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Probabilistic Quantification of Incremental Dynamic Analysis Results

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Abstract

Incremental Dynamic Analysis (IDA) is a parametric analysis method that has recently emerged in several different forms to estimate more thoroughly structural performance under seismic load. It involves subjecting a structural model to one or more ground motion records. This method considers both inherent randomness and model uncertainty, so it used to probabilistic analysis of structures at high seismic loading. The objective of this study is to improve efficient, but accurate procedures for probabilistic analysis of nonlinear seismic behavior of structure. According to the three-parameter Log-normal distribution more rationally describe maximum story drift ratio at a higher value of spectral acceleration. The traditional method based on two-parameter Log-normal distribution is compared with the presented procedure based on three-parameter Log-normal distribution on analytical data. Improvement in the probabilistic estimation of maximum story drift ratio demand are illustrate with a SAC-9 story, moment resisting frame building exposed to a set of 20 ground motion.

Keywords: Incremental dynamic analysis, uncertainty, Two-parameter Log-Normal distribution, Three-parameter Log-Normal distribution

1. INTRODUCTION

Incremental Dynamic Analysis (IDA) is a procedure developed for accurate estimation of seismic demand and capacity of structure that requires non-linear response history analysis of the structure for an ensemble of ground motion, each scaled to many intensity levels, selected to cover the entire range of structural response, all the way from elastic behavior to global dynamic instability.

Several approaches have been proposed to calculate probabilistic estimates of drift demands for structures exposed to seismic events. It is common to use a two-parameter lognormal distribution to describe the probability distribution of the response variables [1]. The two-parameter lognormal distribution is convenient because the parameters are easily fitted using the method of moments or maximum likelihood estimates. Therefore, when response parameters for relatively large ground motion intensity levels are distributed far from the origin, the spread of a two-parameter lognormal distribution would be distorted because of the lower bound constraint to the origin. This distortion may have a significant influence in both the drift values and computed probabilities, for this reason the objective of this study is to determine whether using the three-parameter lognormal distribution of maximum story drift ratio for a given ground motion intensity to provide a better fit than using the two-parameter lognormal distribution.

This study deals with the evaluation of method to improve the probabilistic quantification of maximum story drift ratio demand for structural systems exposed to severe ground motions. Maximum story drift ratio demand refers to maximum story drift ratio along the height of each story in structure. The ground motion intensity level is characterized by the elastic spectral acceleration at the first mode period of the structure $S_a(T_1)$. The probabilistic quantification of maximum drift demands is an important component of performance-based seismic design during earthquake events. This study compares the probability distributions of the response variable of interest, for example, maximum story drift ratio over the height of structure versus intensity of ground motion for a 9-story steel moment resisting frame (MRF) at a site in California. As a structure is designed to go beyond its elastic capacity under severe ground motion, will be carried out nonlinear time-history analysis to predict the seismic demand. The 9-story building was designed