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Characterization of Mechanical Properties Displayed in Body Armor Ballistic Fibers

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ABSTRACT

The current body armor systems manufactured using ballistic fibers are not performing as theoretical results predict and are causing injuries. The actual maximum projectile penetration speed that the body armor can endure is significantly lower than the theoretical maximum speed, thus causing a costly build-test relationship that is not aided with modeling design efforts. The main aim of this research is to determine the maximum penetration speeds for ballistic yarns and fabrics. Secondary aim is to examine the common assumption that during transverse impact, single fiber is under pure tension and shear stress is negligible. To examine aforementioned assumption, fibers are tested under quasi-static state with 810 Material Testing System. Different types of fibers are tested in various angles with different Fragment Simulation Projectiles (FSP). A total of seven types of fibers are tested including Kevlar and Dyneema which are the two of the most commonly used materials in body armor systems. The results from static experiments show that the failure strain is significantly affected by the impact angle which indicates the presence of shear stress during impact. The failure strain decreases with increasing impact angle and rate of decrease is maximum for FSP followed by round projectile, with blade projectile showing the lowest rate of decrease. Therefore, the shear stress in ballistic fibers must be accounted for theoretical predictions of penetration velocity for fabric armor systems.

KEYWORDS

Ballistic limits, body armor, transverse impact, shear stress, ballistic fiber.

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