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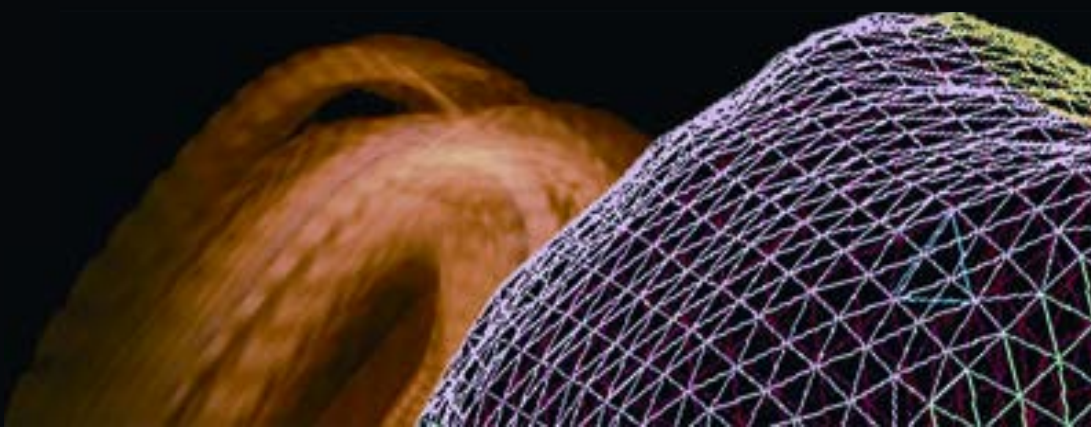
MULTIPHYSICS 2019

14 - 15 December 2019
Dubai, UAE



MULTIPHYSICS 2019

14-15 December 2019
Dubai, UAE

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General Information

Scope of Conference

Understanding real physics and performing Multiphysics simulation are extremely important to analyse complex systems in order to better design and manufacture engineering products.

The objective of the conference is to share and explore findings on mathematical advances, numerical modelling and experimental validation of theoretical and practical systems in a wide range of applications.

The scope of the conference is to address the latest advances in theoretical developments, numerical modelling and industrial application, which will promote the concept of simultaneous engineering. Typical combinations would involve a selection from subject disciplines such as Acoustics, Electrics, Explosives, Fire, Fluids, Magnetic, Nuclear, Soil, Structures, and Thermodynamics.

Registration Pack – Collection Hours

Registration packs should be collected from the Registration Desk. Collection Hours are as follows:

Saturday, 14th December	9:00-17:30
Sunday, 15th December	9:00-17:30

Special Events

Saturday, 14th December Group Photograph	11:00
Saturday, 14th December Conference Banquet	19:30

Timing of Presentations

Each paper will be allocated 18 minutes. A good guide is 14 minutes for presentation with 4 minutes left for questions at the end.

Good timekeeping is essential, speakers are asked to keep strictly to 18 minutes per presentation.

Group Photograph

A group photograph will be taken during the tea/coffee break on the first day of the Conference.

Language

The official language of the conference is English.

Audio-visual

The lecture room will be equipped with the following: One laptop, one LCD projection and cables, one screen, and one microphone.

Delegates are requested to bring presentations on a memory stick.

Paper Publication

Authors are invited to submit full-length papers for publication in 'The International Journal of Multiphysics' by 31st January 2020.

There is no Article Processing Charge (APC) for one article per registration.

Sponsorship

The Conference Board would like to thank the sponsors for their support.

Keynote Speaker

Professor M Souli
University of Lille
Lille, France

BIOGRAPHY

Mhamed Souli is Professor of Computational Mechanics at Lille University, France since 2000. He completed his PhD at Nice University in 1990, and worked as research associate 1991-1993 as research associate at Stanford University and senior research developer 1993-1999, at Livermore Software Technology in Livermore California. Mhamed Souli is co-founder and Associate Editor of the International Journal of Multiphysics, and Co-Chair of the Fluid-Structure Interaction Committee, ASME PVP Division since 1978. He is the author of 2 books, and over 80 peer reviewed publications and presentations including keynote addresses at international symposia and conferences. His industrial research and engineering experience include work for Boeing USA, Jaguar UK, EDF French Nuclear Industry, and DCNS French Navy. His research and development interests include Fluid Structure Interaction, CFD with emphasis on multiphase flow and coupling with structures, and their applications to industrial problems. Recent research includes Arbitrary Lagrangian Eulerian (ALE) finite element formulation, coupling methods, and application of parallel computing techniques to these approaches.

MULTIPHYSICS 2019

PROGRAMME

TIME	Saturday 14 December 2019	Sunday 15 December 2019
09:00 - 09:30	**Registration**	
09:30 - 11:00	**Keynote Address & Synopsis**	**Session 2.1** *Advanced Materials*
11:00 - 11:30	**Break / Posters**	
11:30 - 13:00	**Session 1.2** *Multiphysics Applications*	**Session 2.2** *Fluid Structure Interaction*
13:00 - 14:00	**Lunch**	
14:00 - 15:30	**Session 1.3** *Modelling Techniques*	**Session 2.3** *Heat Transfer*
15:30 - 16:00	**Break / Posters**	
16:00 - 17:30	**Session 1.4** *Aerospace and Marine*	**Session 2.4** *Impact and Explosions*
19:30	**Banquet**	

Full Programme

Saturday 14 December 2019

09:00 – 09:30 Registration

09:30 – 09:45 Conference Opening

Opening of The 14th International Conference of Multiphysics 2019

Basem Alzahabi, President, Al Ghurair University, Dubai, UAE

09:45 – 11:00 Session 1.1
Keynote Address & Synopsis

Chair: M Moatamedi, The International Society of Multiphysics

Keynote Address: FEM and Particle methods for Industrial Applications

M Souli, University of Lille, Lille, France

Synopsis Part 1: The International Journal of Multiphysics
Synopsis Part 2: The International Conference of Multiphysics 2020
Synopsis Part 3: The Art of Multiphysics

H Khawaja, The International Society of Multiphysics

11:00-11:30 Break / Posters & Group Photograph

Saturday 14 December 2019

11:30-13:00 Session 1.2
Multiphysics Applications

Chair: B Alzahabi, Al Ghurair University, UAE

On the equivalence of a system dynamic method for modelling Multiphysics systems and the Tetrahedron-of-State-Concept within the Bond graph modelling approach
G Boiger
ZHAW Zurich University of Applied Sciences, Winterthur, Switzerland

A fast and accurate optic disc localization method for pathologically damaged retinal fundus images
M A U Khan, K I Aziz, S S Ahmad, R Kanna, M Moatamedi, B Alzahabi
Al Ghurair University, Dubai, UAE

Investigation of modal distortion and temporal effects in torsional resonators
D Brunner[1,3], J Goodbeard[2], S Kumar[2], H Khawaja[3], G Boiger[1]
[1]Zurich University of Applied Sciences, Winterthur, Switzerland
[2]Rheonics GmbH, Winterthur, Switzerland
[3]UiT The Arctic University of Norway, Tromso, Norway

Numerical study of explosive welding with an interlayer by using SPH and ALE method
Y Mahmood, P Chen
Beijing institute of technology, Beijing, China

Online signature verification using velocity model
R S Malik, M A U Khan, S S Ahmad
Al Ghurair University, Dubai, UAE

13:00-14:00 Lunch

Saturday 14 December 2019

14:00-15:30 Session 1.3
Modelling Techniques

Chair: G Boiger, ZHAW Zurich University of Applied Sciences, Switzerland

Multi-physics and multi-scale adaptive mesh predictive modelling using machine learning and data assimilation
F Fang[1], R Hu[1], J Zheng[2], J Li[3], M Chen[1], C C Pain[1], I M Navon[4]
[1]Imperial College London, London, UK
[2]Institute of Urban Environment, Chinese Academy of Sciences, Xiamen, China
[3]Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China
[4]Florida State University, Tallahassee, USA

KYAMOS Multiphysics: A cloud-based GPU, InfiniBand Software
A P Papadakis
KYAMOS Limited, Nicosia, Cyprus

Complexity-based machine learning of real-time data of dynamic processes
W Hafez[1], K Aziz[2], I Wattar[2]
[1]Synaptics.io, Toronto, Canada
[2]Al Ghurair University, Dubai, UAE

Intelligent system for rice leaf disease and intensity detection and its cure
M A Anwar
Al Ghurair University, Dubai, UAE

Adaptive mesh Multiphysics modelling
C Pain
Imperial College London, London, UK

15:30-16:00 Break / Posters

Saturday 14 December 2019

16:00-17:30 Session 1.4
Aerospace and Marine

Chair: C Pain, Imperial College London, UK

Transient multiphase CFD simulations to improve fixture design and fluid flow in press quenching of aerospace gears
M Vidoni, M Maigler
Liebherr-Aerospace Lindenberg GmbH, Allgäu, Germany

Simulation of contamination by exhaust emissions from docked marine vessels
A Zubiaga[1], H A Khawaja[2], G Boiger[1]
[1]ZHAW Zurich University of Applied Sciences, Winterthur, Switzerland
[2]UiT The Arctic University of Norway, Tromso, Norway

Fully compressible SPH schemes for UNDEX simulations
R Messahel[1], I Zisis[2], M Moatamedi[1]
[1]Al Ghurair University, Dubai, UAE
[2]TU, Eindhoven, The Netherlands

Multiphysics analysis of CFRP using Charpy in cold temperatures
Z Andleeb[1], C Strand[2], M Ilyas[2], H Khawaja[2], M Moatamedi[3]
[1]Gulam Ishaq Khan Institute of Technology, Topi, Pakistan
[2]UiT The Arctic University of Norway, Tromso, Norway
[3]Al Ghurair University, Dubai, UAE

Bio-based nanomaterials and potential applications in the UAE
J Mao
Al Ghurair University, Dubai, UAE

19:30 Conference Banquet

Sunday 15 December 2019

09:30-11:00 Session 2.1
Advanced Materials

Chair: E Albahkali, King Saud University, KSA

Dynamics of anisotropic break-up in FCC-nanowires
V N Gorshkov[1], P Sareh[2], V V Tereshchuk[3], A S Fallah[4]
[1]Los Alamos National Lab, Los Alamos, USA
[2]University of Liverpool, Liverpool, UK
[3]Igor Sikorsky Kyiv Polytechnic Institute, Kyiv, Ukraine
[4]Brunel University London, London, UK

Experiments and numerical simulations of energetic single crystals under quasi-static uniaxial compression with different initial temperature
W Hu, Y Wu, Z Shao, F Huang, Z Zhang, X Wang
Beijing Institute of Technology, Beijing, China

