THE EFFECT OF THE FREQUENCY CHARACTERISTICS OF GROUND MOTIONS ON NONLINEAR STRUCTURAL RESPONSE

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In deterministic studies of nonlinear dynamic response, particularly those aimed at determining near-maximum response of structures which may be subjected to ground motion originating from widely separated potential earthquake foci, it is of interest to know what general type of accelerogram to use as input in a dynamic analysis in order to obtain a good estimate of the expected maximum response with a limited number of analyses. This knowledge is of particular value when specifying input motions for use in the nonlinear dynamic analysis of a specific structure.

Insofar as dynamic structural response is concerned, the principal ground motion parameters are intensity, duration, and frequency content. Intensity is used to indicate a characteristic measure of the amplitude of the acceleration pulses in a record. Duration refers to the length of the record during which relatively large amplitude pulses occur, with due allowance for a reasonable build-up time. The frequency characteristics of a given ground motion have to do with the energy content of the different component waves making up the motion.

Although the effects of intensity and duration on dynamic structural response have been studied by a number of investigators, very little has been done to study the effect of the frequency characteristics of the input motion, particularly with respect to the objective mentioned above.

This study presents the results of the dynamic nonlinear analysis of isolated structural walls with hysteresis loops characterized by a decreasing value of the stiffness with increasing amplitudes of inelastic deformation. The study of the effect of the frequency characteristics of the input motion was undertaken primarily in an effort to narrow down the number of accelerograms which could be used in a parametric study while still providing a reasonable estimate of the maximum response under a likely combination of unfavorable conditions.

A rough basis for classifying accelerograms in terms of their damped velocity spectra as "broad band" and "peaking" is proposed. The results of the analysis of various structures having different fundamental periods and yield levels are presented and discussed. The results indicate that when extensive yielding occurs in a structure so that a significant change in the effective period of vibration results, a broad band accelerogram is more likely to produce a more severe response compared to a peaking accelerogram of the same intensity and duration. On the other hand, when only minor yielding occurs so that no significant increase in the effective period results, a peaking record will more likely produce the more severe response.

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