BLAST PRESSURE EFFECTS ON THE HELMET SHELL, HELMET PAD, SKULL AND BRAIN SYSTEM

X. G. Tan, P. Matic

U.S. Naval Research Laboratory, Materials Science and Technology Division - Code 6300, Washington, DC 20375, USA

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Blast pressure transmission into the brain is a complex sequence of events associated with military traumatic brain injuries. Blast pressure transmission generally occurs by a combination of direct exposure of the head, infiltration under a combat helmet and propagation through the combat helmet. Understanding and quantifying how combat helmets, designed primarily for blunt and ballistic impact, affect blast pressure transmission is important for integrating multiple threats into helmet design and optimization.

This presentation discusses a set of computational simulations focusing on helmet pad suspension material, geometry and spacing effects on blast pressure transmission. The simulations are based on a planar test geometry developed at the Naval Research Laboratory to measure and visualize blunt and ballistic impact events. This planar geometry incorporates the helmet shell, helmet pads, cranium surrogate material and brain surrogate material to effectively capture the essential component and system level responses to dynamic events. Simulations of blast exposure, infiltration and propagation events are modeled using the coupled Eulerian-Lagrangian fluid structure interaction (FSI) solver. The shock wave interaction with helmet and head generated by a high explosive is simulated using the computational fluid dynamics (CFD) method. The shock wave loads are applied to the helmet and head finite element (FE) model to simulate the stress wave transmission and capture the mechanical response. Two representations of the brain geometry, one uniform idealization and one featuring characteristic gyri and sulci, are modeled. The results demonstrate the effects of pad size and spacing on the underlying tissue deformation and stresses. These results are reviewed in context with the prior results for blunt and ballistic impacts.