Influence of the silicone filler on the mechanical response of cellular metals
M Vesenjak[1], I Duarte[2], N Novak[1], L Krstulović-Opara[3], Z Ren[1]
[1]University of Maribor, Maribor, Slovenia
[2]University of Aveiro, Aveiro, Portugal
[3]University of Split, Split, Croatia

Influence of surface treatments in natural fibre reinforced composites
A A Sultan, M A A Al Shehhi, M Aruna
Al Ghurair University, Dubai, UAE

Analysis of diamond crystal characteristics synthesized by different dynamic loading methods
T Yi, S Shi-yuan, W Yuan-wei, H Feng-lei
Beijing Institute of Technology, Beijing, China

11:00-11:30 Break / Posters

Sunday 15 December 2019

11:30 – 13:00 Session 2.2
Fluid Structure Interaction

Chair: T Watanabe, National Fisheries University, Japan

Effect of changing fluid pressure on the ibration and noise of a fiberglass pipe using fluid structure interaction
E AlBahkali[1], Z Almutairi[1], T AlBahkali[1], M Souli[2], H Elkanani[1]
[1]King Saud University, Riyadh, KSA
[2]Laboratoire de Mécanique, Lille, France

Transient response of metallic square plates subject to sequential blasts
N Mehreganian[1], A S Fallah[2], L A Louca[1]
[1]Imperial College London, London, UK
[2]Brunel University London, London, UK

Simulation study on influence of explosive load on safe operation of pipeline
Y He, Z Liu, M Li
Beijing Institute of Technology, Beijing, China

Influence of complex obstacles on the propagation of explosive blast wave
X Li, Z Liu, X Wang, M Li, Y Zhao
Beijing Institute of Technology, Beijing, China

A novel Adaptive Mesh Enlargement method on large-scale impact and explosion problems
T Li, C Wang
Beijing Institute of Technology, Beijing, China

13:00-14:00 Lunch

Sunday 15 December 2019

14:00-15:30 Session 2.3
Heat Transfer

Chair: A Fallah, Brunel University, UK

Numerical modeling of eeating uniformity in microwave single-mode cavities using coupled electromagnetic/heat diffusion equations
E A Ali, R Messahel
Al Ghurair University, Dubai, UAE

Multiphysics study of forced convection conjugate heat transfer (CHT) problem
H Khawaja[1], A Nadem[1], M Moatamedi[2], B Alzahabi[2]
[1]UiT The Arctic University of Norway, Tromso, Norway
[2]Al Ghurair University, Dubai, UAE

Convective transport through layered systems
E Holzbecher
German University of Technology in Oman (GUtech), Muscat, Oman

Numerical investigation of natural convection in an inclined wavy solar collector containing a nanofluid
S Kadri, K Djermane, E Bourbaba, M Elmir, R Mehdaoui
TAHRI Mohamed University, Bechar, Algeria

Study on shock loading pre-processing for freeze-drying
T Watanabe[1], M Nakamura[1], K Shimojima[2], S Tanaka[3], K Hokamoto[3], S Itoh[2]
[1]National Fisheries University, Yamaguchi, Japan
[2]Okinawa National College of Technology, Okinawa, Japan
[3]Kumamoto University, Kumamoto, Japan

15:30-16:00 Break / Posters

Sunday 15 December 2019

16:00-17:30 Session 2.4
Impact and Explosions

Chair: F Fang, Imperial College London, UK

Experimental and numerical investigation of the effect of key factors on Deflagration to Detonation Transition (DDT) of HTPB propellant
F Zhen, L Wang, Z Wang
Beijing Institute of Technology, Beijing, China

Meso-scale failure simulation of polymer bonded explosive with initial defects by the numerical manifold method
G Kange, P Chen, Y Ning
Beijing Institute of Technology, Beijing, China

Experimental and numerical study on the flame propagation and overpressure prediction of unconfined gas explosion
M Li, Z Liu, X Li, Y Zhao, P Li
Beijing Institute of Technology, Beijing, China

Hierarchical surface instabilities in the granular medium subject to explosion
X Shi, L Liu, K Xue
Beijing Institute of Technology, Beijing, China

A modified mesoscopic reaction rate model for shock initiation of PBX explosives
Z Bai[1], Z Duan[1], L Wen[2], Z Zhang[3], Z Ou[1], F Huang[1]
[1]Beijing Institute of Technology, Beijing, China
[2]Ministry of Environmental Protection, Beijing, China
[3]National University of Defense Technology, Changsha, China

17:30 Close of Conference

Posters

CFD modelling of pollutant transport from a docked marine vessel
S K Madsen[1], Z Asier[2], H A Khawaja[1], G Boiger[2]
[1]UiT The Arctic University of Norway, Tromso, Norway
[2]ZHAW Zurich University of Applied Sciences, Winterthur, Switzerland

Comparative study on projectile penetration into different strength concrete targets
X Zang, H Wu, S Zang, F Huang
Beijing Institute of Technology, Beijing, China

Damage characteristics of rod-like jet impacting on spaced multi-plate structure at hypervelocity
C Shang, Qi Zhang, Y Lu, W Liu, X Zhong, Y Pei, X Guo
Beijing Institute of Technology, Beijing, China

Dynamic spherical cavity expansion analysis of concrete/rock based on Hoek-Brown criterion
H Dong, H Wu, J Li, A Pi, F Huang
Beijing Institute of Technology, Beijing, China

Experimental and numerical investigation of oblique perforation of truncated Ogive-Nosed projectiles with elliptic cross-section in double-layered steel plate with gap space
H Wang, X Pan, H Wu, A Pi, J Li, F Huang
Beijing Institute of Technology, Beijing, China

Experimental research on penetration behavior of rective material fragment folded in steel jacket impacting double-spaced aluminum plates
P Jun
Xi'an Modern Chemistry Research Institute, Xi'an, China

Flow and heat transfer investigation on forward facing step flow using Cu-water nanofluid
R Kanna, S A Theibeche, H Shahid
Al Ghurair University, Dubai, UAE

Heat shock loading by liquid nitrogen to parasite
T Watanabe[1], M Nakamura[1], H Ohta[1], K Shimojima[2]
[1]National Fisheries University, Yamaguchi, Japan
[2]Okinawa National College of Technology, Okinawa, Japan

Microstructure evolution and mechanical properties of 5083 Al-1050A Al-Q235A plate fabricated by explosive welding
Q Zhou, P Chen
Beijing institute of technology, Beijing, China

Multiphysics study of infrared thermography (IRT) applications
Z Andleeb[1], M Ilyas[1], H Khawaja[2], M Moatamedi[3]
[1]Ghulam Ishaq Khan Institute of Engineering Sciences and Technology, Topi, Pakistan
[2]UiT The Arctic University of Norway, Tromso, Norway
[3]Al Ghurair University, Dubai, UAE

Optimisation and application of Hall effect sensor
B Elhouaria, K Syham
TAHRI Mohamed University, Bechar, Algeria

Penetration of rod-like jet into thick concrete target
Y Lu, Q Zhang, C Shang, W Liu, X Zhong, Y Pei, X Guo
Beijing Institute of Technology, Beijing, China

Phase change phenomena of water under decompression state
T Watanabe[1], M Nakamura[1], H Ohta[1], K Shimojima[2]
[1]National Fisheries University, Yamaguchi, Japan
[2]Okinawa National College of Technology, Okinawa, Japan

Simulations and analysis of the propagation of turbine blade fissuring
S Bennoud, A Allali
University of Saad Dahlab, Algeria

Thin vessel detection for improved retinal vessel segmentations
S Sohail, M A U Khan, S S Ahmad
Al Ghurair University, Dubai, UAE

SESSION 1.1

KEYNOTE ADDRESS & SYNOPSIS

SATURDAY, 14 DECEMBER 2019
09:30 – 11:00

CHAIR

M Moatamedi
The International Society of Multiphysics

Saturday, 14 December 2019
09:30 – 11:00

Keynote Address

FEM and Particle methods for Industrial Applications

Professor M Souli
University of Lille
Lille, France

For simulation of Fluid Structure Interaction problems classical FEM (Finite Element Method) and FVM (Finite Volume Method) were the main formulations used by engineers to solve these problems. For the last decades, new formulations have been developed for fluid structure coupling applications using mesh free methods as SPH (Smooth Particle Hydrodynamic) method, and DEM (Discrete Element Method). Up to these days very little has been done to compare different methods and assess which one would be more suitable. In this presentation the mathematical and numerical implementation of the FEM and SPH formulations for hydrodynamic problem are described. From different simulation, it has been observed that for the SPH method to provide similar results as FEM Lagrangian formulations, the SPH meshing, or SPH spacing particles needs to be finer than FEM mesh.

SESSION 1.2

MULTIPHYSICS APPLICATIONS

SATURDAY 14 DECEMBER 2019
11:30 – 13:00

CHAIR

B Alzahabi
Al Ghurair University
UAE

On the equivalence of a system dynamic method for modelling Multiphysics systems and the Tetrahedron-of-State-Concept within the Bond graph modelling approach

G Boiger
ZHAW Zurich University of Applied Sciences, Winterthur, Switzerland

A system-dynamic method, best suited to model simple, yet highly dynamic multiphysics-systems has been investigated and re-organised such that a 1:1 equivalence to the tetrahedron-of-state-concept within the well known bond graph modelling approach can be stated. While in 'bond graph literature' Gibbs fundamental equation is usually cited merely in the context of modelling thermodynamic systems, it can be shown that Gibbs fundamental concept constitutes the basis and justification for modelling any multiphysics-system with either bond graph- or system-dynamic methodology.
Thus both approaches are valid for linear- and angular-mechanical-, electrodynamic-, hydraulic/pneumatic- and with limitations concerning the concept of inertance/inductivity for thermodynamic- and chemical-systems. While being most practical and efficient for zero or one-dimensional problems, there is no theoretical limitation towards modelling two or three-dimensional cases with either method. Upon deeper investigation it becomes obvious that a thorough definition of the analogies and differences between capacitive- and inductive-systems is essential for working out the compatibility of system-dynamic approaches to the somewhat older and better-established bond graph methods.
Furthermore it can be shown that if capacitive- and inductive-systems are clearly distinguished, typical system-dynamic elements such as containers filled with conservative quantities, capacities, inductivities, potentials, equations of state and fluxes, find their related counterparts within the tetrahedron-of-state-concepts of momentum, displacement, general flow, effort, resistance, inertance and compliance non-respectively. Selected examples of first order capacitive-inductive, mechanical-, fluid- and electro-dynamic-systems, serve well to demonstrate the easy applicability, efficiency as well as general validity of the modelling-concepts in discussion.

