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MULTIPLE EXPLOSIVELY FORMED PENETRATOR (MEFP) WARHEAD TECHNOLOGY DEVELOPMENT

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Over the last few years, U.S. Army TACOM-ARDEC has conducted extensive analyses and tests in Multiple Explosively Formed Penetrator (MEFP) warhead technology. Conventional Explosively Formed Penetrator (EFP) Warheads, like the ones found in systems like SADARM and WAM, form a single rod shaped penetrator, while MEFP warheads form multiple compact ball shaped or ellipsoid shaped penetrators. MEFP warheads will improve the probability of hitting and killing a lightly armored target.
The goal of this paper is to provide an overview of MEFP warhead applications and design. Unlike conventional fragmentation munitions, the shape of each MEFP and the MEFP pattern can be optimized for a specific application or system. Another advantage is that an optimized compact MEFP will provide deeper penetration and longer standoff capability than fragments produced by convention fragmentation munitions. Test data will be presented to demonstrate that it is possible to control MEFP shape and pattern.

BACKGROUND

MEFP Warhead technology was initiated in the 1980's to provide a warhead that could produce many highly effective penetrators for the attack of light materiel targets. Previously, EFP warheads were designed to produce a single rod shaped or ball shaped penetrator for deep armor penetration. With the MEFP warhead concepts, the liner was designed and formed to produce many individual penetrators to attack light materiel area targets. Initial MEFP warhead concepts utilized a steel case, LX-14 explosive billet and a tantalum, iron or copper liner embossed or formed to produce the individual penetrators (Figure 1).

A MEFP liner is basically a conventional EFP liner that produces a shotgun like spray of compact fragments. The MEFPs are formed and projected from the liner after the explosive billet is detonated. Figure 1 shows the basic components of a typical MEFP warhead; liner, housing, retaining ring, detonator and booster.

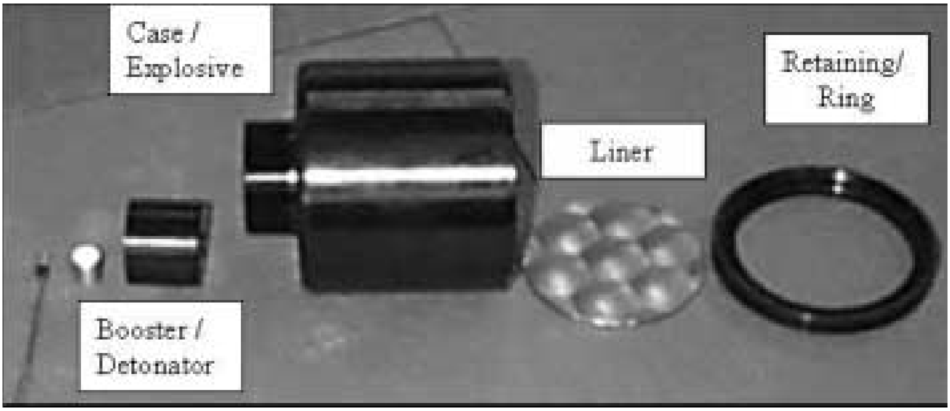

Figure 1: Cylindrical MEFP Warhead.

With the advent of the MEFP warhead concept, designs were investigated for a variety of weapon systems. Warheads were analyzed and tested for use in mine clearing, various demolition devices for defeat of diesel fuel drums and light armor.

Penetrator shapes including strips, spheroids, ellipsoids, and rods have been designed and tested for various applications (Figure 2). Penetrator weights from 5 to 50 grams have been provided in various warhead designs with velocities of .5 to 2.5 km/sec. Penetrator spray patterns of various sizes and shapes have also been demonstrated by liner design changes to provide focused or directional patterns.

An extensive test database has been produced to verify performance at standoffs from .25 to 100 meters against armor and light materiel targets.

