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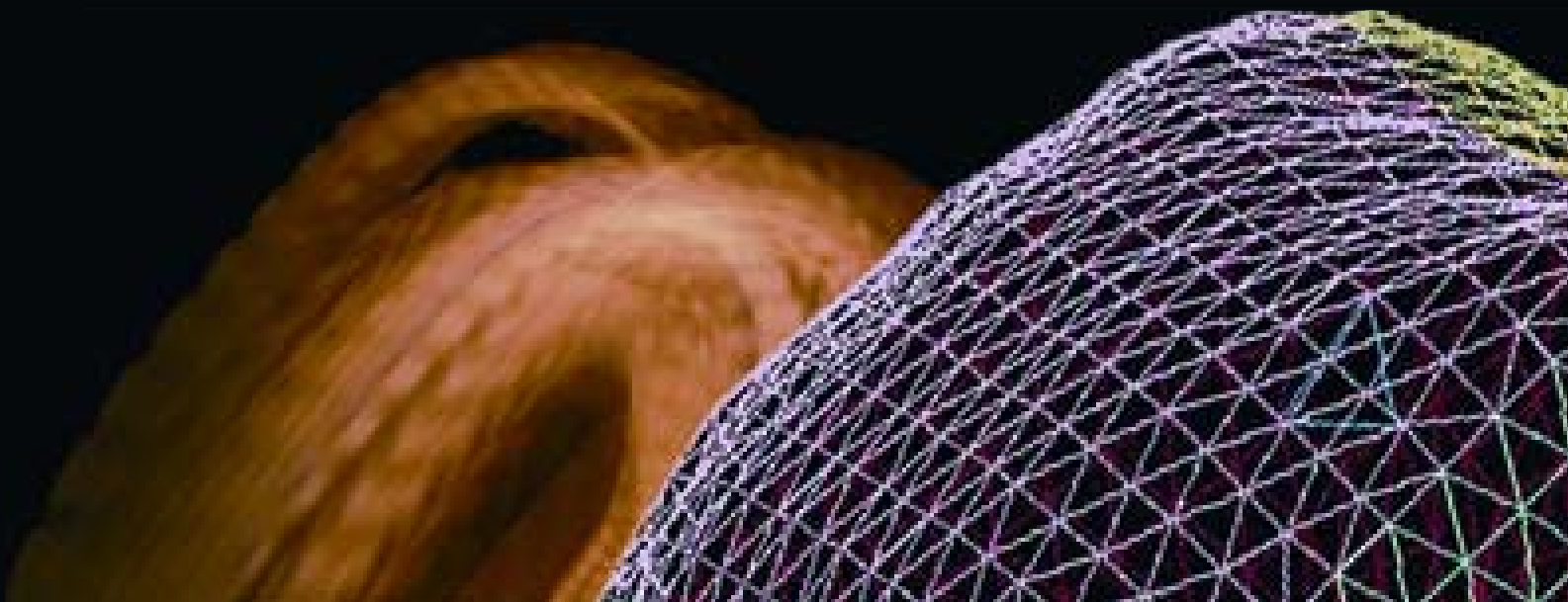
MULTIPHYSICS 2018

13 - 14 December 2018
Krakow, Poland



MULTIPHYSICS 2018

13-14 December 2018
Krakow, Poland

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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:

Thursday, 13th December	9:00-17:30
Friday, 14th December	9:00-17:30

Special Events

Thursday, 13th December Group Photograph	11:00
Thursday, 13th December Conference Banquet	19:30

Timing of Presentations

Each paper will be allocated 20 minutes. A good guide is 15 minutes for presentation with 5 minutes left for questions at the end.

Good timekeeping is essential, speakers are asked to keep strictly to 20 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 2019.

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

Krzysztof Dragan
PhD DSc Eng
Air Force Institute of Technology
Warsaw, Poland

BIOGRAPHY

Colonel Krzysztof Dragan graduated from the Military University of Technology, Warsaw in 2001 with the MSc degree in Applied Physics. He has been employed at the Polish Air Force Institute of Technology since 2002. He used to work as Team Leader for the NDE group in Division for Aeronautical System's Reliability and Safety in the Aircraft Structural Integrity Laboratory. He received the PhD degree on March 2008 based on dissertation related to elaboration efficient technology for composite helicopter main rotor blades inspection. Since that time, he was responsible for delivery of technologies for structural integrity monitoring for aging aircraft programs. His further career was connected with implementation of the Health Monitoring Systems for manned and unmanned aerial systems. He was leader of the national and international R&D projects related to diagnostics and monitoring of aerial platforms. He collaborates with number of national and international Universities and industrial R&D organization. At present he works as Head of the Airworthiness Division in the Air Force Institute of Technology in Warsaw. His research interests are focusing on: non-destructive testing, acoustics for diagnostics, signal processing, composite smart materials, health monitoring, image processing and machine learning.

MULTIPHYSICS 2018

PROGRAMME

TIME	Thursday 13 December 2018	Friday 14 December 2018
09:00 - 09:30	**Registration**	
09:30 - 11:00	**Keynote Address & Synopsis**	**Session 2.1** *Thermal Modelling*
11:00 - 11:30	**Tea/Coffee Break**	
11:30 - 13:00	**Session 1.2** *Impact and Explosions*	**Session 2.2** *Advanced Materials*
13:00 - 14:00	**Lunch**	
14:00 - 15:30	**Session 1.3** *Simulation Techniques*	**Session 2.3** *Multiphysics Applications*
15:30 - 16:00	**Tea/Coffee Break**	
16:00 - 17:30	**Session 1.4** *Aerospace*	**Session 2.4** *Posters*
19:30	**Banquet**	

Full Programme

Thursday 13 December 2018

09:00 – 09:30 Registration

09:30 – 09:45 Conference Opening

Opening of The 13th International Conference of Multiphysics 2018
Jerzy Wiciak, Deputy Dean for Science, Faculty of Mechanical Engineering and Robotics, AGH University of Science and Technology, Poland

Maciej Petko, Head of Department of Robotics and Mechatronics, AGH University of Science and Technology, Poland

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

Chair: M Moatamedi, The International Society of Multiphysics

Keynote Address: Health Monitoring implementation to aerial platforms for structural integrity monitoring - need or necessity?

Krzysztof Dragan, Air Force Institute of Technology, Warsaw, Poland

Synopsis Part 1: The International Journal of Multiphysics
Synopsis Part 2: The International Conference of Multiphysics 2019

Hassan Khawaja, The International Society of Multiphysics

11:00-11:30 Tea/Coffee Break & Group Photograph

Thursday 13 December 2018

11:30-13:00 Session 1.2
Impact and Explosions

Chair: A Martowicz, AGH University, Poland

Investigation of center bore annular shaped charge formation and penetrating into steel targets

Cheng Wang, Wenlong Xu,
State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, Beijing, China

Non-contact evaluation of boundary conditions influence on guided waves propagation in thin soft layers

Patrycja Pyzik, Lukasz Ambrozinski,
AGH University of Science and Technology, Poland

Experiment and numerical analysis of softening of meat using underwater shock wave

Ken Shimojima, Yoshikazu Higa, Osamu Higa, Hideaoki Kawai, Kazuyuki Hokamoto,
Department of Mechanical Systems Engineering, National Institute of Technology, Okinawa College, Japan

On the prediction of rupture impulse of the square plates subjected to localised blast load

Navid Mehreganian[a], Arash Fallah[b]
a. Imperial College London, London, UK
b. Brunel University London, UK

13:00-14:00 Lunch

Thursday 14 December 2018

14:00-15:30 Session 1.3
Simulation Techniques

Chair: E Albahkali, King Saud University, KSA

Enhancing the understanding of complex phenomena in powder coating, by applying Eulerian-Lagrangian simulation methodology

