requirements of three cities: Los Angeles, Seattle, and Boston. The N-S perimeter frames of 9- and 20-story buildings are analysed in this paper. For all three locations, sets of 20 ground motion records were assembled representing probabilities of exceedance of 2% and 10% in 50 years (return periods of 2475 and 475 years, respectively). The 2/50 set of records is used in the subsequent analysis.

Comparative Evaluation of Procedures

Each of the six buildings was analysed by two procedures: nonlinear response history analysis (RHA) and MPA and for each of the 20 ground motions. Contributions of the first three “modes” or the first five “modes” were considered for the 9-story buildings and 20-story buildings, respectively. Figure 1 shows the median values of story drift demands by these two procedures. Results presented elsewhere (Chopra and Goel, 2001) show that the first “mode” alone is inadequate in estimating story drifts. However, by including the response contributions of higher modes, the height-wise distribution of story drifts estimated by MPA is generally similar to the trends noted from nonlinear RHA (see Fig. 1).

Figure 1 also includes story drift demands for each building determined by pushover analysis using the three force distributions in FEMA-273. The target roof displacement in the analyses using FEMA force distributions was taken as equal to its value determined by the MPA procedure to achieve a meaningful comparison of the two methods. The height-wise variation of story drifts determined from the FEMA force distributions differs considerably from nonlinear RHA. Clearly, the FEMA force distribution procedure is inadequate; it does not predict the increasing drifts in the upper stories of Boston structures; the concentration of large story drifts in the upper stories of Seattle structures (especially in the 20-story building); and the complex variation of story drifts over the height of the 20-story Los Angeles building. Obviously, the MPA procedure performs much better than FEMA force distributions in estimating story drift demands.

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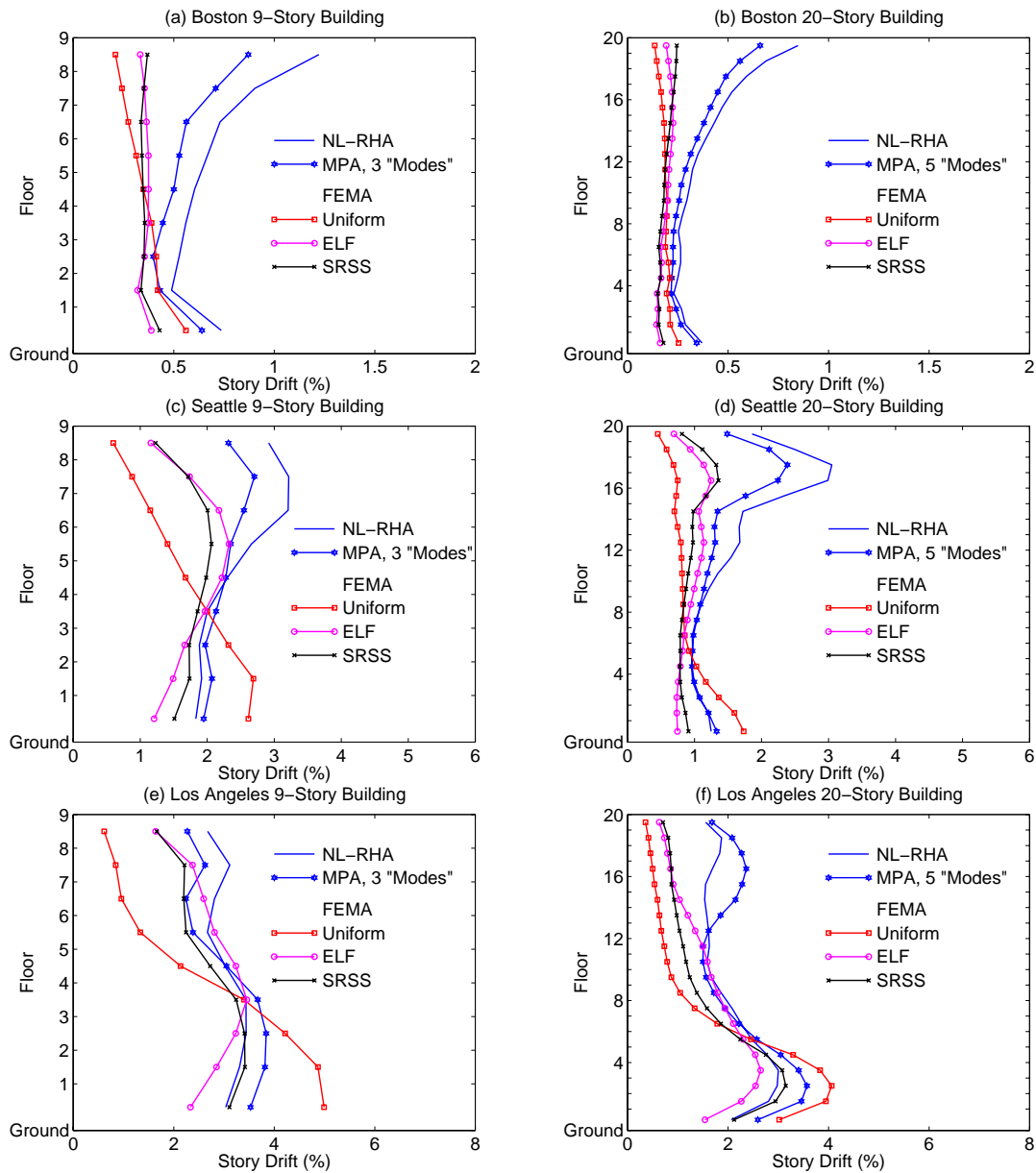


Figure 1: Comparison of median story-drift demands determined by five procedures: pushover analysis using three force distributions in FEMA-273, MPA, and nonlinear RHA; gravity loads excluded

References

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