Impact Analysis and Dynamic Response of a 40mm Sensor Grenade

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Abstract: The Army is developing new grenades with sensors instead of explosives. A grid of 40-mm grenades will be fired from conventional M16 rifles. The projectiles must survive gun launch and impact. After impact, soldiers will get a real-time 'picture' of a local area. Signals from the onboard sensors will be processed on a hand-held computer that captures the activity within the grenade web.

The grenades need to operate after they impact different types of structures. The payload contains sensitive electronics. Due to the nature of the electronics, most of the grenade structure is non-metallic to prevent attenuation of the signals. Impact energy must be absorbed by the ogive/nose section of the projectile. Different designs were evaluated to determine the g-loads exerted on the electronics and the reflected velocity of the grenade. A steel plate was used as the base-line impact structure. Results were compared for crushable polymer foams, crushable metal foams, and collapsible polymer structures. These analyses were completed using ABAQUS Explicit, a general-purpose finite element code. Collapsible polymer structures provided the smallest g-forces to the electronics and the smallest reflected velocities after impact.

Keywords: Grenades, Sensors, Crushable Foam, Damage, Dynamics, Experimental Verification, Failure, Impact, Polymer Structures, Johnson-Cook.

1. Introduction

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The modeling of grenade impact was performed using ABAQUS Explicit v6.8-1 finite element analysis software. The solid geometry originated in Pro/Engineer Wildfire v3.0. The analyses detailed in this paper will show the predicted accelerations at the electronics package induced by the impact event. The most sensitive electronic components contained in the package can withstand a maximum acceleration of 22,500Gs axially without failing. This threshold was determined by separate component testing of the electronics. The developed model is used to evaluate different design concepts and materials and determine resulting accelerations at the printed circuit board (PCB) stack. Ultimately, this model is used as a tool to select satisfactory candidates for fabrication and prototype testing.

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