A NUMERICAL STUDY ON VALIDITY OF THE SPHERICAL APPROXIMATION OF BLAST FROM CYLINDRICAL CHARGES

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It is apparently widely held that the blast wave from a cylindrical charge is indistinguishable from that of a spherical charge of the same mass at distances greater than “a few charge radii”. We have undertaken a series of high resolution calculations to examine the quantitative differences between such spherical and cylindrical charges. All charges in this study are bare charges with no case material.

In previous experiments with axially detonated L/D=1 cylindrical charges with hemispherical caps the shock front was not spherical to pressures of less than 0.1 bars. In this paper we demonstrate that there are significant differences between blast waves from a sphere and from center detonated cylindrical charges. To demonstrate the differences in blast waves for weapon geometries, the blast wave produced from a spherical charge is compared to the blast wave from cylindrical charges with a variety length to diameter ratios.

The results of high resolution calculations of the detonation and blast wave propagation from a one kilogram charge are compared. In the first case the charge is a sphere of C-4, center detonated with a small cylindrical detonator. The results of this calculation are examined for spherical symmetry and are compared to the TNT blast standard (ANSI standard: ANSI/ASA S2.20-1983 (R2011)) with an enhanced energy release to account for the more energetic C-4 material.

Monitoring stations were placed every 5 cm along radials spaced 5 degrees from vertically down (-90 degrees) to vertically up (+90 degrees). For the spherical charge we show that at a range of 40 charge radii the monitoring stations report similar values for overpressure and time of arrival and show the spherical expansion is symmetric. This, however, is not the case for the cylindrical charges. The overpressure and time of arrival reported at the same range as the spherical case are not symmetric and can never reach symmetry. At that distance the shock velocities are approaching the ambient sound speed and therefore the time difference will continue to grow at all ranges beyond 40 charge radii because the overpressure is higher (as is the propagation velocity) in the direction of the earlier time of arrival.

The conclusion from this study is that the blast wave from a cylindrical charge, even with an L/D of 1, can never be equal to or even approximately that of a sphere which could have implications on assessments of weapon performance and effectiveness.