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Cranfield University Centre of Excellence in Counter-Terrorism

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Abstract. The formation of Cranfield University's Counter-Terrorism Centre of Excellence was announced in late summer 2017. It has been established in conjunction with Pool Re, a mutual reinsurer which underwrites over £2 trillion of exposure to terrorism risk in the UK. The centre will provide thought leadership in catastrophic and unconventional terrorism loss assessment and mitigation so as to improve the UK's economic resilience.

We introduce the reinsurance industry for a technical audience to explain the rationale for the Counter-Terrorism Centre of Excellence. The centre's aims and some results from preliminary simulations on explosive blast in a complex city centre performed in collaboration with reinsurance broker Guy Carpenter are presented. The prospects for physics-based simulation, for terrorist insurance loss-estimation and encouraging mitigation in reinsurance are outlined.

Keywords: Counter-Terrorism, CBRNE Centres of Excellence Activities, Software and Tools for Safety & Security, Economical issues related to CBRNE, Modelling and Simulation.

1 Introduction

Readers will be familiar with insurance in which a policyholder pays a sum of money (a premium) to an insurer in order to be compensated should the policyholder suffer specified losses. CBRNE terrorism insurance is not available for households in the UK, but is provided for businesses to ensure their confidence to invest. Large losses associated with, for example, extreme weather events, earthquakes, and terrorism, have spurred the development of reinsurance [1], which may be thought of as insurance for the insurer. In Sec. 2 we further describe reinsurance and how the pool system for terrorism reinsurance was developed in the UK following the 1993 Bishopsgate bombing, leading to the formation of Pool Re [2]. Pool Re is now funding the development of the interdisciplinary Cranfield University Counter-Terrorism Centre of Excellence as described in Sec. 3. Preliminary work on blast loading from explosive events is presented

in Sec. 4, and Sec. **Error! Reference source not found.** outlines how such loading will be used in insurance loss estimation.

2 Reinsurance and Terrorism Reinsurance

An insurer seeks a reinsurer in order to share the risk associated with a policy or set of policies when potential losses would bankrupt, or severely deplete the reserves of, the insurer. For a premium, the reinsurer contracts to cover losses on the primary insurer's policy that are in excess of a lower limit (the retention), and up to a specified loss limit [1]. Reinsurance is available in the UK for many risks, but we consider the building and business continuity risks associated with large scale terror attacks.

2.1 Pool Re - Pool Reinsurance for UK Terrorism

Following the 1993 Bishopsgate bombing, which resulted in one dead, 44 injured and £0.35 billion (bn) in damage, reinsurers stopped providing terrorism cover causing businesses to question their future viability in the UK. The UK Government intervened and set up a pool system named Pool Re [2] to own the risk from large terrorism losses.

The Pool Re scheme provides reinsurance for terrorism losses beyond a market retention limit. Initially, only cover for explosive and fire risk was provided. CBRN cover was added in 2003 and presently provision of cyber-terrorism cover is being considered. Following Pool Re's success, ten or more similar schemes have been created worldwide [3].

The Members (insurers) of the Pool Re scheme cede premium to Pool Re in respect of the cover they provide. As of December 2016, these premiums have accrued to give Pool Re funds of £6.3 bn. The market retention limit for members is £0.15 bn. Losses beyond this are successively covered by the following:

1. £0.5 bn of Pool Re funds;
2. £2 bn from international reinsurers (known as *retrocessional reinsurance*), negotiated by Guy Carpenter on behalf of Pool Re; and
3. A further £5.8 bn of Pool Re funds.

This amounts to £8.45 bn of scheme resilience. Annually Pool Re pays premium to UK's Her Majesty's Treasury, which is recallable should losses exceed Pool Re's funds. If losses exhaust its reserves, Pool Re would draw further funds from the UK government to meet its obligations.

Pool Re is seeking ways to reduce and mitigate terrorism risk: events are held to inform reinsurers of changes in risk; research is funded at Cambridge Judge Business School on cyber security and at Cranfield University on CBRNE models (e.g., see Sec. 4); and Pool Re and Cranfield University are creating a Counter-Terrorism Centre of Excellence as now described.

3 Cranfield University Counter-Terrorism Centre of Excellence

Cranfield University is a wholly postgraduate university, providing world-leading expertise in the security and defence sector to industry, security services, military and governments around the world. Its counter-terrorism capabilities include surveillance and intelligence, forensics, CBRNE, counter-terrorism studies, leadership and management, explosives, ballistics, cyber-security, and national infrastructure protection.

Under Pool Re funding, Cranfield will develop an interdisciplinary Counter-Terrorism Centre of Excellence to provide thought leadership for catastrophic and unconventional terrorism loss assessment and so improve UK economic resilience to terrorist action. By combining Cranfield's facilities and the capabilities of current staff with new appointments and external collaboration, the centre will provide sufficient critical mass to allow enhanced research, education, skills and understanding in the UK counter-terrorism stakeholder community.

