EVALUATION OF FRAGMENT SIZE DISTRIBUTIONS FOR OVERLOADED CONSTRUCTION FACADES: EXPERIMENTS AND DATA COLLECTION

K. Marchand[1], M. Sanai[2], G. Rolater[1]

[1]Protection Engineering Consultants, 1100 NW Loop 410, Suite 300, San Antonio, TX, 78213, USA; [2]SRI International, 333 Ravenswood Ave., Menlo Park, CA 94025, USA

Key words : Airblast, Debris, Distributions, Fracture, Shock Tubes,

Building facades can be a source of collateral damage through fragmentation. To evaluate the threat posed by facade fragments, an understanding of the size distribution and momentum of fragments is required. Protection Engineering Consultants, DTRA and SRi scientists and engineers have provided insight in this area using sophisticated experimental and statistical analyses methods.

Airblast loads can result in fragmentation in several size regimes, depending on the significance of the overpressure and the impulse duration of the event. Immediate loading of structural components at very high overpressures will result in fragmentation at the material level. In contrast, at lower overpressures sustained over longer durations, fragmentation due to excessive structural (flexure and shear) deformations is more likely.

For material-level fragmentation, a series (31 tests) of small shock tube tests were conducted. For structural-level fragmentation, 9 tests were conducted in a large diameter shock tube. In both series, the fragmentation behavior of concrete, glass, concrete masonry, brick and clay tile was investigated. In the small shock tube setup, square specimens were placed at the end of a shock tube simply supported by a plate with a circular opening. In the large shock tube setup, square structural scale specimens were investigated. After fracture of the specimens, fragments were retained through the use of a catcher system and videographic analysis was used for in-flight velocity and mass measurement of fragments.

Collected fragments were first run through physical sieves and grouped by size. Following this, sophisticated scanning and image identification software was used to provide fragment counts and areas; information which was used to extrapolate mass data for individual fragments. Video analysis of fragments was done in two ways. In the first, side-view high-speed video was analyzed with PEC's Frag Trak software to capture fragment sizes and velocities. In the second, rear high-speed videography and analysis was performed in selected tests. In this approach, selected frames were analyzed using the scanning software. Frames were pre-processed to subtract the background and outline the fragments monochromatically.

This paper presents an overview of the experimental techniques, a summary of results, and successes and failures in the testing and data collection. This data supported subsequent data analysis and distribution predictions.