EVALUATION OF FRAGMENT SIZE DISTRIBUTIONS FOR OVERLOADED CONSTRUCTION FACADES: DATA ANALYSIS AND DISTRIBUTION PREDICTION

K. Marchand[1], G. Rolater[1], E. O'Hare[1]

[1]*Protection Engineering Consultants, 1100 NW Loop 410, Suite 300, San Antonio, TX, 78213, 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.

Using the information derived from experiments on fragment size and velocity collected as discussed above and in a related paper, cumulative distributions of fragment mass and velocity were formed and normalized by average values. Following this, probability density functions (PDFs) and cumulative distribution functions (CDFs) were fit to the normalized data. Overall, Weibull and power law distributions produced the best fits.

Using the experimental data and distributions as a basis, a probabilistic, physics-based model was developed through the use of numerically based metamodels to represent the mass distribution of glass and concrete façade types. Both spandrel and structural concrete panels were investigated. LS-DYNA was used to develop and analyze panels models.

LS-DYNA model validation using the experimental results was first performed. Next, a parametric study, utilizing validated panel models, was performed to determine the effects of varying significant panel properties on fragment mass distribution. A numerical fragment tracking algorithm was then used as a post-processing tool to determine final fragment count and mass for each parametric model. Finally, fragment results were used to develop mass distributions for comparison to experimental data and for use in metamodel development.

To develop mass distribution metamodels, a Central Composite Design (CCD) was performed, by which the influence of variable input parameters to output responses could be examined and subsequent relationships determined. Variables included load, and geometric and material parameters of interest, which were investigated between predetermined limits based on common constructions practices and criterion.

This paper presents some simplified response equations derived from the work described above.