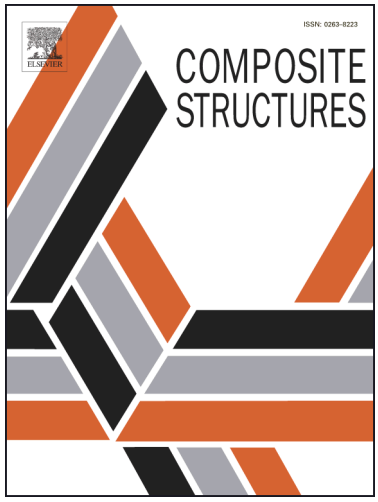

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Progressive failure of bolted single-lap joints of woven fibre-reinforced composites

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Abstract

Modeling progressive failure of bolted composite joints under high bearing strains is challenging due to the highly nonlinear geometric and material behavior and multiple contact surfaces. In this study, the progressive failure of bolted single-lap joints of woven composites is investigated numerically and experimentally. The finite element (FE) model employs continuum shell elements for each ply and cohesive elements for the material interfaces. Explicit FE analysis is employed due to its capability in treating contact with complex geometries. Material nonlinearities due to fiber rupture in the tows and matrix micro-cracking are accounted for by appropriate material degradation modelling. A set of experiments was conducted and digital image correlation (DIC) was used to measure displacements around the bolted area. The bearing failure characteristics of the bolted joint, including the crushing of the composite material due to the rotation of the bolt head as predicted by FE analysis agree with experimental observations. Element deletion as a practical numerical strategy to overcome convergence issues is proposed for large local element distortions and extensive local material crushing. It is shown