

"THE EFFECT OF EXPLOSIVE TYPE AND DELAY BETWEEN ROWS ON FRAGMENTATION"

Mark S. Stagg, Civil engineer
Stephen A. Rhol, Research physicist
Rolfe E. Otterness, Mechanical engineer

Twin Cities Research Center
Bureau of Mines
Minneapolis, MN.

ABSTRACT

The Bureau of Mines fired seven test blasts in a 22-ft bench of limestone, screening the material to investigate the influence of explosive type and between row delays on fragmentation. Four 4-hole, single-row test shots were conducted evaluating dynamite, ANFO, emulsion, and a 60-40 emulsion-ANFO mix. Three 12-hole shots, with three rows of 4-holes, evaluated delays between rows of 24, 36, and 120 ms. Accurate in-hole electronic delays were used, firing within 1.5-ms of the nominal delay. All seven shots had a 6- to 7-ft burden, 10-ft spacing, with a hole diameter of 3-1/2 in fired on a 12-ms delay between holes in the row. The tests were instrumented with strain gauges grouted in the burden region examining stress wave and gas pressure effects. Fiber optic probes were used to confirm timing and to obtain detonation velocities.

The type of explosive had little effect on the coarse size, +4-in material. A slight reduction in the amount of finer size, -4-in material, did result when the explosive charge was decoupled. The effect of delays between rows was minimal, influencing only the breakup of a massive 2-ft bed located in the stemming region. Strain data were similar to data previously reported suggesting fracturing between holes in a row occurred from both stress wave and gas pressure effects.