THE SPECTRAL SHAPE EFFECT ON THE COLLAPSE OF ASYMMETRIC RC-SMF BUILDINGS

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Keywords: Asymmetric, Collapse Capacity, Spectral Shape, Torsionally Stiff, Torsionally Flexible

A large number of ground motion records are usually used to do nonlinear dynamic analysis in a collapse assessment. So, the record selection method has an important role on collapse assessment results. Assessment results may be very conservative if the record selection is consistent with the Uniform Hazard Spectrum (UHS) (Haselton and Deierlein, 2006). However, Baker and Cornell (2006) introduced a new measure named *epsilon* (ε) in record selection. That parameter indicates the number of standard deviations by which an observed logarithmic spectral acceleration differs from the mean logarithmic spectral acceleration of a ground motion prediction equation. Baker and Cornell (2006) showed that the mean collapse capacity of a 7-story non-ductile reinforced concrete (RC) building increased by a factor of 1.7 with regarding to that new measure in record selection. Similar observations were reported by other studies (Haselton and Deierlein, 2006; Zareian, 2006). All of these studies are on symmetric buildings.

This study examines the effect of ground motion selection method based on spectral shape of records on the collapse of low-rise asymmetric buildings. The example buildings are 5-story reinforced concrete special moment frame (RC SMF) buildings. The buildings are designed based on ACI 318-05. The fundamental period for design is 0.6 second and the buildings have a design base shear coefficient of 0.078. OpenSees software is used for modeling and analysis. The collapse capacity of those building models with different mass eccentricities is evaluated by 3D modeling. The deterioration properties of structural elements are simulated using a proper hysteretic model developed by Ibarra et al. (2005). The hysteretic model parameters are related to the physical properties of beam-columns using empirical predictive equations developed by Panagiotakos and Fardis (2001) and Haselton and Deierlein (2006). Floors are modeled as rigid slabs. Structural damping (with 5% damping ratio) is modeled using a Rayleigh-type damping and proportional to mass and initial-stiffness of structural elements.

The collapse capacity is obtained for a set of 22x2 far-field strong ground motions using Incremental Dynamic Analysis (Vamvatsikos and Cornell, 2002). Spectral acceleration at the fundamental translational mode period is considered as the ground motion intensity measure. The intensity measure increases in an IDA until the dynamic instability occurs in a building. The median of collapse capacities is used in the evaluation. The results are provided for both torsionally stiff and torsionally flexible buildings. The ratio of the first torsional frequency to the first translational frequency is introduced as a measure of frequency ratio (i.e. $\Omega=\omega_\theta/\omega_1$) in this study and used to distinguish torsionally flexible buildings from torsionally stiff ones. The frequency ratio alters by changing the mass moment of inertia of floors in different mass eccentricities. For instance, the values of $\Omega = 0.6$ and $\Omega = 1.6$ in the results stand for torsionally flexible and torsionally stiff buildings, respectively.

The spectral shape of records is considered as an effective factor on assessment results when used in a ground motion selection. In order to examine the spectral shape effect on the collapse capacity of an asymmetric building, an attenuation equation introduced by Boore et al. (1997) is used to consistently determine ε values. Then, a linear regression method is used to adjust the median collapse capacity in order to take ε effect into account. Zareian (2006) introduced the proposed method to consider the effect of ε on the collapse capacity of wall- and frame-type regular buildings. Haselton and Deierlein (2006) also used that method in the collapse safety assessment of 65 reinforced concrete regular frame buildings. The ratio of adjusted to unadjusted collapse capacity of asymmetric building models is shown in figure 1. According to the results, it is important to pay attention to the dominant spectral shape in a seismic region when a record set is selected to use in the collapse assessment. For torsionally stiff buildings (Ω = 1.6 or 1.8), that importance is significantly less as mass eccentricity increases. However, there ratio occurs in mass eccentricities higher than 10% in torsionally flexible buildings (Ω = 0.6 or 0.8).

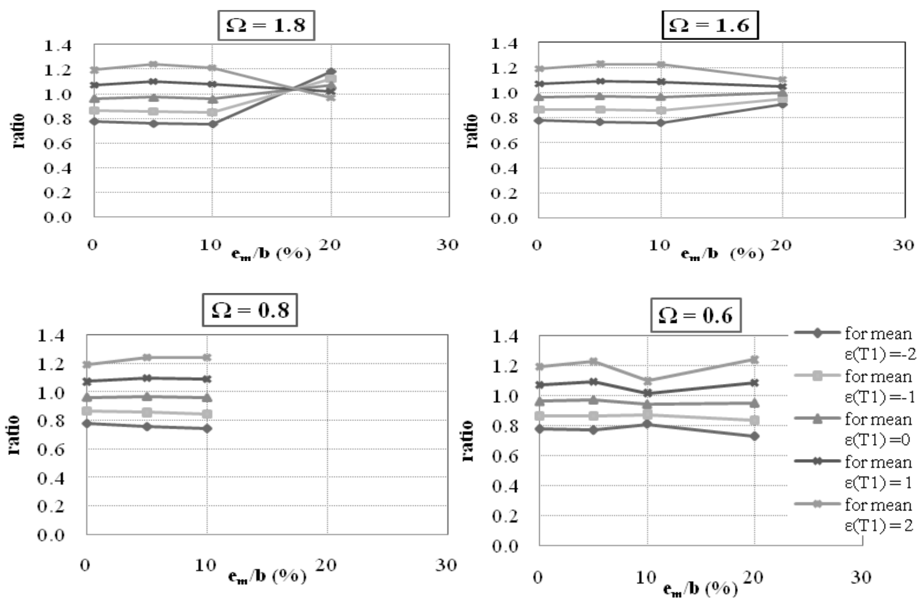

Figure 1. Spectral shape effects on the collapse capacity of 5-story asymmetric building

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