G.Boiger, M.Boldrini, B.Siyyahan

ZHAW Zurich University of Applied Sciences, ICP Institute of Computational Physics, Switzerland

Comparison of Explicit Method of Solution for CFD Euler Problems using MATLAB® and FORTRAN 77

Anders Nordli, Hassan Khawaja

UiT-The Arctic University of Norway, Tromsø, Norway

EOF-Library: highly efficient open-source coupler for FEM and FVM frameworks

Juris Vencels

University of Latvia, Riga, Latvia

Multiphysics approach for a pantograph-catenary system simulation

Paweł Zdziebko, Tadeusz Uhl, Adam Martowicz

AGH University of Science and Technology, Poland

15:30-16:00 Tea / Coffee Break

Thursday 14 December 2017

16:00-17:30 Session 1.4
Aerospace

Chair: A Fallah, Brunel University, UK

Aerodynamic Improvement of Test Rig for Investigation of Blade Cascade at Large Incidence Angles of Subsonic Flow

Vadym Kruts, Anatoliy Zinkovskii; Serhii Kabannik,
IPS NAS of Ukraine

The Express Method for Determination of Stability Limit of Axial Compressor Blading against Subsonic Flutter

Kyrylo Savchenko, Serhiy Kabannyk, Yevheniia Onyshchenko,
IPS, NAS of Ukraine

Prediction of mechanical and electrical properties of composites based on weft-knitted fabrics

V. Stavychenko[a], M. Shevtsova[a], P. Shestakov[a], A. Litvinova[a], O. Mazna[b], V. Kokhany[b], I. Obodeeva[b]
a. KhAI
b. IMPS NASU

Lightweight MAX phases - based materials heat-resistant in oxidizing and hydrogen atmosphere

PRIKHNA Tetiana[1], OSTASH Orest[2], SVERDUN Vladimir[1], CABIOC'H Thierry[3], KARPETS Myroslav[1], SERBENYUK Tetiana[1], STAROSTINA Alxanda[1], JAVORSKA Lucyna[4], DUB Sergey[1], KUPRIN Alexander[5]
1 Institute for Superhard Materials of the National Academy of Sciences of Ukraine
2 Karpenko Physical-Mechanical Institute of the National Academy of Sciences of Ukraine
3 Universite de Poitiers, Chasseneuil Futuroscope Cedex, France
4 The Institute of Advanced Manufacturing Technology, Krakow, Poland
5 National Science Center Kharkov Institute of Physics and Technology, Kharkov, Ukraine

19:30 Conference Banquet

Friday 15 December 2017

09:30-11:00 Session 2.1
Thermal Modelling

Chair: B Alzahabi, Al Ghurair University, UAE

IR Thermography in Multiphysics Applications

Hassan Khawaja
UiT-The Arctic University of Norway, Tromsø, Norway

Multi-scale Electrochemical-Thermal models for Automotive Battery Pack Thermal Management

K. Darcovich(1), D.D. MacNeil(1), S. Recoskie(1), Q. Cadic(2), F. Ilinca(3)
(1). National Research Council of Canada, Energy, Mining and Environment Research Centre, Ottawa, Ontario, Canada
(2). ICAM-Toulouse, 75 avenue de Grande Bretagne, 31300 Toulouse, France
(3). National Research Council of Canada, Automotive and Surface Transportation Research Centre, Boucherville, Québec, Canada

Laser Spot Thermography - scanning mod

Jakub Roemer, Łukasz Pieczonka
AGH University of Science and Technology, Krakow, Poland

Nonlocal approaches for modeling components of gas foil bearing

Adam Martowicz, Jakub Bryla, Jakub Roemer, Wieslaw J. Staszewski
AGH University of Science and Technology, Krakow, Poland

11:00-11:30 Tea / Coffee Break

Friday 15 December 2017

11:30 – 13:00 Session 2.2
Advanced Materials

Chair: C Wang, Beijing Institute of Technology, China

Investigation on Multi-Material Flows by Coupling MMALE and FDM
Tao Li, Hao Li, Cheng Wang,
State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, Beijing, China

A novel ex-situ aluminum foam filled fourfold-tube nested tube system as the energy absorber
Bin Xu, Cheng Wang, Wenlong Xu,
State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, Beijing, China

Multi-Material Interface Method Based on Hyperelastic Model
Wanli Wang, Cheng Wang
State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, Beijing, China

Flame propagation characteristic of explosion in the tube with a tilted obstacle
Yangyang Cui, Cheng Wang
State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, Beijing, China

13:00-14:00 Lunch

Friday 15 December 2017

14:00-15:30 Session 2.3
Multiphysics Applications

Chair: H Khawaja, UiT-The Arctic University of Norway

Frequency band structure of phononic dispersion in fractal lattices

Navid Navadeh[a], Vladimir V Tereshchuk[b], Vyacheslav Gorshkov[b], Arash S Fallah[c]
a. Imperial College London, UK
b. Kiev Polytechnic Institute, Ukraine
c. Brunel University London, UK

Impact of fouling on mechanical resonator-based viscosity sensors: Comparison of experiments and numerical model

Daniel Brunner[a,c], Kaus Häusler[a], Sunil Kumar[b], Hassan Khawaja[c], Moji Moatamedi[c], Gernot Boiger[a]
a. ZHAW Zurich University of Applied Sciences, ICP Institute of Computational Physics, Switzerland
b. Rheonics GmBH, Winterthur, Switzerland
c. UiT-The Arctic University of Norway, Tromsø, Norway

A Comparison Between Two Different Elbow Design for a Fiberglass Pipe Using Fluid Structure Interaction

Essam AlBahkali[1], Hisaham Elkanani[1], Zeyad Almutairi[1], Thamer AlBahkali[1], Mhamed Souli[2]
[1]Department of Mechanical Engineering, King Saud University, Riyadh, Saudi Arabia, [2]Laboratoire de Mécanique, de Lille, UMR CNRS 8107, Villeneuve d'Ascq, France

Numerical simulations of ultrasonic waves self-focusing in composite laminates

Lukasz Pieczonka, Daniel Błaszkiewicz, Radosław Mormul
AGH University, Poland

15:30-16:00 Tea / Coffee Break

Friday 15 December 2017

16:00-17:00 Session 2.4
Posters

IR Thermography of Steel Specimens undergoing Tensile Tests
Even Stange, Hassan Khawaja
UiT-The Arctic University of Norway, Tromsø, Norway

Finite Structure Interaction of Aquaculture Net Cages
Odd Einar Myrli, Hassan Khawaja
UiT-The Arctic University of Norway, Tromsø, Norway

An Efficient Grayscale Representation for Retinal Vessel Extraction
Mohammad Asmat Ullah Khan, Mojtaba Moatamedi, Basem Alzahabi
Al Ghurair University, UAE

Numerical procedure for identifying the ammonia concentration of the sewage influent based on SCADA measurements of the effluent properties
P. Król, A. Gallina*, T. Uhl*, T. Żaba***
**Department of Robotics and Mechatronics, AGH University of Science and Technology, Kraków, Poland,*
***MPWIK S.A. w Krakowie, Kraków, Poland*

CFD modelling of pollutant transport
Synne Karoline Madsen, Hassan Khawaja
UiT-The Arctic University of Norway, Tromsø, Norway

17:00 Close of Conference

SESSION 1.1

KEYNOTE ADDRESS & SYNOPSIS

THURSDAY, 13 DECEMBER 2018
09:30 – 11:00

CHAIR

M Moatamedi
The International Society of Multiphysics

Thursday, 13 December 2018
09:30 – 10:50

Keynote Address

Health Monitoring implementation to aerial platforms for structural integrity monitoring - need or necessity?

