

39th conference with international participation



PROCEEDINGS OF
COMPUTATIONAL MECHANICS 2024

November 4 - 6, 2024

HOTEL SRNÍ
CZECH REPUBLIC



Central European Association
for Computational Mechanics

Sponsor of the conference

DOOSAN Škoda Power

PROCEEDINGS OF COMPUTATIONAL MECHANICS 2024

ISBN 978-80-261-1249-5

Published by

University of West Bohemia, Univerzitní 8, 301 00 Plzeň, Czech Republic, IC 49777513

Edited by

Vítězslav Adámek

Alena Jonášová

Stanislav Plánička

Conference secretariat

Jana Nocarová

Department of Mechanics

Faculty of Applied Sciences

University of West Bohemia

Univerzitní 8

301 00 Plzeň

Czech Republic

phone: +420 377 632 301

e-mail: vm@kme.zcu.cz

Copyright © 2024 University of West Bohemia, Plzeň, Czech Republic

PREFACE

The proceedings contain 58 conference papers of 73 talks presented at the 39th conference **Computational Mechanics 2024**, which was held at the Hotel Srní in Srní, Czech Republic, on November 4 – 6, 2024. This annual conference, which was attended by more than 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://acm.kme.zcu.cz/>).

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 CM2024 enjoyed their stay in the beautiful nature of the Šumava region in a meaningful way. Finally, we would like to invite you all to come to the next conference CM2025.

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, New Technologies Research Centre, 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 Naď

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 Zapoměl

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

Bublík O., Heidler V., Vimmr J.: <i>Simulating fluid dynamics in a cascade of oscillating blades using a convolutional neural network</i>	1
Chindada S., Prasad C. S., Pešek L.: <i>Numerical investigation of dry-friction coupling on pin-on-disk system: 3D FE numerical modelling</i>	3
Cimrman R., Fink J., Šonský J.: <i>Flexoelectricity, piezoelectricity and 3D printing</i>	7
Dupal J.: <i>Periodic solution of non-symmetrical rotor vibration</i>	11
Elbarghthi A., Dvořák V.: <i>Mesh refinement strategies for complex plate heat exchanger geometries</i>	13
Fischer C., Náprstek J.: <i>Numerical analysis of non-stationary response types in the stochastic van der Pol equation</i>	17
Halamka V., Hrabačka M., Zavřel J., Beneš P., Hajžman M., Šika Z.: <i>Trajectory planning and control of manipulators based on tensegrity structures with manipulability and modal properties optimization</i>	21
Hansen H., Kochová P., Heczko J., Hajžman M.: <i>Salmon tissue compression test and its modelling using particle dynamics</i>	25
Himmel J., Vomáčko V.: <i>Numerical failure analysis of composite rails of cycling saddle</i>	29
Hladík O., Teichman J., Kousal J.: <i>Higher accuracy simulations of distant retrograde orbit within three- and n-body problem</i>	33
Hrabačka M., Hajžman M., Bulín R., Smolík L.: <i>Software development for a multibody pantograph model and FEM catenary system</i>	37
Hračov S., Macháček M.: <i>Case study of galloping in a low-voltage insulated bundled overhead line</i>	40
Hron D., Hajšman M., Vimmr J.: <i>Numerical investigation of wall heat transfer coefficient in a cylindrical annulus for steam turbine design</i>	44
Kazmina V., Štefan R., Chylík R., Holan J.: <i>Computer application for numerical analysis of reinforced concrete structural members strengthened by composite plates</i>	48
Kepka M., Kepka Jr. M., Minich R.: <i>Advances in the computational-experimental assessment of fatigue life of welded joints of bus bodyworks</i>	52
Klesa J., Fürst J.: <i>Axial compressor design using KOBRA airfoils</i>	54
Kratochvíl A., Valenta J., Slavík S.: <i>Ground vibration testing of light sport aircrafts and gliders</i>	58
Kraus K., Vašák M., Šika Z.: <i>Quasi-zero stiffness concept for vibration suppression strategies</i>	62
Krivošej J., Šika Z.: <i>A flatness-based approach for mechanical systems with series elastic actuators</i>	64
Ledvinková B., Hračov S., Macháček M.: <i>The influence of the blockage effect on the aerodynamic characteristics of the bluff body in the airflow</i>	68

