37th conference with international participation

PROCEEDINGS OF
COMPUTATIONAL MECHANICS 2022

November 7 - 9, 2022

HOTEL SRNÍ
CZECH REPUBLIC
The proceedings contain 56 conference papers presented at the 37th conference Computational Mechanics 2022, which was held at the Hotel Snížky in Snížek, Czech Republic, on November 7 – 9, 2022. This annual conference, which was attended by nearly eighty participants from the Czech Republic, Slovakia and from abroad, was organised by the Department of Mechanics, Faculty of Applied Sciences of the University of West Bohemia under the auspices of

- Miloš Železný, the Dean of the Faculty of Applied Sciences,
- Rudolf Špoták, the President of the Pilsen Region,
- Czech Society for Mechanics,
- Czech National Committee of IFToMM,
- Central European Association for Computational Mechanics.

The main objective of this traditional conference is to bring together academicians, researchers and industrial partners interested in relevant disciplines of mechanics including

- solid mechanics,
- dynamics of mechanical systems,
- mechatronics and vibrations,
- reliability and durability of structures,
- fracture mechanics,
- mechanics in civil engineering,
- fluid mechanics and fluid-structure interaction,
- thermodynamics,
- biomechanics,
- heterogeneous media and multiscale problems,
- experimental methods in mechanics,

to create an opportunity for meeting, discussion and collaboration among the participants. As in the previous years, the three best papers presented at this conference were awarded the Czech Society for Mechanics Award for young researchers under 35 years of age.

To all conference participants, we offer the possibility to publish their peer-reviewed full papers in the international journal Applied and Computational Mechanics indexed by Scopus. This journal has been published by the University of West Bohemia since 2007 (see https://www.kme.zcu.cz/acm/).

We would like to express our gratitude to all the invited speakers for their significant contribution to the conference and the time and effort they put. Considerable acknowledgement belongs also to the members of the Organising Committee for their important work.

We strongly believe that all participants of the CM2022 enjoyed their stay in the beautiful nature of the Snížek region in a meaningful way. Finally, we would like to invite you all to come to the next conference CM2023.

Jan Vimmr
University of West Bohemia
Chairman of the Scientific Committee

Vítězslav Adámek
University of West Bohemia
Chairman of the Organising Committee
SCIENTIFIC COMMITTEE

Chairman:
Jan Vimmr
University of West Bohemia, Faculty of Applied Sciences, Czech Republic

Members:
Miroslav Balda
Research and Testing Institute Plzeň, Czech Republic
Jiří Burša
Brno University of Technology, Faculty of Mechanical Engineering, Czech Republic
Jan Dupal
University of West Bohemia, Faculty of Applied Sciences, Czech Republic
Václav Dvořák
Technical University of Liberec, Faculty of Mechanical Engineering, Czech Republic
Jiří Fürst
Czech Technical University in Prague, Faculty of Mechanical Engineering, Czech Republic
Miroslav Holeček
University of West Bohemia, Czech Republic
Jaromír Horáček
Institute of Thermomechanics, Czech Academy of Sciences, Czech Republic
Michal Kotoul
Brno University of Technology, Faculty of Mechanical Engineering, Czech Republic
Jiří Křen
University of West Bohemia, Faculty of Applied Sciences, Czech Republic
Vladislav Laš
University of West Bohemia, Faculty of Applied Sciences, Czech Republic
Justín Murín
Slovak University of Technology in Bratislava, Faculty of Mechanical Engineering, Slovak Republic
Milan Nad
Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava, Slovak Republic
Jiří Náprstek
Institute of Theoretical and Applied Mechanics, Czech Academy of Sciences, Czech Republic
Miloslav Okrouhlík
Institute of Thermomechanics, Czech Academy of Sciences, Czech Republic
Luděk Pešek
Institute of Thermomechanics, Czech Academy of Sciences, Czech Republic
Jindřich Petruška
Brno University of Technology, Faculty of Mechanical Engineering, Czech Republic
Jiří Plešek
Institute of Thermomechanics, Czech Academy of Sciences, Czech Republic
František Pochylý
Brno University of Technology, Faculty of Mechanical Engineering, Czech Republic
Pavel Polach
Research and Testing Institute Plzeň, Czech Republic
Eduard Rohan
University of West Bohemia, Faculty of Applied Sciences, Czech Republic

Josef Rosenberg
University of West Bohemia, Faculty of Applied Sciences, Czech Republic

Milan Růžička
Czech Technical University in Prague, Faculty of Mechanical Engineering, Czech Republic

Milan Sága
University of Žilina, Faculty of Mechanical Engineering, Slovak Republic

Petr Sváček
Czech Technical University in Prague, Faculty of Mechanical Engineering, Czech Republic

Zbyněk Šika
Czech Technical University in Prague, Faculty of Mechanical Engineering, Czech Republic

Michael Valášek
Czech Technical University in Prague, Faculty of Mechanical Engineering, Czech Republic

Jaroslav Žápměl
VŠB – Technical University of Ostrava, Faculty of Mechanical Engineering, Czech Republic

