SIGNIFICANCE OF SEISMIC RESPONSE SPECTRUM NORMALIZATION IN NUCLEAR POWER PLANT DESIGN

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SUMMARY

Seismic design criteria are normally specified in terms of peak accelerations and response spectrum shapes normalized by peak accelerations. Such spectrum shapes are derived from statistical analyses of a number of normalized response spectra from historic earthquake motions. Normalization of earthquake motions is necessary to obtain a comparable level of severity in motions recorded under different geo-seismological conditions. Peak ground acceleration has been most commonly used to normalize seismic response spectra primarily because it is a convenient parameter, somewhat representative of the intensity of motion and zero period ordinate for acceleration response spectrum. However, there appears to be a wide consensus that this is not a good measure of the earthquake motion severity and hence a good parameter for spectrum normalization. Several other parameters are proposed for spectrum normalization including peak acceleration-velocity-displacement triad, peak velocity, spectrum intensity, etc. The purpose of this paper is to study the significance of spectrum normalization by different parameters in deriving spectrum shapes associated with given probability levels. Influence of such spectrum shapes on seismic design of nuclear power plants is discussed. Response spectra are generated from an ensemble of significant historic free-field earthquake motions including three orthogonal components. Normalization parameters, such as, peak acceleration, peak velocity, peak acceleration-velocity-displacement triad, spectrum intensity and rms acceleration are evaluated for each motion. The response spectra are normalized by the corresponding parameters resulting in five ensembles of spectrum shapes. The spectrum shape ensembles are statistically analyzed to determine appropriate probability distributions for spectral ordinates. Spectrum shapes associated with given probability levels are derived on the basis of these probability distributions. The spectrum shapes normalized by different parameters are compared for given probability levels.

Significant variations in spectrum shapes derived by different normalization techniques would indicate that a more appropriate parameter than the peak ground acceleration should be used in normalizing these spectra. It is expected, however, that the spectrum shapes for frequency range of interest in the nuclear power plant design may not be sensitive to normalization parameter. This should, then, confirm the validity of the most commonly used technique.