Lobovský L., Mandys T., Karbanová A., Salášek M., Krystek J., Hnátík J., Sklenička J., Křen J.: <i>Computational and experimental modelling of unstable pelvic fractures</i>	72
Louda P., Příhoda J.: <i>Numerical simulations of ventilation effects in transonic wind tunnel flow</i>	75
Macháček M., Hračov S.: <i>Influence of torsional stiffness on the galloping instability of a low-voltage insulated power line</i>	79
Majko J., Vaško M., Handrik M., Piroh O., Sága M., Pijáková K.: <i>Concerns in tensile testing of thermoplastic composites produced by FFF method</i>	83
Marhan T., Sváček P.: <i>Numerical approximation of aeroacoustics induced by flow over a square cylinder</i>	86
Masák J., Pešek L., Bula V., Šnábl P., Gabriel D., Zolotarev I., Snížek J., Souček J.: <i>Experimental validation of the DPU computational model for the Vigil mission using modal analysis</i>	90
Matušů M., David P., Blaha D., Papuga J., Rosenthal J.: <i>AI-based fatigue life prediction of additively manufactured AlSi10Mg considering self-heating effect and printing position on the build platform</i>	92
Michálek T., Liberová S., Vágner J., Jaroš P., Šlapák J.: <i>Experimental verification of stiffness characteristics of railway freight wagon buffers</i>	96
Minárik J., Šimon J., Ftorek B., Vaško M., Sága M.: <i>Comparison of nonlinear and linearized oscillating mechanical systems</i>	99
Murín J., Goga V., Paulech J., Gálik G., Kutíš V., Hrabovský J.: <i>Geometrically nonlinear thermoelastic numerical analysis of an actuator made of nylon springs</i>	103
Náprstek J., Fischer C.: <i>Vibration and stability of a self-excited aeroelastic SDOF system with random coefficient perturbations</i>	108
Padovec Z., Vondráček D., Mareš T.: <i>Thermoelastic stresses in wound cylindrical composite shells</i>	112
Páleník R., Meca O., Poruba Z.: <i>Validation of co-rotational formulation results</i>	116
Pavlas J., Ružička M., Slavík S.: <i>Mechanism of fatigue crack initiation and propagation in the ZS6K blade of a turboshaft engine</i>	119
Pech O., Zálešák M., Charvát P., Klimeš L.: <i>Experimental investigation of air flow distribution in an air-PCM heat exchanger</i>	122
Pešek L., Schumann W.: <i>Testing of advanced algorithms for classification and prediction of flutter states of measured time-variable responses of a randomly-tested airfoil</i>	126
Pijáková K., Sága M., Vaško M.: <i>Contribution to the assessment of multi-axial fatigue of engineering components by the finite element method</i>	130
Plánička S., Levý T., Vimmr J., Jonášová A.: <i>Calculation of the heat transfer coefficient using the Newton's law of cooling</i>	134
Pokatilov G., Henyš P., Špetlík M.: <i>Predicting linear elastic behavior of structural metamaterials using machine learning</i>	137

Polach P., Prokýšek R., Papáček Š.: <i>On underactuated bipedal systems walking: Gait pattern modeling and analysis of a stepladder with decorator</i>	141
Rohan E.: <i>Effective piezoelectric behaviour due to flexoelectric microstructure – homogenization based modelling</i>	145
Šika Z., Kraus K., Hajžman M., Bulín R.: <i>Friction identification and active elimination on multi-DoF mechanism</i>	149
Skácelík R., Španiel M.: <i>Application of nonconforming voxel mesh for 3D printing simulations</i>	152
Sláma V., Tsymbalyuk V. A., Eret P., Peterka T., Macálka A.: <i>Measurements and numerical calculations on flutter test rig in a linear turbine blade cascade</i>	156
Šnábl P.: <i>Analytical modeling and analysis of mistuned blades in blade cascade system</i> . .	160
Štefan D., Rudolf P., Pochylý F.: <i>Simulation and dynamics of secondary vortex structures induced by low discharge and high swirl in cylindrical pipe</i>	164
Sváček P., Pučejdl P.: <i>On mathematical modelling and numerical simulation of human phonation process</i>	167
Švadlena J., Krivošej J., Bodnárová J., Daniel M., Šika Z.: <i>Upper limb muscle model and its control for exoskeleton interaction</i>	171
Svárovský J., Parma S., Štefan J., Marek R., Vaňková T., Gabriel D., Plešek J.: <i>Development of methodology for experimental analysis of strain hardening of 3D printed alloy AlSi10Mg under multiaxial quasistatic loading</i>	173
Valášek J., Sváček P.: <i>Aeroacoustic simulation of human phonation considering contact</i> .	176
Valášek M., Vampola T., Štorkán J.: <i>Concept of overall performance simulation model of AMBER hybrid aircraft propulsion</i>	180
Vaňková T., Parma S., Marek R., Gabriel D., Džugan J.: <i>Implementation of an orthotropic elasto-plasticity model with advanced kinematic hardening rule</i>	184
Voldřich J., Matas R.: <i>Prediction of the noise level emitted by a pipeline with transported hydrogen based on measurements of the DN 300 pipe with extreme natural gas flow at the RU10 Mutěnice</i>	188
Vomáčko V., Šidlof P.: <i>Design and failure analysis of composite blade for flutter measurements</i>	192
Zapoměl J., Kozánek J.: <i>Effect of electromagnetic parameters on operation of vertical rotors supported by superconducting bearings</i>	196
Zavřel J., Šika Z.: <i>Influence of the experiment on the identification of passive effect parameters</i>	200
Zeman V., Hlaváč Z., Dyk Š.: <i>Mathematical modelling of grid-to-rod-fretting in PWR with mixed core</i>	202
Zítek F., Beneš P., Šika Z.: <i>Kinematic calibration of Delta robot Autonox RL5-1450-6kg</i> .	206