Critical Issues in Developing a Uniform Hazard Response Spectrum for Engineering Design and Safety Evaluation of Existing Structures

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Abstract

A uniform hazard response spectrum (UHRS) output from a probabilistic seismic hazard analysis (PSHA) is commonly used for engineering design and safety evaluation of existing structures in recent years. However, problems were found in several engineering projects when it was used in the structural dynamic analysis of existing structures. This is mainly due to the spectrum is too wide to content too much longer-period vibrations. The problem is coming from many different sources and critical issues will be discussed.

The sources of problem in developing a UHRS include many aspects. (1) How good is the data processing and filtering-out of long-period noises in the strong-motion records for developing of ground-motion prediction equations (GMPEs); records containing long-period noises will always result in long-period rich UHRS and cause problem in design and safety evaluation of high dams and high rise buildings. (2) How good is a GMPE has been developed; if the strong-motion data was not properly processed, or if the model of form of a GMPE is not proper, or the regression method is not good enough for the non-linear regression, the residuals of ground-motion values or σ will be too large so that PSHA will output a higher level of hazard and cause a large (high and fate) UHRS, which is very unfavorable to all structures. (3) If the development a GMPE is mixing soil site and rock site strong-motion data, the result response spectral shape will be like a mixed soil-site spectrum and rock-site spectrum. This is not reflecting the nature and will overestimate the risk of a rock-site structure and underestimate the risk of a soil-site structure. (4) If the development a GMPE is mixing strong-motion data from subduction zone interface earthquakes and subduction zone intraslab earthquakes, the result response spectral shape will also be like a mixing of spectral shapes of these two kinds of earthquakes. This is also not reflecting the nature and will overestimate the risk from the intraslab earthquakes and underestimate the risk from the interface earthquakes.

In this talk, I will clarify the problems and issues in developing a UHRS with examples. Suggestions and cautions will also be given.