Accepted Manuscript

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M.M. Moure, S.K. García-Castillo, S. Sánchez-Sáez, E. Barbero, E.J. Barbero

PII: S0263-8223(17)30350-1
DOI: http://dx.doi.org/10.1016/j.compstruct.2017.05.059
Reference: COST 8568

To appear in: *Composite Structures*

Received Date: 31 January 2017
Revised Date: 27 April 2017
Accepted Date: 23 May 2017

Please cite this article as: Moure, M.M., García-Castillo, S.K., Sánchez-Sáez, S., Barbero, E., Barbero, E.J., Matrix cracking evolution in open-hole laminates subjected to thermo-mechanical loads, *Composite Structures* (2017), doi: http://dx.doi.org/10.1016/j.compstruct.2017.05.059

MATRIX CRACKING EVOLUTION IN OPEN-HOLE LAMINATES SUBJECTED TO THERMO-MECHANICAL LOADS

M. M. Moure[a], S. K. García-Castillo[a], S. Sánchez-Sáez[a], E. Barbero[a*], E. J. Barbero[b]

[a] Department of Continuum Mechanics and Structural Analysis, University Carlos III of Madrid, Avda de la Universidad 30, 28911 Leganés, Madrid, Spain

[b] Mechanical and Aerospace Engineering, West Virginia University, Morgantown, WV 26506, USA

Abstract

In this work, a constitutive model is developed and used to predict matrix cracking and fiber damage evolution in all the plies of symmetric laminates when both mechanic and thermal loads are applied. A model previously developed is modified to take into account the thermal stresses that appear in each ply when the temperature is reduced below the Stress Free Temperature. Data of matrix damage initiation and evolution due to thermomechanical loads for four materials and six laminate lay-ups taken from the scientific literature are used to validate the model. A good correlation between the predictions and the experimental results is found. The model is used to analyze the thermomechanical damage in laminates containing a centered hole subjected to in-plane tensile loads. It is observed that the thermal load alone does not produce a stress concentration around the hole but the thermal residual stress accelerates damage accumulation during mechanical load.

Keywords: Open-hole laminates; Thermomechanical; Transverse cracking; Finite element analysis; Discrete Damage Mechanic

1. INTRODUCTION

Composite laminates are widely used in aerospace and aircraft industries, in structural applications such as pressure vessels, aircraft fuselage, etc. These structures are subjected to in-plane loads [1] and temperatures between -250º and 120ºC [2]. Sometimes, these components contain thousands of holes for joining purpose or cut-outs for opening accesses. The presence of a hole on a laminate produces a stress gradient that increases the stress field in its proximity. This phenomenon changes the failure mechanisms of the laminate and produces a reduction of the failure strength of the structure compared to that with no hole.