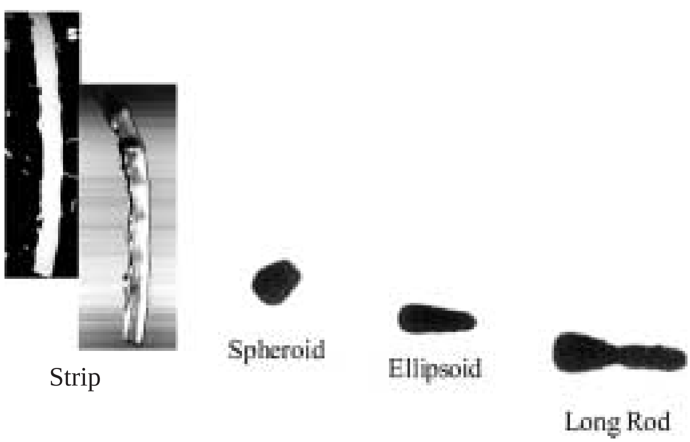

Figure 2: MEFP shapes.

MODELING

A modeling capability has been demonstrated to predict penetrator formation, MEFP pattern coverage and MEFP interaction with the target. Both Lagrangian and Eulerian hydrocodes have been used to predict the MEFP warhead penetrator characteristics. Figure 3 shows typical warhead models for cylindrical, triangular and rectangular shaped designs. These models have shown excellent agreement with test results for the designs tested. Figure 4 shows the correlation of the simulation verses test results for three cylindrical warheads designed to produce 10, 17, 25 gram penetrator patterns. It can be noted that a few of the test penetrators were prevented from reaching the target due to impacts with the test fixture. Figure 5 shows excellent correlation of the pattern simulation verses test results for a rectangular warhead design.

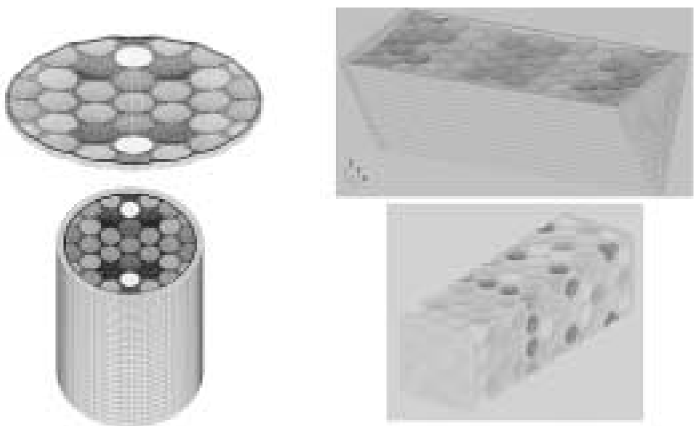

Figure 3: MEFP warhead models.

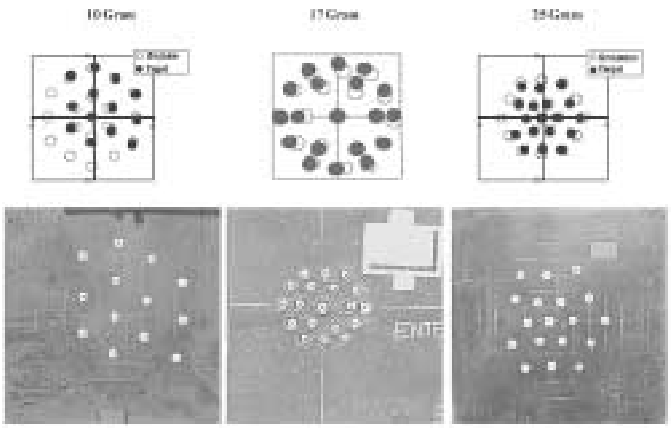

Figure 4: Penetrator patterns (simulation vs. test).

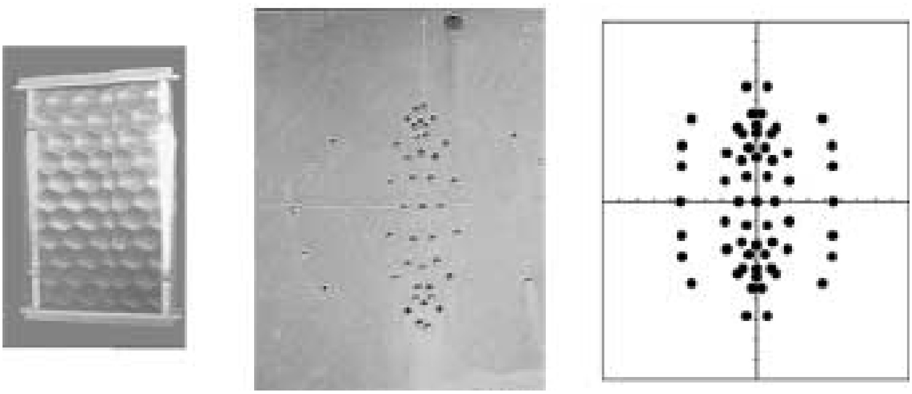

Figure 5: Penetrator patterns (simulation vs. test).

