GENERATION OF A NEW LOADING ALGORITHM FOR FRAMED STRUCTURES FROM HIGH FIDELITY CFD SIMULATIONS

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Abstract:

Following large-scale explosive events, such as those that can result from industrial accidents, an ability to estimate the charge mass involved in the incident is crucial for understanding the cause of the explosion and informing emergency response planning. One way this can be approached is through the use of an inverse, or reverse engineering, method that can be employed to estimate a charge mass based on structural damage observations. Application of this type of method often requires a means of modelling the physical behaviour of the blast and building response. Previous validation studies have explored such a method using semi-empirical techniques to estimate the blast loading and fast-running non-linear single degree of freedom models to predict the subsequent structural response. When compared against data from the 2020 Beirut Port explosion, these studies resulted in an over-estimation of the charge mass, likely due to an under-prediction of the blast loading.

In order to improve the blast loading estimations, an iterative numerical study approximating the loading on a single-storey steel framed structure in Beirut was conducted using the CFD code blastFoam. Blast pressures acting on the structure were recorded and used to construct a new fast-running low-fidelity algorithm. When compared to the CFD output, the prediction of impulse and subsequent structural response using the new algorithm increased over that predicted in the previous studies. This resulted in an improvement in the charge mass estimation from 2.61kT to 0.49kT, which now falls within the accepted range from literature of 0.1kT < charge mass < 1kT. The new loading algorithm was subsequently tested on an arbitrary multi-storey reinforced concrete framed structure, showing similar results.

This paper presents the findings of this study, in addition to discussions on limitations of, and improvements to, the loading algorithm.