Krzysztof Dragan
PhD DSc Eng
Air Force Institute of Technology
Warsaw, Poland

Providing reliable and universal Structural Health Monitoring (SHM) system allowing for direct aircraft inspections and maintenance costs reduction is one of the major issues in the aerospace community. The installation of SHM sensors in aerial and especially composite structures for structural health monitoring requires care selection of a proper techniques to guarantee its reliability and lack of effects affecting structure durability. There are several SHM technologies which are exist based on the principles of the Non-Destructive Evaluation Technology. Among them we may differentiate: techniques based on guided Lamb waves, strain monitoring based on Fiber Optic Sensing.

In the paper an approach for the aerospace structure damage growth monitoring and early damage detection of the both metal and composite structure will be presented based on selected SHM techniques. Advantages and limitations of addressed technologies will be highlighted. Experience of the author with described technologies to aerial structures will be presented. In particular, some issues concerning the limitations and applicability in connection with legal framework and operational procedures will be also provided.

Thursday, 13 December 2018
10:50 – 10:55

Synopsis Part 1

The International Journal of Multiphysics

Hassan Abbas Khawaja
The International Society of Multiphysics

The scope of the International Journal of Multiphysics (ISSN: 1750-9548) is to address the latest advances in theoretical developments, numerical modelling and industrial applications 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, Soil, Structures, and Thermodynamics. This journal aims to publish high quality findings of basic research and development as well as engineering applications. The editorial board members of the journal are highly respected and internationally recognised in various fields of Multiphysics and they represent both academia and industry.

The International of Multiphysics is indexed in

- Elsevier® Scopus (SNIP, CiteScore, SJR)
- Elsevier® Engineering Village (EI Compendex)
- Clarivate Analytics® Emerging Sources Citation Index (ESCI)
- Clarivate Analytics® Web of Science
- Crossref®
- EBSCO Research Databases
- Web (Google Scholar, Baidu, CNP-Linker, etc.)

Thursday, 13 December 2018
10:55 – 11:00

Synopsis Part 2

The International Conference of Multiphysics

Hassan Abbas Khawaja
The International Society of Multiphysics

The objective of the International Conference of Multiphysics 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, Impact, Explosions, Fire, Fluids, Magnetism, Nuclear, Soil, Structures and Thermodynamics.

Multiphysics Conferences have been organised in Krakow Poland, Beijing China, Zurich Switzerland, London United Kingdom, Sofia Bulgaria, Amsterdam The Netherlands, Lisbon Portugal, Barcelona Spain, Kumamoto Japan, Lille France, Narvik Norway, Manchester United Kingdom, and Maribor Slovenia. Researchers from all around the world participated in these events. The Organisers and the Management Committee are thankful to all attendees for making these events successful.

The International Conference of Multiphysics 2019 will be held on 12-13 December 2019 in Dubai, UAE, organized by the International Society of Multiphysics and Al Ghurair University.

SESSION 1.2

IMPACT AND EXPLOSIONS

THURSDAY 13 DECEMBER 2018
11:30 – 13:00

CHAIR

A Martowicz
AGH University of Science and Technology
Poland

INVESTIGATION OF CENTER BORE ANNULAR SHAPED CHARGE FORMATION AND PENETRATING INTO STEEL TARGETS

Cheng Wang, Wenlong Xu
State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, Beijing, China

In order to solve the problem of the lack of penetration hole diameter for traditional EFP and penetration depth for existing annular shaped charge, a center bore annular shaped charge (CBASC) is designed. A theoretical model to calculate the microelement velocity of liner is established. The reliability of numerical simulation for CBASC is verified by X-ray experiments. The process of CBASC formation is given, and the main influencing factors for the formation of CBASC are revealed. Experiments are conducted to study the influence of the main parameters of hyper annular projectile charge on the penetration depth and hole diameter. The optimal design results of different charge diameters are verified. The results show that the position of maximum liner wall thickness, angle of θ, and shell thickness have great influence on radial velocity, penetration depth and hole diameter of CBASC. With the increase of the angle θ and shell thickness, the penetration hole diameter decreases, and the penetration depth increases gradually. Under the same conditions, the hole diameter caused by CBASC with different charge diameters is larger than that by EFP, and the penetration depth is greater than the traditional annular shaped charge caused. The CBASC can penetration a hole diameter of 0.92 times the charge diameter, and penetration depth can reach 0.64 times the charge diameter.

annular shaped charge, penetration, X-ray, numerical simulation

NON-CONTACT EVALUATION OF BOUNDARY CONDITIONS INFLUENCE ON GUIDED WAVES PROPAGATION IN THIN SOFT LAYERS

Patrycja Pyzik, Lukasz Ambrozinski
AGH University of Science and Technology, Poland

Tissue elasticity is an important diagnostic parameter. Over the recent years shear waves elastography (SWE) has been developed as a tool permitting imaging of lesions stiffer than surrounding tissues. The method is already clinically used for imaging of breast, liver, prostate etc. More recently adaptation of this technique for evaluation of eye cornea elasticity was proposed. The method, called acoustic micro tapping (AμT), uses a focused air-coupled transducer that creates acoustic-radiation force resulting from reflection of the ultrasonic beam.
Tissue motion is tracked using phase-sensitive optical-coherence tomography (PHS-OCT) system, which makes the system non-contact. Because the thickness of eye cornea is much smaller than the wavelength of excited shear waves, boundary conditions at the tissue interfaces have to be considered. In this paper we present experimental evaluation of guided waves propagation in thin soft materials mimicking soft-tissue. Two scenarios are considered: symmetric air-tissue-air and no symmetric air-tissue-water interfaces. Dispersion curves obtained from both cases are compared with analytical results calculated using suitable boundary conditions. The experimental setup consists of the AμT source and laser Doppler vibrometer as a detector.
The authors would like to acknowledge Foundation for Polish Science for a project carried out within Homing programme co-financed by the European Union under the European Regional Development Fund, agreement no. Homing/2017-3/19.

guided waves, thin layer, acoustic micro tapping

EXPERIMENT AND NUMERICAL ANALYSIS OF SOFTENING OF MEAT USING UNDERWATER SHOCK WAVE

Ken Shimojima, Yoshikazu Higa, Osamu Higa, Hideaoki Kawai, Kazuyuki Hokamoto, Department of Mechanical Systems Engineering, National Institute of Technology, Okinawa College, Japan

National Institute of Technology, Okinawa College (ONCT) has developed the food processing device by the underwater shock wave. The processing method by spalling phenomena was developed, which is different from a past crushing method is developed. In this presentation, we experimented of softening meat using prototype shock wave machine. The experimental conditions and the value of softening of meat were clarified.
We estimated the particle velocity by shock wave propagation velocity of the meat using a visualization device and high-speed camera. A numerical analysis model of meat was created based on the obtained particle velocity.

