FRAGMENTATION AND BLAST EFFECTS OF ADDITIVELY MANUFACTURED WARHEADS

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Performance of penetrating warheads is mainly assessed on penetration and blast/fragmentation capabilities. Traditional manufacturing processes/materials limit the design evolution and thus penetrating warhead blast performances. Additive manufacturing could improve warhead performances.

Penetrating warhead design has to deal with two contradictory goals: hard and deep perforation (thick casing) and high blast effects (thin casing). Recent developments of additive manufacturing allowed to create a lattice structure between two thin plates (or shells).

The penetrating capabilities of this kind of warheads have been demonstrated in 2018 [1]. The present works focus on fragmentation and blast effects assessment of lattice-structure based warheads.

The first part of the study consists in the numerical modelling of the fragmentation of lattice structures. Impetus® applied an innovative particle approach to represent both high-explosive and solid casing (lattice structure) using the γ-SPH-ALE formalism [2, 3]. As a meshless method, this method is relatively simple to implement and allows to benefit from GPU parallelization (gain in accuracy and computation time). The first results on the fragmentation of lattice-based warheads revealed promising capabilities in terms of predetermined or controlled fragmentation. Several lattice configurations have been numerically assessed and selected. Then, the structures have been manufactured by MBDA, filled with high explosive and tested in semi-closed cell. The objectives of these tests are to measure the Quasi-Static Pressure (QSP) and observe the fragmentation behavior of the structures by catching the fragments. Comparison between the trials and the numerical simulations has been realized with a very good correlation. The use of lattice structures allows good penetration capabilities and enhanced blast effects in comparison with traditional full casings.

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[1] Limido, J (2018) *Additively manufactured penetrating warheads, DYMAT*
[2] Vila, J. P. (1999) *On Particle Weighted Methods and Smooth Particle Hydrodynamics. Mathematical Models and Methods* in Applied Sciences 09, p. 161-209.
[3] Lanson, N. and Vila, J.P. (2008) *Renormalized Meshfree Schemes I: Consistency, Stability, and Hybrid Methods for Conservation Laws*, SIAM Journal on Numerical Analysis 46, p. 1912-1934.