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Influence of projectile nose shape and incidence angle on the ballistic perforation of laminated glass fiber composite plate

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Abstract

In this study, experimental and finite element analyses of perforation behaviour of unidirectional glass fiber reinforced cross ply laminate have been presented, considering different projectile nose shapes, incidence velocities, incidence angle and laminate thickness. A pneumatic gun was used to propel 52 g steel projectile of diameter 19 mm at incidence velocity up to 300 m/s, where the projectiles are having different nose shapes such as ogival, conical, spherical and blunt. The target plate of size 140 mm × 140 mm and thickness 3.3 and 6.6 mm were made by unidirectional (UD) glass fiber with orientation (0°/90°/90°/0°) and $(0°/90°/90°/0°)_2$ respectively. A three dimensional finite element model is developed using Lagrangian, eight nodded brick element in ANSYS/AUTODYN, v14.5. The elastic properties of GFRP laminate is obtained from tensile tests in Universal Testing Machine in the civil engineering laboratory of IIT Roorkee, India. The velocity and acceleration-time histories of projectile along with ballistic limit, energy absorption and damage pattern in target plate are presented. The results obtained from numerical simulation are having good correlation with the corresponding experimental values and many new interesting results are also generated especially for oblique impact.

Keywords: GFRP laminate, material characterization, impact load, FE analysis, incidence angle