



Recent advances in textile composite for impact protection

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Abstract

Many studies demonstrate that 3D composites have high ballistic impact damage resistance at low velocity impact protection (Miravete, 1999). A higher performance of 3-D structural composites compared to 2-D laminates has also been revealed (Bao *et al.*, 2005). Taking into account the impact studies achieved on 3D woven composites (Khalid, 2006), high performance has been revealed due to their resistance to de-lamination (Chou and Ko, 1989). The 3D angle interlock fabric displays high strength and damage resistance as a consequence of the interlaced structure of the warp and weft between the adjacent layers (Ko, 1989). In this study, different ballistic tests have been performed with conventional ammunitions such as 9mm, 7.62mm AP, and 6mm hard steel ball to understand the different energy absorption capacities of the 3D warp interlock fabric composite. Base on these results, a final target made of ceramic tiles and 3D textile composite has been achieved to absorb a total energy of 8000J during the impact with 12.7mm AP ammunition.

Key words: 3D composites, Ballistic tests, Energy

1. Introduction

The ballistic impact belongs to the impacts said to be "low" mass, "high" speed. Ballistic threats are generally small projectiles such as bullets fired from rifles and handguns but they can as well be rockets or fragments (shrapnel). The kinetic energy spread out by these projectiles is determined by the formula:

$$E_c = \frac{1}{2} mV^2 \text{ in (J),}$$

m: projectile mass usually given in kilogram (kg),

V: projectile velocity is given in meter/second (m/s).

There are several types of projectiles (armour

piercing, jacketed, expansive...) which differ by their mass, shape (hemispherical, conical or flat), constitutive materials (lead, hardened steel, tungsten-carbide...) but also by their impact velocity. Therefore, according to the threats, the impact kinetic energies are different, so mechanisms to stop the projectiles are also different.

1. 1. Low-energy impact

Low-energy impacts correspond to hand gun ammunitions (revolver, semi-automatic) and long guns such as rifles using soft lead core bullet which easily deforms. The range of calibres is between 5.56 to 11 mm (Figure 1). The calibre is, in general, the projectile