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Editorial

Special Issue on Explosion Effects in the Built Environment

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Over the last two decades, highly publicized disasters caused by explosions have become an all too frequent occurrence. The threat to the built environment and human life from explosions is an unfortunate aspect of modern life, whether these events arise from military activities, terrorist attacks, or industrial accidents. The effects of explosions resonate far beyond the immediate incident and its catastrophic damage. Explosions cause massive economic hardship and environmental damage and put pressure on health systems, communications, transportation, and other systems on which modern societies rely. They can disrupt the ability of national governments to care for their people, resulting in considerable political upheaval and even causing regime changes.

This Special Issue has collected papers considering the effects of explosions, covering the event chain from the explosion to downstream harm in the built environment. How is the explosion output influenced by the built environment in which it occurs? Generally, these contributions cover the quantification of loads from air and buried charge explosions, the combined effects of high shock pressures and fragmentation, the structural response to explosions, the specific nature of explosions in urban areas, and the analysis of features designed to protect others from harm caused by explosions.

Ratcliff et al. [1] thoughtfully reviews the current state-of-the-art in blast engineering and identify common ways that shock propagation in urban areas is described, as well as discussing areas of disagreement among researchers that need addressing in the future. The importance of carefully controlled and representative experimental and numerical simulation tools, especially on a smaller scale for improved fidelity and cost-effectiveness, are highlighted as key areas for future development. These better methodologies could significantly advance the prediction, mitigation, and response to explosive events in cityscapes in the future. Gabriel et al. [2] present experimental and modeling work on urban blast loads and addresses the issue of scaling, showing the potential of inter-scaling between idealized lab-scale experiments involving a few grams of plastic explosive to larger-scale outdoor field trials conducted using TNT.

Real-world explosions are often not just air-blast events but involve the detonations of encased explosives or explosives buried within another medium. Atoui et al. [3,4] conducted two studies into the influence of air-blast loading and their projectile impact. In the first study [3], impact and blast are applied separately, showing that regions of plates with impact perforations rupture more readily under blast loading. The second study [4] is able to capture the essential features of a shrapnel bomb at the laboratory scale by detonating C4 with embedded ball bearings, producing controllable combined blast and fragment loading on a downstream target plate. These experiments were modeled to gain further insights into combined blast and projectile impact loads, extending the dataset beyond the experimental range. Both approaches represent laboratory versions of potential real-world explosions in the built environment.

Lodge et al. [5] present results that quantify the influence of soil mineralogy on the impulse produced from a shallowly buried charge detonated below ground: a common hazard in many conflict regions or those with a historical legacy of buried landmines to address this. This work shows the importance of soil conditions on the loading and the difficulties that some of the existing models have in predicting the effects in quartz-based

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and carbonate sand (compared to the assumed traditional Leighton Buzzard soil used in many Western world studies).

Yankelevsky et al. [6] and Flores et al. [7] study the damage inflicted on flat panels when subjected to impulsive loads. Reinforced concrete slabs were studied numerically, using Autodyn [6], to appreciate the reason why dynamic shear failures occur under impulsive loads. The failure modes exhibited by the slabs under static loads are different from those exhibited by slabs under impulsive loads, calling into question the relevance of static-loading-based structural analyses for the built environment in which explosive events may be a potential threat. Shear failures are also of concern to Flores [7] for cross-laminated timber (CLT) panels [7]. They report on a novel way to test CLT panels under impulsive loads and evaluate their post-test residual strength. However, the results suggest that shear failures were related to the laboratory four-point loading condition, as similar shear failures have not been observed in explosive detonations. This underlines the importance of the representative experimental and numerical simulations described in [1] and highlights the difficulty of achieving this under laboratory conditions.

Protection systems are the topic of interest in the remaining contributions [8,9]. Shekhar et al. [8] report results from an experimental and computational study on the influence of geometric features on the damage and impulse transfer of scaled steel V-structures under blast loading. Similar full-scale V-structures are used on the underside of most mine-resistant ambush-protected vehicles used in conflict and peace-keeping regions across the globe. These findings highlight the importance of bend radius at the apex of the V-structure, with lower radii reducing the impulse transfer and increasing the rupture threshold of the V-structure, both with favorable outcomes. Leon et al. [9] analyzed the loading that could ensue from a fire in a pyrotechnic storage facility (such as a fireworks factory or market). Such accidents are not unheard of, and their work shows how safety tests conducted without consideration of the explosion overpressure can be a dangerous approach to evaluating the risk such incidents pose. Their work also analyses various extinguishing agents, making recommendations for the most appropriate ones for use in the design and regulation of these storage facilities.

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