The aims of the Centre of Excellence are:

- Encourage, co-ordinate, procure and conduct academic research to aid in understanding the risk of UK terrorism and propose resilience measures.
- In conjunction with Pool Re, provide an appropriate forum for improved dialogue between the UK Government, the insurance industry and other stakeholders.
- Conduct research into current and future terrorist attack vectors and methods, and assess relevance to the insurance industry.
- Agree common terms of reference, and improve understanding between industry sectors to aid more consistent assessment of the threats and risks.
- Collate and share data to allow for more realistic modelling. Employ this data to develop a common perception of risk between key stakeholders.
- Publish a code of conduct for use by vendors, providing advice to the insurance industry, and manage a register of experts.
- Propose insurance industry mechanisms to encourage behaviours likely to reduce the probability and consequences of a terrorist event in the UK.
- Commission independent and joint government research on pre- and post-loss mechanisms that mitigate the effect of an act of terrorism.
- Work with international academic and governmental institutions on joint initiatives to improve the understanding and evolution of the terrorist.
- Act as a conduit for information on the terrorism threat and mitigating strategies from the UK Government.

The Centre will be led by the newly appointed Professor of Counter-Terrorism from the end of January 2018. The Professor will, amongst other things:

- Forge a research programme, aligned with Pool Re's and Cranfield's research strategy leading to high-quality, academic publications.
- Lead bids for research funding to various bodies, not just Pool Re.
- Lead the development of and delivery of education in resilience and counter-terrorism including professional development and Masters courses.

Preliminary work on both CBRN and explosive blast loss (see Sec. 4) has been performed from late 2016 through 2017.

4 Damage and Loss Assessment for Explosive Events

Present insurance sector blast damage estimation tools simplify explosive blast physics, and either ignore the effects of buildings on the blast wave, or assume a straight path for the blast wave, limiting damage to buildings with a line of sight to the charge location [5]. Such approaches have doubtful validity in built-up areas due to blast waves being channelled along streets, reflected off buildings and diffracted around corners [6].

In Sec. 4.1 we describe our approach to the estimation of blast loads on city centre buildings and in Sec **Error! Reference source not found.** we present some preliminary results.

4.1 Methodology

We employ our computational fluid dynamics tool, ProSAir [7], which simulates the effects of the detonation of a high explosive charge, using a high resolution, finite volume scheme. The geometry is provided as a geometric *shapefile* [8] augmented with building height. The shapefile data type describes the buildings' components as vertically extruded polygons, as shown in the example of Fig. 1. A pre-processor was written using MATLAB's Mapping Toolbox [9] to convert the shapefile to ProSAir input.

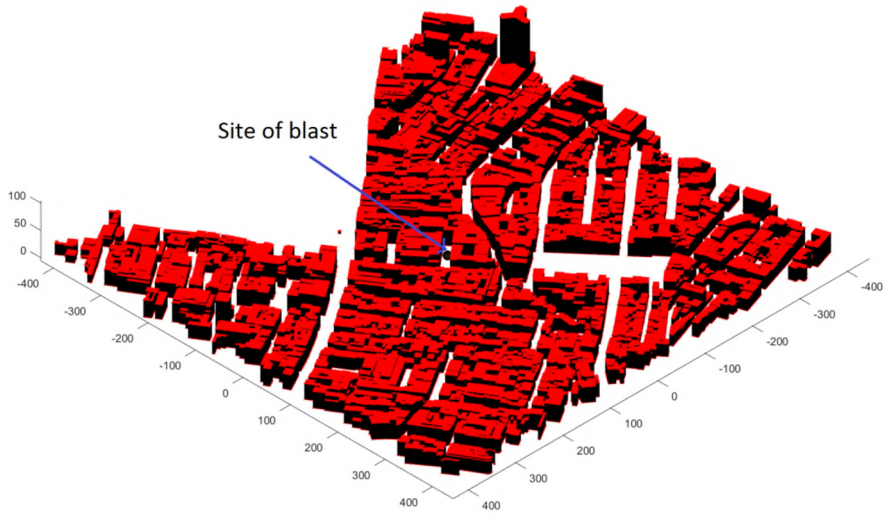

Fig. 1. Shapefile description of a complex city area with 3675 shapes over 800 x 800 m.

ProSAir was used to simulate the blast waves arising from the detonation of the explosive charge. For commercial reasons, we are unable to share the results for the scenario of Fig. 1. However we have developed a generic city centre configuration to demonstrate the challenges associated with such work. The generic configuration is

shown in Fig. 2. The blast was taken to be from 10 tonnes of TNT detonated 2 m above the ground.

