THE EFFECT OF STRUCTURAL SYSTEM ON SELECTION OF INPUT GROUND MOTIONS FOR PERFORMANCE BASED SEISMIC DESIGN

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One of the primary needs in seismic performance-based design is nonlinear dynamic analysis of the structure under different ground motions. Current practice seismic design codes mainly prescribe to choose proper ground motions based on individual match of records to a target spectrum. Recent studies express doubts about this method and indicate that the selected ground motions result in underestimated structural responses.

These studies employed the standard deviation in the selection process and estimated more realistic responses. In their proposed method, apart from comparing the average of selected ground motions with a target spectrum, one should consider the target spectral standard deviation values in the selection process.

A useful method which considers the simultaneous effect of a mean and standard deviation in the ground motion selection process is conditional spectrum (CS). In this method, site's specifications, as well as a ground motion prediction equation (GMPE), are used to determine the mean and the standard deviation values of the conditioning spectral value. Further, the epsilon concept is employed to specify the mean and the standard deviations at other spectral periods for the target response spectrum (Baker & Lee, 2018). Then, proper ground motions are selected.

In order to investigate the structural system effect on structural responses provided by the selected ground motions, two 8-story steel frames with different seismic resisting systems; Special Moment Resisting Frame (SMRF) and Special Concentric Braced Frame (SCBF) are considered in the present study. These two structures have been modeled in OpenSEES software, where the inelasticity is captured by plastic hinges at the ends of the beam-column elements.

The nonlinear time history response of each structure, using acquired ground motions are used to obtain a seismic demand hazard curve (SDHC), which shows the probability of exceedance, for an engineering demand parameter (EDP). SDHC is a combination of nonlinear time history analysis and probabilistic calculations; therefore, nonlinear behavior and the structural system can have a significant influence on SDHC. Figure 1 presents the obtained SDHC for an SMRF in this study, which has calculated using the following equation (Kwong et al., 2015):

$$\lambda_{EDP}(z) = \int P(EDP > z \mid IM = x).\left| d\lambda_{IM}(\mathrm{x}) \right| \tag{1}$$

Also, a benchmark is calculated using an engineering demand parameter prediction equation (EDP-PE), to assess the accuracy of the developed SDHCs. For this purpose, probabilistic seismic hazard analysis (PSHA) theories are used, and an EDP-PE replaces a GMPE in order to obtain the benchmark SDHC. In this study, the selected engineering demand parameter (*EDP)* is maximum interstory drift ratio (MIDR). EDP prediction model that has been used to obtain benchmark SDHC, is an equation introduced by Neam & Taghikhany (2016).

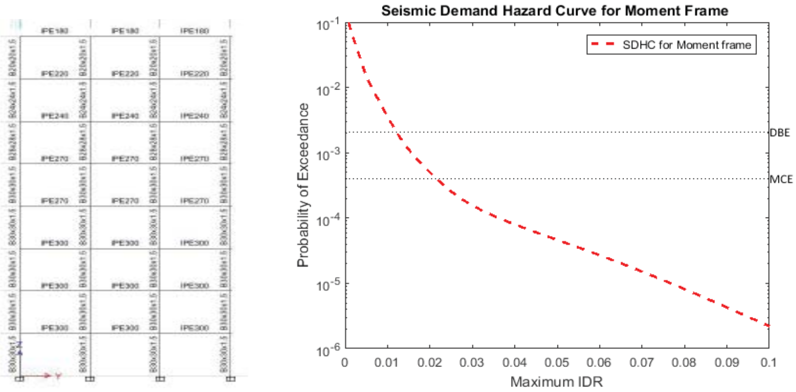

Figure 1. 2D Model of eight story structures, and seismic demand hazard curve for moment frame structure.

Figure 2 shows a comparison between SDHC and the benchmark SDHC in both structures. It indicates that SDHC is unbiased until DBE level for both structural systems, the discrepancy in SMRF are increased by increasing ground motion level than DBE level while SCBF system is robust until MCE level.

According to the results, the CS method, which only considers spectral accelerations in the vector of IMs, provides a proper estimate of the results until the DBE level. However, if the results are expected at higher intensity levels, for SMRFs, and structures with more severe nonlinear behaviors other methods that incorporate the variety of intensity measures in the vector of IMs should be considered in the selection process (e.g. duration, CAV, AI, etc.) (Bradley, 2012).

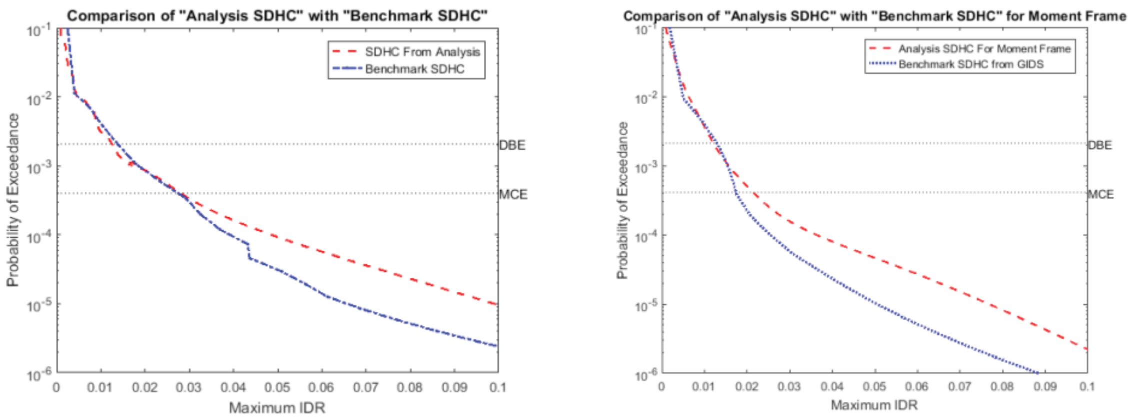

Figure 2. Comparison of SDHCs for (a) Special Concentric Braced Frame (SCBF) and (b) Special Moment Resisting Frame (SMRF) with their benchmark SDHCs.

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