DESIGN OF PROTECTIVE ENTRANCES

Joseph D. Baum[1], Fumiya Togashi[1], Orlando L. Soto[1] and Rainald Lohner[2]

[1]SAIC, 1710 SAIC Drive, McLean, VA 22102, USA
[2]George Mason University, Fairfax, VA 22030, USA

Key words: Blast wave propagation, Numerical design, Shock-structure Interaction

Over the past two decades several significant resources were expanded on designing, testing, codifying and implementing blast resistant walls, columns, glass, windows, doors, etc. Blast walls have sprung around several US Government facilities around the world. While properly designed and installed blast walls can withstand significant blast and fragment loads, the entry points, even when equipped with blast-resistance doors, would likely fail at lower pressures and impulse loads. The design challenge posed was: is it possible to design an enclosed structure (portico) that will reduce entry doorway loads to acceptable (below a critical) values.

The initial design examined several types of blast walls. Results of 3-D numerical simulations using FEFLO showed significant peak pressure and impulse value reductions. Nevertheless, these exceeded design criteria. Next we examined enclosed entrances composed of angled corridors, with angles varying from 45^o to 90^o. These designs failed to deliver: while the incident shock values were significantly reduced, the reflected shocks from the walls that entered the corridor, produced loads exceeded acceptable levels. After examination of the flow patterns observed in some of these simulations we concluded that proper design must achieve:

a. Minimize the amount of energy entering the portico (in early as well as late time) while allowing a nominal corridor width of 4 ft (an appropriate value for an average person);
b. Accelerate the entering shocks past the entry doorway to minimize diffracted shock loading;
c. Angle the entry path with respect to the doorway, to maximize wave diffraction angle;
d. Accelerate and maximize the mass flux exiting the portico, without resorting to mechanical devices or actuated valves;
e. Minimize repeated shock wave recirculation in the portico.

Based on these principles we came up with a design. We validated this design for several blast wave diffraction scenarios, for various charges placed at different angles with respect to the entryway. The design has shown to reduce blast and impulse loading significantly (close to an order-of-magnitude), while still enabling access through the entryway.

Details of the design considerations, and numerical validation for several scenarios, will be presented in the final paper.