

Time-dependent system reliability analysis method based on the outcrossing rate

Dequan ZHANG^{1,2}, Xu HAN¹, Chao JIANG¹, Qing LI²

¹State key laboratory of advanced design and manufacturing for vehicle body, college of mechanical and vehicle engineering, Hunan University, Changsha 410082, China,

zhangdq@hnu.edu.cn

²School of Aerospace, Mechanical and Mechatronics Engineering, The University of Sydney, Sydney, New South Wales 2006, Australia, qing.li@sydney.edu.au

Abstract

The time-dependent reliability analysis for time-variant system structures with a large number of inherently uncertain parameters signifies a very important problem in engineering. The traditional system reliability method usually computes the static reliability index and failure probability by first order reliability method (FORM). The traditional method may not be efficient when evaluating the reliability of system under stochastic loads. In this study, a novel reliability approach is proposed based upon the outcrossing rate method for time-variant system structures. The method extends the classical outcrossing rate method to system reliability problem whose limit-state functions have both random variables and stochastic processes. The PHI2 method can compute the outcrossing rate by solving the reliability of the parallel system with two components. Then the time-dependent reliability analysis can be converted into the time-independent reliability analysis where traditional static reliability methods can be used. The multi-dimensional normal integral problems are estimated by the recently developed matrix-based system reliability method in time-dependent system structures. The time-dependent reliability index and failure probability can be efficiently obtained. In this paper, two numerical examples are provided to demonstrate the efficiency and the accuracy of the method.

Keywords: system reliability; time-dependent reliability; stochastic process; outcrossing rate.