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EFFECTIVENESS OF MODIFIED PUSHOVER ANALYSIS PROCEDURE FOR THE ESTIMATION OF SEISMIC DEMANDS OF BUILDINGS SUBJECTED TO NEAR-FAULT EARTHQUAKES HAVING FORWARD DIRECTIVITY

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SUMMARY

Near-fault ground motions with long-period pulses have been identified as being critical in the design of structures. These motions, which have caused severe damage in recent disastrous earthquakes, are characterized by a short-duration impulsive motion that transmits large amounts of energy into the structures at the beginning of the earthquake. In nearly all of the past near-fault earthquakes, significant higher mode contributions have been evident, resulting in the migration of dynamic demands (i.e., drifts) from the lower to the upper stories. Due to this, the static nonlinear pushover analysis (PA) (which utilizes a load pattern proportional to the shape of the fundamental mode of vibration) may not produce accurate results when used in the analysis of structures subjected to near-fault ground motions. The objective of this paper was to improve the accuracy of the pushover method in these situations by introducing a new load pattern into the common pushover procedure. Several PAs are performed for six existing reinforced concrete buildings that possess a variety of natural periods. Then, a comparison is made between the PA results (with four new load patterns) and those of FEMA-356 with reference to nonlinear dynamic time-history analyses. The comparison shows that, generally, the proposed pushover method yields better results than all FEMA-356 PA procedures for all investigated response quantities, and is a closer match to the nonlinear time-history responses. In general, the method is able to reproduce the essential response features providing a reasonable measure of the likely contribution of higher modes in all phases of the response.

1. INTRODUCTION

Estimating the seismic demand of buildings requires explicit consideration of the inelastic behaviour of the structure. While nonlinear response history analysis is the most powerful and most difficult procedure for the estimation of seismic demands, current structural engineering practice uses a nonlinear static procedure (NSP) otherwise known as pushover analysis (PA). PA has been developed over the past 20 years, and has become the preferred analysis procedure for the purpose of design and the seismic performance evaluations as the procedure is relatively simple and considers post-elastic behaviour. However, the procedure involves certain simplifications that result in approximations in its seismic demand predictions, in particular for near-fault earthquakes.

In near-fault earthquakes, significant higher mode contributions do exist, resulting in the migration of dynamic demands from the lower to the upper stories. These higher modes affect the dynamic

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