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Establishing a predictive method for blast induced masonry debris distribution using experimental and numerical methods

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Abstract

When subjected to blast loading, fragments ejected by concrete or masonry structures present a number of potential hazards. Airborne fragments pose a high risk of injury and secondary damage, with the resulting debris field causing major obstructions. The capability to predict the spatial distribution of debris of any structure as a function of parameterised blast loads will offer vital assistance to both emergency response and search and rescue operations and aid improvement of preventative measures. This paper proposes a new method to predict the debris distribution produced by masonry structures which are impacted by blast. It is proposed that describing structural geometry as an array of simple modular panels, the overall debris distribution can be predicted based on the distribution of each individual panel. Two experimental trials using 41kg TNT equivalent charges, which subjected a total of nine small masonry structures to blast loading, were used to benchmark a computational modelling routine using the Applied Element Method (AEM). The computational spatial distribution presented good agreement with the experimental trials, closely matching breakage patterns, initial fragmentation and ground impact fragmentation. The collapse mechanisms were unpredictable due to the relatively low transmitted impulse; however, the debris distributions produced by AEM models with matching collapse mechanisms showed good agreement with the experimental trials.

Keywords: blast, modular, masonry, fragmentation, debris, applied element method

1. Introduction

A blast wave is caused by the propagation of a high amplitude shock discontinuity, resulting from physical or chemical detonations [1]. The interaction of blast waves with structures can lead to high levels of structural damage, failure of internal systems, secondary fire, structural collapse, obstructing debris and potentially fatal injury to any occupants [2]. Much research has been conducted into the effects of blast loading and

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