System dynamic modelling, tetrahedron of state, bond graphs, inductivity, inertance, multiphysics-systems

A fast and accurate optic disc localization method for pathologically damaged retinal fundus images

M A U Khan, K I Aziz, S S Ahmad, R Kanna, M Moatamedi, B Alzahabi
Al Ghurair University, Dubai, UAE

Automated detection and localization of an optic disc (OD) in retinal fundus images plays an important supporting role in the analysis of digital diabetic retinopathy diagnosis systems. Majority of OD localization techniques through accurate suffer from high computational cost (few minutes/image). A retinal image displays a network of blood vessels emerging from a brightest circular region, referred to as optic disc (OD). The vessels show a strong vertical trend near the optic disc and become mostly horizontal as we move away from the optic disc to the periphery. Exploiting the fact, an ultra-fast optic disc location algorithm is recently introduced. The method resulted in search space reduction and consists of projection on horizontal and vertical axes. The detection time reduces to a few seconds/image but faces robustness issue while dealing with retinal images where OD region is blurred or the image contains bright exudates. The failure is due to the reason that projection results in multiple peaks that required including geometric features like brightness and shape to come up with one unique peak, and thus got an increase in the computation time. This paper describes a modification to the original algorithm, where the horizontal projection is followed with a fast Hough transform that finds circular objects which takes into account shape and brightness clues both in one compact algorithm with least amount of time. The modified algorithm was tested and found to be computationally effective against blurred and badly-illuminated images. Simulation tests were performed on a publicly available DRIVE, STARE, MESSIDOR databases. The proposed method achieves an average accuracy of 97.7% for localization with an average time of 25 seconds/image.

Optic Disc, retinal images, horizontal projection, computationally efficient

Investigation of modal distortion and temporal effects in torsional resonators

D Brunner[1,3], J Goodbeard[2], S Kumar[2], H Khawaja[3], G Boiger[1]
[1]Zurich University of Applied Sciences, Winterthur, Switzerland
[2]Rheonics GmbH, Winterthur, Switzerland
[3]UiT The Arctic University of Norway, Tromso, Norway

Monitoring fluid properties such as viscosity and density is crucial in many industrial processes. Sensors based on mechanical resonators allow monitoring the viscosity online, which enables a fast measurement times in order to maintain process quality and stability. To develop these sensors, accurate models are needed to optimize design and to gain a better understanding of their functioning.
In a previous study, a tubular sensor has been investigated. It consists of a thin-walled tube which is excited in torsional vibrations. Experiments have been conducted and compared with a steady state model of the fluid-solid interactions that determine the behavior of the sensor. These agreed well with measured characteristics of the sensor ta low viscosities, but showed a significant deviation at high viscosities. It is not clear whether this was due to modal distortion or to temporal effects. This study investigates the cause of these deviations at high viscosities by means of numerical simulations. This more detailed model accounts for temporal and well as fluid-structure interactions. Simulations are conducted in LS-DYNA and MATLAB to model the fluid-structure interaction to determine the impact of the fluid on the torsional mode as well as to include temporal effects.

Viscometer, viscosity sensor, viscosity measurement, mechanical resonator, torsional resonator, fluid-structure interaction

Numerical study of explosive welding with an interlayer by using SPH and ALE method

Y Mahmood, P Chen
Beijing institute of technology, Beijing, China

Explosive welding is a useful technique for joining different or similar metal alloys that are not easily welded by any other means of welding. Welding quality can be improved by introducing an interlayer in parallel plate combination. The interlayer is inserted between two parallel plates (called flyer and base) that need to be welded. During this welding process, two different interfaces are formed with different shapes (i) flyer-interlayer interface (ii) interlayer-base interface. Similarly, the energy dissipation, pressure and plastic strain during impact are divided into two interfaces. Since explosive welding is a rapid event, and it is difficult to measure these parameters by experiment, therefore, simulation is one of the best tools for evaluating these parameters.
In the present study, an explosive welding process with an interlayer was simulated with the help of smoothed particle hydrodynamics (SPH) formulation along with Euler-Arbitrary Lagrangian Eulerian (ALE) coupling. All calculations were done in ANSYS Autodyne software. For this purpose, a modified density-based JWL equation of state was used for ANFO explosive. Two titanium (grade 2) plates in the presence of Ti6Al4V interlayer were simulated. The numerical analysis showed that the flyer-interlayer interface had a flat shape while interlayer-base had the regular wavy pattern. Moreover, the pressure, temperature and plastic strain at both interfaces satisfied the required welding conditions. In addition, an experiment was performed to confirm the simulation results. The comparisons revealed that the simulated and experimental results were in good agreement with each other.

Explosive welding, interlayer, JWL equation of state, simulation

Online signature verification using velocity model

R S Malik, M A U Khan, S S Ahmad
Al Ghurair University, Dubai, UAE

Conventional signature tablets provide outputs in the form of shape and velocity signals. Previously strokes for signature identification are extracted with the help of minima of the velocity signal. However, the resulting strokes are larger and complicated in shape and thus make the subsequent job of generating a discriminative template for verification purposes challenging. We investigate a new stroke-based algorithm that splits the velocity signal into three bands, that is, low, medium and high. Strokes are extracted with the help of these band and result in which are smaller and simpler in nature. Training of our proposed system revealed that low and high-velocity bands of the signal are unstable, whereas the medium-velocity band can be used effectively for discrimination purposes. Euclidean distances of strokes extracted on the basis of medium velocity band are helpful in developing template used for verification purpose. The experiments conducted show improvement in the discriminative capability of the proposed stroke-based system.

Velocity, signature, strokes, euclidean distance

SESSION 1.3

MODELLING TECHNIQUES

SATURDAY 14 DECEMBER 2019
14:00 - 15:30

CHAIR

G Boiger
ZHAW Zurich University of Applied Sciences
Switzerland

Multi-physics and multi-scale adaptive mesh predictive modelling using machine learning and data assimilation

F Fang[1], R Hu[1], J Zheng[2], J Li[3], M Chen[1], C C Pain[1], I M Navon[4]
[1]Imperial College London, London, UK
[2]Institute of Urban Environment, Chinese Academy of Sciences, Xiamen, China
[3]Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China
[4]Florida State University, Tallahassee, USA

Multi-physics problems (e.g. flooding, chemical processes) typically have important dynamics that operate over a range of length scales. The use of adaptive unstructured meshes in multi-physics modeling can provide accurate results since the mesh is dynamically adapted according to the evolving physical features. That is, the mesh resolution can be adjusted dynamically to simulate the physical process accurately and effectively. We will demonstrate the capability of multis-scale adaptive modelling for urban environmental problems (flooding, air pollution, for example). Two flooding scenarios are used to assess the performance of a newly developed adaptive mesh flood model (Floodity): the Glasgow's urban flooding event of 2002 and the joint flooding events in Greve, Denmark. The results with use of adaptive meshes have been compared to those from existing models. It has been found that Floodity is able to provide relatively accurate results while the computational cost is reduced by 20 - 88% in comparison to fixed mesh models.
We also present new numerical techniques such as, machine learning (ML), reduced order modelling (ROM) and data assimilation (DA), for real-time operational modelling and uncertainty analysis. Having the compatibility of ML and ROM will be nothing short of revolutionary for a large number of disciplines. Here the capabilities of ML-ROMs have been demonstrated in air pollution, urban flows, ocean, flood prediction. The combination of ROM, ML and DA enables a rapid and accurate modelling response in emergencies.

Multi-physics, adaptive unstructured meshes, machine learning, reduced order modelling, data assimilation

KYAMOS Multiphysics: A cloud-based GPU, InfiniBand Software

A P Papadakis
KYAMOS Limited, Nicosia, Cyprus

Recently, there has been an increased interest in the simulation of engineering multiphysics problems. This interest is driven by the need to solve engineering problems quickly and efficiently during the design process and save money and resources by building engineering products and optimizing them. As a result, the Computer Aided Engineering (CAE) industry has been formed which offers solutions both of free and proprietary licensing. The CAE industry is currently of the order of €8 Billion and has an annual growth rate of 10-12% and it is expected to reach €14 Billion by 2025. In this paper, we provide an introduction of the CAE industry, the various companies that form the industry, the major players, their strengths and weaknesses, the algorithms they use, the problems they solve, the market share, any opportunities that arise, the current and future trends. We discuss the various software and companies out there and methods they use. Then, we analyze the current state of KYAMOS software, at which stage we are currently in and where we want to be and how we place ourselves in the market. Next, we present the development of a new innovative Finite Volume-Total Variation Diminishing method that could potentially be commercialized for the CAE industry. We present the theory behind our KYAMOS solvers and discuss the advantages and disadvantages of our methods and future steps towards commercializing our product. For comparison purposes, we compare a serial and parallel version of the code using the Message Passing Interface (MPI) and show the advantages of using this technique. We conduct simulations in terms of validation and accuracy by running benchmark test cases such as square wave propagation, shock on a wedge test and explosion simulations, where analytical solution is available. We demonstrate the ability of the algorithm to capture the shock gradients accurately free from non-physical oscillations. We also demonstrate the various boundary conditions implemented in the simulation and test its validity. Additionally, we demonstrate and test the Finite Element Galerkin parallel method using MPI and its ability to solve elliptic problems. It is found that the developed algorithms perform superior to existing solvers and could potentially be used for marketing purposes in the KYAMOS software.

This work was co-funded by the European Regional Development Fund and the Republic of Cyprus through the Research and Innovation Foundation (Project: START-UPS/0618/0058)

High performance computing, Multiphysics, software, message passing interface, CUDA aware MPI, cloud computing, InfiniBand

Complexity-based machine learning of real-time data of dynamic processes

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Advanced data analytics and machine learning are increasingly adopted in process industries (energy, oil and gas and manufacturing) as part of Asset Optimization (AO) programs. A crucial role of AO is to reduce the risk and cost of unplanned shutdown through predictive multiphysics models of process assets (gas compressors, turbines, heat exchangers), also known as Digital Twins.
This paper presents a "robust" machine learning algorithm that overcomes key robustness issues of state-of-the-art machine learning paradigms, including Deep Neural Networks (DNN).
The algorithm utilizes predictive dynamic models, complexity-based regularization and real-time sensory data in order to support "reliable" asset optimization. The paper focuses on learning parsimonious causal representation of diagnostic relations between real-time sensory data and process faults (for monitoring and incipient-fault detection of critical process assets).
The learning algorithm is illustrated using benchmark industrial processes (from chemical, manufacturing and energy-generation industries). The examples demonstrate how the machine learning algorithm takes advantage of:
1. Multiphysics dynamic models (as expert hints) that support capturing of ensemble causal relations, and avoiding coincidental causality in sample datasets (as in the case of DNN).
2. Complexity measures to address ill-posedness and provide robust generalization. The complexity measure used in this paper is the hardware-based decomposed function cardinality (DFC) which is equivalent to Kolmogorov complexity measure of program length (and Minimum-Description Length MDL). It is directly related to Occam's Razor principle.
The paper also outlines an approach for automatically extracting minimal set of features from real-time data of dynamic processes.

