

Investigation on high velocity impact response and residual strength of carbon fiber reinforced laminated plates with strengthening rib

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Abstract. In this paper, ballistic impact tests on carbon fiber reinforced laminated plates with strengthening ribs were carried out with examined projectiles of Ti-6Al-4V titanium alloy to investigate the impact response at nominal velocities of 210m/s. The influence of strengthening rib on damage formation were discussed particularly by applying different loading conditions such as projectile attitude. By combining Digital image correlation (DIC) method with strain gauges, the measurement of displacement in the specified area was realized. Besides, the ultrasonic C-scan was employed to detect damages after impact. Moreover, residual strength tests for composites after impact and composites with prefabricated incision were conducted to investigate the correlation and equivalence between two distinct damage. In addition, numerical simulation method was employed to provide further insight into the characteristics of damage and target response. A user subroutine VUMAT with revised Ladeveze failure criteria was used to support simulations to assess target response and characteristics of damage created from different impact conditions. Results show that there is a significant transition in the deformation mode as changes of projectile attitude are applied. Moreover, the damage area and energy absorption appear obvious distinction, which is supposed to influence the residual strength. Furthermore, both the experiments and simulations results indicate that the delamination induced impact can greatly influence the residual strength. The work in this paper may provide guidance for the designing composites wing and fan blade containment system.

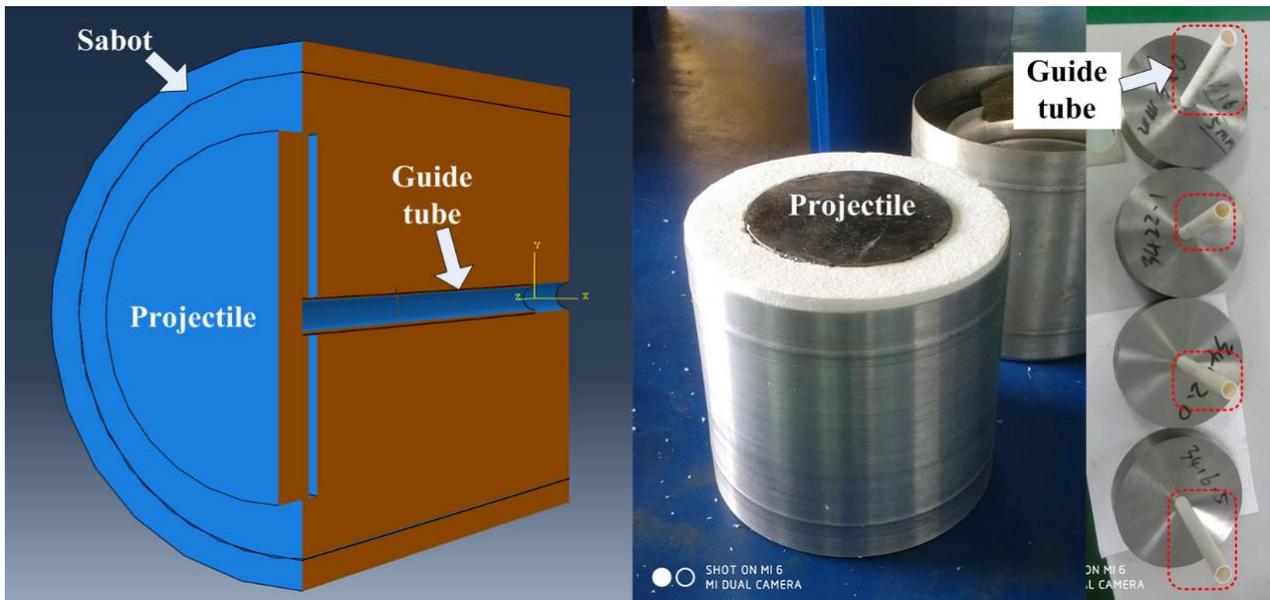


Fig. 1 Control of projectile attitude



Fig. 2 High speed photos and visible damage for composites impacted by projectiles with different attitude

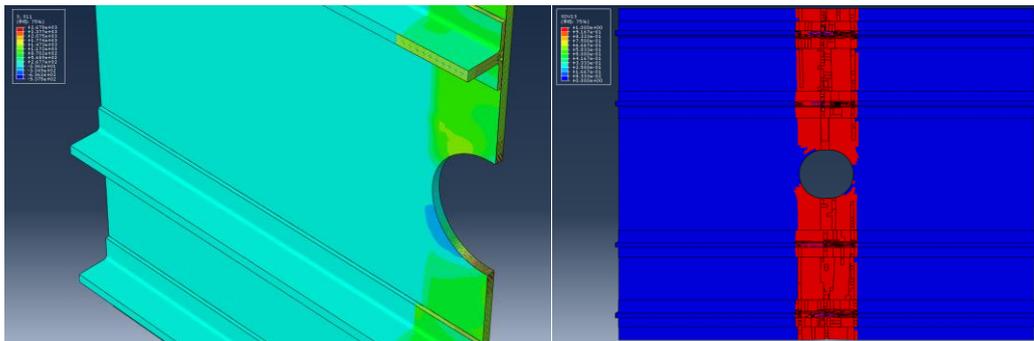


Fig. 3 Simulation of residual strength by using a user subroutine VUMAT with revised Ladeveze failure criteria