Shock wave, softening, meat, numerical analysis

ON THE PREDICTION OF RUPTURE IMPULSE OF THE SQUARE PLATES SUBJECTED TO LOCALISED BLAST LOAD

Navid Mehreganian[a], Arash Fallah[b], Luke Louca[a]
a. Imperial College London, London, UK
b. Brunel University London, UK

Localised blast loads, emanating from improvised explosive device are detrimental to the structures and would potentially cause damage and perforation through thickness of the structure. With the recent advancement in the tailored metallurgy of the armour steel and characteristics of composites, evaluation of the blast and ballistic design limit of armour plated structures against the minimum impulse to instigate rupture, or rupture threshold, is significant in various fields of engineering.
A generic localised pressure pulse load was idealised as a multiplicative decomposition of spatial and a rectangular temporal function. The spatial function was assumed as a piece-wise continuous function of axi-symmetric distribution of constant pressure over a central zone of the target, then exponentially decaying beyond this zone. A theoretical model to predict the rupture threshold of square plated structures damaged by blast loads of this kind is presented, using the concept of energy absorption effectiveness factor. The factor is defined as the quotient of the total energy of the blast, to the maximum energy up to failure of the material determined through quasi-static tensile stress data. Within the constitutive framework of limit analysis, a unique energy absorption effectiveness parameter was evaluated, irrespective of the material type, and proposed as the design limit to compare the effectiveness of various materials of prismatic sections to the blasts, given a prior knowledge of the load parameters (stand-off, charge mass and charge diameter).
The relevant numerical simulations were carried out using the fluid-structure interaction techniques to quantify the preliminary data and to confirm the validity of the theoretical model. The results obtained based on these models also concurred with the experimental results available in the literature.

Energy absorption effectiveness factor, Rupture impulse, Localised blast, Stand-off distance, Material type

SESSION 1.3

SIMULATION TECHNIQUES

THURSDAY 13 DECEMBER 2018
14:00 - 15:30

CHAIR

E Albahkali
King Saud University
KSA

ENHANCING THE UNDERSTANDING OF COMPLEX PHENOMENA IN POWDER COATING, BY APPLYING EULERIAN-LAGRANGIAN SIMULATION METHODOLOGY

G.Boiger, M.Boldrini, B.Siyyahan
ZHAW Zurich University of Applied Sciences, ICP Institute of Computational Physics, Switzerland

After having developed and validated a Eulerian-Lagrangian simulation model for powder coating applications, the novel OpenFoam® based tool has been steadily enhanced, adapted and improved. In accordance with statistically valid observations from extensive experimental series, various sub-models have been devised in order to further increase the predictive quality of the software. In the course of this improvement- and adaption process i) an efficient scheme to achieve accurate fluid-particle coupling has been introduced, eliminating experimentally non-observable coating imprints on the substrate, ii) a method to realistically predict particle motion close to substrate surfaces as well as particle-surface sticking behaviour has been devised and finally iii) a semi-implicit dynamic particle-charging algorithm has been developed to account for corona-particle charging effects.
On the basis of these improvements, solver predictions have become accurate enough to now provide never-before achieved insight into phenomena and parameter dependencies of the powder coating process. In particular the model has greatly helped to better understand connections between coating efficiency as well as coating quality and parameters like applied voltage, volumetric air-flow rate, substrate-pistol distance and substrate-pistol angle. These results constitute the basis of a variety of possible powder coating process improvements in the near future.

powder-coating, Eulerian-Lagrangian, coating efficiency, charging model, CFD, OpenFoam®

COMPARISON OF EXPLICIT METHOD OF SOLUTION FOR CFD EULER PROBLEMS USING MATLAB® AND FORTRAN 77

Anders Nordli, Hassan Khawaja
UiT-The Arctic University of Norway, Tromsø, Norway

This work presents a comparison of an explicit method of solution for an inviscid compressible fluid mechanics problem using Euler equations for two-dimensional internal flows. The same algorithm was implemented in both FORTRAN 77 and MATLAB®. The algorithm includes Runge–Kutta time marching scheme with deferred correction. Both solvers were initialized in the same manner. In addition, it was ensured that both solvers have the exact same values for time step, convergence criteria, boundary conditions, and the grid. The only difference between the two solvers was the precision of variables.
The problem solved was a two-dimensional dual bump with an accelerating flow through a duct. The problem was initialized with the stagnation pressure of 100 kPa and stagnation temperature of 300 K at the inlet. The outlet static pressure was set to 27.2 kPa and the duct geometry defined solid free-slip walls. The grid was divided into 120 (x-direction) by 30 (y-direction) cells. The variables computed in each cell were density, pressure, x-momentum, y-momentum, and energy. The convergence criterion was set to be 1e-5 for the maximum x- and y-momentum values and 5e-6 for the average x- and y-momentum values.
Both the MATLAB® and FORTRAN 77 solvers converged according to the specified convergence criterion. It was found that the number of iterations taken by MATLAB® was lower than the FORTRAN 77. It was also observed that the outlet to inlet mass flow ratio was different for MATLAB® and FORTRAN 77. The results also indicated about 10% maximal difference in the final densities. The reasons for both solvers to converge to slightly different solutions was due to the fact that the precision of variables was different.

CFD, Compressible Euler Problems, FORTRAN 77, MATLAB®

EOF-LIBRARY: HIGHLY EFFICIENT OPEN-SOURCE COUPLER FOR FEM AND FVM FRAMEWORKS

Juris Vencels
University of Latvia,
Riga, Latvia

EOF-Library is software that couples Elmer FEM and OpenFOAM simulation packages. It enables efficient volumetric field interpolation and communication between finite element (Elmer) and finite volume (OpenFOAM) simulation packages. Coupling is based on Message Passing Interface which results in low latency, high data bandwidth and parallel scalability.
The coupler consists of a collection of Elmer and OpenFOAM libraries that are dynamically linked during runtime. It is flexible and allows any number of scalar and vectorial fields to be sent in one or both directions. It is not altering the modelling of physics, but rather provides a framework for automatic interpolation and communication. All three software packages - EOF-Library, Elmer and OpenFOAM are open-source, and thus freely available. This makes them attractive for cloud computing, especially among small and medium companies.
There are known applications of EOF-Library in magnetohydrodynamics (levitation, wave generation and casting), electro-fluid-thermal coupling (cooling of electrical devices) and industrial plasma physics (vacuum arc PVD coating, magnetron sputtering), but the coupler can also be easily extended to other applications where volumetric fields are shared between Elmer and OpenFOAM.
In our talk we will present our successful experience with EOF-Library in the field of magnetohydrodynamics and will outline a few other possible applications that could benefit from coupling FEM and FVM frameworks.

Elmer; FEM; EM; OpenFOAM; FVM; CFD; MHD

MULTIPHYSICS APPROACH FOR A PANTOGRAPH-CATENARY SYSTEM SIMULATION

Paweł Zdziebko, Tadeusz Uhl, Adam Martowicz,
AGH University of Science and Technology,
Krakow, Poland

In electrified railways, pantograph-catenary systems are involved in passing the energy to a train via mechanical contact between pantograph slider and catenary contact wire. Dynamic interaction of those components directly affects the quality of current collection. It is, therefore, desired to reduce the fluctuations of the contact force measured between pantograph slider and contact wire. This can be achieved by tuning the pantograph suspension characteristics, but the adequate iterative process of finding the best suspension properties is time-consuming and expensive. Therefore, a numerical analysis is an useful tool for achieving the desired optimization results, but basing only on simulations. In this approach an adequate numerical model is required. The authors prepared a multi-domain co-simulation tool to perform the above stated investigation. The catenary is modeled via the Finite Element Method while the pantograph is created using the Multibody dynamics approach. The co-simulation between these codes is run to achieve results of the contact force between contact slider and catenary contact wire. A transient run is carried out with the chosen passage speed. The most important phenomena, which are considered in the prepared co-simulation setup, are: elastic wave propagation in the catenary, nonlinearity regarding contact properties of the cable elements, i.e. contact and messenger wires (droppers), aerodynamic forces acting on the pantograph components as well as the electromagnetic force acting on the pantograph slider, which is localized within the range of the magnetic field around the contact wire. The simulation approach was validated with the European Standard 50318. The Fluid-Structure Interaction model employed for designation of aerodynamic forces acting on the pantograph components was validated with experimental data measured in the wind tunnel. Based on the validation results, it is concluded that the presented multi-domain co-simulation tool can effectively simulate the interaction between catenary and pantograph mechanism. This work has been supported by the AGH University of Science and Technology, WIMiR, research grant no. 15.11.130.627.