Machine learning, complexity measure, neural networks, dynamic systems, asset optimization

Intelligent system for rice leaf disease and intensity detection and its cure

M A Anwar
Al Ghurair University, Dubai, UAE

This is a fundamental fact that crops productivity contributes to the economy of agricultural countries and therefore require more efforts in increasing the crops yields by investing in every aspect to achieve the targets. The crops yield is dependent on many things including the diseases and hence the early disease identification or prediction and cure will play a role in increasing the crops yield. The image processing technology could effectively be used in the detection as well as in estimating the intensity of the diseases. This paper presents an efficient algorithm to detect the rice leaf disease and its intensity necessarily required to decide for curing measures. The K-Mean algorithm alone is not sufficient for clustering the different colors in an image and when used with Gaussian Mixture approach produces good results. The proposed respective appropriate algorithm will be applied on each of three rice leaf diseases; Bacterial Leaf Blight, Brown Spot, and Leaf Smut for testing the efficacy and efficiency.
There system will facilitate the farmers with the support of centralized corporate system to detect the disease and its intensity and thereafter suggestion for cure. The farmer will acquire the images of the rice leaves affected by the diseases using mobile and will submit the system. The system consists of four active modules (i) Image Acquiring Module, (ii) Disease and Intensity Detection Module, (iii) Cure Recommendation Module, and (iv) Stakeholders Communication Module.
An additional part of the system is Data Warehousing and Reporting Module that will store the historical data about diseases and cures and then be used for case-base analysis.

MATLAB, image segmentation, HSV, clustering

Adaptive mesh Multiphysics modelling

C Pain
Imperial College London, London, UK

Here we present an adaptive unstructured mesh model for multi-physics, for example, radiation transport/neutronics, thermal hydraulics/multi-phase flows, and solids mechanics modelling. We present the coupling of these models together with their applications which now cover a range of industrially important, multi-physics phenomena including: ocean and atmospheric prediction, pollution dispersion through urban environments, single and multi-phase flows. To maximize computational efficiency and accuracy, we employ adaptive mesh resolution to perform some of the multi-scale modelling in which the finite element / control volume meshes are optimized to represent the physics. It is shown how errors in the overall solution can be calculated and how this approach can also be used to generate error measures to guide mesh adaptivity/numerical resolution.
The model Fluidity (developed by AMCG, Imperial College London) is used for the CFD. It is a multi-phase model based on arbitrary unstructured finite element meshes and has an anisotropic dynamic mesh adaptivity capability. This allows us to resolve highly complex geometries.
We outline future research directions in multi-physics modelling, an approach to adaptive multi-scale modelling and how this may be linked to predictive modelling including uncertainty quantification, data assimilation and reduced order, or rapid, modelling.

Adaptive meshes, Multiphysics

SESSION 1.4

AEROSPACE AND MARINE

SATURDAY 14 DECEMBER 2019
16:00 - 17:30

CHAIR

C Pain
Imperial College London
UK

Transient multiphase CFD simulations to improve fixture design and fluid flow in press quenching of aerospace gears

M Vidoni, M Maigler
Liebherr-Aerospace Lindenberg GmbH, Allgäu, Germany

Press quenching is a specialized heat treatment process used in the production of carburized gears that allows constraining distortion within a very tight range. This allows aerospace designers to optimize gear performance and weight but is a challenge for manufacturing.
In press quenching heated components are loaded in a press that delivers a quenching fluid, typically oil, to the component surface and constrains the geometry with a quenching fixture specifically designed for each part. Currently fixtures are designed based on empirical experience and on a large number of pre-production tests. The distribution of the oil speed on the component surface and of the wetting time have a relevant effect of the achieved component dimensions and distortion at the end of the quenching process.
This work presents a computational fluid dynamics (CFD) study where the transient multiphase oil-air flow in the initial stage of the quenching process is simulated using ANSYS Fluent®. The fixture geometry is simplified and the mesh optimized to achieve an acceptable computational time. Alternative fixture geometries and oil input flows are compared for an example component. The resulting fixture fill up sequence and the oil distribution in the fixture is compared for different cases. The model is validated with experiments. The results were useful to select a fixture design for production experiments and the simulations performed represent the first steps towards a multiscale and multiphysics simulation of the process.

Heat treatment simulation, press quenching, distortion, multiphase flow, CFD, aerospace gears

Simulation of contamination by exhaust emissions from docked marine vessels

A Zubiaga[1], H A Khawaja[2], G Boiger[1]
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[2]UiT The Arctic University of Norway, Tromso, Norway

Plumes emissions from industrial activities and chimneys of large boats can carry a number of pollutants to nearby cities causing a detrimental effect on the life quality and health of local citizens and ecosystems. Carbon dioxide (CO2) is the main by-product in exhaust plumes. Although it does not have any health effect, it is well-known its influence on the climate warming, in addition, the fluid-dynamics behaviour of CO2 is representative for any gas pollutant in the plume. The main pollutants are waste products of the industrial activity or the combustion processes, mainly carbon monoxide (CO), nitrogen and sulfur oxides (NOx, SOx) in gas phase and solid particulate matter.
In the present work, we have made a comprehensive study of the effect that CO2 plumes from the harbour of Tromsø (Norway) have in the contamination levels in the city. We have used computational fluid dynamics modelling of CO2 transport and diffusion in air. OpenFOAM® has been used for the simulation of the gas mixture. The Navier-Stokes equation has been solved including compressibility effects of perfect gases and buoyancy effects. Turbulence effects have been treated within the k- model of the Reynolds Averaged Navier–Stokes (RANS) equations. The simulation workflow has been improved by developing a steady-state solver that overcomes the inefficiency of the transient calculation when it comes to calculate long time effects. The effects of solid pollutants will be addressed using a Lagrangian solver to describe the transport within the plume.
The influence of the wind speed and direction, as well as, the height of the chimneys in the distribution of CO2 and pollutants has been studied comprehensively. The parameter studies have been run in the online platform KALEIDOSIM®. The presented results will help to evaluate the impact of the CO2 emissions in the everyday life of local citizens.

Computational fluid dynamics, lagrangian, contamination, plume, high performance computing

Fully compressible SPH schemes for UNDEX simulations

R Messahel[1], I Zisis[2], M Moatamedi[1]
[1]Al Ghurair University, Dubai, UAE
[2]TU, Eindhoven, The Netherlands

Simulation of underwater explosion (UNDEX) problems becomes more and more the focus of computational engineering in the naval industry, where multi-material arbitrary-Lagrangian-Eulerian methods (MM-ALE) are dominant. Although standard mesh-less weakly compressible Smoothed Particles Hydrodynamics (SPH) formulations have been developed for such applications, it seems to have severe limitations in terms of robustness: firstly, it is limited to low-density ratio problems; secondly, it requires the calibration of constant parameters in the classical Monoghan-type artificial viscosity resulting in a problem-dependent approach.
It is this study, we propose to demonstrate the robustness of the fully compressible SPH (FC-SPH) schemes to solve UNDEX problems and to investigate the influence of the different artificial dissipation parameters on the numerical solution. In the absence of an analytical solution, the FC-SPH results are compared to the MM-ALE approach results that have already been validated and successfully used to model several complex compressible multi-phase phenomena including UNDEX problems.

Fully compressible, Smoothed Particle Hydrodynamics, shock wave, underwater explosion

Multiphysics analysis of CFRP using Charpy in cold temperatures

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[2]UiT The Arctic University of Norway, Tromso, Norway
[3]Al Ghurair University, Dubai, UAE

Carbon fiber reinforced polymer (CFRP) composites have emerged as a major class of structural materials and have significant potential use as a substitution for metals in aerospace, marine, automotive, and architecture due to their higher-strength-to-weight-ratio. CFRP is well-suited for various applications, but their mechanical properties such as 'low-velocity impact resistance' are not well-studied.
In this study, the low-velocity impact resistance of CFRP composites was investigated with the help of Charpy tests. The CFRP samples were tested at room temperature and at low temperature (-20°C). The experimental results indicated about 10% drop in energy-absorbing capability of CFRP samples at low temperatures in comparison to room temperatures.
The experimental results obtained for the room temperature were validated through finite element simulations using ANSYS® Workbench Explicit Dynamics. The CAD model is built accordingly to the dimensions of the experiments. The model is applied with appropriate material properties, initial and boundary conditions. The mesh sensitivity analysis is performed to improve the accuracy of the finite element model. The numerical results helped to narrow down on the CFRP material properties that change with temperatures.

CFRP, Charpy test, low temperature, numerical Analysis, ANSYS

Bio-based nanomaterials and potential applications in the UAE

J Mao
Al Ghurair University, Dubai, UAE

The current environmental concerns generate an increasing interest in the production and processing of high-value materials and polymers from lignocellulosic biomass. Among these, nanocellulose has received in the last decade a strong academic and industrial attention due to its advantageous properties, such as high mechanical strength, high surface area, and biocompatibility. It also lends itself to a wide range of surface functionalization and can self-assemble into interesting liquid crystalline structures. Nanocellulose has shown a great potential in a variety of applications from the automotive and packaging industries to water desalination and tissue engineering. This presentation will introduce nanocellulose as a unique topic in the Middle East and discuss its potential in the UAE.

Nanomaterials, nanocellulose, bio-based polymers

SESSION 2.1

ADVANCED MATERIALS

SUNDAY 15 DECEMBER 2019
09:30 – 11:00

CHAIR

E Albahkali
King Saud University
KSA

Dynamics of anisotropic break-up in FCC-nanowires

V N Gorshkov[1], P Sareh[2], V V Tereshchuk[3], A S Fallah[4]
[1]Los Alamos National Lab, Los Alamos, USA
[2]University of Liverpool, Liverpool, UK
[3]Igor Sikorsky Kyiv Polytechnic Institute, Kyiv, Ukraine
[4]Brunel University London, London, UK

Nanowires are known to be thermally unstable and may break up into chains of nanoparticles at temperatures well below their melting point. This phenomenon is reminiscent of the well-known Rayleigh-Plateau instability of liquid jets, when periodic sausage-like perturbations of the jet surface increase with time. The corresponding nanowire/jet shape modifications must be followed by a decrease in total surface energy. However, unlike isotropic liquid jet surfaces, the realization of this abatement in the system with a strong lattice structure and physical dissimilarity of bounding facets, leads to specific features of nanowire break-up viz. significant variations in the average distance between “nano-drops” and their size, the formation of long-living dumbbells, and zigzag-like structures. We have here analyzed the physical mechanisms of such diversity. The results obtained are valuable from the fundamental scientific viewpoint as well as being potentially useful in applications e.g. in fabrication of optical waveguides based on ordered nanoparticles chains.

