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Pressure effects in an enclosed volume due to EFP impact

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Explosively Formed Projectiles (EFPs) are large mass, high velocity projectiles capable of penetrating armor even at large stand-off distances. The recent surge in their use against personnel in theatre has lead to a lot of questions regarding their effects on armored vehicles.

The main method of damage from an EFP is by slug itself and secondary debris formed in the penetration process. However, one question that has been raised is whether the perforation of an EFP into an enclosed volume, such as an armored vehicle, can lead to a hazardous or even lethal pressure buildup inside. Through the use of numerical simulations and calculations we have looked at the possible effects that could lead to an increase in pressure.

A standard EFP was designed, modeled and simulated in AUTODYN. The formation and acceleration of the slug was investigated. Simulating the impact of several representative armor thicknesses yielded full perforation of all.

We have identified three possible effects that could increase the pressure inside the space:

- Shockwave from penetrator.
- Shock wave from the detonation products, in the case of a short stand-off distance.
- Displacement and reverberations of the armor plate acting as a piston on the adjacent air.

These effects were investigated separately through numerical simulations. Calculations of the pressure from an oscillating armor plate were done using acoustic theory [1][2]. Pressure-time profiles at several points inside the volume were found in each of the three cases, and by applying the Axelsson model [3] for human injury we were able to calculate injury estimates.

In some cases the maximum pressure peak measured inside the space was significant. However, due to the very short duration of the pressure pulse, the effect of pressure seems to be of little importance.

1. David T. Blackstock: “Fundamentals of physical acoustics”, John Wiley & Sons, Inc., 2000

2. Kinsler, Frey, Coppens, Sanders: “Fundamentals of acoustics, 4th edition”, John Wiley & Sons, Inc., 2000

3. ”Test methodology for Protection of Vehicle Occupants against Anti-vehicular Landmine Effects”, NATO RTO-TR-HFM-090