catenary, pantograph, dynamic interaction, simulation, numerical model

SESSION 1.4

AEROSPACE

THURSDAY 13 DECEMBER 2018
16:00 - 17:30

CHAIR

A Fallah
Brunel University
UK

AERODYNAMIC IMPROVEMENT OF TEST RIG FOR INVESTIGATION OF BLADE CASCADE AT LARGE INCIDENCE ANGLES OF SUBSONIC FLOW

Vadym Kruts, Anatoliy Zinkovskii, Serhii Kabannik,
IPS NAS of Ukraine

In the course of aerodynamic testing of blade cascades, it is important to provide flow uniformity ahead of the cascade and similar conditions of their flow. With variation of stagger and attack angles of cascade the width of working section should be adjusted to coincide with the end blade cascades. To provide the fulfillment of these requirements it is proposed to use an accelerating nozzle, which upper and lower walls have been shaped according to two sine wave blade, whereas side walls have been made in accordance with Bernoulli's lemniscate with a possibility to change the distance between them. Moreover, rotating vanes have been developed at the cascade tips, which increased the efficiency of control for spatial flow periodicity in cascade at large angles of attack.

field of velocities, spatial flow periodicity, blade airfoil, accelerating nozzle, Bernoulli's lemniscate

THE EXPRESS METHOD FOR DETERMINATION OF STABILITY LIMIT OF AXIAL COMPRESSOR BLADING AGAINST SUBSONIC FLUTTER

Kyrylo Savchenko, Serhiy Kabannyk, Yevheniia Onyshchenko,
IPS, NAS of Ukraine

The analysis of defects detected in the development and operation of aircraft engines implies, in most cases, the aerodynamic nature of excitation of rotor blade vibrations. Self-induced vibrations or flutter are among the most critical ones. At flutter, there is a rapid increase of the vibration amplitudes of blades, which can cause the fatigue crack propagation with their further fracture. In the development of engine, it is obligatory to determine the critical conditions of flutter occurrence along with the gas-dynamic strength calculations to ensure the reliability of blade assemblies. This applies especially to the compressor blades, which are made with a higher aspect ratio and integral joint connection with the blade wheel disk, where there is no structural damping of vibrations. In the modern practice of engine building, the assessment of flutter stability of blade assemblies is based on the statistical methods using the results of tests for engines under bench test and full-scale conditions. The obtained data for stable and unstable conditions of various blade assemblies make it possible to establish the empiric limits of their flutter. Such approach to the solution of the problem is possible only for the blade assemblies with rather similar geometry and aerodynamic flow conditions, which is not always conceivable for modern ones. An incorrect determination of the aerodynamic stability limits of blade assemblies at the stage of advanced development might involve significant material and time costs associated with the redesign, experimental verification and development as a part of a full-scale engine. Therefore the paper proposes the technique of experimental and calculation determination of the dynamic stability limit of the blade assembly against subsonic flutter and examples of its application for flexural mode of vibrations of aircraft gas-turbine engine axial compressor blades for various operation modes.

blade assembly, subsonic flutter, dynamic stability limit, plane cascade of blade airfoils, attack angle

PREDICTION OF MECHANICAL AND ELECTRICAL PROPERTIES OF COMPOSITES BASED ON WEFT-KNITTED FABRICS

V. Stavychenko[a], M. Shevtsova[a], P. Shestakov[a], A. Litvinova[a], O. Mazna[b], V. Kokhany[b], I. Obodeeva[b]
a. KhAI
b. IMPS NASU

The present study is devoted to the prediction of the mechanical and electrical properties of polymer composites based on weft-knitted fabrics produced from high strength carbon fibers for structural and other types of applications. Rational choice of the yarns material knitting schemes for these types of fabrics allow to obtain multifunctional composite materials with the required combination of mechanical, electrical and other properties, depending on the design purpose. The FEM-based method that takes into account changing of fabric structure during molding process was proposed for this purpose. Preliminary simulation of the reinforcing material deformation under the molding pressure allows us to use the initial (undistorted) structure of the fabric and improves the accuracy of the prediction. Approbation of the developed method was performed for polymer composites based on several types of fabrics with different structures and types of yarns. To confirm the reliability of the simulation, standard specimens based on mentioned fabrics were manufactured and tested for which the necessary mechanical and electrical properties were determined. Studies have shown that the numerical values, obtained using the proposed method, are in good agreement with the experimental results. This makes it possible to use this method to solve the problem of choosing the material of the yarns and the rational knitting scheme of the fabric to obtain the necessary properties of resulting composite materials taking into account possible effect of molding process.

Carbon fibers, weft-knitted fabrics, finite element method, mechanical properties, electrical resistivity

LIGHTWEIGHT MAX PHASES - BASED MATERIALS HEAT-RESISTANT IN OXIDIZING AND HYDROGEN ATMOSPHERE

PRIKHNA Tetiana[1], OSTASH Orest[2], SVERDUN Vladimir[1], CABIOC'H Thierry[3], KARPETS Myroslav[1], SERBENYUK Tetiana[1], STAROSTINA Alxanda[1], JAVORSKA Lucyna[4], DUB Sergey[1], KUPRIN Alexander[5]

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2 Karpenko Physical-Mechanical Institute of the National Academy of Sciences of Ukraine

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4 The Institute of Advanced Manufacturing Technology, Krakow, Poland

5 National Science Center Kharkov Institute of Physics and Technology, Kharkov, Ukraine

MAX-phases are characterized by general formula Mn+1AXn, where n = 1, 2 or 3; M – early transition metals; A – elements of A-group and X is C or N. Materials have high bending and compression strength, fracture toughness at room and high temperatures, excellent damping characteristics, high thermal shock resistance, chemical stability, good machinability, high electro- and thermal conductivity, low friction coefficient, low coefficient of thermal expansion, they are stable in the radioactive environment, resistive in hydrogen and oxidation atmosphere. They also have self-healing properties. The complex of characteristics of the developed materials make them promising for application in the extreme environments. The dense MAX-phases-based materials of Ti,Nb–Al–C systems of 211 and 312 structural types are stable in hydrogen and oxidizing environments at 600°C, are about twice lighter and more stable in air than Cr-containing Crofer steels widely used as interconnects for hydrogen fuel cells. The most resistant in air at 600°C (for 1000 h) among the studied materials turned out to be Ti2AlC-based and somewhat less stable (Ti, Nb)3AlC2 – based. The Auger study confirmed the presence of some oxygen in the structures of Ti2AlC and (Ti,Nb)3AlC2 what can be the explanation of their high stability against oxidation. The oxide films on the surfaces of the materials with Nb were thinner. Ti3AlC2-based materials demonstrated 4.6-5.8 GPa microhardness at 5 N load, 500-570 MPa bending and 700-1300 MPa compression strengths, their fracture toughness reached 10.2±0.4 MPa•√m, and electrical conductivity 2.7•106 Sm/m at 20°C. The bending strength of Ti3AlC2-based material in air at 20°C was 535 MPa, after been keeping at 600°C in air and hydrogen it decreased to 490 and 500 MPa, respectively. For (Ti,Nb)3AlC2 –based materials the bending strength at 20°C in air was 480 MPa, but increased for 10% after heating at 600°C in air and in hydrogen.

