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A micromechanical model of interfacial debonding and elementary fiber pull-out for sisal fiber-reinforced composites

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Abstract: The interfacial failure behavior of sisal fiber-reinforced composites (SFRCs) was studied experimentally and theoretically. The residual pull-out strength of the SFRCs was observed to gradually decrease during the single sisal fiber pull-out test, after which the SFRCs presented multiple failure modes, including at the interface between technical fiber and matrix and at the interface between elementary fibers. To further investigate the failure mechanisms of SFRCs, using the traditional shear lag model, a double-interface model tailored to the unique multi-layer interface structure of plant fibers was developed to describe the fiber pull-out behavior and the interfacial adhesion status of single plant fiber-reinforced composites (PFRCs). By comparison with other existing models, using the experimental applied stress as reference, the proposed double-interface model was found to provide a more accurate quantitative theoretical prediction of the interfacial failure behavior of PFRCs during multi-stage fracture of the two interfaces.

Keywords: A. Fibers; B. Interface; B. Debonding; C. Failure criterion; C. Stress transfer

1. Introduction

In recent decades, plant fibers have been thrust into the global spotlight as an environmentally-friendly material with the advantages of low cost, renewability and biodegradability [1, 2] and have become promising alternatives to traditional synthetic fibers in the fabrication of composite materials owing to their favorable mechanical and physical properties [3, 4]. A lot of researches have focused on investigating the