AUTOMATED GENERATION OF SPECTRUM COMPATIBLE ARTIFICIAL TIME HISTORIES

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SUMMARY

Criteria for the seismic design of nuclear power plants are usually defined in the form of response spectra. It is therefore generally necessary to generate artificial time histories of ground motions to "match" these spectra. These time histories may then be used for the generation of floor response spectra for the design of equipment and piping systems, and for the nonlinear analyses of structures and equipment in case such analyses are warranted. It is possible to generate a number of time histories to match a given spectrum. However, to generate a time history with the necessary frequency and phase-angle contents and other basic characteristics and at the same time achieve a desired match, it is important to use a judicious combination of frequency-domain and time-domain procedures, and to exert complete control over all the iterative steps. This paper presents such a procedure.

State-of-the-art techniques are first reviewed for the generation of spectrum compatible artificial time histories of ground motion. A recently developed completely automated iterative procedure employing a combination of frequency-domain and time-domain techniques in any desired sequence for the development of spectrum-compatible artificial time histories is then presented. The procedure employs the following four basic steps: (1) generation of an initial (starting) time history using either sinusoidal superposition with an envelope function or specification of a real time history of a recorded ground motion, (2) manipulation of both the amplitude and the phase of the Fourier transform representation of this time history in accordance with criteria formulated from the comparison of a computed response spectrum and the target response spectrum. Successive time histories are then generated having response spectra converging to the target design spectrum, (3) manipulation of the amplitude and phase of the Fourier transform representation only locally in areas where the peaks of the computed spectra have larger magnitudes of deviations than desirable to obtain a closer match between the computed spectra and the target spectrum, and (4) manipulation of local areas of the latest time history at times where maximum response occurs.

A description of computer program EDAC/SEQGEN, which completely automates the above steps, is then presented. The program employs efficient numerical algorithms, thus enabling it to perform a number of iterations using much less computer time than in previous studies. Complete automation of all the above steps and inclusion of versatile plotting options in the program considerably reduces engineer-computer interaction.

Results are presented for the development of two artificial time histories with corresponding spectra matching the target USNRC Regulatory Guide 1.60 response spectra within about 5 to 7 percent. The importance of inclusion of additional higher frequency components and redistribution of phase angles in obtaining better control over the procedure and excellent matches between the computed and the target spectra are also discussed. Recommendations for future studies are then presented.