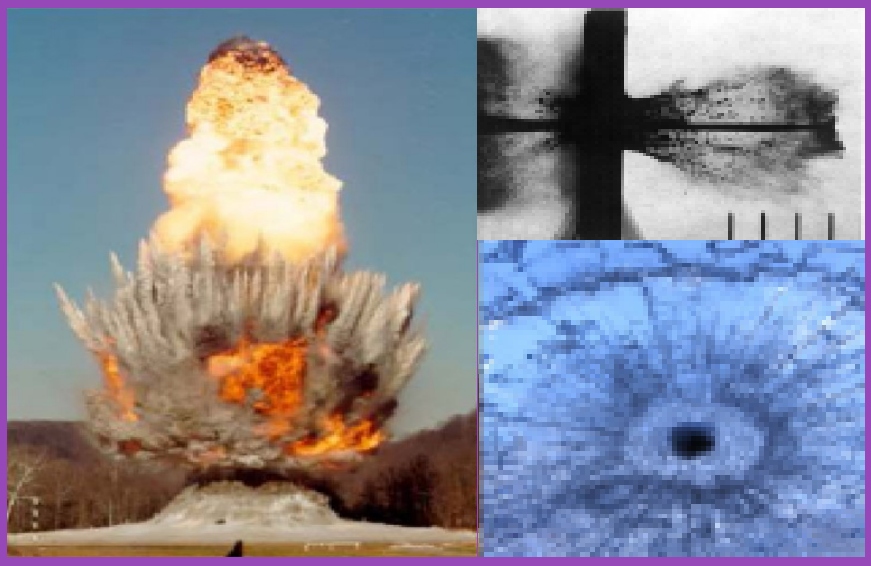
Impact and Blast Effects: Theory, Analysis and Design

A three-day short course



Impact and Blast Effects

The course is designed for professional engineers, consultants, researchers and graduate students, who are involved in the analysis, testing, modelling, design and assessment of structures against impact, blast and shock loads. The course will cover basic and theoretical concepts, material characterisations, analysis, modelling and design methods and the practical applications for structural protection against impact, blast and shock effects.

3 Days, November 6th -8th 2023

K&C
Karagozian & Case

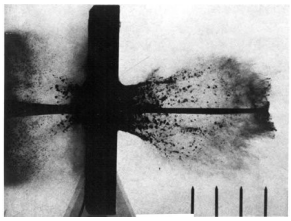
MANCHESTER 1824
The University of Manchester

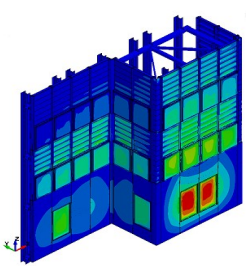
Impact and Blast Effects:Theory,Analysis and Design Background

Impact and blast threats exist in a wide range of engineering, security and defence sec-tors, which have been frequently linked to industrial safety in the fields of surface/air/space transportations, nuclear power plant, offshore platforms, critical facilities in other industries and infrastructures, and protections against impact, blast and shock effects in accidental, terrorism and battlefield events. Depending on the impact velocity, blast in-tensity and shock environment severity, material and structural behaviour may become very different from their quasi-static behaviour when inertia and/or strain-rate effects become dominant in these events, which need to be considered in the design of pro-tective structures for impact and blast loads and shock environment. This short course integrates material characterization, basic theory, design methodology and latest re-search progress and offers an extensive introduction to professionals and researchers for dealing with impact, blast and shock effects in various engineering fields.

Impact and Blast Effects and the University of Manchester

Many research, teaching and consulting activities on the impact and blast subjects have been conducted in School of Engineering (SoE) at The University of Manchester. The Impact & Explosion Laboratory in SoE is specialised on penetration mechanics, dynamic behaviour of engineering materials at high strain-rates, and structural response to impact, blast and shock loads. It hosts the Impact Facilities at high pressure, temper-ature & strain-rate as part of UKCRIC-National Centre for Infrastructural Materials. Our partner, Karagozian & Case (K&C) has a unique and highly technical set of skills in science and engineering providing consulting services for analysis, test, simulation and design of structural and mechanical systems subjected to blast, impact and shock effects. K&C is recognized for its leadership role in these areas using high-fidelity physics-based (HFPB) numerical models.