Ti, Nb-Al-C MAX phases, high-temperature resistance in air and hydrogen, bending and compressing strengths, microhardness, fracture toughness

SESSION 2.1

THERMAL MODELLING

FRIDAY 14 DECEMBER 2018
09:30 – 11:00

CHAIR

B Alzahabi
Al Ghurair University
UAE

IR THERMOGRAPHY IN MULTIPHYSICS APPLICATIONS

Hassan Khawaja
UiT-The Arctic University of Norway, Tromsø, Norway

It is seen that Infrared (IR) thermography is becoming one of the very popular and effective methods in the industry as well as research and development sectors. IR thermography being a remote non-contact/non-destructive means of testing is perfectly suitable for tests in extreme environments. In addition, it is fast, reliable and detailed. Due to the advantages offered by IR thermography, it is becoming extremely popular in a number of industries. Not only industry but academic and research institutions are also finding IR thermography as one of the fundamental tools in their arsenal for teaching as well as research. The proposed presentation discusses three case studies where IR thermography has been used effectively in research and development projects at the UiT-The Arctic University of Norway.

The first case is about the determination of ice properties using IR thermography in conjunction with three-dimensional finite difference solution of the heat equation. In this study, thermal conductivity and heat transfer coefficient were found for fresh water and seawater ice. The results revealed the difference in the properties. The results were found to be in close agreement with the literature.

The second case study presents the estimation of thermal insulation (IREQ) of different types of thermal clothing. The results clearly showed the difference between the insulation ability of sweaters, summer jackets and winter jackets.

The third case presents tensile testing of steel samples with IR thermography of the samples. It was a noticed that steel samples were about 20-25°C warmer at the time of failure.

Infrared (IR) Thermography, Multiphysics, Infrared Imaging, FLIR Camera

MULTI-SCALE ELECTROCHEMICAL-THERMAL MODELS FOR AUTOMOTIVE BATTERY PACK THERMAL MANAGEMENT

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(2) ICAM-Toulouse, 75 avenue de Grande Bretagne, 31300 Toulouse, France
(3) National Research Council of Canada, Automotive and Surface Transportation Research Centre, Boucherville, Québec, Canada

This study integrates three numerical models for determining the thermal state of automotive battery packs. A coarse scale Ohm's law finite-volume approach determined the current distribution in prismatic battery cells, along with a microstructure scale model for the electrochemical state, and were ultimately coupled to a volumetric heat transfer model to provide the thermal state of operational automotive battery packs. The objective was to evaluate the thermal management performance of two types of cooling plate configurations for liquid cooling systems. The first design is known as an Ice Plate, which is inserted between the main faces of every second cell in the battery pack. A second design is known as a Cold Place, which is placed underneath a block of cells, and dissipates heat only through the small bottom face of the cell, exploiting favourable anisotropic heat transfer properties.
In general, given its greater contact with the battery cell, the Ice Plate performs better. The Cold Plate however is less complicated and less expensive to integrate into the battery pack, and can have its performance augmented by employing elevated cooling circulation rates. Cold Plates also compare favorably to Ice Plates in cases where the battery cell casing is made of metal, a more thermally conductive material.
Time-temperature profiles were obtained for the two cooling plate systems for a range of cooling levels and varying degrees of cell degradation under US EPA US06 and Highway drive cycles. Battery service lifetime estimates were made for both cooling configurations, allowing a comprehensive evaluation of their relative merits under a broad range of operational conditions and system variables.

electrochemical-thermal model, multi-scale model, automotive battery, thermal management

LASER SPOT THERMOGRAPHY - SCANNING MOD

Jakub Roemer, Łukasz Pieczonka
AGH University of Science and Technology, Krakow, Poland

Nondestructive techniques becomes integral part of modern engineering. NDT finds application everywhere, especially where there is a need for failure-free machines operation. Unscheduled downtimes can significantly reflect on factory's economy. There are many certified NDT testing methods like ultrasound, penetrant testing or radiography. However, there is steel a need for investigation new, more robust, faster or just cheaper techniques. Especially for demanding applications where physical contact with tested structure should, for any reason, be avoided. One of the promising techniques is that based on thermography, especially active thermography where the tested structure is stimulated by external source. There are several techniques related to IR such as vibro-thermography, pulse thermography or laser thermography. IR based techniques become more affordable due to lowering cost of equipment, which in many cases was a limiting factor in many industrial applications. This work shows laboratory testing for laser spot thermography used in scanning mode.
This work has been supported by the AGH University of Science and Technology, WIMiR, research grant no. 15.11.130.832

NDT, Laser, Thermography, Crack detection

NONLOCAL APPROACHES FOR MODELING COMPONENTS OF GAS FOIL BEARING

Adam Martowicz, Jakub Bryla, Jakub Roemer, Wieslaw J. Staszewski
AGH University of Science and Technology, Krakow, Poland

The work is devoted to the applications of various nonlocal modeling techniques to the selected components of gas foil bearing (GFB). A typical radial GFB consists of the bushing covering two types of specialized foils. These foils are made of superalloys and assure proper operation of the bearing. The inner foil (top foil) remains in direct contact with the journal of the shaft, whereas the outer one (bump foil) constitutes an elastic-damping supporting component. It allows to keep the required tens-of-micrometer-thick air film efficiently and hold the journal in the correct position. The structure of GFB does not include any moving component, hence, it is considered a reliable and robust support of the shaft, especially in a high-speed rotating machinery. Due to the existing complexity of the phenomena identified in GFB, it is desired to propose and test new modeling approaches that will help to model the behavior of GFB more reliably. Amongst others, the following phenomena in GFB are of the scientific interest: heat transport and distribution, thermoelasticity, elastic wave propagation and energy dissipation. The authors of the present work focus on the nonlocal modeling techniques that may be used to solve some of the above mentioned phenomena. In particular, peridynamics and nonlocal formulation of the finite difference method are investigated to address: wave propagation, thermal diffusion and the phenomenon of superelasticity. This study was funded by National Science Center, Poland (grant number OPUS 2017/27/B/ST8/01822).

gas foil bearing, nonlocal model, peridynamics, nonlocal finite difference scheme, partial differential equation, shape memory alloy

SESSION 2.2

ADVANCED MATERIALS

FRIDAY 14 DECEMBER 2018
11:30 – 13:00

CHAIR

C Wang
Beijing Institute of Technology
China

INVESTIGATION ON MULTI-MATERIAL FLOWS BY COUPLING MMALE AND FDM

Tao Li, Hao Li, Cheng Wang,
State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, Beijing, China

A new method coupling Multi-Material Arbitrary Lagrange Euler (MMALE) and Finite Difference Method (FDM) was present for multi-material calculation, such as two-dimensional shock tube problem and air explosion. With fifth-order Weighted Essentially Non-Oscillatory (WENO) scheme and third-order TVD Runge-Kutta method, FDM has the advantages of fast calculation and high resolution. MOF method integrated in MMALE is widely used for tracking the interface between two or more kinds of medium, which can reconstruct the interface only by calculating the centroid and volume fraction of mixed mesh. MMALE method adopts mixed mesh with applying the closed model theory to update the variables in mixed mesh. Combining the strong point of MMALE and FDM, MMALE is applied in the region near the interface for precisely tracking the position and status of interface, and the pure mesh away from the interface uses FDM. Between the different kinds of mesh, Lagrange and Euler mesh, the status of mixed mesh is transferred by a bilinear interpolation. Thus, MOF method is effectively extended to the calculation of FDM, improving largely the efficiency relative to the ALE method. It can calculate strong shears and complex deformation flows problems, which is not easily calculated by traditional ALE methods.

