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A CONTINUUM DAMAGE MODEL FOR BOLTED JOINT FAILURE PREDICTION IN FIBER-REINFORCED COMPOSITES

José Jerônimo Rabelo Faria(1), Alfredo Rocha de Faria(1), Maurício Vicente Donadon(1), Sérgio Augusto Capasciutti de Oliveira(1), Ragnar Larsson(2)

(1) Department of Aeronautical and Mechanical Engineering, Instituto Tecnológico de Aeronáutica, Brazil

(2) Department of Industrial and Materials Science, Chalmers University, Sweden

Abstract: The present study presents a three-dimensional Continuum Damage Model (CDM) applied to failure prediction of composite bolted joints, implemented into Abaqus™/Explicit Finite Element (FE) code using a VUMAT user-subroutine. The damage model is developed on an energy-based context, enabling the prediction of failure initiation and propagation at the intralaminar level. The model is capable of predicting longitudinal, transverse and in-plane shear failure modes. Mesh independence is achieved through a damage evolution rule that accounts for the damage progression speed. Interlaminar failure mechanisms are also implemented in the model utilizing Cohesive Elements (CEs), natively available in Abaqus™. The prediction of variable mixed-mode failures is possible without the need of prior knowledge concerning the mixity ratio between delamination modes. This is achieved through the application of a single-damage variable for all delamination modes. Numerical predictions of the load-displacement behavior, as well as damage propagation and failure of single-lap bolted joints are presented and assessed through a correlative study with experimental and numerical results available in literature.

Keywords: Continuum Damage Mechanics, Explicit Finite Element Analysis, Fiber-Reinforce Composites, Bolted Joints.