HOW TO COMPARE THE SEISMIC PERFORMANCE OF STRUCTURES

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The performance comparison of different structural designs, be they alternate structural configurations or simply differently proportioned versions of the same type, is a common, yet little-understood operation in earthquake structural engineering, both in practice and in research. Although it may not explicitly appear in typical engineering calculations, it is a fundamental task that every professional engineer sooner or later encounters. It is essentially the basic premise of seismic design, needed to rationally select, e.g., one structural system or rehabilitation strategy over another, especially when little relevant experience is available.

Comparing structural configurations to find the best candidate has thus remained a favorite subject of researchers and engineers alike. With the emergence of performance-based earthquake engineering, such comparisons now need to be performed on the basis of the seismic performance, preferably at several limit-states. Such a direct evaluation can become cumbersome, requiring seismic hazard information. Therefore, shortcuts and simpler techniques have been introduced that are generally based on the concept of system fragility, as estimated through the various methods of structural analysis. Still, there is no general consensus on the metrics that can be used for such an evaluation; some researchers adopt force or displacement response quantities derived from static or dynamic methods, while others prefer to compare capacities in terms of intensity or response measures.

For example, Figure 1 shows the median Incremental Dynamic Analysis (IDA) curves for two competing designs, where the violation of the Collapse Prevention limit-state, according to FEMA-350 (SAC/FEMA 2000), appears as a single point on each curve. Comparing the Collapse Prevention performance of the two alternatives in terms of the engineering demand parameter would suggest that No. 2 is the best. A comparison in terms of the intensity measure would suggest No. 1 instead. Both methods of comparison have appeared in the literature and are still in use. Unfortunately, only one is correct. Thus, we perform a comparative evaluation of the available choices and point out the pros and cons of each, showing some of the common fallacies that plague the results of such comparisons.

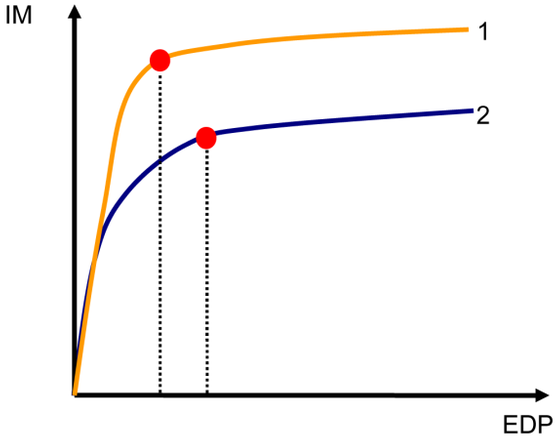

Figure 1. Two idealized median IDAs with different I_M and E_{DP} capacities

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