MMALE, MOF, multi-material calculation, mixed mesh

A NOVEL EX-SITU ALUMINUM FOAM FILLED FOURFOLD-TUBE NESTED TUBE SYSTEM AS THE ENERGY ABSORBER

Bin Xu, Cheng Wang, Wenlong Xu,
State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, Beijing, China

Load-displacement response and energy absorption of aluminum foam-filled and empty FT (fourfold-tube) nested tube systems were investigated experimentally. In quasi-static test, all FT (fourfold-tube) nested systems including aluminum foam-filled tubes and empty tubes were compressed laterally by two rigid plates. Effects of the aluminum foam on deformation mode and energy absorption capability of the foam-filled FT system was analyzed. Experimental results show that the presence of aluminum foam-filled in the FT system changes the deformation modes and increases the energy absorption of the FT system, besides, the robustness of the FT system was improved significantly. In dynamic experiments, impact loading apparatuses SHPB (split Hopkinson pressure bar) and dynamic measurement techniques (velocimeter, dynamic strain gauge, high-speed imaging) were used to test the dynamic deformation mode of the foam-filled FT system with different strain rate. The results demonstrate that the foam-filled FT system can provide a better efficient impact force reduction and desired deformation mode compared to empty tubes. The improved aluminum foam-filled FT system can be widely used in engineering fields for enhancing its crashworthiness under impact.

Nested-tube system; Aluminum foam-filled tube; Deformation mode; Energy absorption capacity; Dynamic loading

MULTI-MATERIAL INTERFACE METHOD BASED ON HYPERELASTIC MODEL

Wanli Wang, Cheng Wang,
State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, Beijing, China

Based on the governing equations of hyperelastic model, we can depict gas liquid and solid by a unified form. Since the stress tensor is defined by specific internal energy and the deformation gradient tensor, the expression is very complicated to get the eigenmatrix. Based on the orthogonal decomposition of the acoustic tensor we get the analytic expression of the eigenmatrix and the fifth-order WENO finite difference scheme has been applied successfully in space reconstruction. Besides, we improve the HLLD Riemann solver by take into consideration of a seven-wave-structure (HLLD-7), in which case the shear wave speed is different at each direction and the Rayleigh-Hugoniot relationship is applied forth across the shear waves on each side of the contact discontinuity. This provides a new viewpoint for the calculation of anisotropic materials. And then we propose a method to deal with the friction surface by use the Coulomb law of friction. Numerical result shows that when the friction coefficient was set to zero the friction model will degenerate into a fixed interface condition.

Hyperelastic model, Friction model, WENO, HLLD

FLAME PROPAGATION CHARACTERISTIC OF EXPLOSION IN THE TUBE WITH A TILTED OBSTACLE

Yangyang Cui, Cheng Wang,
State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, Beijing, China

Obstacles are unavoidable in coal mine laneways and combustible gas pipeline. However, the obstacles may enhance the intensity of the explosion, or change the propagation characteristic. In this study, a cuboid tube (600 mm in length, 110 mm in width and 100 mm in height) was used. The tube has a glass window, from which the propagation characteristic of explosion flame can be observed. A high-speed camera was used to collect the images at a rate of ten thousand images per second. We have chosen four kinds of initial pressures (0.1 – 0.25 bar) to investigate the influence on the flame propagation with a tilted obstacle in the tube. We found that backflow occurred when the initial pressure was low. However, backflow diminished with the increase of pressure. We could also see that the flame is brighter with higher initial pressure. The flame propagation speed also varied with the pressure. In addition, we observed the flame characteristics by changing the angle of the obstacle from 30° to 150°. We found that when the initial pressure is low, and the angle is large, backflow is rather more apparent. The backflow also contributed to two large vortexes with opposite directions when the obstacle angle was as large as 135°. This research could provide a fundamental basis for explosion protection designs.

Flame propagation, explosion, tube, obstacles

SESSION 2.3

MULTIPHYSICS APPLICATIONS

FRIDAY 14 DECEMBER 2018
14:00 – 15:30

CHAIR

H Khawaja
University of Tromsø
Norway

FREQUENCY BAND STRUCTURE OF PHONONIC DISPERSION IN FRACTAL LATTICES

Navid Navadeh[a], Vladimir V Tereshchuk[b], Vyacheslav Gorshkov[b], Arash Fallah[c]
a. Imperial College London, UK
b. Kiev Polytechnic Institute, Ukraine
c. Brunel University London, UK

Phononic fractal lattices exhibit unique features not present in conventional phononic lattices or metamaterials. Higher frequencies that can be excited in the simple substratum lattice are almost identical with those of the fractal lattice, however; through introduction of fractal microstructure the number of degrees-of-freedom increases so does the number of dispersion surfaces. As a consequence of this, fractal lattices lead to elimination of certain frequency gaps. This is helpful when detectability is desirable. Furthermore, dispersion surfaces flatten as a result of presence of microstructure, a phenomenon that can be viewed as the classical analogue of quantum level repulsion. This could sufficiently decrease the sound group velocity in the fractal lattice and may have practical applications. Different ‘rotating’-‘displacing’ modal interaction to ordinary lattices is also observed in the presence of internal microstructure of the unit cell.

Fractals, bandgap, tailorability, dispersion surface, Brilluoin zone, Floquet-Bloch’s principle

IMPACT OF FOULING ON MECHANICAL RESONATOR-BASED VISCOSITY SENSORS: COMPARISON OF EXPERIMENTS AND NUMERICAL MODEL

Daniel Brunner[a,c], Kaus Häusler[a], Sunil Kumar[b], Hassan Khawaja[c], Moji Moatamedi[c], Gernot Boiger[a]

a. ZHAW Zurich University of Applied Sciences, ICP Institute of Computational Physics, Switzerland

b. Rheonics GmBH, Winterthur, Switzerland

c. UiT-The Arctic University of Norway, Tromsø, Norway

Monitoring fluid properties such as viscosity is crucial in many industrial processes. Viscosity sensors based on mechanical vibrations can offer a solution to monitor the fluid viscosity online. However, such sensors' sensitivity drop due to fouling and it is a common problem in industrial processes.

The goal of the presented study is to investigate the effects of a purely elastic fouling layer on the sensing element of a viscosity sensor using experiments and numerical models. The sensor used in this study is a probe style torsional resonator. The measuring principle of this sensor is correlating the damping of the resonating system to the viscosity-density product of the surrounding fluid. In case of fouling, the characteristics of the resonator are affected by the fouling layer. In the given study, the impact on the damping due to the fouling layer is investigated by conducting the experiments and comparing it with three different numerical models.

In experiments, the sensor has been coated with metal in the sensing area. Then, the sensor has been immersed into different fluids to determine the impact of the metal layer on the viscous induced damping.

To understand the physical implications of the deposit on the resonating system three different numerical models have been developed. These models describe the resonator with increasing degree of detail. First model is using single mass spring system, second model is two masses with three springs system, and third model is 3D structural model solved in COMSOL® Multiphysics. In all of the above models, the fluid-structure interaction is weakly coupled with an analytical solution for the flow field. These models are compared and tested against the experiments.

Viscosity sensor, viscosity measurement, mechanical resonator, fluid-solid interaction

A COMPARISON BETWEEN TWO DIFFERENT ELBOW DESIGN FOR A FIBERGLASS PIPE USING FLUID STRUCTURE INTERACTION

Essam AlBahkali[1], Hisaham Elkanani[1], Zeyad Almutairi[1], Thamer AlBahkali[1], Mhamed Souli[2],
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[2]Laboratoire de Mécanique, de Lille, UMR CNRS 8107, Villeneuve d'Ascq, France

A fluid structure interaction (FSI) simulations are performed to study natural frequencies and their amplitudes for two different design fiberglass pipe elbow. One of the elbow has a sharp edge and the other has curved edge. The finite element (FE) for both models is built using eight-node elements. A large number of elements are used to ensure the conversion of FE results. The boundary conditions that are applied on the right side of both models is subject to fixed supports in the axial, vertical directions, and free support at lateral direction, and at the lift side is subject to a fixed support in all axes. 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 two different positions before and after the elbow are extracted from the simulation. The result shows that the amplitudes in the lateral direction are large compare to other axes. In addition, by comparing the result of the two different design elbow, it shows that a reduction in the amplitude is occurred by approximately 50, 16, and 50 presents in the axial, vertical, and lateral direction respectively when the design of the elbow is curved. Furthermore, when the pressure is reduced by 40 percent, the dominated natural frequency is shifted and the amplitude is almost eliminated.

