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Mohamed Habibi, Luc Laperrière, Hojjat Mahi Hassanabadi

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Influence of low-velocity impact on residual tensile properties of nonwoven flax/epoxy composite.

Mohamed Habibi[1, 2]*, Luc Laperrière[1] and Hojjat Mahi Hassanabadi[2]
[1] Department of mechanical engineering, Université du Québec à Trois-Rivières, Quebec, Canada.
[2] Centre de recherche industrielle du Québec, Québec City, Canada.
*Corresponding author: Mohamed Habibi
E-mail address: Mohamed.Habibi@uqtr.ca

Abstract

This paper addresses the damage resistance and post-impact damage effect on residual tensile properties of nonwoven flax fibers reinforced epoxy composites subjected to low-velocity impact. Two different impactors: hemispherical and conical, at six different impact energy levels: 4J, 6J, 8J, 10J, 12J and 14J were assessed. The experimental results to investigate the influence of impactor type suggest that the penetration of the impactor and induced damage are more important with a conical impactor. The post-impact damage patterns and failure mechanisms of impacted samples were characterized by ultrasonic C-scan inspection. Results suggest that damage induced by the impact included matrix cracking, and delamination, which are more important with a conical impactor. Tensile properties show a significant effect of the impact induced damage on the performance of the composite. A particular effect was identified for an impact energy from 8J, where the tensile modulus E0 and E1 are decreased by 53.5% and 59.3%, respectively. This effect was also confirmed by the examination of the strain map, describing the deformation behavior of the material at different impact energy, where a stress concentration localized in the impacted zones was identified.

Keywords: Flax fiber composites; Low-velocity impact; C-scan; Tensile properties.

1. Introduction

In recent years, composite materials have been widely used in various industrial applications; automotive transports (body components, casings, cabins, seats, etc.), marine transports (hovercraft, racing boats, canoes, etc.), and space transports (different aircraft components), etc. Most of the cited applications give a crucial importance to lightweight materials and to the performance/mass ratio. The latter is a key parameter in the energy efficiency of the different transport equipment. This importance is justified by the fact that 85% of the total life-cycle energy is consumed during service operations. For example, a further reduction of a car mass by 100 kg produces a saving of about 0.7l (l) fuel each 100 km [1-4]. Moreover, this ratio is a characteristic of materials with high specific mechanical properties, which is the case