Prediction on fatigue properties of centrally notched composite laminates under off-axial random loading

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1. Introduction

Compared with the traditional metal materials, fiber reinforced polymer composites have advantages on strength, stiffness and fatigue durability. Therefore, they are widely applied in aeronautics and astronautics engineering [1, 2], vehicle [3, 4] and wind turbine blade structure [5, 6]. In these engineering structures, the composite components are subjected to the random loadings from acoustic and vibrational environment. The prediction for fatigue properties of the composite structures under random loading is necessary to ensure the reliability.

2. Body of abstract

The fatigue properties of the plain weave carbon fiber reinforced epoxy composite laminates with the central notch subjected to in-plane off-axial random loading are investigated. The composite layer is under in-plan multiaxial stress state. The tensile residual strength and compressive residual strength in the material principal directions and the in-plane shear residual strength are calculated under random responses of the stress components, respectively. Combining the Tsai-Wu polynomial, the composite failure criterion under multiaxial random stress state is developed. The fatigue life of the centrally notched composite laminate is predicted under in-plane off-axial random loading via progressive damage method. Meanwhile, the failure behavior of the laminate is described. The tests of the of-axial random fatigue life are carried out. The life of the predictions are in good agreement with the test data and the failure behaviors from the progressive damage analysis are consistent with experimental phenomenon.

3. Equations, figures, and tables

Tsai-Wu failure criterion is employed for plane stress state:

$$F_1\sigma_1 + F_2\sigma_2 + F_{11}\sigma_1^2 + F_{22}\sigma_2^2 + F_{66}\sigma_{12}^2 + 2F_{12}\sigma_1\sigma_2 = 1 \quad (1)$$

where

$$F_1{=}F_2 = \frac{1}{S_{rT}(t)} - \frac{1}{S_{rC}(t)} \qquad F_{11} = F_{22} = \frac{1}{S_{rT}(t)S_{rC}(t)}$$

$$F_{66} = \frac{1}{S_{r12}^2(t)} \qquad F_{12} = -\frac{1}{2S_{rT}(t)S_{rC}(t)}$$

$S_{rT}(t)$、$S_{rC}(t)$ and $S_{r12}(t)$ are the tensile residual strength, compressive residual strength and the shear residual strength

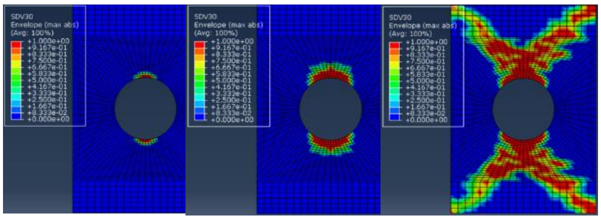

Fig.1 The progressive damage analysis of the composite laminate

4. Deadline and other information

Acknowledgment

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