Development of a shear-based nonlinear static procedure for seismic evaluation of structures

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For exact seismic design and evaluation of structures beyond their elastic deformations, it is necessary to use non-linear analysis. Such a need, has placed the non-linear static analysis procedures in the framework of main stream research works. In this research, a shear-based non-linear static analysis has been developed and following the exploration of six different patterns, a new method has been presented in order to determine the lateral load pattern in which effects of higher modes are included. This method is different from the previous studies in two important aspects including the use of story drifts to calculate the shear force and the more significant one is the proposal of an approximate combination rule that retains sign of the modal lateral forces. In order to evaluate the proposed method, 4 buildings consisting of special steel moment-resisting frames with 10 to 30 stories located in an area prone to an extreme seismic hazard are utilized. 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 the conventional pushover analysis (CPA), modal pushover analysis (MPA) and nonlinear dynamic time history analyses. The nonlinear dynamic analysis is implemented using ten consistent earthquake records scaled with regard to ASCE7-10. The method is fulfilled by using a correction factor to modify the amounts of shear and rotation of plastic hinges in the top stories that causes much better results.The final results show that the proposed method 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 higher accuracy.

Keywords: shear-based non-linear static analysis, contribution of higher modes, seismic assessment of structures, pushover analysis.