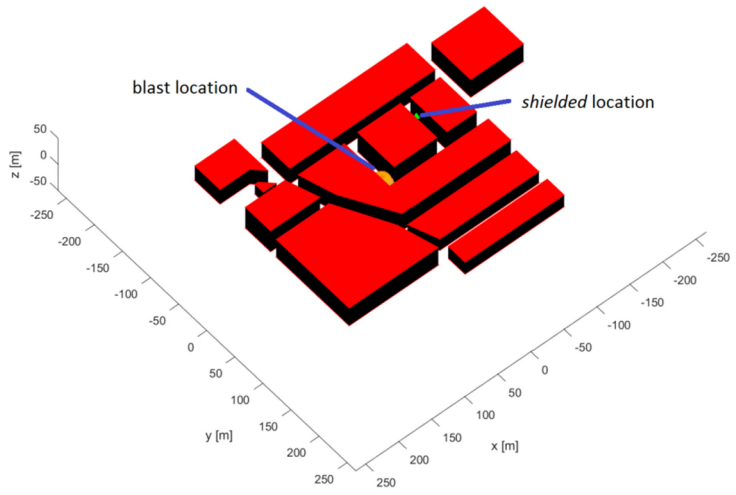

Fig. 2. Configuration of generic city centre location. The shielded location is not visible from the blast location, and would be assumed to be unaffected by the blast according to direct line-of-sight.

4.2 Preliminary Results

A simulation of the generic scenario was run using a cell size of 1.5 m and a domain of 500 x 500 x 100 m, centred on the blast. Data collection points were evenly spaced across the ground of the domain; on buildings they were spaced with at least one every 5 m and one per building surface. The simulated overpressure at various times after the blast is shown in Fig. 3**Error! Reference source not found.** and clearly shows that, due to shock diffraction around street corners and over buildings, the blast wave impacts areas without a line of sight from the blast location.

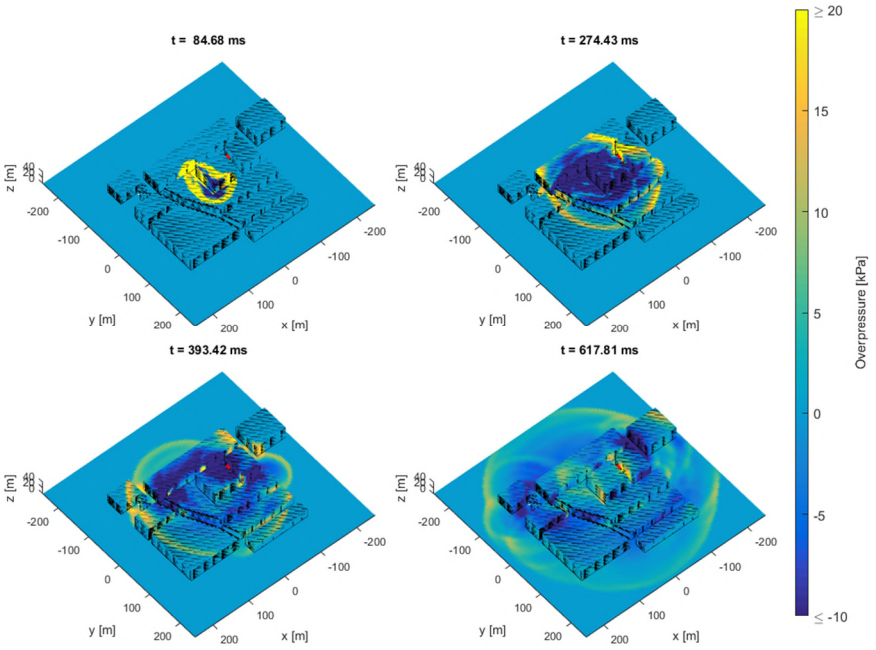

Fig. 3. Overpressure at various times after blast for generic city centre configuration. Note the data exceeds the -10 to +20 range of the scale. The location shown in Fig. 2 (shown in red here) experiences significant pressure loads despite being *hidden* from the blast site.

5 Conclusions and Further Work

As described in Sec. 2, reinsurance allows the insurance risk arising from CBRNE terrorism to be spread between insurers and reinsurers; pool reinsurance enables private sector insurance for catastrophically large events. The remit and financial structuring of the world's first terrorist loss reinsurer Pool Re was given in Sec. 2.1.

Pool Re is now commissioning research to aid understanding of UK terrorism risk and suggested resilience measures. It is facilitating the formation of the interdisciplinary Cranfield University Counter-Terrorism Centre of Excellence led by the Professor of Resilience and Counter-Terrorism. The centre will facilitate research, education, skill development and understanding within the UK's counter-terrorism community, as described in Sec. 3.

In Sec. 4, and as an example of the future work typical of the centre, we have demonstrated the feasibility of simulating terrorist bombings in complex city centres to estimate blast loading on buildings. Such simulations highlight the need to model shock diffraction and reflection to get accurate estimates of blast loading and building damage. Collaborators at Guy Carpenter Ltd are using the simulated blast loads within the FACEDAP [10] building-damage methodology to provide insurance loss estimates,

which will be validated against historic data. Such estimates will then be used to stress-test Pool Re's reinsurance structure.

We are presently working to further improve the accuracy and efficiency of the ProSAir solver. This will allow us to model the effects of uncertainty in the blast site location, charge size, atmospheric conditions, etc. At present, our modelling assumes buildings are perfectly rigid and do not fail. In the future we wish to study how building failure close to the blast centre affects blast loading on more distant buildings.
As a results of increasing our understanding of these features of the blast loading, we will be well-placed to develop improved physics-based estimates of terrorism reinsurance losses to more accurately price premiums and guide premium reductions for resilience measures, e.g., blast-resistant glazing.

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