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Who Should Attend?

This course will provide an introductory training for practicing engineers, consultants, researchers and research students, who may be involved in dealing with impact and blast effects in mechanical engineering, civil engineering, nuclear engineering, aerospace engineering, oil and petrochemical engineering and defence engineering and industries. The course will be also suitable to architects, estate developers, security managers, and government officers who need updating in the latest developments in this area.

Course Content

The course will consist of an introduction to impact, blast and shock threats and their effects on structures, with special emphasis on the fundamental concepts and methodologies of the practical techniques and the latest state-of-the-art developments in material property characterisation and analytical method. The morning will cover material characterisations, impact and shock threats and their effects while the blast loading and effects will be covered in the afternoon sessions. Details of the course content are shown in the programme outline.

Partners

The partners involved in the delivery of the Impact and Blast Effect Course are Karagozian and Case Inc & The University of Manchester.

K&C
Karagozian & Case

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Introduction to the Speakers

Qingming Li (Ph.D, DEng, CEng, FIMechE,)
Professor in Applied Mechanics
Leader of Impact & Explosion Laboratory
Department of Mechanical, Aerospace & Civil Engng., The University of Manchester, UK

Dr Li's expertise is in penetration mechanics, dynamic behaviour of engineering materials at high strain-rates, structural response to impact, blast and shock loads and structural protection. He has more than twenty year's research experience in these fields and has published 200 peer-reviewed journal and conference papers on these subjects, involving in analytical, numerical and experimental studies. He has served on relevant international conference committees and chair-manships, undertaken guest editorships, held guest professorships in several universities and provided consultancies to industries and government bodies. Dr Li is a Fellow of Institution of Mechanical Engineers. He serves as an associate editor of the International Journal of Impact Engineering and editorial board member of International Journal of Protective Structures and Journal of Defence Technology.

Mark Weaver (P.E., S.E.)
Principal, Karagozian & Case Inc., USA

Mark Weaver has over a decade of structural design, analysis, and testing experience that has largely focused on designing structures to mitigate the effects of blast, impact, and shock loads. In his current role at K&C, he leads structural design efforts that aim to develop innovative structural solutions capable of protecting people and infrastructure in the event of malicious man-made threats. Mr. Weaver has served as the principal investigator on efforts aimed at demon-strating the efficacy of structural components and systems to resist blast loads. Recent examples include multi-year efforts that involved blast testing on concrete and cold-formed steel (CFS) walls, concrete columns, cross-laminated timber structures, and CFS truss roof systems. He is also an experienced analyst and routinely employs high-fidelity physics-based analyses to evaluate the blast and impact resistance of his designs and test articles.

Mr. Weaver is actively involved in professional organizations and committees devoted to advancing the state-of-the-art in structural design to mitigate the effects of explosives. He is currently a voting member of the ACI 370 "Blast and Impact Load Effects" committee and an associate member of the ASCE "Blast Protection of Buildings Standards" committee.

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Day 1: Monday 6th November 2023

