Time-dependent reliability analysis with random and evidence variables

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Abstract:

This paper aims to propose a practical and effective hybrid reliability analysis approach for solving the time-dependent problems with the random and evidence uncertain variables in mechanical structures. Most of the existing time-dependent reliability analysis approaches are applicable to probability variables only. However, some of uncertain variables are evidence based in engineering applications. The uncertainty modeling with a large number of epistemic uncertain parameters is considered critically important in structural reliability analysis. In order to improve the accuracy and efficiency, this study adopts stochastic process discretization technique to simulate the loading that varies randomly with time. The surrogate model techniques and a uniformity technique are used to deal with the hybrid variables with aleatory and epistemic uncertainties. The outcrossing rate can be obtained automatically by performing the traditional time-independent reliability analysis using the first-order reliability method (FORM). The reliability index and probability of failure with respect to the time can be acquired easily by the above procedure for duration of time concerned. In this paper, two numerical examples are provided for demonstrating the validity of the proposed approach.

Keywords: time-dependent reliability; stochastic process; evidence theory; outcrossing rate; first-order reliability method