Natural Frequency, Amplitude, Fiberglass Pipe

NUMERICAL SIMULATIONS OF ULTRASONIC WAVES SELF-FOCUSING IN COMPOSITE LAMINATES

Lukasz Pieczonka, Daniel Błaszkiewicz, Radosław Mormul,
AGH University of Science and Technology, Poland

The presentation describes numerical results obtained for Time Reversal (TR) focusing of ultrasonic waves in laminated composites. An anisotropic laminated composite plate with Barely Visible Impact Damage (BVID) was chosen as a non-trivial example. Numerical simulations were performed with use of a commercial Finite Element (FE) software package combined with a developed signal processing framework prepared in Matlab and Python. The MSC.Marc solver was used to perform the required nonlinear multiphysics simulations involving piezoelectric actuators and contact type damage. The presentation discusses theoretical background of the applied focusing technique as well as experimental arrangements necessary to validate the proposed testing methodology in practice.
The research was financed within the scope of the project no. SONATA 2015/19/D/ST8/01905 financed by the National Science Center of Poland.

elastic waves, time reversal, numerical simulations, composites

SESSION 2.4

POSTERS

FRIDAY 14 DECEMBER 2018
16:00 – 17:30

IR THERMOGRAPHY OF STEEL SPECIMENS UNDERGOING TENSILE TESTS

Even Stange, Hassan Khawaja
UiT-The Arctic University of Norway, Tromsø, Norway

In this work, the IR thermography was used to study the steel specimens (DIN 50125 Standard) undergoing the tensile tests. The tensile tests were performed using GUNT® Hamburg Universal Material Tester. The tensile specimens were clamped, and the test force was generated using a hand-operated hydraulic system. A dial gauge measured the elongation of the specimens. Using the WP 300.20 system for data acquisition, the measured values for force and displacement were recorded in a PC. The IR thermographic imaging was performed using the FLIR® T1030sc IR camera and ResearchIR Max software. The steel specimens were coated with high emissivity paint. The tests revealed that the steel specimens show noticeable thermal signature when undergoing tensile loading. The samples were found to be warmer by 20-25 °C at the time of failure. The tests were repeated under various surrounding temperatures such as 25°C, -5°C, -10°C, -15°C, and -20°C. The same study was compared with the finite element numerical simulation in ANSYS® Workbench. The experimental and simulation results were found to be in a qualitative agreement

Infrared (IR) Thermography, Infrared Imaging, FLIR Camera, Tensile Tests, Steel Specimen

FINITE STRUCTURE INTERACTION OF AQUACULTURE NET CAGES

Odd Einar Myrli, Hassan Khawaja
UiT-The Arctic University of Norway, Tromsø, Norway

The number of good sites in less exposed locations for aquaculture farming is limited. Trends are now that the fish cages are increasing in both width and depth, as well as more weather-exposed locations, are taken into use. As the net cages continue to increase in size, so does the material costs. The design of the sea cages should be modified for safe and reliable use in remote offshore locations. Fish farms located in more exposed areas will be subject to more energetic waves and stronger currents, which will cause large net deformations. This is a challenge as fish welfare depends on a certain minimum volume within the net cage. Changing and maintaining net cages are some of the main expenses for fish farms. If the lifetime of the net cages is extended by introducing stronger, longer lasting materials, the overall costs of the nets will be reduced.
The traditional nets are produced in nylon, while the promising solid PET-wire has been introduced to the aquaculture industry. In this paper, we introduce polyurethane to the aquaculture net cages, which will be studied together with nylon and PET-wire. The study is carried out using fluid-structure interaction (FSI) simulation, computational fluid dynamics (CFD) weakly coupled with structure mechanics (FEM). ANSYS® software is employed in the study. We will look at the materials that show the most promising results for aquaculture purposes.

Finite Structure Interaction, CFD, FEM, ANSYS, Net Cages, Fish Farms

AN EFFICIENT GRAYSCALE REPRESENTATION FOR RETINAL VESSEL EXTRACTION

Mohammad Asmat Ullah Khan, Mojtaba Moatamedi, Basem Alzahabi
Al Ghurair University, UAE

Structural changes in retinal blood vessels are important indicators for many diseases including diabetic retinopathy (DR), glaucoma, and hypertension. For many automated vessel extraction methods, the green channel of the RGB color fundus image is often utilized because of the fact that it provides the best contrast among all three channels. We hypothesize that vessel information contained in dropped channels, red and blue, will add to the performance of an extraction process. In this paper, we propose a linear combination framework to utilize all three channels of the color fundus image. We devised a noise-cancellation method that provides the required weights for each color channel image to realize a linear combination framework. The additional information made available through this framework results in better performance for automated vessel extraction algorithms. The performance of the framework is analyzed on publicly available databases of retinal images showing improvements in all three aspects namely accuracy, sensitivity, and specificity.

Retinal Vessels, Noise Cancellation, Grayscale Representation, Unsupervised learning, Filtering

NUMERICAL PROCEDURE FOR IDENTIFYING THE AMMONIA CONCENTRATION OF THE SEWAGE INFLUENT BASED ON SCADA

P. Król, A. Gallina*, T. Uhl*, T. Żaba***
**Department of Robotics and Mechatronics, AGH University of Science and Technology, Kraków, Poland,*
***MPWIK S.A. w Krakowie, Kraków, Poland*

Waste management is a fundamental process to keep the environment in wholesome conditions. The environmental impact of solid waste and wastewater is reduced through the construction of appropriate disposal installations. The objective of biological wastewater plants is to track the process of wastewater treatment by regulating the aeration in biological reactors. One of the most important factors of the chemical processes taking place in the reactor is the concentration of ammonia in the effluent. If this concentration is too high, then it can lead to the damage the plant's reactors. For this reason, the level of ammonia in the effluent, which strictly depends on the free and saline ammonia present in the influent sewage, is constantly measured and controlled by the amount of oxygen blown into the reactor. Unfortunately, the direct measurement of the ammonia concentration in the influent wastewater, for practical reasons, is very hard to perform. It does not allow one to predict the ammonia level in the effluent and develop smart control strategies based on model predictions. This paper proposes a numerical approach for the identification of the ammonia concentration of the effluent based on measurements of the effluent properties. The numerical procedure exploits a computer model of the biological process called the Activated Sludge Model (ASM implemented in the Benchmark Simulation Model that simulates the whole wastewater treatment process. The procedure is applied to the wastewater treatment plant located in Plaszów, Krakow.

The work was supported by the AGH Grant no. 15.11.130.831 and carried out employing the infrastructure of the Centre of Energy AGH (Czarnowiejska 36, 30-054 Kraków, Poland).

Wastewater treatment

CFD MODELLING OF POLLUTANT TRANSPORT

Synne Karoline Madsen, Hassan Khawaja
UiT-The Arctic University of Norway, Tromsø, Norway

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. In this study, it is possible to see the outcome as a tool for mapping the pollutant in the environment close to the source. ANSYS® fluent is used to solve the CFD simulations including CO_2 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 show the pollutant transport in the domain. The simulation not only predicted the spread of the pollutant discharged but also indicated the concentration at any given point in space. This study is very relevant for project planning to assess the impact of pollutant discharge to nearby surroundings.

CFD, pollutant transport, CO_2, two-phase modelling, air pollution