ABSTRACT

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Title of Thesis	"Studies On Glass Fiber-Reinforced Composites For CAE-Driven Design Of Impact Safety Countermeasures"

Man-made materials such as fiber-reinforced composites (FRCs) can be tailored for optimum performance in product design applications in terms of strength and weight. The current work is aimed at studying the behaviors of composite laminates based on E-glass CSM (Chopped Strand Mat) or WRM (Woven Roving Mat) plies with a polyester resin for impact protection applications. Detailed mechanical characterization of CSM and WRM laminates till failure is carried out for tensile, compressive and shear loads by varying manufacturing process, number of plies, and laminate thickness. The effect of fiber volume fraction on mechanical properties is shown. The efficacy of CSM and WRM laminates as energy- absorbing countermeasures is studied by performing quasi-static and axial impact tests on cylindrical tubes made of the stated FRCs. In addition to load-displacement and specific energy absorption attributes, failure modes are of interest in such studies. The potential of FRC laminates for protection against projectile impact is investigated by performing low velocity impact perforation tests with a falling tup fitted with an indentor, and medium to high velocity projectile impact tests in a gas gun-based device. The valuable results generated are used for the validation of nonlinear finite element-based CAE (Computer-Aided Engineering) procedures including application of a multi-modal failure criterion for explicit dynamic analysis. The present study not only throws light on complex mechanical behavior of an important class of lightweight materials under static and dynamic loads, but also simulation tools for the design of impact safety countermeasures such as bullet-proof laminates and energy–absorbing components for automotive body structures.