Session	Title/Theme Duration	Elements	Time
		Day 1	
	Registration	Tea and Coffee	9:00-9:25
	Introduction	Introduction of the short course	9:25-9:30
A1 QL	Dynamic behavior of ductile materials	Strain-rate and different strain-rate regimes Strain-rate effects & micro-mechanics mechanisms for ductile materials Physics-based strain-rate equations Empirical strain-rate equations Legitimacy of Johnson-Cook equation Coupled thermal effects	9:30-10:20
A2	Dynamic behavior of brittle materials	Strain-rate effects & micro-mechanics mechanisms for brittle materials Empirical strain-rate equations for concrete-like materials Implementation of strain-rate equations in material models	10:20-10:50
Morning Tea Break 10:50-11:10			
A2	Dynamic behavior of brittle materials	Continue	11:10-11:30
A3	Split Hopkinson pressure bar technique	Introduction to split Hopkinson bar set-ups Elastic stress wave propagation Basic assumptions and equations Issues that need to be concerned for the valid interpretation of SHPB measurement results	11:30-12:30
Lunch Break 12:30-13:30			
B1 MW	Introduction to Modern Protective Technologies	Background – The Need for Effective Protective Technology Hazardous Effects Associated with Explosions Conventional Design vs. Protective Design: What are the Differences? Analytical Methods Overview Mitigation Measures Overview Validation Testing Overview	13:30 – 14:30
B2	Blast Load Characterization – Part 1	Overview of Explosions Far-Field Blast Loads Deriving from High Explosives Applying Far-Field Blast Loads to Structures Near-Field Blast Loads Deriving from High Explosives	14:30 –15:30
Afternoon Tea Break 15:30-15:50			
B3	Blast Load Characterization – Part 2	Internal Detonation Considerations Other Oxidation-Type Explosions (e.g., vapor cloud, dust) Expansion-Type Explosions (e.g., BLEVE, RPT) Deflagration-to-Detonation Transition (DDT)	15:50 – 16:50
Discussion 16:50-17:00			

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Day 2: Tuesday 7th November 2023

Day 2			
A4	Impact threats and penetration mechanics	Impact threats in civil and military applications Projectile and target descriptions Penetration regimes Jet impact	9:00-9:50
A5	Local impact effects on metallic target	Local and global impact effects Penetration and perforation Ballistic limit and testing method Empirical formulae	9:50-10:20
Morning Tea Break 10:20-10:30			
A5	Local impact effects on metallic target	Continue	10:30-11:00
A6	Local impact effects on concrete target	Local impact effects Perforation and scabbing limits Analytical models and predictive tools Empirical formulae	11:00-12:00
Lunch Break (12:00-12:45) & lab visit (12:45-13:30)			
B4	Analyzing Structures for Blast Loads	Single-Degree-of-Freedom (SDOF) Model Rapid Analysis Aids (e.g., breach curves, P-I curves) High-Fidelity Physics-Based (HFPB) Modeling: When is it Necessary? HFPB Modeling Issues (e.g., element formulation, hourglass, boundary conditions) Material Models (e.g., concrete, steel)	13:30 – 14:30
B5/B6/B7	Blast-Resistant Design of Concrete, Steel and Wood	Blast Design Overview for (1) Concrete (e.g., cast-in-place, tilt-up, post-tensioned) (2) Steel (e.g., hot rolled, cold-formed) (3) Wood (e.g., light frame, mass timber) Design Considerations (e.g., far-field, near-field) Modeling Blast Effects Response of Concrete/steel/wood Structures Validation Testing of Concrete/steel/wood Structures Exposed to Blast Loads	14:40 –15:25
Afternoon Tea Break 15:25-15:45			
B5/B6/B7	Blast-Resistant Design of Concrete, Steel and Wood	Continue	15:45 – 17:00
Course Dinner 18:00-20:00 (Venue to be confirmed)			

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Day 3: Wednesday 8th November 2023

