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A progressive fatigue damage model for composite structures in hygrothermal environments

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Abstract: An improved progressive fatigue damage model (PFDM) involving hygrothermal effects was proposed to predict fatigue failure of composite structures in hygrothermal environments. In the improved PFDM, a unified model was established to evaluate the variation of composite material properties caused by hygrothermal environments. The hygrothermal-induced material properties were utilized in the stress analysis model, material degradation models and fatigue failure criterion. The hygrothermal strains were introduced into the constitution equation to account for the hygrothermal effects. A residual-strain-based gradual material degradation model and a micromechanics-based sudden material degradation model were enhanced to describe the damage of composite materials in hygrothermal environments. Besides, fatigue tests and progressive fatigue damage analyses of an open-hole laminate were performed in hygrothermal environments. The good consistency between the numerical and experimental results validated the improved PFDM. Both the experimental and numerical outcomes indicate that the effective moisture equilibrium considerably reduces the compressive strength and compressive fatigue life of the open-hole laminate made of T800 carbon/epoxy composites.

Keywords: Composites; Hygrothermal effect; Progressive fatigue damage model; Fatigue life.

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