Performance of fish scale-inspired armor under impact loading by different impactor shapes – A numerical investigation

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Abstract 200 – 300 words

Fish scale-inspired armour exhibits numerous advantages over conventional armour plates. The study includes the hybrid scale-tissue design with scales inclined at a certain angle. The fish scale-inspired design had a curved radius of 200 mm, a length of 19 mm, a width of 12 mm and an inclination of 10°. Total size of the specimen measured 80 mm × 80 mm × 10 mm. The acrylonitrile butadiene styrene (ABS) material represented the hard scales, while thermoplastic polyurethane (TPU) mimicked the soft tissue. Low-velocity impact scenarios were investigated using commercially available software LS-Dyna. Scales/ABS were modelled using a plastic kinematic (MAT03) material model, while the tissue/TPU were modelled using plasticity polymer (MAT89). The effect of indenter shape (hemispherical, conical, and flat head) were studied at impact energy and velocity of 100 J and 6 m/s. During the impact process, all the impactors fully perforated the sample. The performance of the specimen was evaluated based on specific energy absorption and damage area. Specific energy absorbed by the conical indenter was the largest, followed by the hemispherical indenter. The bio-inspired specimens resisted the flat indenter early on, while elastic resistance on other indenters gradually increased in the elastic region. The peak force absorbed by the hemispherical, conical, and flat head indenters was 6.1 kN, 5.4 kN and 3.7 kN, respectively. The primary failure modes were shear failure and tensile breaking of the scales. The present study highlighted the effect of indenter shape on impact behaviour on fish-scale inspired design.

Keywords: Bio-inspired design, indenter shape, armor, composite structure