DESIGN

MEFP liners have been fabricated using tantalum, iron or copper. A hexagon pattern is imparted on the liner to produce the individual penetrators. Design tools were developed to control the size of the MEFP (as shown in Figure 6), control the shape of the MEFPs (as shown in Figure 4) and also to control the MEFP pattern (as shown in Figure 7). The MEFP quantity, size, mass and pattern can be adjusted to optimize the warhead's lethality for application in a particular munition. Figure 6 also shows the modeling simulations compared to the actual test flash X-rays for three specific designs. Figure 7 shows that the penetrator area coverage can be controlled and predicted as shown in three specific warhead tests.

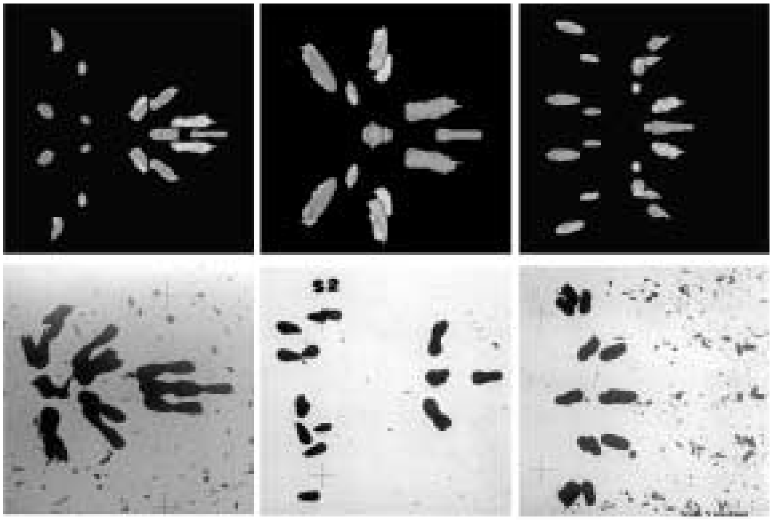

Figure 6: Penetrator shape comparison (simulation vs. test X-ray).

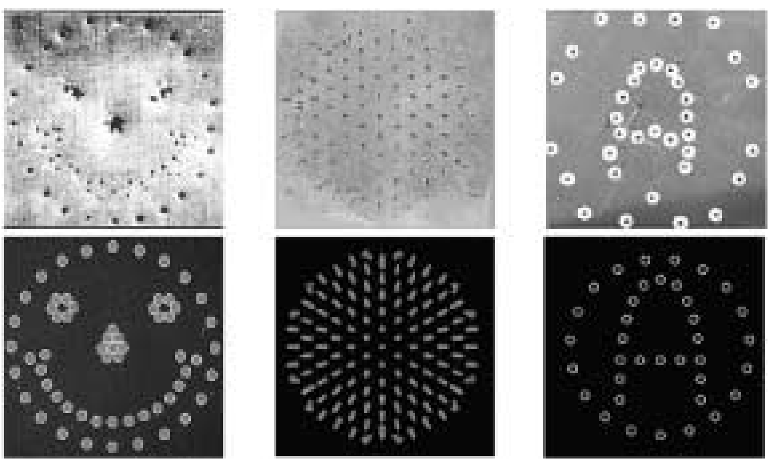

Figure 7: Penetrator pattern control (simulation vs. test).

APPLICATIONS

MEFP warhead technology has been applied to many different systems to attack a variety of targets. Primary targets including various thicknesses of armor and steel up to 1 inch thick have been penetrated at standoffs up to 100 meters. Other targets have included diesel fuel drums and mine fields.

CONCLUSIONS

MEFP warhead technology has advanced to produce many new and novel applications for attack of critical targets. Computer models have been established to design and evaluate MEFP warhead lethality, achieving good predictions of MEFP formation and pattern coverage. Promising MEFP warhead concepts are being pursued and evaluated for the SADARM, WAM and other systems.