Nanowire, Nanoparticle, thermal instability, Rayleigh-Plateau, dumbbell, surface energy

Experiments and numerical simulations of energetic single crystals under quasi-static uniaxial compression with different initial temperature

W Hu, Y Wu, Z Shao, F Huang, Z Zhang, X Wang
Beijing Institute of Technology, Beijing, China

Uniaxial compression tests for energetic single crystals (RDX and HMX) have been conducted to investigate deformation behavior at different initial temperatures in the range of 173-348K. Large energetic single crystals were grown and recrystallized using acetone-solvent slow evaporation method, and then was polished to cylinders at a speed of 50 r/min using a polishing machine. The stress-strain curves show obvious temperature softening effects. With the increase of temperature, the fracture stress of the crystal decreases and the energetic single crystals exhibit more ductility than brittleness. Shear fracture modes can be observed for RDX and HMX single crystals at room temperature, in which case smeared micro-cracks are formed resulting in transparent single crystal being crushed into pieces. (210) RDX single crystals are most susceptible to cleavage fracture along the (010) orientation. The HMX single crystals are mainly cleaved along the (011) orientation. Moreover, the mechanical behavior of HMX shows obvious anisotropy. (100) HMX single crystal has the largest resolved shear stress showing strong fracture, while (011) HMX single crystal is dominated by plastic slip with the highest fracture stress. A mesoscale damage model has been developed based on the finite element software ABAQUS, which considers nonlinear elasticity, dislocation-based crystalline plasticity, temperature-dependent parameters and shear fracture. The simulated stress–strain curves agree well with experimental results, which show that the model can well describe the deformation behavior at different temperatures under uniaxial compression for energetic single crystals.

Energetic single crystals, temperature softening effects, shear fracture, anisotropy, damage model

Influence of the silicone filler on the mechanical response of cellular metals

M Vesenjak[1], I Duarte[2], N Novak[1], L Krstulović-Opara[3], Z Ren[1]
[1]University of Maribor, Maribor, Slovenia
[2]University of Aveiro, Aveiro, Portugal
[3]University of Split, Split, Croatia

Cellular metals are being increasingly used in industrial applications, due to their unique advantages, like high specific stiffness, high capacity of energy absorption, good damping behaviour and excellent heat insulation. However, with increased porosity the overall stiffens and energy absorption capacity of cellular metals significantly decreases due to geometrical effects. This can be alleviated in case of open-cell cellular metals by introducing various cell fillers. This study thus investigates the effect of using a silicon filler in combination with different types of cellular metals with open-cell morphology (e.g. aluminium foam, auxetic copper structure) on the mechanical behaviour of such hybrid structures. The non-hybrid and hybrid specimens were fabricated and experimentally subjected to quasi-static and dynamic compressive loading conditions. The mechanical behaviour and the energy absorption properties of the hybrid structures were determined with comprehensive analysis of numerous experimental tests. The advantageous influence of the silicon filler has been confirmed and quantified. A more ductile behaviour and higher energy absorption capacity has been observed by introducing the silicon filler into open-cell cellular metals.

Cellular metals, open-cell morphology, cell filler, silicone, compressive tests, mechanical properties

Influence of surface treatments in natural fibre reinforced composites

A A Sultan, M A A Al Shehhi, M Aruna
Al Ghurair University, Dubai, UAE

There have been numerous endeavors to replace synthetic fibers with natural fibers in fiber reinforced composites, due to increasing environmental alertness and diminution of oil assets. The information that natural fibers are existing inexpensively and in plenty, being biodegradable and low density, have driven many scientists throughout the world to reconnoiter their application potential in several industrial segments. Nevertheless, natural fibers also require some confines such as high moisture absorption and subsequent swelling and degradation, poor chemical and fire resistance, high dispersion of mechanical properties, poor interfacial interactions with polymeric matrices. Consequently, there is an enormous concern to modify the surface of natural fibers through many techniques, in order to overcome their intrinsic downsides and to effectively utilize these materials in different applications. The chemical treatment of fiber is intended at improving the adhesion between the fiber surface and the matrix. Modification in fiber surface results with increase in fiber strength. This study compares the result of different types of surface treatments of natural fibrous materials, chiefly Calotropis procera and Sisal fibers, on the mechanical properties of fiber composites. The application of surface treatments on fibrous materials can improve the compatibility with composite materials.

Surface treatments, Calotropis procera fibre, Sisal fibre, fiber-reinforced composites, mechanical properties

Analysis of diamond crystal characteristics synthesized by different dynamic loading methods

T Yi, S Shi-yuan, W Yuan-wei, H Feng-lei
Beijing Institute of Technology, Beijing, China

The crystal characteristics of the diamond samples that are synthesized by several dynamic loading methods, i.e., explosion and impact, have been characterized by XRD and TEM and compared with the diamonds synthesized by static high-temperature and high-pressure methods. The crystal lattice integrity of the diamonds synthesized by the dynamic load methods is poor, and the diamonds possess the characteristic of polycrystalline coalescence. Similar to the static diamonds, the diamonds synthesized by the methods of plane shock wave and detonation products are also single cubic crystal, while the diamonds synthesized by the methods of axial symmetry shock wave and direct detonation have different proportions of cubic and hexagonal crystal structures. The reasons for the formation of these properties have been studied by analyzing the synthesis process and technical characteristics. The results are helpful for the reasonable application of these diamond products, and also have some significance in deepening the understanding of the synthesis mechanism of different dynamic loading methods.

Dynamic loading methods, XRD, TEM, crystal characteristics

SESSION 2.2

FLUID STRUCTURE INTERACTION

SUNDAY 15 DECEMBER 2019
11:30 – 13:00

CHAIR

T Watanabe
National Fisheries University
Japan

Effect of changing fluid pressure on the ibration and noise of a fiberglass pipe using fluid structure interaction

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[2]Laboratoire de Mécanique, Lille, France

A fluid structure interaction (FSI) simulations are performed to study natural frequencies and their amplitudes for a fiberglass pipe. The finite element (FE) for the model is built using eight-node elements. A large number of elements are used to ensure the conversion of FE results. The boundary conditions for pressure and flow rates were set according the normal operation condition of a real station pipe line. Conformity of results validity was done by comparing the pressures at pump branches to the found simulated results. The velocity of fluid flow, and the resultant pre-stress contour extracted by a co-simulation run for both computational fluid dynamics (CFD) and structure analysis are computed to solve this problem. The natural frequencies and their amplitudes at five different positions are extracted from the simulation. Running the simulation at two different flow pressures, the results show that when the pressure is reduced, the dominated natural frequencies are shifted, and their amplitudes are almost eliminated. It is also noticed that the noise is reduced to normal level. Finally, the amplitude in the longitudinal axis is affected by the main header line supply pipe and high pressure respectively.

Natural frequency, pressure, amplitude, fiberglass pipe

Transient response of metallic square plates subject to sequential blasts

N Mehreganian[1], A S Fallah[2], L A Louca[1]
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[2]Brunel University London, London, UK

Several numerical models along with an analytical one are developed for a comparative study on the response of monolithic, ductile, isotropic square plates subjected to multiple close-in blasts applied sequentially. Notably, extensive pressure pulse generated from a single charge of this blast type results in inherently localised response, leading potentially to failure and damage in the square panels. However, due to the interference of blast waves from consecutive detonation of charges, various spectra of deformation may occur, whereby large or small transverse deformations are anticipated.
The numerical simulations were carried out using the co-simulations and Fluid-Structure Interaction (FSI) techniques, such as Coupled Eulerian Lagrangian one, in order to investigate: (i) the air wave superposition from the multiple blast charges i.e. the pressure profile (spatial and temporal), (ii) the effect of time lag between the blasts, (iii) the spectrum of impulse density (impulse per unit area) along the plate's characteristic lengths and their influence on the total response (transient and permanent deformation) of the plate. The results are also compared against a single blast pressure pulse which would virtually result in identical permanent deformation.
Within the scope of this work an analytical model is developed by considering a piecewise multiplicative function of spatial and temporal parts representative of the localised blasts and investigated. Using a kinematically admissible velocity profile and considering a rigid, perfectly plastic plate, the theoretical model was developed by retaining the influence of finite displacements while ignoring visco-plasticity. It is anticipated that the results obtained using the methods developed and adopted would enhance our understanding of the influence of multiple blast phenomena for design purposes.

Fluid Structure Interaction (FSI), sequential blast, localised blast, wave superposition, multiple charges

Simulation study on influence of explosive load on safe operation of pipeline

Y He, Z Liu, M Li
Beijing Institute of Technology, Beijing, China

Pipelines transportation is one of the most essential means of oil, gas and water transport mode. Many construction operations including blasting and excavation operations often encounter near the pipelines. In order to study the impact of explosive load on the safe operation of pipelines, a series of experiments were designed to find out the damage law of the pipeline. In these experiments, four distances of 0 mm, 100 mm, 200 mm, and 500 mm were set to simulate the effects of the explosion on the pipeline during the explosion. The pipeline is always buried in the soil or exposed to the air. Therefore, air and soil are selected as the medium between the explosion source and the pipeline, and the internal medium of the pipeline is also selected with or without pressure. In this study, the TNT dose of the pipeline rupture was studied for different media and different distances. The simulation results show that in the soil, as the distance increases, the dose of TNT required for the collapse of the pressurized pipeline increases sharply. When the distance is 0 mm, 200 g of TNT will rupture the tube, and at a distance of 100 mm, 7.5 kg of TNT is required. Under the same TNT dose, the damage of the pressurized pipeline is less than that of the unpressurized pipeline, and the degree of pipeline damage buried in the soil is less than that of the pipeline exposed to the air. These results indicate that the pressurized pipeline buried in the ground can operate better in the face of the impact of the explosion. This has a certain significance for the long-term safe and effective use of pipelines.

