Application of subset simulation approach for reliability analysis of structural systems

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Abstract

Estimation of failure probability in structural systems is a challenging problem in reliability analysis of structures. For problems with small failure probability or high dimensions, common methods such as Monte Carlo simulation (MCS) method cannot be useful; in these cases, a simulation method which is so called 'Subset Simulation' approach can be the best offer. The most common algorithm in this method is Modified Metropolis-Hastings (MMH) algorithm. In this paper, we solve two problems with Subset Simulation (SubSim) method. The first problem is a reinforced concrete beam, and the other problem is a simply support beam. By comparing the results of the proposed method with the resulls obtained from MCS, it's observed that the results of SubSim approach agrees well with the resulte of MCS. Therefore, the SubSim method is robust technique to estimate the reliability index and probability of failure with high accuracy.

Key words: Probability of failure, Reliability analysis, Subset simulation, Reliability index, Monte Carlo simulation.

1. Introduction

Reliability analysis has been playing an increasingly important role in engineering structures in recent years [1]. In the last decades, the inherent uncertainties of structural properties have been taken into account in structural reliability analysis [2]. The reason being that the deterministic safety factor is not a reliable measure of risk, so that structures with the same safety factor may reveal distinct level of risk. Accordingly, numerous reliability methods have been used to deal with uncertainty in the structural stability analysis, including, the Point Estimate Method (PEM) [3], the First-Order Reliability Method (FORM) [4,5] and the First-Order Second Moment (FOSM) Method [6,7] in addition to many variants of the Monte Carlo Simulation (MCS) [8-10].