CHARACTERISTICS OF THREE COMPONENT SPECTRA COMPATIBLE TIME HISTORIES

by

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It is a common practice in the U. S. nuclear power industry to consider three component inputs in the seismic resistant design of nuclear power plant facilities. One can either input the three components one by one and combine the peak response from three individual inputs by the root-sum-square approach or input three components simultaneously and combine the response algebraically at each time increment. For majority cases, the root-sum-square combination of individual inputs yield satisfactory results. However, in some special cases, e.g., calculating soil bearing pressure underneath the mat, etc., it is preferable to input the three components simultaneously. When three components are input simultaneously, a question arises as to how should the three components of the ground motions correlate to one another?

Newmark et al. recommended that the three components should be independent. Penzien and Watabe showed that an orthogonal set of axes can be defined for earthquake ground motions along which the covariances equal zero. This set of orthogonal axes is called the principal axes of the ground motions. Hence, they concluded that artificially generated components of ground motions need not be correlated statistically provided they are directed along a set of principal axes.

The kind of artificial time histories used by the industry now has to satisfy certain regulatory requirements. That is,the response spectra of the artificial time history has to be consistent with the design spectra. This requirement can be satisfied either by local suppressing or amplifying the spectrum of a given time history or by iterating the amplitudes of a series of harmonics with random phase angles where the initial amplitudes can be estimated from the assumed power spectral density function or the undamped pseudo velocity spectrum. During the process of generating this kind of time histories, some correlations are created among the three components. Hence, it is the intention of this paper to determine the acceptable level of correlations among the three components of artificial time histories.

In this paper, the statistical values of the correlation coefficients of strong motion accelerograms recorded in 104 events are calculated. Based on this study, it is recommended that the acceptable level of correlation among any two of the three components can be 0.16 or 0.2 depending on whether the absolute mean or mean plus one standard deviation is used as the criterion. For more detailed information on this study, Reference 1 can be referred to.

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1. C. Chen, "Simulation of Three Component Spectra Compatible Time Histories," Proceedings of 2nd ASCE Specialty Conference on Structural Design of Nuclear Plant Facilities, New Orleans, LA, December 1975.