MODELLING LOADING AND BREAK-UP OF RC STRUCTURE DUE TO INTERNAL EXPLOSION OF FRAGMENTING SHELLS

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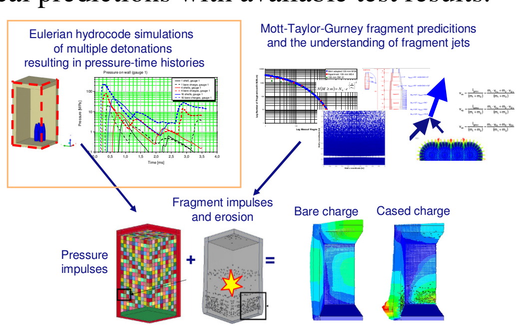
The Klotz Group, an international group of experts on explosion safety, investigates the debris throw hazard associated with the accidental detonation of ammunition in reinforced concrete structures. Experiments are combined with engineering models but also with results of advanced computational modeling, which is the topic of this paper. EMI and TNO are establishing a sophisticated three step approach to analyze the explosion phenomena of single and multiple bare and cased charges in a RC-structure. In the first step the blast loading and gas pressure is modeled including the venting process. The cubicle RC structure was modeled in 3D to capture the correct structural failure mode and venting process, from the coupled fluid-structure interaction simulations. The second step consists of fragment trajectory predictions using fragmentation matrices based on arena test data together with hydrocode simulations for deeper understanding the fragment jetting effects. The predicted blast and fragment loads are the input for the third step on the dynamic response and break-up of the structure. In this step the structure was modeled in more detail than in step 1 in order to capture the local failure phenomena and final break-up as good as possible.

The approach was applied on a series of explosion tests with cased and uncased charges. The simulations predicted higher velocities, higher kinetic and higher internal energy for the bare charge tests, while the impulse at the wall is higher for the shell tests. The predicted debris launch conditions are in good agreement with the test results, which exhibited clear differences for the bare and the cased charges. Evidently, the spatial and temporal load distributions have a significant effect on the failure of the structure. The simulations provide the info to interpret the test data correctly.
The results of this three step approach are promising in spite of the fact that the currently available commercial codes and numerical (material) models can hardly deal with the extreme conditions of explosive loading and full break-up of the RC structure. In the paper we will present and discuss the computational strategy and the comparison of numerical predictions with available test results.



Three step KG-simulation approach