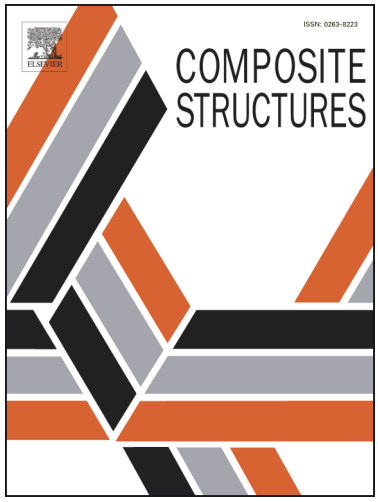

Finite element modeling of damage development in cross-ply composite laminates subjected to low velocity impact

Chao Zhang, Enock A. Duodu, Jinan Gu

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Chao Zhang*, Enock A. Duodu, Jinan Gu

School of Mechanical Engineering, Jiangsu University, Jiangsu, Zhenjiang, China

*Corresponding author: Chao Zhang, E-mail: zhangchao@ujs.edu.cn, Tel: +86 511 88780169, Fax: +86 511 88790627, Department of Mechanical Design, 301 Xuefu Road, Zhenjiang, 212013, Jiangsu, China

Abstract: Composite laminates are susceptible to low-velocity impact and the induced damage substantially reduces the residual mechanical performance and safe-service life of the composite structures. In this paper, a finite element model based on continuum damage mechanics is presented to study the dynamic mechanical response and damage development in cross-ply composite laminates subjected to transverse low velocity impact. Hashin criterion and a gradual degradation scheme are applied to predict the intra-laminar damage initiation and evolution; a damage-friction interface constitutive model is utilized to predict the inter-laminar delamination induced by impact loading. A user-material subroutine VUMAT involving these constitutive models of intra-laminar and delamination damage is coded and implemented in the finite element package ABAQUS/Explicit. Numerical analysis is conducted on cross-ply composite specimens with different impact energies to study the impact force-time, force-displacement and energy-time histories curves as well as the damage evolution behaviors of matrix cracking and interface delamination. The numerical results show acceptable accord with available experimental data validating the efficiency of the proposed model. Moreover, the effect of interface friction on the delamination inhibition response of cross-ply composite laminates under impact is also investigated.

Keywords: Composite laminates; finite element modeling; low velocity impact; damage prediction; delamination