Pipeline, explosive destruction, TNT, safe operation

Influence of complex obstacles on the propagation of explosive blast wave

X Li, Z Liu, X Wang, M Li, Y Zhao
Beijing Institute of Technology, Beijing, China

When explosion accident occurs in large places where people and buildings are relatively dense, the existence of complex obstacles may cause special changes on the propagation of shock wave and the distribution of blast overpressure field compared with the traditional propagation law. In order to study the influence of complex obstacles on the propagation of explosive blast wave and the distribution of blast overpressure field and then put forward corresponding theoretical formulas, a series of experiments were designed to reveal these phenomenon. In these experiments, totally four groups of complex obstacles with the distance of 1m, 1.5 m, 2 m and 2.5 m from the explosion source were set respectively to simulate the existence condition of a certain large place. Free field condition were set to obtain contrast data. In this study, five experiments were conducted with explosive dosage of 0.25 kg TNT and 0.5 kg TNT respectively. The experimental results demonstrated that under free field condition, the peak overpressure values of explosive shock wave decreased constantly with the propagation of blast wave. However, under complex obstacles condition, the impact of blast wave on the rear position of complex obstacles was enhanced than that of the last group of obstacles. The average overpressures of two different types of explosive dosage at 2.5 m were 0.0246 MPa and 0.0444 MPa respectively, while the average overpressures at the distance of 3 m from the explosion source were 0.0354 MPa and 0.0558 MPa respectively. Those important findings hint that the existence of complex obstacles has a certain retarding effect on the attenuation of shock waves. What's more the formula obtained by fitting experimental data could have certain significance for the theoretical calculation and the prediction of the damage of explosive accidents in public places.

Blast wave, peak overpressure, obstacle, theoretical prediction

A novel Adaptive Mesh Enlargement method on large-scale impact and explosion problems

T Li, C Wang
Beijing Institute of Technology, Beijing, China

An Adaptive Mesh Enlargement (AME) method for large-scale impact and explosion problem is developed. First, based on Level Set and Real Ghost Fluid Method for tracking interface between two mediums, the ordinary WENO scheme with Runge-Kutta method are utilized to solve Euler equations. Then, implementation of this method with threshold condition, storage and assignment, data extension and parallelization are exhibited in detailed. Some 1-D numerical tests are designed and indicate that this method is accurate and efficient. Last, an experimental set and corresponding simulation with this method is studied. Overall process of near ground explosion by simulation is shown, where shock wave, rarefaction wave and their reflected wave is analyzed clearly. Pressure at some typical positions are recorded by experimental sensors and gauges in simulation, respectively. The largest error is 3% between pressure obtained by this method and experimental results. All the results show that this new method is a better way to simulate large-scale problem.

Explosion, impact, large-scale, adaptive, WENO

SESSION 2.3

HEAT TRANSFER

SUNDAY 15 DECEMBER 2019
14:00 – 15:30

CHAIR

A Fallah
Brunel University
UK

Numerical modeling of eeating uniformity in microwave single-mode cavities using coupled electromagnetic/heat diffusion equations

E A Ali, R Messahel
Al Ghurair University, Dubai, UAE

Microwave heating has established itself as a viable thermal processing technique in many sectors of the manufacturing industry, due to its many advantages, such as reduced heating time, efficient use of energy, and compact space among others. However, one of the main problems encountered in industrial, as well as domestic microwave heating applications, is the non-uniformity of heating profile that leads to creation of the hot/cold spots in the material to be processed. In order to overcome this problem, a number of techniques, such as the use of rotating support plate and/or wave steering blades have been applied especially in small scale domestic applications to some success. the use of these methods for large scale industrial processes are uneconomical and may not be practical. Suggested methods recently investigated for industrial microwave heating applications include, the use of intermittent sources, and/or the construction interference of the incident and reflected waves inside the processed material. Numerical modeling plays an important facilitating role in these cases and is of high demand by industries working in this field.
In this paper we present a numerical modeling technique of microwave heating uniformity in single-mode microwave heating applicators. The dielectric material to be processed, is placed in the middle of a waveguide section supporting a single TEmn mode, where m and n are integers, and is fed by two oppositely directed intermittent microwave sources. For the case of the TE0m mode, the problem reduces to one or two-dimensional problem and the coupled Maxwell and Heat diffusion equations are solved using mixed analytical and numerical techniques. For the general case of the TEmn mode, the problem is tackled numerically using conformal FDTD technique implemented in QuickWave-3D package. The package is also used to check the mixed analytical/numerical solution of the governing equations, with good agreement between the two solutions. The model is also verified by experimentally reported results with good agreement between the numerical and experimental results.

Numerical modeling, microwave hating, heating uniformity, hot spots

Multiphysics study of forced convection conjugate heat transfer (CHT) problem

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[1]UiT The Arctic University of Norway, Tromso, Norway
[2]Al Ghurair University, Dubai, UAE

This paper presents a problem undergoing conjugate heat transfer (CHT). Conjugate heat transfer problems are common is domestic heating/cooling, industrial heat exchangers, cooling of electronics (e.g. PC fans). It is to be noted that in conjugate heat transfer problems, the convection part of the heat transfer is dominated.
In the given study, a hypothetical case is built where a heat source (a burning candle) is placed under a thin aluminium sheet. The aluminium sheet is exposed to wind velocity using a fan (velocity of ~1.75 m/s). The aluminium sheet is coated with acrylic paint to increase the infrared emissivity of the surface. FLIR® T1030sc camera is used to visualise the developed infrared signature. Precautions are taken to ensure the correctness of results.
The given problem is simulated using ANSYS® Multiphysics, where fluid mechanics equations; continuity, Navier-Stokes and energy are coupled with the heat equation. This Multiphysics problem is solved using a finite volume method. Mesh sensitivity analysis is performed to ensure the correctness of results.
The results from infrared thermography and the Multiphysics model are compared and found to be in reasonable accuracy.

Infrared Thermography (IRT), Multiphysics, Conjugate Heat Transfer (CHT)

Convective transport through layered systems

E Holzbecher
German University of Technology in Oman (GUtech), Muscat, Oman

Heat or mass transfer through a system of porous layers is a relevant topic in various application fields. Packed-bed catalytic reactors contain layers. Insulating materials may consist of layers. Heat transfer in the sub-surface of the earth is very much determined by the geological layers involved. Aside from the understanding of natural geology, the heat flux is relevant for heat storage beds, for example. The mass transfer of CO2 is of concern for carbon sequestration in geological formations. In the contribution a hypothetical system of three layers is examined in detail, using numerical CFD modelling. Convective motions are a multi-physics phenomenon, in which flow and transport processes interact in a two-way coupling. The density of the fluid depends on the value of transport variable. The coupling leads to non-linear behaviour. Convective motions appear, when a critical threshold for the Rayleigh number is exceeded. As a result the heat transfer due to convection is much higher than in the case of pure conduction, which corresponds with the no-flow situation. The numerical studies show that in a layered system different types of convective patterns may appear than in the homogeneous case. Convection cells may occur that are aligned with the higher permeable layers. For a relevant parameter range of layer Rayleigh numbers and layer thicknesses we determine diagrams that illustrate the excess heat transfer, measured by the Nusselt number. Convective heat transfer can be up to seven times higher than for pure conduction.

Convection, heat and mass transfer, CFD, Rayleigh-number, Nusselt number

Numerical investigation of natural convection in an inclined wavy solar collector containing a nanofluid

S Kadri, K Djermane, E Bourbaba, M Elmir, R Mehdaoui
TAHRI Mohamed University, Bechar, Algeria

The present paper gives a numerical study of natural convection heat transfer inside the inclined wavy solar collectors containing nanofluid. The collector has a wavy absorber and cover. The inclined wavy walls are maintained at constant temperature but different values. The vertical walls are assumed to be adiabatic. The nanofluid used is Al2O3-water. This problem consists in solving the system of equations containing: mass conservation, Navier Stokes and energy with adapted simplified hypotheses. Transport equations are solved numerically by finite element method. Governing parameters are taken as Rayleigh number (from 106 to 5×107), inclination angle (from 20° to 60°), volume fraction (from 0 to 10%) and aspect ratio (from 1 to 4). Results are presented by streamlines, isotherms, local and overage Nusselt numbers.

Nanofluid, natural convection, wavy inclined solar collector, finite element method

Study on shock loading pre-processing for freeze-drying

T Watanabe[1], M Nakamura[1], K Shimojima[2], S Tanaka[3], K Hokamoto[3], S Itoh[2]
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In the food industry, it is hoping high value-aided product and the increase in efficiency of food processing. On the other hand, we get an experimental result that the load of the shock wave improves an extraction of food, and soften food. We tried to examine the effectivity of the shock wave as pre-processing for freeze-drying from the result in permeation character seen in the radish and so on. In the case of freeze-drying, the object tends to be limited to the small or thin one with size, from the sublimability in processing, the performance in case of the restoration and the viewpoint of the cost performance ratio. Therefore, we used comparatively large beheaded shrimps and squids and attempted to review the effectivity of the shock wave processing about being freeze- drying. The improvement of the sublimation speed was gotten from the result that the pressure change during freeze-drying processing and the improvement of the reconstitution was gotten from the result using hot water. It was expected that the reconstitution of the freeze-dried food is improved and that a processing time is abridged, by shock wave loading as pre-processing for freeze-drying. This phenomenon will be modeled, and it will be compared with a result of an experiment.

Shock Loading, pre-processing, freeze-drying

SESSION 2.4

IMPACT AND EXPLOSIONS

SUNDAY 15 DECEMBER 2019
16:00 – 17:30

CHAIR

F Fang
Imperial College London
UK

Experimental and numerical investigation of the effect of key factors on Deflagration to Detonation Transition (DDT) of HTPB propellant

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In order to research the influence of key factors on deflagration to detonation transition of HTPB composite solid propellant, DDT were studied by experiments and numerical simulations. The characteristic of DDT process and the effect of different key factors on DDT were obtained. The results show that DDT process of the propellant had longer run time to detonation but shorter run distance to detonation than that of explosives. The velocity and pressure of propellant DDT were lower than that of explosives under the same conditions and it is easier to form low velocity detonation. The influence of ignition energy on DDT is less than that of charge density, confinement and diameter of propellant. DDT could occur in the propellant with 80% TMD (theoretical maximum density), and the velocity of detonation was 3950 m·s-1 but did not occur in the propellant with 50% TMD. With the increase of loading density (50%~80% TMD), the possibility of DDT increases. In addition, numerical simulation results are in good agreement with experimental results and show that large diameter and strong confinement could induce the transition of DDT for the propellant easily.

