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DIRECT PERFORMANCE BASED SEISMIC DESIGN OF A STRONGBACK BRACING SYSTEM BY USING YIELD FREQUENCY SPECTRA METHOD

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The prescriptive methods of seismic design of structures that are used in conventional codes, while not having sufficient insurance to achieve performance objectives, are also due to the structural adaptability weakness of designing new combinational systems. In these regulations, the design of the structure is based on force and then, by controlling the amount of displacement and deflections, the structural serviceability is checked (FEMA, 2012). However, the use of these methods does not have optimal results for the design of new and hybrid systems, whose seismic behavior is not determined in the regulations. In fact, it is necessary to design these systems based on performance and considering the structural vulnerability behavior at different hazard levels. On the other hand, due to the complexity of performance based seismic design techniques and their inverse probabilistic nature, their use has not been much welcomed by engineers.

In this regard, a new performance based design method, which is called Yield Frequency Spectra (YFS), proposed by Vamvatsikos et al. (2013) in order to expedite the iterative performance based design process of a structure. In this method by using a nonlinear single degree of freedom system, a direct relation between structural strength and a set of performance objectives is established (Vamvatsikos & Aschheim, 2016).

In this paper, a new hybrid bracing system called Strong-Back system and is proposed by Lai (2012), due to the existence of a rigid module for the optimal distribution of interstory drift ratio over the height of the building is considered. In Figure 1, a comparison between this structural system behavior and the conventional concentric bracing system is shown. Therefore first we designed a six story Strong-Back bracing system based on ASCE7-16 (ASCE, 2016), then a two-dimensional model has been used in OpenSEES software to evaluate the nonlinear response of the structure.

Using analysis results, it was determined that the code based structure does not meet the required performance targets. Then utilizing the site seismic hazard curve and backbone capacity curve, the Yield Frequency Spectra of the structure was extracted, which is shown in Figure 2. The performance objectives are depicted on the YFS plot using cross marks. Each cross mark is associated with a C_y value that is normalized yield strength coefficient.

Based on the results of nonlinear static and dynamic analysis of the structure, which are shown in Figure 3, it was concluded that the designed structure by using YFS method provides all the desired performance targets with proper accuracy. An important point in this approach is to achieve a set of performance targets by designing and evaluating structural performance only once and for all.

Due to the fact that the structure is regular in both plan and height, as well as the height of the structure is not tall (the effect of higher modes can be neglected), the final design is achieved only in fisrt try and evaluation process.

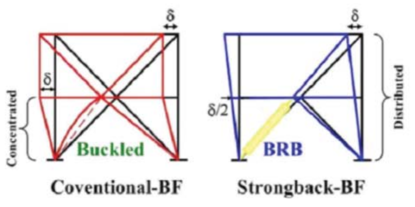

Figure 1. Comparison of the behavior of a strongback system with the conventional concentrically steel braced system (Lai, 2012).

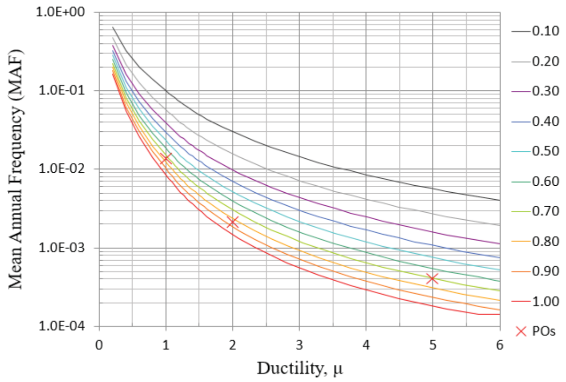

Figure 2. Extracted YFS of the studied building.

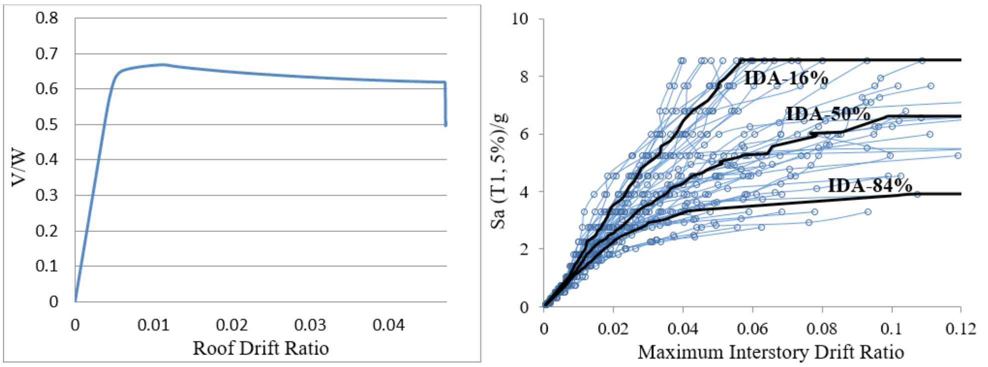

Figure 3. Pushover and IDA curves of the YFS-based design building.

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