Fatigue reliability analysis of composite material considering the growth of effective stress and critical stiffness

Jianxiong Gao[1], Fei Heng[1], Yiping Yuan[1], and Pengnian Zhu[1]

[1]Xinjiang University

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Abstract

Abstract: Fatigue damage accumulation will not only cause the degradation of material performance, but also lead to the growth of effective stress and critical stiffness. However, the existing fatigue reliability models usually ignore the effective stress growth and its influence on critical stiffness of composite material. This study considers the combined effects of performance degradation and effective stress growth, and a pair of fatigue reliability models for composite material is presented. Firstly, the fatigue damage in composite material is quantified by its performance degradation, and the fitting accuracy of several typical fatigue damage models is compared. Subsequently, the uncertainties of initial strength and initial stiffness are considered, and a pair of probabilistic models of residual strength and residual stiffness is proposed. The performance degradation data of Gr/PEEK $[0/45/90/-45]_{2S}$ laminates are utilized to verify the proposed probabilistic models. Finally, the effective stress growth mechanism and its influence on failure threshold are elaborated, and a pair of fatigue reliability models for composite material is developed. Moreover, the differences between strength-based and stiffness-based reliability analysis results of composite material are compared and discussed. **Keywords:** fatigue reliability; performance degradation; effective stress; fatigue damage; composite material

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