

## Comparative Assessment of Enhanced Multi-mode Pushover Analysis Methods for Performance Based Design

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## Summary

Performance Based Design is a logical design process to determine the performance of such structures where normal code-based prescriptive methods may not apply. Although Non-Linear Time History Analysis has proven to be the most appropriate and reliable approach to follow, it requires considerable effort, cost and skill, which may be either not practical or justified in many cases. For such cases, Non-linear Static Pushover Analysis has become a popular “tool” for PBD. However, NSPA has an inherent deficiency that its invariant load distribution cannot take the higher-mode effect into consideration which may have significant effects in structure, especially mid- to high-rise buildings. Several attempts had been made to develop NSPA so that the higher-mode effects can be considered. This paper investigates the effectiveness of several enhanced pushover methods in predicting the response of structures in comparison with NLTHA solution.

**Keywords:** Performance based design; Enhanced pushover analysis; Seismic evaluation.

## 1. Introduction

Performance Based Design (PBD) is a logical design process that will give a solution to achieve a specified performance. Most Codes now incorporate a performance based design option as an alternative to its prescriptive requirements. Linear analysis is far from accurate, while nonlinear analysis is more difficult but can give rational result. For practical reasons, people may choose non-linear pushover analysis than Non-Linear Time History Analysis (NLTHA). Despite of the “exact” solution which NLTHA offered, higher computational cost compared to NSPA becomes a disadvantage of NLTHA.

However, NSPA has several inherent deficiencies. One of them is that the NSPA invariant load distribution cannot take the higher-mode effect into consideration which will take important role for structures that their behavior will be affected by higher mode (e.g. tall buildings). This issue pushed engineers to develop enhanced pushover procedures that can consider higher-mode effects.

## 2. VARIOUS METHOD

Pushover Analysis method can be categorized into three major groups based on how they analyze the structure (lateral load vector). The groups are Single Mode Pushover Analysis Method (SMPAM), Simple Pushover Analysis Method (SPAM), and Multi-mode Pushover Analysis Method (MMPAM). Figure 1 shows the categorization of enhanced pushover methods.