On the Computation of Seismic Loss Tail Probability Distributions for Stochastic Structural Dynamic Systems

Cheung Sai Hung*
Assistant Professor, Nanyang Technological University, Singapore
shcheung@ntu.edu.sg

Sahil Bansal
PhD Candidate, Nanyang Technological University, Singapore
sahi0004@e.ntu.edu.sg

Prior estimation of losses (e.g., economic loss, downtime and casualty) in a structure due to future uncertain earthquakes, especially those which can lead to disastrous consequences, is essential to reduce potential losses and assist recovery. Taking into account uncertainties such as those from structural modeling, the modeling of uncertain ground excitations due to future earthquakes and the models for damage and loss analysis, the computation of seismic loss tail probability distribution will unavoidably involve the computation of high-dimensional probability integrals. The resulting problem is computationally very challenging due to a large number of random variables involved (often of the order of thousands or more), the value of the integrand being a function of the solution of stochastic differential equations governing the stochastic dynamics of structural systems, and complex domain of integration. A new stochastic simulation based method is proposed for an efficient computation of the aforementioned probability integrals. The applicability of the proposed method is shown by an illustrative example involving a multi-storey building. Although this work is motivated by the need of seismic loss estimation of civil engineering structures, the proposed algorithm should be applicable to other types of systems which require computation of integrals of similar forms to the ones studied here.

Key Words: tail probability, seismic loss, stochastic dynamics, civil engineering structures