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COMPOSITE IMPACT ATTENUATOR WITH SHELL AND SOLID MODELLING

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Composite have been increasingly used in cars for their advantages of lightweight, high strength, corrosion resistance and easy manufacturing [1]. Recently, carbon fiber reinforced plastic (CFRP) gains growing popularity in numerous advanced and high performance applications for crashworthiness [2] thanks to its superior impact resistance, respect to metals or other composite materials. As regards racing cars, the regulations have become stringent and restrictive over time and cover different safety related aspects. As a consequence new structures for energy absorption has become indispensable parts to take into account during design.

The present work is dealing with the lightweight design and the crashworthiness analysis of a composite impact attenuator for a Formula SAE racing car [3,4]. Such structure (Figure 1) has a geometry very similar to a square frusta in order to obtain a progressive deformation confined at impact wall maintaining a nearly constant strength during the axial crushing [5-7].

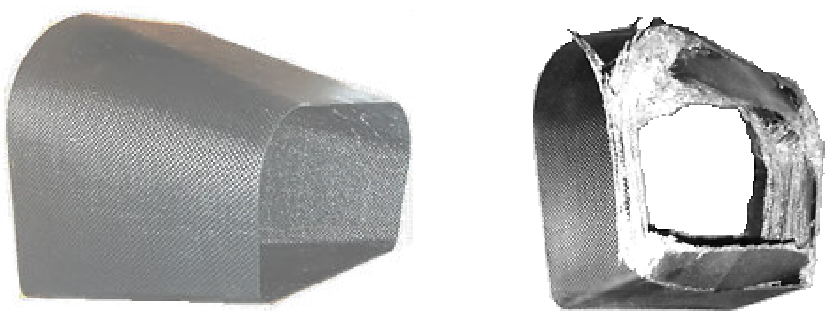

Figure 1. Impact attenuator before and after axial impact

During the design of this structure it is important to pay attention not only to the material distribution in various zones but also to the lamination process, which can heavily affect the energy absorption capability. The analysed impact attenuator is manufactured by lamination of prepreg sheets in carbon fibres and epoxy resin. To reduce the development and testing costs of a new safety design, it is recommendable to use computational crash simulations for early evaluation of safety behaviour under vehicle impact test. The dynamic analysis was therefore conducted both numerically, using explicit finite element code as LS-DYNA, and experimentally, by means of an appropriately instrumented drop weight test machine, in order to validate the model. The thin-walled layered structure was numerically analysed using both shell and solid elements in order to reproduce the laminate as closely as possible, taking into account also the possibility during crushing of an interlaminar failure which plays a significant role during energy absorption mechanism. The proposed models are able to predict, with a good level of accuracy, the deformation process of such impact attenuator when subjected to dynamic loading as those imposed by technical regulation.

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