DDT, HTPB propellant, key factors, explosion mechanism

Meso-scale failure simulation of polymer bonded explosive with initial defects by the numerical manifold method

G Kange, P Chen, Y Ning
Beijing Institute of Technology, Beijing, China

Polymer bonded explosive (PBX) is a kind of composite consisting of the polymer binder and embedded explosive particles as two bulk constituents, in which the particle volume fraction is often higher than 90%, usually along with a large number of the particle/binder interfaces as the third constituent in the meso-structure. In the present work, the deformation and failure behaviors of PBX with intitial defects are simulated at the meso-scale by the numerical manifold method (NMM), which unifies continuous and discontinuous deformation analysis into one framwork. In the NMM, a visco-elastic constitutive model is implemented to describe the deformation of the polymer binder, an elastic visco-plastic constitutive model is implemented to describe the deformation of explosive particles, and a bilinear cohesive contact relationship model is used to describe the deformation and debonding of the particle/binder interfaces. The fracturing of the polymer binder and explosive particles is described based on the maximum tensile stress and the Mohr-Coulomb criteria. Three catergories of initial defects, including the initial interfacial debonding, initial voids in the polymer binder, and initial micro-cracks in the explosive particles, are predesigned in the NMM simulations of PBX meso-structures under both uniaxial tensile and compressive conditions. The tension-compression asymmetry, the influence of the initial defects on the meso-structure failure modes/patterns and the macroscopic effective tensile/compressive strength of PBXs are investigated. The factors that cause the differences between the NMM results and other numerical or experimental results are analyzed and discussed. This work enables and proves the NMM to be an robust numerical tool for further simulation studies of the mechanical performances of PBXs, as well as other particle-fillled composites, at the meso-scale.

Polymer bonded explosive, NMM, meso-structure, fracture or failure

Experimental and numerical study on the flame propagation and overpressure prediction of unconfined gas explosion

M Li, Z Liu, X Li, Y Zhao, P Li
Beijing Institute of Technology, Beijing, China

Shock wave and thermal radiation were two main hazards of gas cloud deflagration in the open space. Actually the intensity of thermal radiation often appeared to be stable and easy to forecast. However, when it comes to the shock wave or overpressure that the gas cloud deflagration produced, the situation became complex and the intensity can not be forecast easily. Because the deflagration intensity was often affected by the gas could size, ignition energy, combustion mode of the cloud, flame speed and etc. So the prediction of the gas cloud deflagration intensity in the open space was relatively difficult. In this study, a series of small-scale gas cloud explosions were made to investigate the deflagration characters, flame acceleration process and overpressure distribution. The gas cloud was restricted by different sizes of latex balloon and ignited by different energy sources. High-speed video camera was used to record the flame propagation process. Computational fluid dynamics (CFD) method was used to simulate this deflagration process and predict the blast field parameters. Experimental results showed that the rupture of the balloon can strongly accelerate the flame speed for about 10 times reached 18 m/s but also deform the shape of the fireball. What's more, when the flame was ignited by a weak ignition the distribution of overpressures in the near field was not stable in the repeated experiments but stable in the far field. The numerical simulation results showed good agreements with the experimental results especially for the blast overpressure distributions of strong ignition experiments, which proved the applicability of the numerical model.

Experimental, numerical, unconfined gas explosion, flame speed

Hierarchical surface instabilities in the granular medium subject to explosion

X Shi, L Liu, K Xue
Beijing Institute of Technology, Beijing, China

The initiation and growth of instabilities arising from the internal and external surfaces of granular rings subjected to an explosion are investigated via both experiments and numerical calculations. Particle rings consisting of smooth glass spheres and angular glass beads confined inside a radial Hele-Shaw cell were dispersed by divergent blast waves issued from a vertical detonation tube. Small single-mode perturbations imposed upon the internal surfaces of rings grow into nonlinear structures in the form of bubbles and spikes, a typical late-time structure of Richtmyer-Meshkov (RM) instability. The asymptotic bubble velocity is markedly increased in the particle rings consisting of angular grains with much lower packing density which allows much faster establishment of diffusional pressure gradient inside the granular medium. Unlike the smooth bubbles and mushroom-like spikes in the classic RM, high wave-number finger-like instabilities become evident inside the fully-fledged bubbles with saturated advancing velocities. We speculate these instabilities are of Saffman-Taylor instability governed by the Darcy's law. These finger-like instabilities are initiated earlier and more unstable in the medium of angular grains. A grain-scale numerical investigations coupling the compressible computational fluid dynamics (CFDcomp) and discrete element method (DEM), CFDcomp – DEM, were employed the evolution of diffusional pressure and drag force fields inside the granular medium as well as the momentum field. The numerical investigations not only reproduce the experimental observations, more importantly, reveals the roles played by the pressure gradient and drag forces during different stages of instability growth

Explosion, granular medium, surface instability, CFD-DEM, RM instability, ST instability.

A modified mesoscopic reaction rate model for shock initiation of PBX explosives

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[2]Ministry of Environmental Protection, Beijing, China
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Based on experiments and numerical simulations, a modified mesoscopic reaction rate model for a polymer bonded explosive (PBX) is proposed by introducing a burn-up and a porosity factors to describe effects of the outer burning on the surfaces of explosive grains at the low-pressure slow reactive stage and the initial charge density, respectively. This model can predict well the influence of the particle size, the porosity and the shock loadings on the shock initiation (i.e., ignition and detonation growth) processes of PBXs, and the calculated pressure-time histories inside the explosive samples are in good agreement with the experimental data. Moreover, it is found that the detonation grows the fastest in the explosive with a moderate porosity, and the smaller the explosive's particle size, the more difficult the explosive to be ignited but faster the detonation grows once the explosive has been ignited. The modified mesoscopic reaction rate model shows its potentiality for quantitatively predicting the effects of the mesostructure of PBXs on the shock initiation and detonation growth processes with a high degree of confidence.

Shock initiation, Lagrangian experimental system, modified mesoscopic reaction rate model, particle size, porosity, PBX explosive.

POSTERS

CFD modelling of pollutant transport from a docked marine vessel

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[2]ZHAW Zurich University of Applied Sciences, Winterthur, Switzerland

With the increase of the human activities in the Arctic, including land and sea, is resulting in higher release of pollutants to the environment. These pollutants can be categorised as gases released in the air such as carbon dioxide, sulphur dioxide, NOx, etc., and waste released in seas such as chemical toxins, microplastic, etc.
This work presents a computational fluid dynamics (CFD) study presenting a two-phase Euler model for pollutant transport from a docked marine vessel at the Breivika harbor, Tromsø, Norway. The model is built by collecting the regional GPS data and converting into localized spatial coordinates.
ANSYS® fluent is used to solve the CFD simulations including a plume of CO2 and air in a two-phase Euler model. A free mesh is built for the solution using ANSYS® meshing tools with increased mesh intensity in critical regions. Mesh sensitivity study is conducted to ensure the correctness and reliability of the results. The results are checked qualitatively with a similar OpenFOAM CFD model and found to be in a good agreement.
The range of test cases varying the vessel's height, wind velocities and directions are performed. It is found that the impact of plume towards the local buildings reduces with the increase of the vessel's height. Also, the plume raises high and diffuses in the air at lower wind velocities and vice versa.
The study was also in agreement with the observations of the local port authority (Tromsø Havn KF).

CFD, pollutant transport, CO2, two-phase modelling, air pollution

Comparative study on projectile penetration into different strength concrete targets

X Zang, H Wu, S Zang, F Huang
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With the development of the weapon system, high strength concrete has been applied to the protection facilities for its excellent performance. Therefore, for the characteristics of high-strength concrete, it is of great theoretical and practical need to carry out research on the anti-penetration ability of different strength concrete. In this paper, the experiments of projectiles penetrating C80 and C120 high-strength concrete targets in different speed ranges are carried out, and compared with the results of the previous experiments of the projectiles penetrating C35 and C60 concrete targets. The characteristics of the target's anti-penetration ability with the change of compression strength are obtained. The penetration depth is analyzed by means of calculation method based on cavity expansion theory and experience penetration formula method, and compared with the experimental data. The results show that as the strength of the concrete target increases, the penetration depth of the projectile becomes smaller, but the reduction is slower and the mass erosion of the projectile increases. The higher the concrete strength, the greater the surface damage of the target, indicating that the brittleness of concrete increases with the strength. The traditional experience penetration formula has poor applicability to high-strength concrete and needs to be re-fitted with relevant parameters.

Penetration, high strength concrete, penetration depth, experience penetration formula

Damage characteristics of rod-like jet impacting on spaced multi-plate structure at hypervelocity

C Shang, Qi Zhang, Y Lu, W Liu, X Zhong, Y Pei, X Guo
Beijing Institute of Technology, Beijing, China

For a shocked melt-cast explosive, the hot spots formed by the pore collapse in matrix explosive component are considered, and a hot-spot ignition model with an elastic/viscoplastic double-layered hollow sphere is established based on the mesoscopic structure of the melt-cast explosive. Moreover, a mesoscopic reaction rate model is developed to describe the shock initiation process of the melt-cast explosives, and a three-term reaction rate equation is also proposed. Furthermore, the numerical simulation of the shock initiation experiments of the melt-cast explosive Composition B (TNT/ RDX) has been carried out. As the numerical results, including the arrival times of shock waves and the pressure growth behind wave fronts in different Lagrange locations with different loading pressures, are in good agreement with the experimental data, it is indicated that the mesoscopic reaction rate model is available for describing the shock initiation characteristics of the melt-cast explosives, which is significant to the further investigation on the shock initiation mechanism of the melt-cast explosives.

Melt-cast explosive, shock initiation, hot-spot ignition, reaction rate model, pore collapse

Dynamic spherical cavity expansion analysis of concrete/rock based on Hoek-Brown criterion

H Dong, H Wu, J Li, A Pi, F Huang
Beijing Institute of Technology, Beijing, China

Cavity expansion theory has been widely used in the prediction of penetration depth for projectiles into geotechnical materials, in which the Mohr-Coulomb yield criterion was adopted to describe the effect of pressure on material yield. However, this criterion was failed to capture typical characteristics of materials under high hydrostatic pressures, as the effect of the second principal stress was disregard. For a precise description of the yield features of different geotechnical materials with varied strength, in this present manuscript, Hoek-Brown yield criterion, is introduced into the plastic zone, and a response zone called elastic-cracking-dilatant-compaction zone for concrete/rock was established. The influence of the brittleness parameter and material integrity parameter on the relationship between cavity pressure and normal expansion velocity is discussed. Then, a penetration depth formula of rigid projectiles into semi-infinite concrete/rock targets is established. Compared with the classical Forrestal model, our model with higher accuracy has a well-being prediction of the penetration depth of concrete/rock materials with different strengths. Further, effective of cavity expansion theory for concrete targets with varied compressive strengths are discussed based on previous research work.

