ISET Journal of Earthquake Technology, Paper No. 549, Vol. 57, No. 1, March 2020, pp. 17-32

SEISMIC FRAGILITY ANALYSIS OF UNREINFORCED MASONRY STRUCTURES IN THE BAYESIAN FRAMEWORK

S. Ghosh

Department of Civil Engineering
Indian Institute of Engineering Science and Technology
Shibpur, Howrah – 711103, India
E mail id: *gh.swarup@gmail.com*

S. Chakraborty (Corresponding Author)

Department of Civil Engineering
Indian Institute of Engineering Science and Technology
Shibpur, Howrah – 711103, India
E mail id: *schak@civil.iiests.ac.in*

ABSTRACT

An efficient seismic fragility analysis (SFA) of unreinforced masonry (URM) buildings in the Bayesian framework utilizing limited numbers of nonlinear time history analyses (NLTHA) results is explored. Specifically, the SFA approach combines a generic Bayesian linear regression based demand prediction model with equivalent frame model based on advance force-based fibre elements to properly capture nonlinear seismic response of URM buildings. The effectiveness of the proposed approach is compared with the fragility results obtained by other commonly used SFA approaches considering the most accurate direct Monte Carlo simulation (MCS) based results as the benchmark. The SFA approach is numerically demonstrated by considering a typical two storey URM building. The proposed SFA approach provides much improved fragility estimates using limited numbers of NLTHA results with respect to that of obtained by the other commonly used methods when compared with direct MCS based fragility results.

KEYWORDS: Seismic Fragility Analysis, Bayesian Linear Regression, Unreinforced Masonry Structure, Markov Chain Monte Carlo, Gibbs Sampling

INTRODUCTION

Unreinforced masonry (URM) buildings are among the oldest type of constructions and numerously found all over the world including India. Many of such buildings are located in highly earthquake prone areas. The performances of URM structures are often satisfactory under normal gravity loading conditions. However, the poor tensile and shear strength of masonry walls made this type of structure highly susceptible under lateral loads. The poor performances of such structures noted in the past earthquakes are attest to this. Thereby, seismic vulnerability assessment of URM buildings has received significant research attention due the large number of dwelling in URM buildings all over the globe still in the present days. The assessment generally includes probabilistic definition of seismic loads and structural strength parameters incorporating different sources of uncertainty present in the system. Seismic fragility analysis (SFA) in the probabilistic performance based earthquake engineering framework (PBEE) is the most useful tool in this regard. The present study deals with SFA of URM buildings.

The most direct and accurate method of SFA of structures is based on direct Monte Carlo Simulation (MCS) technique [1-5]. In MCS, a statistical approach is employed to obtain a large number of structural responses from different random realizations of a structure subjected to an ensemble of ground motions scaled to a specific intensity level. However, such full simulation approach needs a large number of repetitive nonlinear time history analysis (NLTHA) of real structure to obtain acceptable confidence in estimated probability of failure of structure. This seems to be a computationally challenging task. Due to