APPLICATION OF SUBSET SIMULATION IN ESTIMATING RELIABILITY OF STOCHASTIC DYNAMICAL SYSTEMS

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ABSTRACT

Reliability estimation of stochastic dynamical systems can give rise to problems that are infinite dimensional because of the continuous parameters time and space needed to define the systems in the most general case. Analytical methods like FORM (First Order Reliability Method) fail when applied to such problems. Simulation techniques like crude Monte Carlo Simulation can also fail when we are dealing with low failure probabilities. Subset simulation incorporating Markov Chain Monte Carlo (MCMC) moves is used in the present work for all reliability estimation as it overcomes both efficiency related issues of crude MCS and implementation issues of analytical methods. A few benchmark studies are conducted on the subset simulation technique and its advantages, disadvantages and design issues are discussed. For the present study reliability of a bridge is estimated subject to random vehicular and seismic loads. Vehicle structure interactions are affected by vehicle speed, vehicle and bridge mass and material and geometric properties of the bridge, all of which could be random. The vehicle structure interactive forces are also affected by random surface roughness of the bridge deck. The bridge is modeled as a Euler-Bernoulli beam and the vehicle is idealized as an SDOF system with a sprung and a un-sprung mass. For the current study the performance criteria is mid-span deflection and is computed using modal analysis. Sensitivity studies are done on the reliability with respect to the various parameters associated with the bridge.

Keywords: Time dependent reliability, Subset simulation, vehicle structure interaction