Numerical Simulation of the Critical Blast Wave of Mines on APV's Crew Members

Alon Brill [1] and Paul A. Du Bois [2]

[1] Netvision

[2]Consulting Engineer, Freiligrathstr. 6, 63071 Offenbach, Germany

Summary:

Blast wave generated by energy released when a mine is detonated, travels through the air at supersonic velocity. Has a high pressure front and hits a vehicle in about 100 μm giving rise to overpressure on it. Blast created by expanding explosion products and air moving behind shock front; results in dynamic pressure on a vehicle. Soil ejecta thrown up when mines are buried in the ground; augment significantly impact of blast wave.
Survivability of military vehicles with respect to mine blast loading has two aspects. First structural survivability must be ensured meaning that the vehicle's armour must not be penetrated and the passenger compartment must remain intact to prevent overpressure resulting from mine explosions acting directly on crew causing primary injury (lung damage, ear drum puncture) there must be no air paths though which it could propagate.
The second aspect is occupant survival which is mainly a function of acceleration levels in the occupant pelvic, spine and head region due to the initial acceleration pulse. To attenuate transmission of stress waves crew seats should be attached to hull sides or roof and incorporate damping materials. To avoid being struck by bulging floor crew's seats should be well above it and their feet should not rest on it but on inner floor spaced from hull bottom plate or on raised foot rests. Reduction can be achieved by designing the vehicle motion due to explosions. The Motion of vehicles due to mine explosions is related not only to their weight but also their size and shape because of the impulse which act on them. Impulse is a function of pressure, angle and time of the blast, the vehicle's projected area and is minimized by the hull being "streamlined" with a V-bottom and no sponsons or wheel wells. Another way to keep acceleration levels low is to use energy absorbing seat systems which come however at substantial cost.

In this study numerical simulation was used to determine the critical mine blast loads in terms of an equivalent charge of TNT for vehicles of different mass. Although many simplifying assumptions were made (such as a rigid vehicle capsule), the simulation allows a fast estimate of the need for energy absorbing seat systems for a given vehicle class under a variety of loading scenarios. The study's conclusions were largely confirmed by a series of full scale experiments that were performed 6 months after the start of the simulation work.