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PROCEEDINGS

Study on Repair of Cracked Aircraft Structures with Single-Sided Bonded Carbon Fiber-Reinforced Polymer Composite Patches

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ABSTRACT

This research aims to investigate efficient repair techniques of cracked Ti-alloy aircraft structures with adhesively bonded carbon fiber-reinforced polymer composite patches. The repaired specimens in the configuration of a Ti-alloy butt joint with one-side bonded composite patch were prepared under multiple repair factors including patch thickness, patch length, adhesive thickness, cure pressure, patch layup and surface treatment. The repair efficiency was evaluated by loading behavior, bonded interface microstructure and failure mode. The three-dimensional (3D) finite element (FE) model has been established. Based on 3D Hashin failure criteria, the damage initiation and evolution in CFRP were simulated. The damages of the adhesive layer and delamination of CFRP were simulated with cohesive zone model. The FE model was validated by experimental and theoretical analysis. The results reveals that the geometric factors affect the loading performance and alter failure modes by adjusting stress distribution in the repair system, whereas the cure pressure and surface treatment act on the bondline and change interfacial properties. A sensitivity-optimization model based on analysis of variance was established for parametrical study to quantify the contribution of repair factors and obtain optimal values. The optimum parameters were validated by repaired central-cracked specimens via static and fatigue tests, which proved that the repaired structure could restore 90.7% loading capacity of intact ones and endure more than 10^6 fatigue cycles of 25% ultimate failure load level of center-cracked ones. The proposed experimental and parametrical study possessed good efficacy in refurbishing strength and stiffness of cracked metallic structures.

KEYWORDS

Composite patch; adhesively bonded repair; cracked aircraft structure; failure mode; parameter optimization

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