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A Novel Univariate Method for Mixed Reliability Evaluation of Composite Laminate with Random and Interval Parameters

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Abstract

Requiring probability density distribution functions of uncertain variables, it is difficult for conventional structural reliability analysis methods to calculate the reliability of composite laminates with both random and interval variables. To evaluate the safety of composite laminated structures under this circumstance, this paper is aimed at developing a precise and efficient univariate method for the reliability assessment of composite laminates taking use of Legendre orthogonal polynomials and Monte Carlo Simulation. In this paper, based on the Tsai-Wu failure criterion and first-ply failure assumption, the failure criterion of composite laminate is constructed firstly. Then the performance function of each lamina is approximately expressed as the sum of univariate contributions of all uncertain variables on the basis of the univariate method. Taking use of Legendre orthogonal polynomials, the univariate functions of random and interval variables are constructed by the least square fitting method and the univariate contribution bounds of interval variables are derived afterwards. Furthermore, the interval of failure probability can be calculated by substituting contribution bounds of interval variables and sample points of random variables into univariate function. At last, two examples and an engineering application are provided to demonstrate the efficiency and accuracy of the proposed method.

Keywords: Composite laminates; Mixed reliability; Random variable; Interval variable; Univariate method; Legendre orthogonal polynomial

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