EFFECT OF CONSTRUCTION QUALITY ON COLLAPSE PERFORMANCE MEASURES OF STEEL MOMENT-RESISTING FRAMES

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Collapse fragility curves represent the probability of exceeding the limit state of sidesway collapse while structures are excited by strong ground motions. These curves play a significant role in estimation of earthquake consequences and seismic risk management (Deierlein, 2004). Uncertainty sources which affect the probability of collapse are categorized into three main sources. Aleatory source of uncertainty is mainly due to random nature of earthquake phenomena and epistemic source of uncertainty initiates from lack of knowledge and inaccuracy of analytical models. On the other hand, linguistic uncertainty is due to lack of definite or sharp distinction while defining the effective parameters. While strong ground motion variability is considered as aleatory uncertainty which affects the collapse fragility curve of structure,parameters like weak story, soft story, geometry, vertical discontinuities and construction quality of structures are parameters which contain linguistic uncertainty.

Incremental Dynamic Analysis (IDA) is assumed to be a consistent methodology to involve strong ground motion uncertainty and has been applied by several researches (e.g. (Ibarra and Krawinkler, 2005; Zareian and Krawinkler, 2006)). Monte Carlo simulation based on analytical response surfaces , mean estimate method and confidence interval method can be mentioned as the approaches to involve effects of epistemic uncertainty due to modeling parameters in collapse fragility curves. In the work presented in this paper, in order to incorporate lexical uncertainty due to construction quality of stucture, theory of fuzzy logic is employed, which has been developed based on fuzzy sets. Construction quality of structures affect the strength and ductility capacity of moment-rotation model. Analytical response surfaces are interpolated to achieved collapse fragility curves considering several levels of construction quality which are good, average and poor.

Numerical value of construction quality index (CQI), in the present study, is represented by a fuzzy number. Triangular membership functions are applied to show the degree of belongingness of CQI to descritive set of construction qulaity ({Good, Average, Poor}).

Relevant fuzzy knowledge base is developed based on analytically derived collapse fragility curves for variuos levels of construction quality. Sugeno fuzzy inference system is applied to estimate constant coefficients of analytical responses in each CQI level. Collapse fragility curve of the structure is evaluated based on Monte Carlo simulation of CQI and estimated response surfaces through fuzzy inference system.

A 3-storey 3-bay moment resisting steel frame (Figure 1) is considered as the case study. Modified Ibarra-Krawinkler model (Lignos, 2008) is applied to represent the moment-rotation behavior of beam to column connections. Column ductility (CD), beam ductility (BD), column strength (CS) and beam strength (BS) are considered as modeling parameters which are defined based on stength and ductility valued of moment-rotation backbone curve (Figure 2). Collapse fragility curves of sampled frame considering variuos levels of construction quality are shown in Figure 3.

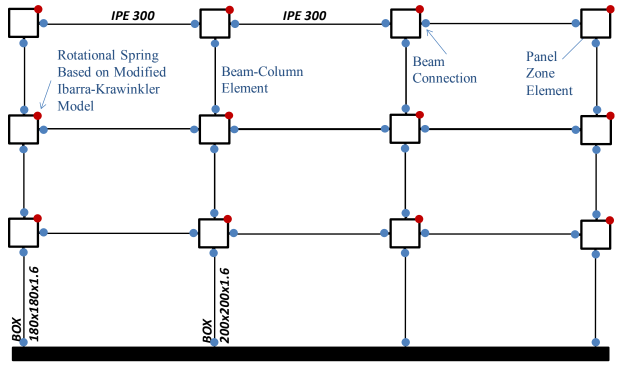

Figure 1. Sampled frame

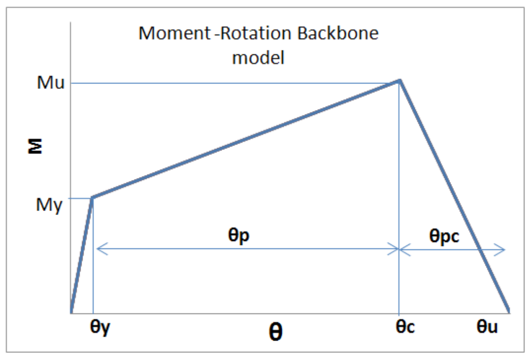

Figure 2. Modified Ibarra-Krawinkler moment rotation (Lignos, 2008)

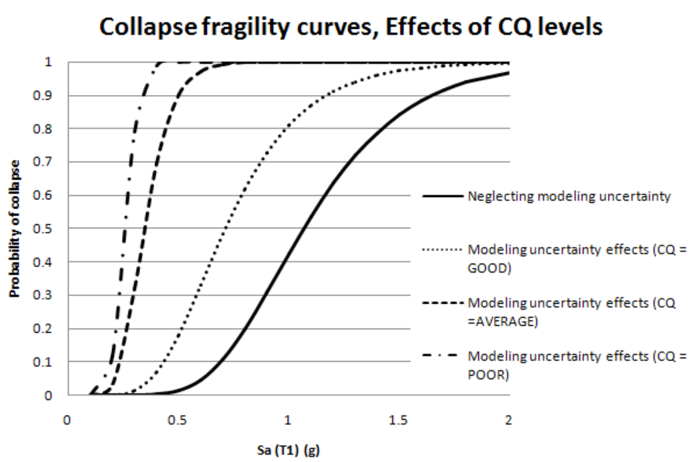

Figure 3. Collapse fragility curves

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