EXPERIMENTAL AND NUMERICAL INVESTIGATION OF SHOCK DIFFRACTION ABOUT BLAST WALLS

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This paper describes a combined experimental and numerical research effort directed at understanding blast wave diffraction about protective blast walls. The ultimate objective of this study is to optimize the construction of blast walls protecting civilian buildings against terrorist attacks. This optimization process must address several complex physical mechanisms. Prime among these are the blast wave diffraction past the blast wall, wave reflection from the ground and the formation of a Mach stem with an increased pressure loading, and the eventual downstream transition of the Mach stem to a regular reflection (shock recovery). This process depends on several parameters, such as explosive charge weight, shape and height-of-burst, wall height and thickness, and the distances between the charge and the wall and the wall to the target.

A series of small scaled tests (1:91.lratio) was recently conducted at the Ernst Mach Institute (EMI), Freiburg, Germany. These tests investigated blast wave diffraction dependence on charge size, and the distances between the charge and the wall, and the wall to the target. Another objective of these sub-scale tests was to obtain data using both pressure measurements and advanced optical methods, to allow comparison with planned large scale tests, where only pressure measurements and advanced numerical predictions will be available. Six pressure transducers were used at each test to provide the quantitative loading, while a sequence of shadowgraphs taken at intervals of 15 to 20 microseconds using a Cranz-Schardin camera, helped in understanding the dominant physical mechanisms and provide direct comparison to those predicted by the hydrocodes.

A complimentary numerical study was recently conducted, using the FEFL098 methodology that solves the time-dependent, compressible Euler equations. Two versions of FEFL098 were applied: the adaptive 2-D axisymmetric and the adaptive 3-D codes. Comparison between the experimental shadowgraphs and the predicted density contours at several times demonstrate that both codes predict the dominant physical mechanisms accurately. Finally, comparison of measured and predicted pressure and impulse data at three locations demonstrates very good agreement in terms of shock arrival time, peak pressure, and pressure and impulse wave amplitude growth and decay (i.e., wave harmonic content). These results indicate that if the primary interest is the initial peak pressure and impulse values on the target, the 2-D axisymmetric code yields accurate, quick, and inexpensive predictions.