NUMERICAL ENERGY ABSORPTION STUDY OF PULTRUDED COMPOSITE TUBES

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INTRODUCTION

The need for a safer vehicle which (i) absorbs energy, (ii) keeps the occupant compartments intact and (iii) ensures tolerable deceleration levels for driver and passengers during the crash event increases due to high speed operation. The above mentioned factors depend upon the design architecture and the materials used in the automobiles [1]. On the other hand, the entire world faces the problem of security for civil engineering structures due to terrorist activities [2]. Hence, a preventive solution is needed to safeguard the civil engineering structures and to avoid human casualties due to explosion. In connection with the above applications, an extensive numerical investigation was carried out to study the energy absorption characteristics and the progressive deformation behaviour of unidirectional pultruded composite tubes subjected to an axial impact load. The circular and square cross sectional glass polyester pultruded composite tubes were considered for this study. A full-scale design of these composite tubes for the above mentioned applications needs a very good numerical model to predict the correct crushing performance parameters.

NUMERICAL STUDY

A comprehensive numerical study was carried out to predict the accurate crushing parameters such as peak crushing load, deformation length and the corresponding energy absorption using models with different degree of complexity. In order to achieve the accurate impact parameters the importance of considering the delamination in the numerical model and the correct modelling of triggering is discussed. The effect of considering the central delamination and multiple delaminations was also proved in terms of the energy absorption. To capture the delamination between the plies the cohesive elements were adopted. The 'Hashin failure criteria' and the 'Quads damage' failure models were used for the shell elements and the cohesive elements respectively. The typical failure modes (circumferential delamination, lamina bending, axial cracks and brittle fracturing) of these composite tubes and the corresponding crushing parameters are achieved using the numerical modelling methodology. Furthermore, this study also addresses the effect of initial geometric imperfections and the mesh sensitivity on the energy absorption of pultruded composite tubes. The results of all these numerical simulations are compared with the experimental results.

RESULTS

The circular and square pultruded glass polyester tube series are studied for an initial impact velocity of 9.3 m/s. As an example, the deformation patterns from one of the approaches using multiple layers of shell elements and cohesive elements are shown in Figure 1. It can be noticed that there was a good correlation observed between the experimental and the numerical deformation patterns. Furthermore, this approach also yielded a very good correlation of crushing parameters such as peak crush load, deformation length and the corresponding energy absorption.

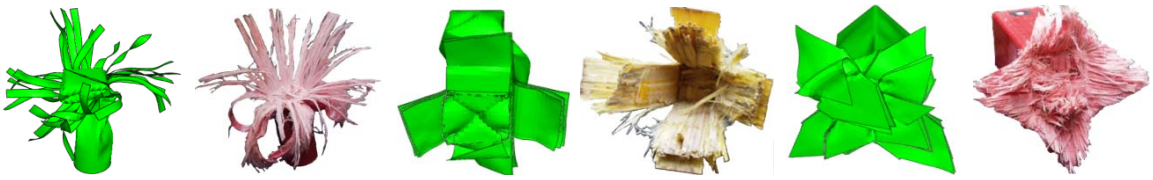

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Figure 1: Comparison of numerical and experimental deformation patterns of circular and square pultruded glass polyester composite tubes.

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