NUMERICAL MODELLING OF REINFORCED CONCRETE COLUMNS SUBJECTED TO CLOSE-IN EXPLOSIONS

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ABSTRACT

Buildings in the public transport sector, such as railway stations or airport terminals, are potential targets for terrorist attacks. The structural consequences highly depend on the robustness and redundancy of the structure, where a progressive collapse is the doom scenario. Critical load effects may particularly occur when an explosive detonates nearby important structural members. In this study, the response of reinforced concrete (RC) columns in existing buildings subjected to a close-in explosion is investigated, in order to develop mitigation measures. One crucial step is to gain a proper understanding of the damage caused by a close-in explosion to bare and protected RC columns. This is obtained through a combined experimental and numerical investigation. Experimental tests were performed where a high-explosive charge is placed above a simply supported RC square column. This test shows that the column is heavily damaged near the charge location while at both ends, the column is mostly intact. Numerical calculations were performed using LS-DYNA, simulating the detonation and column response, where the RC column was modelled with Lagrangian elements and the surrounding fluids (detonation products and air) were modelled with Eulerian elements. Full coupling between the structure and fluid was employed. One of the tests was used to validate the finite element modelling approach. Comparison of the damage in the column reveals a good resemblance with the experiment in terms of the location, size and shape of the damaged concrete zone. Subsequently, a part of an existing structure was modelled following the validated numerical approach. This model consisted of the attacked column, a protective jacket and substructure parts like floors and an underlying column including its column head. The protective jacket proved to keep the damage to the attacked column limited, but significant damage to the substructure was obtained, indicating that additional measures were needed. Different mitigation measures were considered and prediction of the damage reduction were investigated through further numerical simulations.