Blast Effects on Buildings

Dedication

To Emma and Martha,
who make the impossible possible.

Blast Effects on Buildings

Third edition

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Preface

Terrorism, and the expectation that buildings and infrastructure will be designed to protect users and occupants against terrorist attack, have both evolved substantially over the 25 years since this book was first published. The terrorist threat has become more pervasive yet at the same time more diverse in its forms, some of which are less sophisticated. Whereas when this book was first published, the terrorist threat from explosions typically took the form of a charge either hand-emplaced or in a parked vehicle, the threat background is now more complex and more uncertain. Explosive threats may still take the form of a placed charge or a parked vehicle using relatively sophisticated home-made explosives. They may also now take the form of low-grade, highly improvised, explosives, or liquid explosives which require particular expertise to manufacture. Explosives may have fragments packed around the charge specifically to increase the lethality, or there may be no explosive at all and the vehicle itself is used as the weapon with which to engage in terrorism.

We recognise that as engineers we have a duty of care to evaluate the risk from terrorist attack in the design of buildings for which we are responsible, and, except where the risk is negligible, to take steps through the design and operation of the building to mitigate this risk so far as reasonably practicable. There are also practical and commercial reasons for doing so. The expectations of developers, funders, insurers and tenants follow a generally upward trend over time, meaning that whereas once a lesser standard of design was acceptable, now a higher quality is the norm – this is true across the design spectrum, whether concerning thermal performance, material usage, health and safety risks during construction, maintenance and operation of the building, speed of construction or capital and lifecycle costs. The same holds for consideration of terrorist risks in design – whereas once it was acceptable to neglect terrorism from consideration, it is now expected that terrorism will be considered, where there is a recognisable terrorist threat. Our increasing demands in relation to quality of design are also associated with investment decisions and the service life of our buildings. Investment decisions generally become bigger over time, and greater scrutiny is placed on the decision: developers, funders and insurers want to be confident that their investment is sound and the risks are well-managed. Similarly, we expect more from less, placing greater dependence on buildings and infrastructure in the function they are to

provide, combined with ‘sweating’ often ageing assets to wring more value from them without the cost of replacement. All this leads to a certain brittleness in our physical infrastructure and therefore a greater need to evaluate and reduce the risks arising from the hazards that could materialise.

This book attempts to help practising engineers respond to some of these challenges.

Acknowledgements

It is 25 years since this book was first published by my co-authors, Professor Geoff Mays and Dr Peter Smith, and almost 20 years since my first forays into the field of protective design which were in part inspired by their efforts. The first edition of this book was prepared at a time when the UK faced an Irish Republican terrorist threat on the UK mainland, and intended to provide guidance to the structural engineer making their own first forays into the field in response to this threat. It achieved this with an accessible style and content that has been the hallmark of the book over the years and is maintained in this new edition.

I am indebted to Geoff and Peter for their generosity in having allowed me to pick up the baton and update their book for the second edition, and again with this third edition. I have benefitted enormously from the guidance they have given me over the years, as I have done from my colleagues at Arup, past and present, where I have had the good fortune to spend much of the past 15 years working in an area which fascinates me. A particular debt of thanks is owed to David Hadden and to his wife Sue. It was David who took Arup's first steps in the field of protective design in the mid-1990s, around the time of the publication of the first edition. It was also David, and specifically the faith he showed in me, that allowed me to follow him along the path he had first trodden. From his confidence in me and his warm, patient and unwavering style, I have had the tremendous good fortune to work on some of the world's most exciting and ground-breaking projects, and it is from the wealth of knowledge that I gained through David and these projects that enabled me to contribute to the field of blast and protective design through this book.

I am especially grateful to those who have contributed as co-authors of previous editions and whose valuable input remains in this book. I am also grateful for the meticulous eye for detail of all of those who have read, used and taken the time to comment on the earlier editions, without which a great number of errors would have made it into print. Any that remain are mine alone.

Finally, without the strength and encouragement I draw from my wife Emma and my daughter Martha, none of this would have been possible. Thank you.

David Cormie

London, June 2019

About the authors

David Cormie is the leader of blast and protective design in Arup. He has spent his career to date in the design of buildings and structures against extreme loads, and since 2005 has specialised in blast engineering and protective design against terrorist attack. He has led the design of a wide range of landmark and high-profile/high-threat buildings and other structures across the world against security and terrorist threats, including airports, mass transit infrastructure, commercial buildings, international sporting venues, event and leisure venues, government and diplomatic buildings, critical infrastructure and strategic assets. He has published widely in the field of blast engineering, collaborating with many world-leading academic centres on research in different aspects of the field, and has been invited to speak at conferences and other forums throughout the world on the design of buildings and other structures to be resilient against terrorism. He is currently the nominated UK expert on structural robustness working on the update to the Eurocodes. He is a Fellow of the Institution of Civil Engineers and of the Institution of Structural Engineers and is a Principal of the Register of Security Engineers and Specialists, and is Visiting Professor of high strain rate mechanics and blast engineering at Imperial College London.

Geoff Mays is Professor Emeritus of Civil Engineering for Cranfield University. He was formerly Head of Cranfield Defence and Security at the Defence Academy of the United Kingdom, where he conducted research and consultancy and lectures on postgraduate courses in the fields of structural resilience to blast loading and the strengthening of concrete structures. An author of over 90 papers for refereed journals and conference proceedings, he has also written books on the durability of concrete structures and adhesives in civil engineering. He was the convenor of the CEN Committee which led the development of European Standards for the protection and repair of concrete structures and chair of its working group concerned with structural bonding.

Peter Smith was formerly Reader in Protective Structures with Cranfield University at the Defence Academy of the United Kingdom at Shrivenham. He lectured on masters programmes and shorter courses in the UK and worldwide on blast loading, structural response and design. He has supervised research contracts and

undertaken consultancy in this general area for both commercial and government organisations. He is the author of over 100 journal and conference papers and technical reports as well as books in the blast area and was a member of a European working group concerned with explosion effects on urban buildings.