Vladimír Zeman
University of West Bohemia, Faculty of Applied Sciences, Czech Republic
# Table of Contents

Balon A., Beneš P., Šika Z.: *Model reduction in aeroservoelasticity* ........................................... 1  
Bělohoubek M., Hajžman M., Vimmr J.: *Assessment of various computational approaches for airfoil stability analysis with two degrees of freedom* .................................................. 3  
Boualleg A., Cirkl D.: *Mechanical properties of 3D printed composite material* .............................. 7  
Bublík O.: *Solution of incompressible viscous fluid flow using a physical informed neural network* ....................................................................................................................... 10  
Bulín R., Hajžman M., Byrtus M.: *Modelling of gear couplings in the framework of multibody systems* ............................................................................................................................... 12  
Čečrdle J.: *Supplementary aeroelastic analysis of modified LSA-category aircraft* ......................... 14  
Clément J.-B.: *p-Adaptive simulations of Richards’ equation with discontinuous Galerkin method* ................................................................................................................................. 18  
Dupal J.: *Periodical solution of n-DOF parametric system vibration* .............................................. 22  
Dyk Š., Rendl J., Bulín R., Smolík L.: *Local phenomena in tilting-pad journal bearing’s pivot* ............. 24  
Goga V., Berta Š., Murín J., Paulech J., Šarkán L.: *Device for measuring the stiffness of the tensile nylon springs* .................................................................................................................. 26  
Hajžman M., Polach P., Polcar P.: *Multibody dynamics simulations of the railway vehicle for heavy loads transport* ................................................................................................................. 30  
Houdek V., Verlinden O., Hajžman M.: *Non-uniform quaternion spline interpolation in vehicle kinematics* ............................................................................................................................. 34  
Janošík T., Brož F.: *Optimization of a ducted-fan propulsion unit equipped with an internal combustion engine* ...................................................................................................................... 38  
Ježek O., Kopačka J., Gabriel D.: *Post-processing the results of the topology optimization with the level-set technique* ........................................................................................................... 42  
Klesa J., Fukuchi M.: *The comparison of real gas and ideal gas models for compressor design* ........... 46  
Kovář P., Fürst J.: *Compressor cascade total pressure loss correlation modelling at design points using artificial neural networks* ...................................................................................... 50  
Kraus K., Šika Z., Krivošej J.: *Experimental based tuning of active 3-DoF planar absorber* ............... 54  
Krivošej J., Halamka V., Šika Z.: *Pre-stress states and controllability of spatial cable-driven mechanisms* .......................................................................................................................... 56  
Krivošej J., Šika Z.: *Eigenmotion concept of cable driven mechanism with absorbing elements* ........ 59  
Lieskovský J., Beneš P., Šika Z.: *Inverse dynamics approximation for controlling mechanisms with flexible elements* ........................................................................................................ 61
Lukeš V., Rohan E.: Two-scale numerical simulation of acoustic transmission in interaction with flow ................................................................. 63
Minich R., Kepka jr. M., Kepka M.: Assessment of the fatigue life of a city bus ............... 70
Murín J., Kugler S., Aminbaghai M., Paulech J., Hrabovský J., Goga V., Kutiš V.: Kinematic and constitutive equations in warping torsion of FGMs beams with spatially varying material properties ................................................................. 72
Musil J.: On the development of Cahn-Hilliard Navier-Stokes numerical solver within OpenFOAM framework ................................................................. 75
Naď M., Rolník L., Bucha P.: The numerical analysis of cantilever beam structures filled using aluminium foam ................................................................. 79
Náprstek J., Fischer C.: Analysis of van der Pol equation on slow time scale for combined random and harmonic excitation ................................................................. 83
Náprstek J., Fischer C.: Construction of the Lyapunov function reflecting the physical properties of the model ................................................................. 87
Otta J., Šudoma M.: EMA-driven model updating based on material homogenization ........ 91
Padovec Z., Vondráček D., Mareš T.: Stress analysis in filament wounded composite pressure vessels ................................................................. 95
Pařez J., Kovář P., Vampola T.: Sensitivity analysis of thermodynamical parameters on the thermal bowed rotor using 2D finite element model ................................................................. 103
Paulec M., Kopas P., Sága M.: Effects of hardenability on mechanical properties of tool steel 56NiCrMoV7 for forging die ................................................................. 107
Pawlik V., Steinbauer P., Bukovský I.: Online identification using linear neural unit with guaranteed weights convergence ................................................................. 111
Pešek L., Šnábl P., Prasad C.S., Delanney Y.: Numerical simulations of aeroelastic instabilities in turbine blade cascade by modified Van der Pol model at running excitation .............. 115
Rendl J., Smolík L., Dyk Š., Bulín R., Kubín Z.: Treatise on dynamic behaviour modelling of tilting pad journal bearing under operating conditions: From the real world to numerical simulations ................................................................. 119
Rohan E., Heczko J.: Homogenization based two-scale modelling of unilateral contact in micropores of fluid saturated porous media ................................................................. 122
Rohan E., Moravcová F.: Analytical and numerical methods for modelling of acoustic streaming in homogenized rigid porous structures ................................................................. 126