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Multi- Storey Buildings Behavior under Seismic Ground Motion using MAPA Method

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Abstract
The innovative Modal Adaptive Pushover Analysis (MAPA) procedure of asymmetric building systems under seismic ground motions is proposed. In this study the MAPA are extended to two-way asymmetric buildings simultaneously excited by two horizontal components of ground motion using adapted DRAIN-3DX computer program. An asymmetric Multi-story building is analyzed by MAPA procedure. The analytical results are compared with those obtained from nonlinear response history analysis (RHA). When the RHA results are taken as reference, it is seen that the proposed method is capable of estimating the seismic response of frame buildings.
Keywords: Load increment method, Capacity curve, Seismic demand, inelastic spectra

1. INTRODUCTION

The Nonlinear Static Procedures (NSP) or pushover analysis is a major step towards performance-based seismic evaluation and rehabilitation of buildings. The FEMA 356 and ATC-40 documents are favoured the pushover analysis that combines the advantage of explicit treatment of yielding and inelastic deformations with the simplicity of static loading patterns for evaluation of the inelastic seismic response [1, 2]. There are still several unresolved issues in identifying appropriate lateral load patterns to be used in the pushover analysis. Current structural engineering practice uses invariant load distributions described in ATC-40 or FEMA-356. While those invariant load distributions (such as inverted triangle, uniform, or mass proportional) are based on the assumption that the response is primarily in its fundamental mode of vibration, it can lead to incorrect estimates for structures with significant higher mode contributions. This accentuates the need for improved procedures that addresses current drawbacks in the lateral load patterns that are used in pushover analyses. Recently, several improved pushover procedures is proposed to account for higher mode effects while retaining the simplicity of invariant load patterns. These procedures utilize the concept of modal combinations either through a single pushover analysis where the load vectors reflect the contributions from each elastic modal shape considered or through multiple pushover analyses using invariant load patterns based on elastic mode shapes where the contribution from each mode is combined at the end such as the modal pushover analysis (MPA) of Chopra and Goel, [3]. Recently, a modified version of MPA (MMPA) has been proposed in which the inelastic response obtained from first mode pushover analysis has been combined with the elastic contribution of higher modes, [4]. Although, these procedures have been shown to provide more accurate estimates of inter-story drift values than conventional pushover analysis, none of them can account for the redistribution of inertia forces due to structural yielding and the associated changes in modal attributes of the structure. To overcome these limitations, several researchers have proposed adaptive force distributions that attempt to follow more closely the time-variant distributions of inertia forces, [5]. While these adaptive force distributions may provide better estimates of seismic demands, they are conceptually complicated and computationally demanding for application in structural engineering practice. Attempts have also been made to consider more than the fundamental vibration mode in pushover analysis [6]. The static procedure will never be able to completely replace a dynamic analysis; nevertheless, a methodology is searched to obtain response information reasonably close to that predicted by the modal adaptive pushover analyses. The present study is therefore shown to constitute an extremely appealing capacity curve tool for structural assessment. It is fully in line with the recently introduced deformation- and performance-oriented trends in the field of earthquake engineering.
Newly, adaptive spectra-based pushover procedure to estimate seismic demand of structures is proposed by Gupta and Kunnath, [5]. The accuracy of Adaptive Modal Combination (AMC) procedure is investigated to predict critical seismic demand parameters in vertically irregular by Kalkan, [7]. The AMC procedure