World Academy of Science, Engineering and Technology
International Journal of Structural and Construction Engineering
Vol:9, No:08, 2015

The Effect of Different Parameters on a Single Invariant Lateral Displacement Distribution to Consider the Higher Modes Effect in a Displacement-Based Pushover Procedure

Authors : Mohamad Amin Amini, Mehdi Poursha

Abstract : Nonlinear response history analysis (NL-RHA) is a robust analytical tool for estimating the seismic demands of structures responding in the inelastic range. However, because of its conceptual and numerical complications, the nonlinear static procedure (NSP) is being increasingly used as a suitable tool for seismic performance evaluation of structures. The conventional pushover analysis methods presented in various codes (FEMA 356; Eurocode-8; ATC-40), are limited to the first-mode-dominated structures, and cannot take higher modes effect into consideration. Therefore, since more than a decade ago, researchers developed enhanced pushover analysis procedures to take higher modes effect into account. The main objective of this study is to propose an enhanced invariant lateral displacement distribution to take higher modes effect into consideration in performing a displacement-based pushover analysis, whereby a set of laterally applied displacements, rather than forces, is monotonically applied to the structure. For this purpose, the effect of different parameters such as the spectral displacement of ground motion, the modal participation factor, and the effective modal participating mass ratio on the lateral displacement distribution is investigated to find the best distribution. The major simplification of this procedure is that the effect of higher modes is concentrated into a single invariant lateral load distribution. Therefore, only one pushover analysis is sufficient without any need to utilize a modal combination rule for combining the responses. The invariant lateral displacement distribution for pushover analysis is then calculated by combining the modal story displacements using the modal combination rules. The seismic demands resulting from the different procedures are compared to those from the more accurate nonlinear response history analysis (NL-RHA) as a benchmark solution. Two structures of different heights including 10 and 20-story special steel moment resisting frames (MRFs) were selected and evaluated. Twenty ground motion records were used to conduct the NL-RHA. The results show that more accurate responses can be obtained in comparison with the conventional lateral loads when the enhanced modal lateral displacement distributions are used.

Keywords : displacement-based pushover, enhanced lateral load distribution, higher modes effect, nonlinear response history analysis (NL-RHA)
Conference Title : ICSE 2015 : International Conference on Structural Engineering
Conference Location : Venice, Italy
Conference Dates : August 13-14, 2015