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Parametric investigation of reinforcing cracked aluminum plates with single- and double-sided composite patches: An experimental and numerical approach

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Abstract

This study presents a novel investigation into the reinforcement of cracked aluminum plates using double-sided composite patch repair, a technique that is less explored in existing literature, addressing gaps in existing research through an extensive parametric evaluation. A comprehensive parametric analysis was performed to identify the optimal conditions for normalized stress intensity factor (NSIF) increment and improve repair efficiency. To ensure the reliability of the findings, both experimental and finite element (FE) simulations were conducted. The experimental setup involved bonding composite patches to edge-cracked aluminum plates and testing them under uniaxial tensile loading, while numerical modeling was performed using ANSYS APDL. This integrated approach provided a robust understanding of the interplay between patch geometry, material properties, and adhesive characteristics. The findings demonstrate that double-sided composite patches provide improved load transfer, reduce stress concentration, and enhance crack resistance compared to single-sided configurations. The study concludes with practical recommendations for optimizing composite patch repair based on material selection and patch configuration. The novelty of this work lies in its holistic evaluation of composite patch repair parameters, offering a more resilient and cost-effective solution for aerospace and structural applications. © IMechE 2025

Author keywords

and analytical and experimental; Composite patch; FEM; stress intensity factor

Indexed keywords

Engineering controlled terms

Adhesives; Aluminum; Cost effectiveness; Cracks; Plates (structural components); Reinforcement; Repair

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And analytical and experimental; Composite patch repairs; Composite patches; Cracked aluminum plate; Double sided; Experimental approaches; Numerical approaches; Parametric analysis; Parametric investigations; Stress-intensity factors

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