ACCURACY OF CFD PREDICTIONS FOR EXPLOSIVE FAR FIELDS

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Unexploded bombs from WWII are still frequently found on construction sites in many German cities. EOD work in such cases requires to evacuate all inhabited buildings exposed to explosive risks. Traditionally the extent of the evacuation zone is assessed by conservative empirical formulae as a function of the explosive mass of the bomb without consideration of the effects of the actual environment. Due to shock wave attenuation or focusing around buildings or uneven terrain the reach of the explosion may however at least locally differ significantly from the circular perimeter established by the simple formulae. CFD methods may provide better estimates, particularly when a digital city model is available, which can be conveniently used to set up a realistic computational model.

For CFD-based predictions to be actually considered in EOD work it is important to know the accuracy of these predictions. In this context the far field of the explosion is of utmost importance, as it determines the extent of the endangered area. Shattering of window panes may occur at pressure amplitudes down to about one kPa which are reached (in free field) at Hopkinson-scaled distances of above about 25 m/kg$^{1/3}$.

In the presented investigation we have therefore evaluated the evolution of the relative errors of overpressure amplitudes and maximum overpressure impulses with distance in the range between 5 m/kg$^{1/3}$ and 30 m/kg$^{1/3}$ in 3D free field computations. The relative errors were determined through comparison with grid-converged 1D computations in spherical symmetry. The dependencies of the error on the spatial resolution and on the orientation in the Cartesian grid have been analyzed for the APOLLO Blastsimulator and for ANSYS Autodyn. The importance of the choice of the flux limiter in the numerical scheme for the accuracy of the far field predictions is demonstrated by comparing results obtained for different limiters. Based on the findings from this study a 3D coupled limiter is suggested which improves the grid isotropy of the overpressure predictions and maintains an almost constant relative error with distance. The presently achievable accuracy of the far field predictions for an explosion in an urban environment is evaluated by means of a grid convergence study for a representative case.