Recent Advances in Reliability Estimation of Time-dependent Problems Using the Concept of Composite Limit State

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Keywords: *Time-dependent probability of failure; System reliability; Random process quantification; Composite limit state; Convex polyhedral safe sets*

Abstract

A new reliability analysis method is proposed for time-dependent problems with limit-state functions of input random variables, input random processes and explicit in time using the total probability theorem and the concept of composite limit state. The input random processes are assumed Gaussian. They are expressed in terms of standard normal variables using a spectral decomposition method. The total probability theorem is employed to calculate the time-dependent probability of failure using a time-dependent conditional probability which is computed accurately and efficiently in the standard normal space using FORM and a composite limit state of linear instantaneous limit states. If the dimensionality of the total probability theorem integral (equal to the number of input random variables) is small, we can easily calculate it using Gauss quadrature numerical integration. Otherwise, simple Monte Carlo simulation or adaptive importance sampling is used based on a pre-built Kriging metamodel of the conditional probability. An example from the literature on the design of a hydrokinetic turbine blade under time-dependent river flow load demonstrates all developments.