Evaluation of Damage Resistance of Bulletproof Car Body Panel for Different Material Configuration

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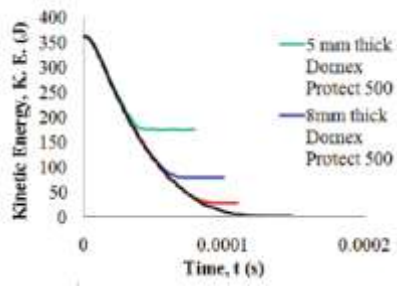
Abstract:

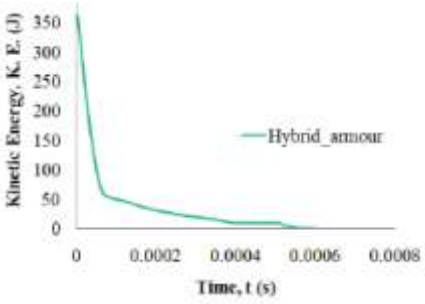
Armours are the ballistic resistant plates which give protection from fast moving bullets, torpedo, missiles, etc. Armour material is selected based on the threat level, weight, cost etc. For bullet proof car body panel, thick steel plate is the most preferred material. To reduce weight of these panels, aramid or carbon fiber reinforced plastic are used along with steel plate. The current project is aimed at evaluating new material configuration with aluminium foam and steel for better protection as well as weight reduction..

FE methodology used for armour protection was validated for both metal and composite panels. Penetration resistance capability at an impact velocity of 400 m/s of bullet was carried out for unarmoured car body panel, a 25 mm thick steel plate and unidirectional and plane woven Carbon Fiber reinforced Plastic (CFRP)/ epoxy and aramid/ epoxy panel with steel. Hybrid armour of four types of material layer was designed and it was simulated to verify penetration resistance. The configurations evaluated are reduced thickness of steel, without aluminium foam, reduced thickness of aluminium foam, only CFRP, only aramid as composite layers. All were verified for penetration resistance.

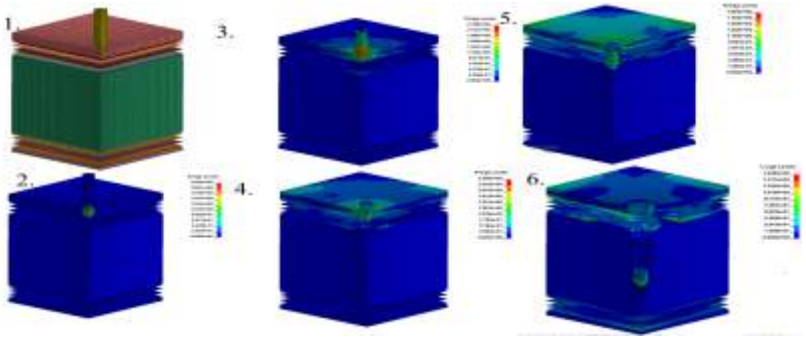
Material configuration in the order of high yield strength material first, then wave spreading material, then energy absorbing material and stopping layer at the end gives better penetration resistance capability compared to any of these individual layers separately. The arrangement of materials and thickness of each layer required depends on the threat level. Foam layer is capable of distributing force to make more participation of next layer in penetration resistance. It was found that a reduction in weight of bulletproof car body panel is possible with hybrid armour structure with steel and aluminium foam, and this also has similar performance as steel for penetration resistance.



Kinetic energy vs. time plot of various thickness of Domex 500 steel



Kinetic energy vs. time plot for hybrid armour



Simulation of penetration behaviour of hybrid armour at 400 m/s velocity