# A Two-day Short Course:
# *Analysis and Design for Blast Effect on Structures*

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

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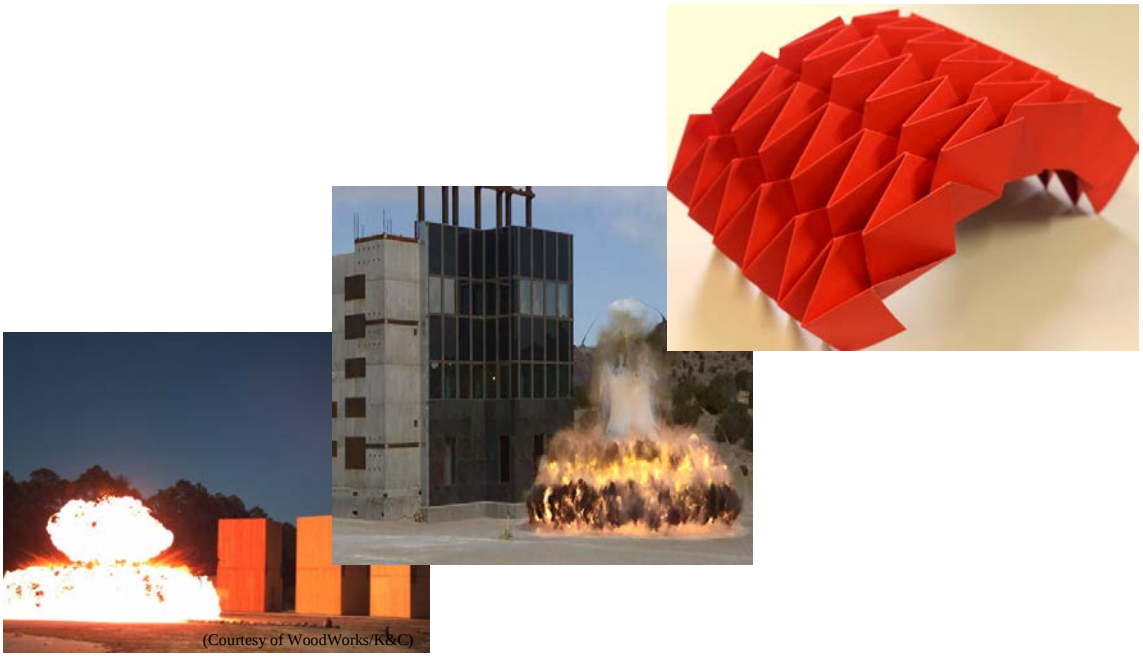

(Courtesy of WoodWorks/K&C)

November 28-29, 2017
Room EN101, Engineering Building, Hawthorn Campus,
Swinburne University of Technology

SWINBURNE UNIVERSITY OF TECHNOLOGY

K&C Karagozian & Case

# A Two-day Short Course: Blast Effect Analysis and Design

## Course Material

A copy of the overheads used in the presentation of the course will be provided as a part of the course material.

## Background

Impact and blast threats exist in a wide range of engineering, security and defence sectors, which have been frequently linked to industrial safety (surface/air/space transportations, nuclear power plant, offshore platforms and critical facilities in other industries) and protections against impact, blast and shock effects in terrorist and battlefield events. Depending on the impact velocity, blast intensity and shock environment, 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 protective structures against impact and blast loads and shock environment. This short course integrates material characterization, basic theory, design methodology and latest research progress and offers an introduction to professionals and researchers for dealing with impact, blast and shock effects in various engineering fields.

## Who should attend

This workshop is designed for:

- Professional engineers and consultants, who involve in protective designs and engineering for buildings and infrastructures against blast and impact loading.
- Researchers and graduate students, who are interested in blast effects analysis for dynamic responses of structural and mechanical systems.
- Government officers, who are the decision makers for protective measures and review protective solutions and designs from consultants.