Cavity expansion theory, Hoek-Brown yield criterion, penetration depth, penetration resistance

Experimental and numerical investigation of oblique perforation of truncated Ogive-Nosed projectiles with elliptic cross-section in double-layered steel plate with gap space

H Wang, X Pan, H Wu, A Pi, J Li, F Huang
Beijing Institute of Technology, Beijing, China

In order to investigate the failure mechanism of truncated ogive nosed projectiles with elliptic cross-section obliquely perforating into steel plate, double-layered ship-building 5mm thick 945 steel plates with gap space have been used in gas gun experiments. Fig.1 shows high-speed photographs of projectiles during penetrating into target. The failure mode (Fig.2) of steel plates and dates of projectile's motion are obtained. Numerical simulations of the experiments were conducted with ABAQUS/Explicit finite element code. The plates are impacted at 0°, 30°, 45° and 60°obliquity. The projectile centroid trajectory and trajectory angle are analyzed. The results show that, due to stress concentrations, the position of crack initiation of petalling is along the major axis and the minor axis of elliptical cross-section. The ballistic limit velocity and projectile's deflection increase with the increase of oblique angle. Meanwhile, the greater the impact velocity is, the greater the impact of trajectory deflection and trajectory angle will be.

Impact dynamics, elliptical cross-section projectile, plate, residual velocity, petal failure

Experimental research on penetration behavior of rective material fragment folded in steel jacket impacting double-spaced aluminum plates

P Jun
Xi'an Modern Chemistry Research Institute, Xi'an, China

For research the damage effect resulted from rective material fragment double-spaced aluminum plates, 14.5mm ballistic rifle had been adopted and the experiment of steel fragments and rective material fragments folded in steel jacket, with the same mass and density, impacting 3mm+3mm double-spaced aluminum plates had been completed. The results indicate that with 500-1400m/s impact velocity, it had the same mechanism which had been identified as the plugging damage pattern and the same morphology which had been observed for round holes, resulted from two kinds of fragment impacting the front plate. Furthermore, it had the similar hole diameter and hole diameter change regularity with velocity. With 1205m/s impact velocity, a large difference for perforation of the rear plate had been presented. The perforation diameter of the rear plate significantly greater than the front plate and it increased significantly with the increase of impact velocity. With 1387m/s impact velocity, the perforation area of the rear plate could be reached four times the cross-sectional area of fragment. The reason was thought to be violent chemical reaction had been produced when penetrated the the front plate. Bright flashes had been observed in high-speed photography, and the intensity of the flashes was positively correlated with the impact velocity. Obtain the threshold velocity of impact ignition of the fragment is 1025m/s under the condition of projectile–target. Based on one dimension positive shock wave theory, the ignition mechanism had been analyzed, The results has important significance to the application of active fragment.

Reactive material fragment, penetration behavior, ignition threshold

Flow and heat transfer investigation on forward facing step flow using Cu-water nanofluid

R Kanna, S A Theibeche, H Shahid
Al Ghurair University, Dubai, UAE

Nanofluid application in heat exchanger is attracted by many researchers due to enhancement of heat transfer for the past two decades. Flow separation is common physics arises in duct flow due to various reasons. The present work aims to investigate the fluid dynamics and heat transfer when Cu based nanofluid is used in forward facing step flow. The results will be compared with pure fluid to reveal the role of nano particles. The governing fluid flow and heat transfer equations will be solved numerically by modified in house code developed by Kanna et.al.
The flow physics will be revealed by varying Reynolds number. The influence of volume fraction will be tested for Cu nanoparticles. Constant wall boundary conditions will be simulated for laminar flow condition. The effective thermal conductivity of the nanofluid is approximated by Maxwell-Garnetts (MG) model for fluid containing a spherical nano particle. The local Nusselt number distribution, reattachment length, size of recirculation eddy will be reported for different Reynolds number and nanofluid volume fraction.

Nanofluid, forward facing step, numerical simulation, laminar flow

Heat shock loading by liquid nitrogen to parasite

T Watanabe[1], M Nakamura[1], H Ohta[1], K Shimojima[2]
[1]National Fisheries University, Yamaguchi, Japan
[2]Okinawa National College of Technology, Okinawa, Japan

In Japan where people like raw food of the marine products, a problem of the parasite often occurs. A similar problem occurs for feed of the dolphin that is very popular in aquarium. A parasite is contained in marine disposal of waste and feed, the method of the management is a subject. There is a guideline of the Ministry of health, labour and welfare. The information that is detailed to the parasite isn't known well. We carried out the research on the actual condition of the parasite. We tried to check about the low temperature tolerance of the parasite for usual freezing and low heat shock by liquid nitrogen experimentally.

Heat shock, liquid nitrogen, parasite

Microstructure evolution and mechanical properties of 5083 Al-1050A Al-Q235A plate fabricated by explosive welding

Q Zhou, P Chen
Beijing institute of technology, Beijing, China

In this study, 5083 aluminum alloy-1050A pure aluminum-Q235A steel cladding plates were manufactured by explosive welding. The macrostructure, interface configuration, micro-hardness and mechanical property of the bonding interface were investigated after explosive welding. The results show that the sine wave interface forms at the boundary between the aluminum alloy and pure aluminum, while the wave between pure aluminum and steel is smaller. Mechanical property tests show that the shearing strength and tensile of aluminum alloy-pure aluminum-steel cladding plates reaches 75 MPa or more. Intermetallic compound forms and strong plastic deformation appear in the explosive welding, which results in higher hardness at the boundary. Hardness value will decrease with an increase in the distance from the boundary.

Explosive welding, 5083 aluminum alloy, Q235A steel, micro-hardness, mechanical properties

Multiphysics study of infrared thermography (IRT) applications

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Infrared thermography is the science of detecting infrared energy emitted from an object, converting it to apparent temperature, and producing images of that radiation, called thermograms. Infrared thermography means "beyond red temperature image". IR thermography being a remote non-contact/non-destructive means of testing is perfectly suitable for tests in extreme environments. Also, it is fast, reliable, and detailed. Due to the advantages offered by IR thermography, it is being employed in various industries. Infrared thermography (IRT) has a long history in industrial applications; however, its use is increasing exponentially in the research and development sectors. Academic and research institutions are finding IR thermography as one of the fundamental tools for teaching and research. This review paper discusses studies where IR thermography has been used effectively in research and development projects at the UiT The Arctic University of Norway. The applications discussed in this work are:

· Thermal conductivity and heat transfer coefficient of freshwater and marine ice.
· An industrial solution for detecting icing.
· Determine relative required insulation (IREQ) of clothes.
· Surface temperature of steel samples under tensile testing at room and cold temperatures.

Infrared thermography, applications, icing, required insulation, tensile testing, cold temperatures

Optimisation and application of Hall effect sensor

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Advances in semiconductor technology have led to the production of more efficient miniature Hall effect sensors. These sensors are now used in various applications. The sensitivity and response of these Hall effect sensors depend on a few parameters such as structure, input voltage and temperature. This paper examines methods for optimizing the performance of Hall effect sensors by reducing offset voltage and increasing magnetic sensitivity. The maximization of the geometric correction factor has also been performed to ensure maximum sensitivity. Optimization studies were conducted using finite element simulated magnetic field results.

Hall sensor, detector, simulation, InAs, Ge, sensitivity, finite elements

Penetration of rod-like jet into thick concrete target

Y Lu, Q Zhang, C Shang, W Liu , X Zhong, Y Pei, X Guo
Beijing Institute of Technology, Beijing, China

For a shocked melt-cast explosive, the hot spots formed by the pore collapse in matrix explosive component are considered, and a hot-spot ignition model with an elastic/viscoplastic double-layered hollow sphere is established based on the mesoscopic structure of the melt-cast explosive. Moreover, a mesoscopic reaction rate model is developed to describe the shock initiation process of the melt-cast explosives, and a three-term reaction rate equation is also proposed. Furthermore, the numerical simulation of the shock initiation experiments of the melt-cast explosive Composition B (TNT/ RDX) has been carried out. As the numerical results, including the arrival times of shock waves and the pressure growth behind wave fronts in different Lagrange locations with different loading pressures, are in good agreement with the experimental data, it is indicated that the mesoscopic reaction rate model is available for describing the shock initiation characteristics of the melt-cast explosives, which is significant to the further investigation on the shock initiation mechanism of the melt-cast explosives.

Melt-cast explosive, shock initiation, hot-spot ignition, reaction rate model, pore collapse

Phase change phenomena of water under decompression state

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The latent heat of the evaporation for water is very big compared with other fluid. Therefore, when evaporation is promoted by decompressing, water lowers the temperature and freezes finally. We made them freeze without applying heat by decompressing water using a vacuum pump. Even if water caused boiling, the pressure kept falling, but when freezing finally, pressure build-up was measured. It was expected that pressure build-up is caused by increase of the evaporation amount by the latent heat release when freezing. An experiment was made in detail. This is the transition phenomenon when switching over from evaporation to sublimation. This seems to bring useful information when considering a phase change model.

Water, decompression, freezing, phase change

Simulations and analysis of the propagation of turbine blade fissuring

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University of Saad Dahlab, Algeria

Cracks and fissures are critical problems of in-service turbine blades that provide severe impact on safety and reliability of these elements and lead to a degradation of structure integrity and fatigue resistance and directly affect the airworthiness of a turbojet engine. Turbine blades must be controlled to keep their integrity and achieve their maximum lifespan. Also; these damages are causes by various stress and constraints of different kinds (thermal stress; mechanical stress…) and the structure is considered to be safe and reliable if accidental damage, corrosion and fatigue cracking can be detected and repaired before such damages degrade structural strength below an acceptable limit. The most important phenomenon which provides turbine blades problems is known as fatigue and it is responsible on the majority of turbine blade damages The aim of this work is to find out the cause of fissure in order to more understand the fissuring mechanism and to be able to study the fissure propagation. Simulations of the fissure propagation under fatigue, at the edge of the turbojet turbine blade are investigated and discussed. The ANSYS code is applied to read all of the geometric dimensions and create the finite element model of studied blade. The obtained results give a good agreement with the theoretical studies of the propagation of the fissure on plate and enable to distinguish the various stages as well as the characteristics of the distribution of constraints on the plate.

Tubrine blade, cracks and fissures, ANSYS

Thin vessel detection for improved retinal vessel segmentations

S Sohail, M A U Khan, S S Ahmad
Al Ghurair University, Dubai, UAE

Automatic detection of retinal blood vessels and subsequent measurement of vessel diameter are critical for the diagnosis and the treatment of different ocular diseases using computers including diabetic retinopathy (DR), glaucoma and hypertension. Many methods are found in the literature for segmentation of blood vessels in the past, however, their limitation mainly lies is in detecting low-contrast thin vessels. The research work presented here investigates the modification of multi-scale line filtering technique that provides special emphasis to the linear thin features while suppressing wider vessels. The thin-vessels detection has been compared with the ground truth made available in DRIVE and STARE databases. The modified line-filtering technique provides promising results in face of brightness variations and noise.

Automatic detection, diameter, thin-vessels, line-filtering

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