STRUCTURE SPECIFIC GROUND MOTION SELECTION: PROS, CONS AND FUTURE DIRECTIONS

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The Pacific Earthquake Engineering Research (PEER) Centre framework is a popular methodology in order to estimate the Mean Annual Frequency (MAF) of exceedance of a particular Limit State (LS) (e.g. FEMA-350, 2000) as expressed mathematically in Equation (1) (Shome, 2000).

$$MAF(LS) = \int_{M}\int_{EDP} G(LS|EDP)\cdot|dG(EDP|IM)|\cdot|d\lambda(IM)| \qquad (1)$$

where EDP is the engineering demand parameter, e.g. maximum inter story drift ratio; *IM* is the intensity measure e.g. Spectral acceleration (*Sa*) at the first period of structure and a given damping ratio; *G (LS|EDP)* denotes the probability of exceeding LS conditioned on the value of EDP and *G (EDP|IM)* denotes the probability of exceeding EDP conditioned on the value of *IM*. One of the key points in calculation of Equation (1) is the inherent assumption about the dependency of EDP only on the chosen *IM*. If there is dependency of EDP on any other indicator (except the chosen *IM*), then, Equation (1) results in a biased estimate of the MAF. Hence the sufficient *IM* is the *IM* which can represent the EDP without any dependency on other variables e.g. magnitude, distance and etc. On the other hand the spectral acceleration at the first period of structure, $S_a(T_1)$, has been commonly used as *IM* in most of the past researches (Baker and Cornell, 2006). Design codes use a suitable *Sa*-based target spectrum to facilitate Ground Motion Record (GMR) selection approach and finally use those GMRs as input to dynamic analysis such as Iranian Code of Practice for Seismic Resistant Design of Buildings, standard no. 2800.

Besides using *Sa*-based elastic spectrum, many approaches have been emerged to predict the response of a structure more precisely. It is proved that $S_a(T_1)$ is not sufficient enough specially when applied to the long-period buildings (Shome, 1999), the structures with high levels of nonlinearity (Shoma, 1999) or in the near source regions (Luco, 2002; Luco, 2007). To deal with this problem, some researchers attempted to introduce new *IMs* which are more sufficient than $S_a(T_1)$ (Tothong, 2007). Despite of the *IM* sufficiency, the attenuation model availability plays an important role in this subject which makes many of the new proposed *IMs* inapplicable.

Most of studies in this field are done for the first mode dominated structures. Moreover, some controversial issues such as the selection and scaling of vertical components, selection of a horizontal pair of components in case of bidirectional analysis, near-fault characteristics and the influence of applying increasing amplitude scale factors on a record while the frequency content is constant are still unsolved (Haselton et al., 2009).

Pros and Cons of the application of structure specific record selection methods have been studied in this paper both qualitatively and quantitatively. After a comprehensive comparison among the features of most common approaches which have been proposed in recent years; these methods are applied to predict the dynamic response of a set of 2D frame structures. Furthermore, a 3D model of a Three-storey asymmetric reinforced concrete building which was designed for gravity loads only (Fajfer et al., 2006) is studied. The structure is referred to in the literature as the SPEAR building which has been studied by other researchers as a representative of plan-asymmetric frame. Figure 1 illustrates a comparison between the statistical efficiency of three scaling methods. The results of an Incremental Dynamic Analysis (IDA) for a 12-story steel frame are reported in Figure 2, too.

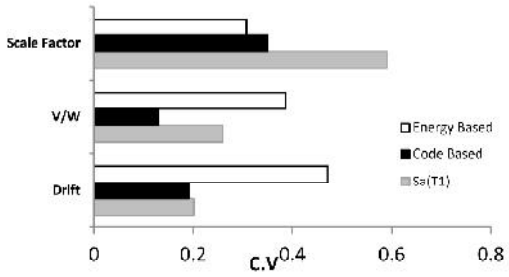

Figure 1. The coefficient of variation (C.V) of the used scale Factors, computed drifts and normalized base shears (V/W) in case of 12-story frame for different scaling methods

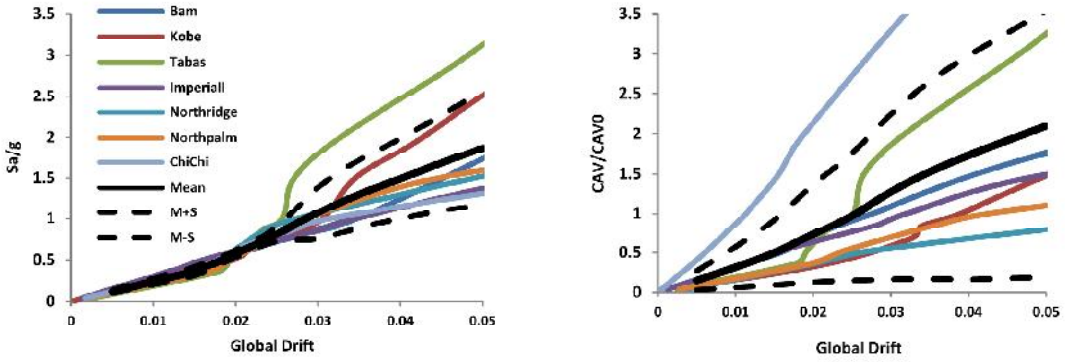

Figure 2. The calculated IDA curves for 12-story frame using Sa(T1) (left) and Cumulative Absolute Velocity (CAV) (right) as the scaling intensity measures

Conclusions confirm the expected fact from qualitative comparison of different method suggesting that no method can be used for all structural purposes and no unique intensity measure can be claimed to cover all important ground motion characteristics ,specially, in case of irregular structural systems. Finally, in the future directions some rational strategies have been proposed to alleviate the counted cons in the paper which need more detailed investigation to ensure the robust structure-specific ground motion selection procedures in future.

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