Dynamic damping capability of a ballistic foam from characterization to numerical investigation

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Abstract

Soldiers light weight armors are in constant evolution to optimize protection efficiency. In this area, more and more complex simulations are investigated with compound structures including polymeric foam, composite, metal and ceramic. Even if numerical capabilities are in perpetual, knowledge of individual material response in the strain, strain rate regime closed to the threat are a needed. Collecting parameters for Equation Of State (EOS), strength and/or rupture models to provide software models are thus a mandatory to ensure reliable numerical investigations.
Since 2015, THIOT INGENIERIE Shock Physics Laboratory has been selected by the French defense procurement agency DGA-Land Systems to perform materials characterization in three main families of ballistic materials. Parallel to those tasks, in-house simulations done by the dynamic material department have shown very good agreement with validation tests based on the dynamic material characterizations. Coupling experimental works and simulation in the same entity have shown its relevance with ceramic (Abdulhamid & Al, LWAG conference, Grenoble 2016) and an Ultra High Molecular Weight Polyethylene composite (Abdulhamid & Al, DYMAT International meeting, Arcachon, 2018).

This paper presents last part of those experimental investigations on a polymeric foam that is implemented on the soldier's chest. Tests have been done in two phases with dynamic characterization and some ballistic tests to evaluate damping behavior below and up to threat level.

Dynamic characterization has been done on Split Hokinson Pressure Bars (SHPB) and in a reverse plate impact configuration. For the first configuration, tests have been done at strain rates between 420 and 5100 s-1 with and without confined radial conditions and results showed the effects of this confinement on compressive strength versus strain response. The second test, plate impact in a reverse condition, gave shock data for implementation in a shock EOS if needed.

Ballistic tests have been performed on clamped metallic referenced target with 2 different metallic spheres to evaluate the dynamic damping of the foam. Digital Image Correlation (DIC) with an ultrahigh speed camera has been setup at the target back face to measure dynamic deformation and thus evaluate the dynamic damping capability of the polymeric foam at the threat level
In-house numerical works are under investigation and first results are promising.

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