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Seismic Fragility Curves using Natural and Synthetic Ground Motions

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Abstract

Fragility curves are useful tools for the probabilistic assessment of the seismic performance of buildings. Nonlinear structural analyses with uncertainties in load and resistance are required to develop fragility curves. A statistically sufficient number of earthquake ground motion records should ideally be obtained from past records of the region of interest to have a satisfying fragility curve. However, the number of available earthquake records in many seismically active zones is limited. In such a situation, use of the synthetic ground motions is an accepted alternative for fragility analyses of buildings. This paper compares the seismic fragility curves obtained from synthetic and natural ground motion records. It is found that synthetic ground motions result in conservative fragility curves with lesser dispersion in drift demand when compared with natural recorded ground motions.

Keywords: synthetic ground motion, uncertainty, fragility curve; performance level; dispersion.

1 Introduction

Fragility curves are used as an evaluation tool in the assessment of the seismic performance of buildings. The assessment of this seismic vulnerability requires selection of earthquake ground motions (load) for the region of interest. Fragility curves developed using natural ground motions of the selected site are typically accepted as more realistic. However, in the absence of such natural ground motions, many previous studies have used synthetic ground motions. It is found that majority of investigations in the past (Bhosale et al., 2017; Ellingwood et al., 2007; Ramamoorthy et al., 2006) have used synthetic ground motions for the development of fragility curves due to unavailability of the sufficient number of natural ground motions. On the other hand, many recent studies (Rajeev and Tesfamariam, 2012; Wu et al., 2012; etc.) have developed fragility curves for RC building frames using natural ground motion data.

An extensive literature review did not reveal any paper that deals with the performances of synthetic ground motion relative to that of natural ground motion. Hence, the focus of the present paper is to understand the effect of ground motion on seismic fragility curve of RC building. Two suites of ground motions are selected for this purpose: (a) recorded natural ground motions from Indian sites and (b) synthetic ground motions (adopted from other sites and converted to match the design spectrum of Indian Standard). Fragility curves for typical RC moment resisting frame are developed as per the SAC-FEMA method (Cornell

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