2-Day Workshop

On
Dynamic Material Behaviour Part 2: Simulation of Metals, Concrete and Composites

Dates
23 August 2017 &
24 August 2017
(Wednesday and Thursday)

Time
Day 1: 9.00 am – 4.30 pm
(Registration starts at 8.45 am)

Day 2: 9.00 am – 4.45 pm

Venue
EST Lab 1 (N1-B2b-13)
School of Civil & Environmental Engineering
Nanyang Technological University | Singapore

Course Instructor

Prof. Dr.-Ing. Werner RIEDEL
Deputy Head of Impact Physics Dpt.
Ernst-Mach-Institut (EMI), Fraunhofer Society
Freiburg, Germany

Organised by:
Protective Technology Research Centre
School of Civil & Environmental Engineering
College of Engineering
Nanyang Technological University | Singapore
Material descriptions for predictive simulations of transient dynamic processes (e.g. crash, shock loading and impact) require a broad knowledge of experimental, analytical and numerical basics, such as:

- Theory of equation of state for solid materials (I)
- Wave propagation analysis of dynamic triaxial deformation processes (I)
- Static and dynamic experimental characterisation procedures (I)
- Suitable state-of-the-art and development stage material models (II)
- Governing equations and suitable discretisation for large deformations and failure behaviour (II)

A four-day course focused to anchor and broaden these basics in view of predictive simulation capabilities for scientists and engineers has been developed over the last decade by scientific staff of Ernst-Mach-Institut:
- Dynamic Material Behaviour Part I: High Rate Testing and Theory [held in March 2017]
- Dynamic Material Behaviour Part II: Simulation of Metals, Concrete and Composites

Part II focuses on predictive application simulations for three different material classes. Concrete modelling for ballistic applications and explosion effects on critical infrastructure is introduced from meso-scale shock analysis to macro-scale, multi-axial hydrocode models for general purposes. Automotive crash and development of hypervelocity impact protection shields serve as applications for structural (CFRP) and protective composites (AFRP/PEFRP). Metal components are in many applications the baseline material type from which complex testing and modeling methods are derived. The course explains on a pragmatic level suitable discretisations in body-fixed and space-fixed coordinates, referring to mesh and particle based finite methods. Part II of the course is the continuation of Part I held in March 2017, but key principles are repeated (sections denoted as part 0), so that Part II will also be useful as stand-alone course for new participants.

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<th>Day 1</th>
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| **Part I: Introduction**  
- Introduction: FH, EMI, Presenter,  
- Strain Rates in Dynamic Applications | **Part 0: Repetition**  
- Repetition: Stress Wave Analysis and Hydrocodes |
| **Part 0: Dynamic Stress Wave Analysis**  
(Summary/Reminder)  
- Dynamic Stress Wave Analysis,  
- Metal Strength Models  
- Shock Waves in Solids | **Part VI: Concrete & Masonry**  
- Meso- and Macromechanical Method for  
- Equation of State  
- Macromechanical Models, Applications  
- Exercise 6: Impact Simulations on Metal, Concrete and Composites  
- Macromechanical Model for Masonry |
| **Part V: Hydrocodes**  
- Governing Equations, Referentials, Discretisations  
- Shock Treatment, including Strength, Hydrocode Cycle  
- Examples of Different Discretisations  
- Exercise 5: Space Protection Shield | **Part VII: Composites**  
- Orthotropic Nonlinear Strength and Equation of  
- State: Protective and Structural Composites in Space  
- Crashworthiness of CFRP Laminate Structures  
- Multiscale Models for Composites  
- Modelling of Fabric Materials |

~~~ ABOUT THE INSTRUCTOR ~~~

Werner RIEDEL  Prof. Dr.-Ing.

Professor Werner RIEDEL is the Deputy Head of the Impact Physics Department of Ernst-Mach-Institut (EMI), Germany. He received degrees in Mechanical Engineering from the Technical Universities of Munich (1994) and Compiègne, France (1996). At EMI he specialised in numerical modelling of materials and components under dynamic loads. In 2000 he received the doctoral degree at the University of the German Armed Forces at Munich. Selected project examples are the direction of the ADAMMO study for ESA, (material models for orbital debris impact on ISS) and the VITRUV project (urban security) in EU-FP7. Dr Riedel authored 103 scientific publications from 1996 to 2017. He was invited as Visiting Professor by Tokyo Institute of Technology in 2006 and 2010, and is Professor at Furtwangen University in Security & Safety Engineering since 2011. He is holding the position of a Visiting Associate Professor at NTU-CEE.
## Workshop Organised by Protective Technology Research Centre

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<th>Date</th>
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<td>50 Nanyang Avenue, Singapore 639798</td>
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<td>Fees</td>
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<td>Please submit the scanned registration form at least 10 working days before the commencement of the workshop (<a href="mailto:d-ptrc@ntu.edu.sg">d-ptrc@ntu.edu.sg</a>).</td>
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## Registration Form

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Payment Mode: By Cheque or By Bank Transfer to NTU (NTU’s Bank Details will be at the bottom of the invoice)

Cheque: (bank/no. …………..) Amount: S$………………

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To: Nanyang Technological University
Protective Technology Research Centre
School of Civil & Environmental Engineering
Blk N1.1-B3-03, 50 Nanyang Avenue, Singapore 639798
Attn to: Ms Debbie Low

For registration and enquiries, please send your email to d-ptrc@ntu.edu.sg.

Tel: 6790 5285