ON THE CALCULATION OF TNT EQUIVALENT FOR CYLINDRICAL-SHAPE CHARGES OF HIGH EXPLOSIVES

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Abstract: The problem of TNT equivalent calculations for cylindrical-shape charges of high explosives with the length-to-radius (L/R) ratios $L/R = 2$, 3, and 4 is considered. The numerical simulations by Ansys Autodyn and GDT codes of shock wave propagation from ground explosions of cylindrical-shape charges were performed. As a result, analytical formulae for overpressures as functions of the reduced distances R' are obtained. It is shown that the TNT equivalent of cylindrical-shape charges are variable and decrease monotonically from 2 to 0.8 with the distance from the explosion center. The calculation errors at different mesh densities are estimated. The optimal sizes of a calculation cell for different peak pressure values of the air shock wave are determined, which ensure a sufficient accuracy of calculations.

Keywords: TNT equivalent; overpressure at air shock front; spherical charges, cylindrical charges; measurement error; numerical simulation

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Figure Captions

Figure 1 The error curves for the pressure values obtained in calculations for spherical charges. Ansys Autodyn: *1* — 100 elements per charge radius; *2* — 50; *3* — 25; and *4* — 15 elements. GDT: *5* — 25 elements; and *6* —15 elements per charge radius

Figure 2 Calculation results at different mesh densities in comparison with Sadovsky formula. The scaled cell size $\Delta R'$: *1* — $2 \cdot 10^{-3}$ m/kg$^{1/3}$; *2* — $1 \cdot 10^{-3}$; *3* — $5 \cdot 10^{-4}$ m/kg$^{1/3}$; *4* — [5]; and *5* — Sadovsky formula

Figure 3 The fields of pressure (*a*) and detonation products (*b*) for the explosion of a cylindrical charge with $L/R = 2$ at the end of the first stage of calculation

Figure 4 The field of pressure for the explosion of the cylindrical charge with $L/R = 2$ and $R' = 1.5$ after the "remap" procedure. Time moment — 1 ms

Figure 5 Calculated data for a cylindrical charge with $L/R = 2$ (*1*), approximating function (*2*), and Sadovsky formula (*3*)

Figure 6 Shock overpressure vs. scaled distance: *1* — Sadovsky formula; *2* — $L/R = 2$; *3* — 3; *4* — 4; *5* — 2 [5]; and *6* — $L/R = 1$ [6]

Figure 7 The value of the TNT equivalent for the cylindrical charge with $L/R = 2$ calculated using Sadovsky formula as a function of the scaled distance R'

Table Captions

Table 1 Computational cell sizes required for the calculation of air shock pressure with an error below 2% in different zones of the computational domain

Table 2 Coefficients in formulae (1) and (2) obtained for cylindrical charges with different length-to-radius ratios

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