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EFFECT OF STRUCTURAL MODELING UNCERTAINTIES ON SEISMIC PERFORMANCE OF STEEL MOMENT RESISTING FRAMES

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Incremental dynamic analysis (IDA), introduced by Vamvatsikos and Cornell (2007), is nowadays a widely used tool to study seismic performance of structures and is discussed in many researches and technical reports (FEMA-350, 2000; Vamvatsikos and Fragiadakis, 2010). Using this method is usually based on a deterministic numerical model of structure, which is affected only by aleatory uncertainties (known as record to record effect). But in a more developed method, which is named *extended IDA*; it is possible to perform IDAs with a probabilistic description of structural model. In such case, results will contain both aleatory and epistemic uncertainties.

This Paper aims at evaluating seismic performance of a 5-story steel moment resisting frame through extended IDA, considering uncertainties in damping, mass, yield strength and ultimate strength of steel as probabilistic variables. To this purpose, the seismic performance of mentioned frame is evaluated in two different cases named *Base Case* (including a deterministic structural model) and *Uncertain Case* (including a probabilistic structural model). Separating the uncertainty sources will become feasible by using reliability methods, in order to estimate the range that each source of uncertainty has affected structural performance.

Summarized IDA curves (median and median ± one standard deviation) for both Base Case and Uncertain Case are depicted in Figure 1. It can be seen that epistemic uncertainties has had considerable effect on all curves with decrease in structural capacity, and this decrease has a direct relation to the level of seismic demand.

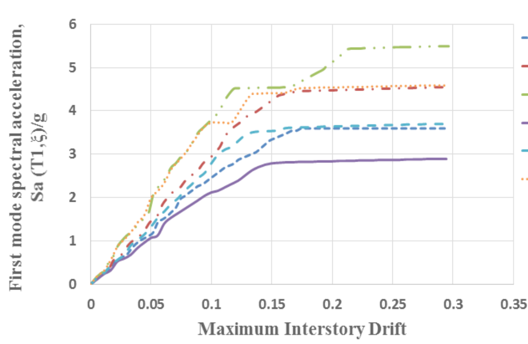

Figure 1. Summarized IDA curves for deterministic structural model (Base Case) and uncertain structural model (Uncertain Case)

According to definitions existing in FEMA-350 (2000), performance limit states namely immediate occupancy (IO), collapse prevention (CP) and global instability (GI) can be defined for steel moment resisting frames. In order to have a better sight into how structural capacities differ from one performance level to the other, fragility curves of three different limit states (IO, CP and GI) are shown together for Base Case in Figure 2. It should be mentioned that OpenSees (2006) has been utilized to create numerical model of structure and also to perform nonlinear time history analyses. The detailed modeling procedure in OpenSees is explained in full paper.

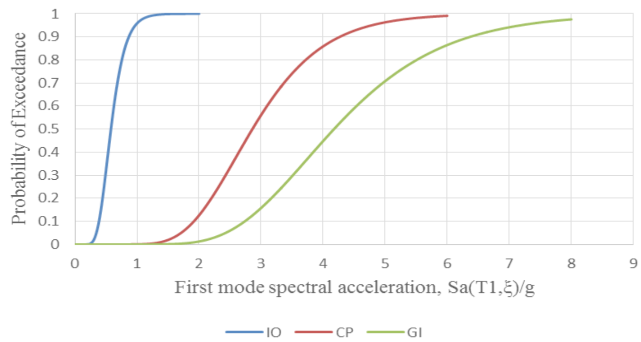

Figure 2. Fragility curves of different performance limit states in comparison

The first result from this study is a significant decrease in seismic capacity of structure after considering epistemic uncertainties. The second result is reduction of dispersions caused by epistemic uncertainties compared with a number of previous studies which aimed at studying moment-rotation characteristics of frame members (Lignos et al., 2008; Vamvatsikos and Fragiadakis, 2010).

Also, a significant difference is observed between fragility curves of CP and GI limit states which represents a desirable performance capacity for special steel moment frame against seismic collapse. For example, an earthquake which imposes a spectral acceleration equal to 2.87g on this structure has a 50% probability of exceedance for CP limit state, whereas it only has 13% probability of exceedance for GI limit state.

In overall, results of this study indicate that incorporation of structural modelling uncertainties can make some substantial differences in safety considerations and damage control plans of a building against a future event of earthquake.

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