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Hybridization effects on quasi-static penetration resistance in fiber reinforced hybrid composite laminates

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Abstract. Quasi static penetration tests (QSPT) were conducted on fiber reinforced hybrid composite laminates with a circular and cylindrical punch. Woven Carbon, Kevlar and S-glass fibers were used as reinforcing fibers for production of hybrid and non-hybrid composite laminates. Punch shear test procedures were employed until the perforation and complete plugging shear out of the laminate. During QSPT experiments, a flat end punch with diameter of 12.7 mm has been used for two different support spans (25.4 and 63.5 mm) to obtain two different support span (D_s) to punch diameter (D_p) ratios (SPR=D_s/D_p=2 and 5). After the experiments, the extent of compression-shear and tension-shear based failure modes were characterized at constant punch displacements of 8 and 10 mm for SPR=2 and 5, respectively. In addition to visualize of front and back side surfaces, composite samples were half sectioned at damage region to observe the amount of delamination and damage through the thickness of the laminate. It was found that hybridization effects were distinctly observed with dominated tension-shear damage mode at SPR=5.

Keywords. Hybrid, composite, fiber, penetration

1. Introduction

In recent years, the demand of materials having superior properties with low cost has led to the development of fiber reinforced composites to replace metals in structural applications. The property of high strength to weight ratio of carbon and glass fiber reinforced composite structures has made them attractive for production of next generation materials. Failure and damage tolerances are very important for understanding of damage mechanism through the composites and many researchers have paid attention about damage and impact properties on composites [1-9]. During the impact event, the characterization of failure and damage spreading in the composites is a complex process resulting in delaminations, matrix cracking and fiber fracture. Quasi static tests are the proper choice to characterize impact events providing much simpler and cheaper way [10]. Damage initiation and propagation can be more easily detected, deflection can be directly measured with great accuracy, and maximum transverse force can be better controlled by using these tests, [11].

The low velocity impact events are considered as quasi-static in which dynamic effects can be neglected [12-16]. Maio et al. [17] studied the prediction of delamination and failure analysis of composite laminates subjected to low velocity impact. A progressive damage model was performed by using finite element method. A good prediction between experimental and numerical results was found for shape and orientation of delamination.

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