- Architects, estate developers and security managers, who are interested in threat and vulnerability assessment and protective technologies for counter-terrorism protection of buildings and infrastructures.

## 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 and analytical method. In the second afternoon, simple demo tests will be given in the Impact Laboratory (EN124 in Hawthorn Campus of Swinburne University of Technology). Details of the course content are shown in the programme outline.

## Partners

The Workshop is jointly offered by Karagozian & Case, Inc., USA, and Impact Engineering Laboratory, Swinburne University of Technology, Australia.

## Introduction to the Speakers

- **Shengrui Lan** (Ph.D)

Principal Scientist, Karagozian & Case Inc., USA

Dr. Lan has 25 years' experience in structural engineering, focusing on finite element analysis of structures under static, dynamic, blast and impact loads. He has performed numerous high-fidelity physics based (HFPB) finite element analyses for blast and impact effects on various protective structures/systems for evaluating their blast/impact resistance and determining their de-sign parameters. His HFPB models have been validated by many full-scale blast field tests and vehicle crash tests.

Dr. Lan has managed/involved numerous projects in blast effects analysis and design for blast protection of airport facilities, blast mitigation retrofits of office buildings including perimeter protection, window upgrade, column retrofit, progressive collapse mitigation and internal explosion isolation. He has been a key member in developing a

series of anti-ram devices for DOS K4 to K12 ratings and a K50 anti-ram wall, which passed the vehicle crash tests.

He authored over 50 papers and reports related to blast and impact effects analysis/design and structural engineering.

- **Guoxing Lu** (MSc, Cranfield, Ph.D, University of Cambridge)

Professor in Impact Engineering
Director, Swinburne Impact Engineering Laboratory
Chair, Department of Mechanical and Product Design Engineering
Swinburne University of Technology, Australia

Professor Lu has over 30 years of research experience in the field of impact engineering. He was a tenured faculty member at Nanyang Technological University, Singapore before he returned to Swinburne in 2015. His expertise is in energy absorption, dynamic behaviour of engineering materials at high strain-rates, structural response to impact, blast and shock loads and structural protection. He has published over 190 papers in international journals. His total number of citations is 4500 with an H-index 35. He has written a monograph with Professor TongXi Yu entitled *"Energy Absorption of Structures and Materials*", 2003.

Professor Lu is an Associate Editor of *International Journal of Impact Engineering*, member of editorial board of other journals: *International Journal of Protective Structures*, *Defence Technology*, *International Journal of Mechanical Engineering Education* and, previously, *Latin American Journal of Solids and Structures*. He has chaired several international conferences. He has been a Chief Investigator for 14 grants from the Australian Research Council and conducted numerous research projects with industry and government organisations.

## Day 1: Tuesday 28 November 2017

| Session | Title/Theme | Elements | Time |
|---|---|---|---|
| **Day 1** | | | |
| A1:1 | Introduction | • Overview: the state-of-the-arts in protective technology<br>• Protective plan and design for buildings/infrastructures<br>• Perimeter protection<br>• Mitigation of debris hazards<br>• Mitigation of progressive collapse of a building<br>• Mitigation of internal explosion | 8:30 – 9:45 |
| **Break 9:45 – 10:00** | | | |
| A1:2 | Blast loads & engineering tools (Part 1) | • Blast loads on structures<br>• UFC 3-340-02: dynamic increase factors, SDOF charts, P-I tools for predicting building response<br>• Characteristics of blast loads<br>• Blast loads interaction with structure<br>• Calculating tools for predicting blast effects | 10:00 – 11:15 |
| **Break 11:15 – 11:30** | | | |
| A1:3 | Blast loads & engineering tools (Part 2) | • Tools for blast load calculation.<br>• SDOF: shape function, resistance function, stiffness versus mass, ductility, algorithm<br>• PI-curves for components, range to effects curves for components<br>• K&C and other design/assessment codes | 11:30 – 12:30 |
| **Lunch 12:30-13:30** | | | |
| A1:4 | Blast-resistant Design (Part 1) | • Blast-resistant design concepts: Resilient and Resistant Design<br>• Strategies for Protective Design: Structure Protection<br>• Determining Risk and Vulnerability: Complicated by Analysis and Threat Uncertainties<br>• Design Process Pertaining to Achieving Blast Resistance | 13:30 – 14:45 |
| **Break 14:45-15:00** | | | |
| A1:5 | Blast-resistant Design (Part 2) | • Structural Systems: Focus on Steel and RC<br>• HFPB Models Offer Outstanding Capability, but Hugh Pitfalls<br>• New design verses retrofit design<br>• Performance versus Prescriptive Design Paradigms<br>• Conclusions, Design Philosophy | 15:00 – 16:15 |
| **Break 16:15-16:30** | | | |
| A1:6 | Blast-resistant Design (Part 2) | • Structural Systems: Focus on Steel and RC<br>• HFPB Models Offer Outstanding Capability, but Hugh Pitfalls<br>• New design verses retrofit design<br>• Performance versus Prescriptive Design Paradigms<br>• Conclusions, Design Philosophy | 16:30 – 17:30 |
| **End of first day.** | | | |

