Computational analysis of projectile impact resistance on aluminium (A356) curvilinear surface reinforced with carbon nanotubes (CNTs) for applications in systems of protection

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ABSTRACT

Computational tests for ballistic impact energy absorption were developed on A356/CNTs composite material with the goal of estimating the improvement of the material's mechanical properties by the contribution of the CNTs [1]. For the implementation of computational tests on the material exposed to projectile impact, A356/CNTs was configured by means of generalized Hooke's model for anisotropic materials [1] and Johnson-Cook's model was used to determine material failure and propagation of energy [2]. The materials' properties values used during ballistic computational tests for A356/CNTs composite with a material type A356 and for CNTs were given a stiffness module of 1.81e12 Pa and a Poisson ratio of 0.45 [3]. During computational tests, finite elements analysis (FEA) was used to study the behaviour of A356/CNTs composite. A curvilinear surface (semi-spheres on a plaque) with an area of 23x23 cm and thickness of 12 mm was elaborated to represent the composite material. A mesh was elaborated in order to determine the behaviour of the surface when subjected to impact dynamic force. Uniform quadrilateral elements were used to develop the mesh. NOM-166-SCFI-2005 was the main guideline for the development of simulations and the determination of ballistics-specific characteristics such as: protection level, gun type, projectile caliber, initial velocity, dimensions of target and others. Mechanical tests performed on the impact-subjected A356/CNTs composites indicated that reinforcement material favor the composite's mechanical properties, achieving energy dissipation-absorption and effectively stopping the projectile trajectory. The impact on surface was done with a 9 mm projectile and the surface was developed with 4.5 mm radium semi-spheres. It was used a 0.3% of nanotube insertions on the composite total volume. The results indicated that under these considerations the design of the plaque stopped the impact. This research offers insight on how perforation of composite materials subjected to ballistic impact is generated. Incidence of damage to wearer, as well as possibility of composite material improvement and the diffusion/dispersion analysis on the curvilinear surface which was also done.

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