BLAST AMPLIFICATION BY FABRICS: A NEW NUMERICAL FORMULATION

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ABSTRACT

The amplification of blast behind clothing or soft ballistic protection fabrics significantly decreases the survivability of the dismounted soldier exposed to a blast event. The experimental studies conducted since the first reports of this phenomenon in the literature, in 1985, allowed some insight into the physical processes responsible for this pressure increase. Two main phenomena were observed: the partial transmission of the incident shock wave reflecting multiple times between the skin and the fabric, and the decrease of air volume between the fabric and the skin due to the fabric movement leading to strong air compression. Few numerical models were developed in light of those insights. Attempts with fabrics modeled by thin opaque shelters led to overprediction of the pressure amplification, while a better accuracy was obtained with a 3D simulation of the fluid-structure interaction at the fabric stitch level. The latter attempt is however computationally intensive as space steps are small and 3D computation can be too prohibitive to model real-scale configurations.

In the present contribution, a new, local-scale, formulation of the fabric behavior is proposed and implemented in a 1D numerical model: the fabric layer is taken as a partly fluid-transparent movable layer. This formulation allows to reproduce phenomena depicted in the shock-tube experiments, at a low computational cost. After a comparison between experimental and numerical data, the model is used to discuss the blast amplification dependency on parameters such as fabric permeability and weight. The formulation proposed is easily extensible to 2D or 3D simulations and could be used to study realistic blast amplification scenarios.