## Day 2: Wednesday 29 November 2017

| Session | Title/Theme | Elements | Time |
|---|---|---|---|
| **Day 2** | | | |
| A2:1 | Progressive Collapse | • Definition & histories; Issues in current standards & practices<br>• Overview of UFC 4-023-03, July 2009<br>Occupancy category<br>Tie force / Alternate path / Enhanced local Resistance<br>Linear static / nonlinear static / nonlinear dynamic procedures<br>• Analysis examples of progressive collapse<br>• Other modes in building collapse<br>• Criteria used in progressive collapse analysis<br>• Performance based design<br>• New generation analysis tools<br>• Test data on progressive collapse | 8:30 – 9:45 |
| **Break 9:45 – 10:00** | | | |
| A2:2 | HFPB models, use and theory | • Introduction to high-fidelity physics-based (HFPB) modeling<br>• Material models for blast effects: concrete, steel, soil, polymers<br>• Validation & verifications of HFPB models<br>• Modeling blast effects response of steel structures<br>• Modeling blast effects response of reinforced concrete structures<br>• Calculation/simulation examples | 10:00 – 11:15 |
| **Break 11:15 – 11:30** | | | |
| A2:3 | Windows / Façade response and retrofit | • Glazing hazards – history review<br>• Blast response of windows, glazing facade<br>• Test data and retrofit methods<br>• Retrofit using polymer films and clear sheets<br>• Fabric catcher system<br>• Cable catcher system | 11:30 – 12:30 |
| **Lunch 12:30-13:30** | | | |
| B2:1 | Novel materials/structures | • Cellular material<br>• Composite structures | 13:30 – 14:45 |
| **Break 14:45-15:00** | | | |
| B2:2 | Novel materials/structures | • Origami structures<br>• Auxetic structures | 15:00 – 16:15 |
| **Break 16:00-16:15** | | | |
| B2:3 | Material's property at high strain rates. | • Principle of Split Hopkinson Bar testing (SHPB)<br>• Demonstration of SHPB tests at Swinburne Impact Engineering Lab | 16:30 – 17:30 |
| **End of Workshop.** | | | |

## Organisational details

### *Deadlines of the course*

Registration by 10 November 2017

Contact: Course Administrator

E-mails: contact@daps2017.org

### *Registration Fees*

- Normal registration - $800 per person
- University Students (Student ID required on registration) - $540 per person
- Group registration from the same institution (5 or more) - $320 per person

### *Payments*

Please go to https://www.trybooking.com/SBDI.

### *Cancellation of payments*

Up to two weeks before the event: except for the credit 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 on each day with breaks for tea and coffee in the morning and afternoon.

### *Accommodation*

Delegates are asked to make their own arrangements for overnight accommodation. There are a number of hotels close to the University. Please contact the Course Administrator for further details.