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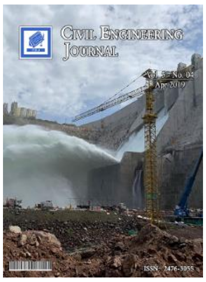

Effects of Near-fault Strong Ground Motions on Probabilistic Structural Seismic-induced Damages

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Abstract

Seismic fragility curves measure induced levels of structural damage against strong ground motions of earthquakes, probabilistically. These curves play an important role in seismic performance assessment, seismic risk analysis and making rational decisions regarding seismic risk management of structures. It has been demonstrated that the calculated fragility curves of structures are changed while the structures are excited by near-field strong ground motions in comparison with far-field ones. The objective of this paper is to evaluate the extents of modification for various performance levels and variety of structural heights. To achieve this goal, Incremental Dynamic Analysis (IDA) method is applied to calculate seismic fragility curves. To investigate the effects of earthquake characteristics, two categories of strong ground motions are assumed through IDA method, i.e. near and far-field sets. To study the extent of modification for various heights of structures, 4 – 6 and 10 stories moment-resisting concrete frames are considered as case studies. Furthermore, to study the importance of involving near-field strong ground motions in seismic performance assessment of structures, the damage levels are considered as the renowned structural performance levels (i.e. Immediate Occupancy, Life Safety, Collapse Prevention and Sidesway Collapse). Achieved results show that the fragility curve of low-rise frame (i.e. 4-story case study) for IO limit state presents more probability of damage applying near-fault sets in comparison with far-fault set. Investigating fragility curves of the other performance levels (i.e. LS, CP and Collapse) and the higher frames, a straightforward conclusion, regarding probability of damage. To achieve the rational results for the higher frames, mean annual frequency of exceedance (MAFE) and probability of exceeding limit states in 50 years are calculated. MAFE is defined as the integration of structural fragility curve over seismic hazard curve. According to the achieved results for 6-story frame, if the structure is excited by near-field strong ground motions the probability of exceedance for LS, CP and collapse limit states in 50 years will be increased up to 11%, 2.4%, 0.7% and 0.4% respectively, comparing with the calculated probabilities while far-field strong ground motions are applied. On the other hand, while the 10-story case study is excited by near-field strong ground motions, the exceedance probability values for mentioned limit states decreases up to 20%, 5%, 4% and 4%, respectively. Consequently, it can be concluded that the lower is the height of the structure, the more will be the increment of probability of damage in the near-field conditions. Furthermore, this increment is much more for IO limit state in comparison with other limit states. These facts can be applied as a precaution for seismic design of low-rise structures, while they are located at the vicinity of active faults.

Keywords: Seismic Fragility Analysis; Near-fault Strong Ground Motions; Incremental Dynamic Analysis; Seismic Risk Analysis.

1. Introduction

Recently, Performance Based Earthquake Engineering (PBEE) is being evolved leading to the next generation performance based seismic design guideline [1]. As the first goal, the guideline is aimed to involve uncertainty sources

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