Day 3			
A7	Soft missiles and aircraft impact	Soft missiles Impact dynamics of cellular materials Aircraft impact	9:00-9:50
A8	R3 impact assessment procedure	Outline of R3-Impact assessment procedure Missiles generated by pressure vessel failure Missiles generated by rotation machine failure	9:50-10:40
Morning Tea Break 10:40-11:00			
A9	A brief introduction of shock environment, shock severity specification and shock damage assessment	Shock environments in different engineering sectors Characteristics of shock signals How to represent shock signals SRS-based shock severity evaluation and its limitations Shock damage boundary method Other shock damage assessment methods	11:00-12:10
Lunch Break 12:10-13:10			
B8	Blast-Resistant Design: steel/ concrete	Blast Design Overview for Steel (e.g., hot rolled, cold-formed) Design Considerations (e.g., far-field, near-field) Modeling Blast Effects Response of Steel Structures Validation Testing of Steel Structures Exposed to Blast Loads Blast Design Overview for Concrete (e.g., cast-in-place, tilt-up, post-tensioned) Design Considerations (e.g., far-field, near-field) Modeling Blast Effects Response of Concrete Structures Validation Testing of Concrete Structures Exposed to Blast Loads	13:10 – 13:55
B9	Design to Prevent Disproportionate (Progressive) Collapse	Design Approaches (e.g., Tie Force, Alternate Path) Analytical Model Complexity (e.g., linear static, nonlinear static, non-linear dynamic) Validation Testing of Structural Systems Exhibiting Disproportionate Collapse	13:55 –14:40
Afternoon Tea Break 14:40-15:00			
B10-B11	Windows Response & Retrofit Perimeter Protection & Anti-ram Barrier	Historical Review of Glazing Hazards Window System Response to Blast Loads Mitigation Measures (e.g., laminates, catcher systems) Validation Testing of Window Systems Exposed to Blast Loads Historical Review of Vehicular Impact Hazards Barrier Response to Vehicular Impact Mitigation Measures (e.g., bollards, planters, active barriers) Validation Testing of Anti-Ram Barrier Systems Exposed to Vehicular Impact	15:00 – 16:30
Discussion and closure of the short course 16:30-16:40			

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Organisational Details

Date / Duration
Three days from Monday 6th November to Wednesday 8th November 2023

Location
The course will be held in the School of Engineering in a brand new Engineering Building A in the south campus of The University of Manchester. The University is close to the city centre (a ten minute walk). Manchester International Airport is located about 10 miles (16km) south of the University. Piccadilly railway station and the central Chorlton Street bus station are also within walking distance.

Language
English

Delegate Fee
The total fee for the three days of the course including hardcopy lecture notes, lunches and the evening course dinner on Day Two is **£1,195**.

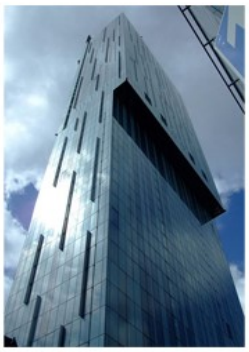
Cancellation of payments
Up to three weeks before the event: free of charge; up to one week before; 50%. Non-attendance will not receive a refund. Cancellation must be in writing to the Course Administrator in advance.

Cancellation by the University
The University reserves the right to cancel the course 10 days before if there are not sufficient delegates registered.

Food
Lunches will be provided for three days. There will be breaks for tea and coffee in the morning and afternoon. A Course Dinner will be arranged for the second evening of the course in a local restaurant.

Accommodation
Delegates are asked to make their own arrangements for overnight accommodation. There are a number of hotels close to the University in central Manchester. Please contact the Course Administrator for further details and there is information on our website.





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Course booking form

3 days 6th-8th November 2023

Please reserve me a place on the above course

Title. Name

Organisation

Address

Post Code

Telephone Contact (Work)

Telephone Contact (Mobile)

Email address

Preferred method of payment

☐ Invoice to my organisation Please give the purchase order number:

Please invoice the following contact person & dept.

I would like to pay by

☐ credit card

☐ Bank Transfer

Signature Date

Other Information.
Please delete where appropriate.

I will / will not have dietary requirements (If yes, please specify).

I will / will not need special facilities for a disability (if yes, please give details)

Please send me details about accommodation close to the venue.

☐

The course will be held on The University of Manchester Campus and location maps will be sent to delegates three weeks before the event.

I found out about this course from:

For general enquiries and registration:
School of Engineering,
The University of Manchester
FAO FESS Ops, Floor 5 South
Engineering Building A
The University of Manchester
Oxford Road
M13 9PL

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