Numerical investigations on 7.62x39 mm projectile ricochet off aramid plates

Marina Seidl*[1], Tom De Vuyst[2], and Nenad Djordjevic[2]

[1]Departement of Protection Technologies, Security and Situational Awareness – French-German research institute of Saint-Louis (ISL), Saint-Louis, France – 5 rue du Général Cassagnou, BP 70034, 68300 SAINT-LOUIS, France

[2]Department of Mechanical and Aerospace Engineering – Brunel University, Granta park, Great Abington, Cambridge, CB21 6AL, United Kingdom

Abstract

Body armour is the only protection a dismounted soldier has against the 7.62x39 mm rifle projectile threat. Upon projectile impact, kinetic energy of the projectile is transformed to deformation work in the armour material and so perforation can be prevented. The dynamic material response upon impact is especially crucial for combat helmets as they need to be light weight for daily usage. Weight limitations challenge helmet manufacturers to make a helmet withstand a direct rifle projectile impact, yet an oblique projectile impact on a helmet has the highest probability. That leads to promote the 7.62x39 mm projectile ricochet off helmets to increase the likelihood of projectile deflection and the survivability of the wearer. Experiments were conducted on projectile impact on plane aramid plates of same material properties as used for manufactured helmets. Further ballistic helmet materials are covered in future research. A projectile is launched at initial velocities from 500 to 700 m/s and obliquity angle of
theta=70 degrees (NATO) where projectile ricochet is observed. The complex nature of the oblique high velocity impact on anisotropic materials make numerical models an important aspect to understand physical dependencies. The modelling approach of Finite Element Method (FEM) and Smooth Particle Hydrodynamics (SPH) is discussed. The FEM model is defined within the LS-DYNA® explicit Lagrangian solver, and the SPH model is calculated in the Meshless Continuum Mechanics (MCM) noncommercial solver. A Johnson-Cook material model and failure criterion describe the projectile. The target plate is represented by a composite damage model.

Keywords: SPH, FEM, LSDYNA, Ricochet, Aramid

*Speaker