STATIC PUSHOVER ANALYSIS BASED ON AN ENERGY–EQUIVALENT SDOF SYSTEM - APPLICATION TO SPATIAL SYSTEMS

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ABSTRACT

In the last decades many of research efforts have focused on developing simple procedures for the approximate estimation of the inelastic performance of buildings under seismic excitation, in order to avoid the significant computational cost and the rest inherent disadvantages of the accurate inelastic dynamic analysis. The result of these efforts was the development of static pushover analysis. Static Pushover Analysis, or Nonlinear Static Procedure (NSP) as it is referred in seismic codes, is a useful tool for the engineering practice. However, it is timely noted by many researchers that this procedure presents many shortcomings and can provide reasonable results only for low and medium rise regular planar systems. Thus, many researchers have proposed advanced nonlinear procedures to overcome these shortcomings

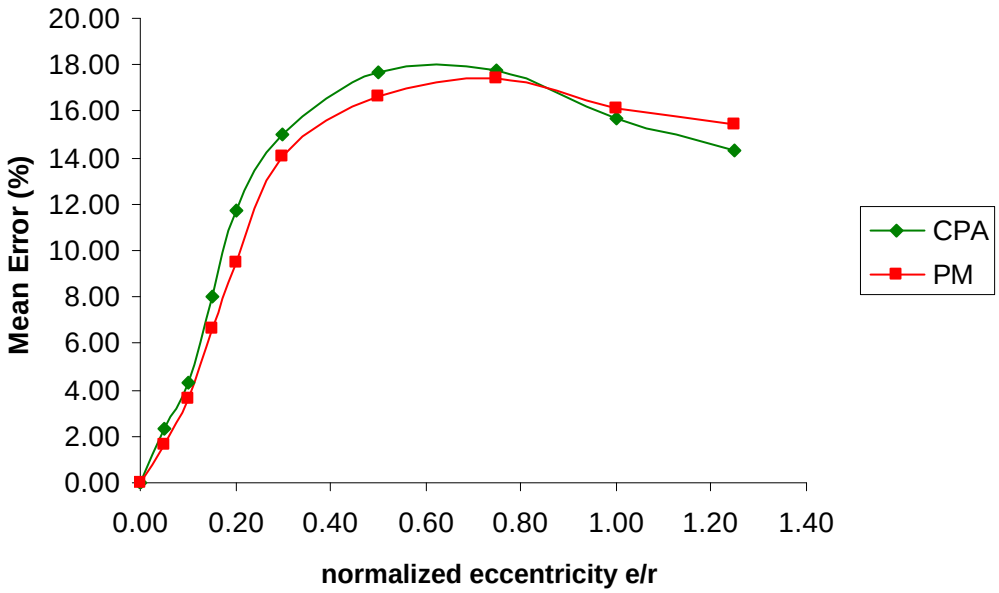
The objective of this paper is the presentation and preliminary evaluation of a new enhanced NSP for the approximate estimation of the seismic response of structures. The steps of the proposed methodology are quite similar to those of the well-known displacement modification method. However, the determination of the characteristics of the equivalent single degree of freedom (E-SDOF) system is based on a different philosophy. Specifically, the definition of the E-SDOF system is based on the equalization of the external work of the lateral loads acting on the structure under consideration to the strain energy of the E-SDOF system.

Firstly, the theoretical background and the underlying assumptions of the proposed methodology are presented and briefly discussed. Taking into account the basic assumptions and applying well-known principles of structural dynamics, some fundamental conclusions are derived and on their basis an alternative energy-equivalent SDOF system is established, which can be used for a more realistic estimation of the target displacement and other response quantities of interest.

Secondly, both steps needed for the implementation of the proposed methodology along with the necessary equations are systematically presented.

Finally, the accuracy of the proposed methodology is evaluated by an extensive parametric study. In particular, the methodology is applied to a series of single storey R/C buildings with different values of normalized (e/r) eccentricities. For each building two sets of pushover analyses are conducted: i) one based on the proposed methodology and ii) a second based on the conventional FEMA 356/440 procedure. Each set of analyses comprises 12 different response spectra corresponding to real strong earthquake motions. The roof displacements are compared to those obtained by nonlinear time-history analysis, which is considered as the reference solution. The whole investigation shows that, in general, the proposed methodology

gives better results compared to those produced by the conventional procedure.



Mean errors (%) of roof displacements for the proposed (PM) and the conventional (CPA) NSPs