Accepted Manuscript

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PII: S1359-8368(17)32526-X

DOI: 10.1016/j.compositesb.2017.10.018

Reference: JCOMB 5338

To appear in: *Composites Part B*

Received Date: 25 July 2017

Revised Date: 18 September 2017

Accepted Date: 10 October 2017

Please cite this article as: Funari MF, Greco F, Lonetti P, Luciano R, Penna R, An interface approach based on moving mesh and cohesive modeling in Z-pinned composite laminates, *Composites Part B* (2017), doi: 10.1016/j.compositesb.2017.10.018.

An interface approach based on moving mesh and cohesive modeling in Z-pinned composite laminates

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ABSTRACT: An FE approach based Arbitrary Lagrangian-Eulerian (ALE) and cohesive fracture mechanics is implemented to investigate the effects of debonding mechanisms on the behavior of z-pinned composite laminates. The model is based on the combination of moving and discrete cohesive interface elements, which allow the simulation of interfacial damage or strengthening mechanisms produced by debonding phenomena or z-pinned techniques, respectively. Moreover, complex phenomena such as crack initiation, coalescence mechanisms are easily implemented in both static and dynamic frameworks. Despite existing approaches, available from the literature, the computational procedure is able to overcome difficulties concerning mesh dependence of the solution, numerical complexities and costs involved in the solving procedure. The numerical implementation of the model and its capability to predict debonding mechanisms are discussed with respect different laminate configurations and onset conditions. Moreover, comparisons with existing experimental results available from the literature are developed to investigate the relationship between strengthened and unstrengthened composite laminates.

Keywords: crack initiation, dynamic debonding, ALE, Z-pins.

Nomenclature

G_I^{pin}	mode I energy release rate for the z-pin
G_{II}^{pin}	mode II energy release rate for the z-pin
G_{IC}^{pin}	single pin critical energy release rate (mode I)
G_{IIC}^{pin}	single pin critical strain energy release rate (mode II)
g_f^{pin}	fracture function of z-pins
g_f	crack growth function for interlaminar damage
N^L	number of the layers
N^D	number of internal discontinuities
N^Z	number of z-pin elements
P_{np}^c	z-pin critical cohesive stress (opening)
P_{tp}^c	z-pin critical cohesive stress (sliding)
T	kinetic energy
T_n^c	critical cohesive interlaminar stress (mode II)