Accepted Manuscript

Analytical model for predicting the tensile strength of unidirectional composites based on the density of fiber breaks

J.D. Vanegas-Jaramillo, A. Turon, J. Costa, L.J. Cruz, J.A. Mayugo

PII: S1359-8368(17)30696-0

DOI: 10.1016/j.compositesb.2017.12.012

Reference: JCOMB 5441

To appear in: *Composites Part B*

Received Date: 24 February 2017

Revised Date: 6 November 2017

Accepted Date: 15 December 2017

Please cite this article as: Vanegas-Jaramillo JD, Turon A, Costa J, Cruz LJ, Mayugo JA, Analytical model for predicting the tensile strength of unidirectional composites based on the density of fiber breaks, *Composites Part B* (2018), doi: 10.1016/j.compositesb.2017.12.012.

Analytical model for predicting the tensile strength of unidirectional composites based on the density of fiber breaks

J. D. Vanegas-Jaramillo[1-2-3*], A. Turon[1], J. Costa[1], L. J. Cruz[2], J.A.Mayugo[1]

[1]*AMADE - Polytechnic School, University of Girona, Girona, Spain.*

[2]*Grupo de Investigación Sobre Nuevos Materiales, GINUMA, Universidad Pontificia Bolivariana, Medellín, Colombia*

[3]*Grupo de Investigación Materiales y Energía, MATyER, Instituto Tecnológico Metropolitano, Medellín, Colombia.*

*corresponding author email: juan.vanegas@udg.edu, Tel: (+57) 312 722 7380

Abstract

While analytical fiber fragmentation models following the global load-sharing (GLS) assumption efficiently reproduce the stress strain curves of unidirectional composites loaded in the direction of the reinforcement when the number of breaks is moderate, they completely fail to predict tensile strength. In this paper, we propose that failure takes place when a critical density of breaks, which depends entirely on the constituent properties, is reached. Therefore, we rewrite classic GLS fragmentation models in terms of the linear density of breaks. The critical number of breaks for a set of glass and carbon reinforced polymer composites is extracted from published experimental data and fitted to an empirical law, with good predictive capability. Our approach complements GLS fragmentation models because it identifies the ultimate stress, from which the stress-strain curve given by the model becomes unrealistic.

Keywords

A: Polymeric-matrix composites (PMCs); **B:** Fragmentation; **C:** Analytical modeling; **D:** Strength.

1 Introduction

Physically-based analytical approaches to anticipate the mechanical properties of composite laminates are fast tools for structural design and permit their constituents to be optimized for a better mechanical performance. Analytical models for the stress-strain behavior of unidirectional plies in the direction of the reinforcement rely on the representation of the stochastic occurrence of breaks along the fibers and, therefore, are referred to as fragmentation models [1,2].