

STOCHASTIC DESIGN APPROACH OF ESTIMATING FAILURE PROBABILITY FUNCTION

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ABSTRACT

A novel approach, called the stochastic design approach, is developed to estimate the failure probability of a system under various system parameter settings. Although it seems to require numerous reliability analysis runs to evaluate the failure probability function, which is a function of the deterministic system parameters, the stochastic design approach only requires a single reliability analysis run. The new approach becomes even more convenient when Subset Simulation is employed to evaluate the failure probability. Statistical properties of the failure probability function estimators are derived, and the pointwise confidence intervals are built accordingly. The use of the new approach is demonstrated with several simulated examples. The results show that the new approach can effectively estimate the entire failure probability function with one single Subset Simulation run. Moreover, the new approach is applicable when the dimension of the uncertainties is high and when the system is highly nonlinear. The stochastic design approach should be valuable for reliability analysis, reliability-based optimization, reliability sensitivity analysis, performance-based engineering and life-cycle engineering.

Key words: reliability analysis, reliability-based optimization, reliability sensitivity analysis, stochastic simulation.