

Booklet of Abstracts

“1st International Conference on Mathematical Modelling in Mechanics and Engineering”

**Mathematical Institute of the Serbian Academy of Sciences and Arts
Belgrade, 08.-10. September 2022.**

Editors: Ivana Atanasovska, Milan Cajić, Danilo Karličić

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PREFACE

It's our pleasure to be the chairs of the '1st International Conference on Mathematical Modelling in Mechanics and Engineering', organized by the Mathematical Institute of the Serbian Academy of Sciences and Arts, and co-organized by the Faculty of Mechanical Engineering, University of Belgrade; the Faculty of Mechanical and Civil Engineering in Kraljevo, University of Kragujevac; and Institute for Information Technologies, University of Kragujevac. The conference will be held in hybrid form at the Mathematical Institute of the Serbian Academy of Sciences and Arts, Belgrade, Serbia, from 8th to 10th of September, 2022.

This conference is planned as the first event in the series of conferences which will be held every two or three years and bring together leading academic scientists, researchers and research scholars to exchange and share experience and research results on various aspects of mathematical modelling in mechanics and engineering. It will bring an interdisciplinary platform for researchers, practitioners and educators to present and discuss the most recent innovations, theories, algorithms, as well as practical challenges encountered and solutions adopted in the fields of Classical Mechanics, Solid and Fluid Mechanics, Computational Mechanics, Biomechanics, Applied Mathematics and Physics, Structural Mechanics and Engineering. A considerable number of prominent scientists and professors submitted their abstracts and confirmed their attendance at the conference. The scientists and researchers from different countries in Europe and the world (Netherlands, UK, Norway, Greece, Spain, USA, Kazakhstan, Italy, Montenegro, India, Malaysia, Slovenia etc.) also have confirmed participation at the conference. We expect that the conference presentations will cover modelling with analytical/numerical and data driven solutions to study complex media, composite aerospace and periodic structures and metamaterials, and capture essential features of linear and nonlinear dynamics and wave propagation behaviour that can lead to new designs of such systems. Some presentations will include new experimental setups to study engineering materials and novel control strategies based on classical or fractional derivative models used to control the dynamics of multibody, flexible and/or electromechanical systems. Finally, we believe that the sessions' discussions will have high potential to give significant contribution to the developments of new and advanced mathematical models of real-world engineering mechanical systems.

We're very proud to announced that the number of accepted contributions to be presented at this Conference is 106, with 7 plenary and 4 invited lecture presentations. We would like to express our gratitude to the institutions that support conference financially: The Ministry of education, science and technological development of the Republic of Serbia; METALFER STEEL MILL doo, Serbia; and SHIMADZU, Serbia. We are especially grateful to the members of the Scientific committee and participants who gave their contribution to this international scientific meeting with their advices and abstracts' reviews. We also thank to the support of the co-organizers of this Conference: The Faculty of Mechanical Engineering, University of Belgrade, Serbia; The Faculty of Mechanical and Civil Engineering in Kraljevo, University of Kragujevac, Serbia; and Institute for Information Technologies, University of Kragujevac, Serbia.

We hope that this conference will be success beginning of a recognized series of international conference events during next decades. We use the opportunity to wish to all participants a successful presentation of their scientific results.

Cordially,

Ivana Atanasovska, Conference Chair
Milan Cajić, Conference Vice-Chair
Danilo Karličić, Conference Vice-Chair



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INVESTIGATION OF SHAPE MEMORY ALLOYS CONSTITUTIVE MODELING

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Keywords: shape memory alloys, modeling, finite element method, finite strains.

ABSTRACT

Shape Memory Alloys are often used as super-smart materials that can follow specific devices' behavior demands by their specific properties [1]. The possibility of memorizing the basic shape or exhibiting large deformations and rotations that can be recovered at a specific temperature inspired researchers to investigate SMA experimentally and simulate the SMA structures response by Finite Element Method (FEM) software. Two main topics which improved the accurate FEM simulation recently are:

- Thermo-mechanical coupling [2] and
- Extension of small strain stress integration algorithm to large strain problems [3].

These provided the possibility to model various specific behaviors such as:

- Response of the SMA structures loaded by various loading rates controlled by force or displacement [2],
- Stress relaxation and creep behavior [4],
- Large deformation and rotations in real SMA structures [3].

In this work, the author will present an overview of the SMA structures' behavior simulation with specific details [2-5] related to further investigation activities.

REFERENCES

- [1] Dunić, V., Slavković, R. and Pieczyska, E. (2018), "Properties and Behavior of Shape Memory Alloys in the Scope of Biomedical and Engineering Applications" in *Biomaterials in Clinical Practice*, Springer
- [2] Dunić, V., Pieczyska, E., Tobushi, H., Staszczak, M., Slavković, R. (2014), "Experimental and numerical thermo-mechanical analysis of shape memory alloy subjected to tension with various stress and strain rates", *Smart Materials and Structures*, 23, 5, 055026 (11pp)
- [3] Dunić, V., Slavković, R., (2020), "Implicit stress integration procedure for large strains of the reformulated Shape Memory Alloys material model", *Continuum Mechanics and Thermodynamics*, 32, 5, 1287-1309
- [4] Dunić, V., Pieczyska, E., Kowalewski, Z., Matsui, R., Slavković, R. (2019), "Experimental and Numerical Investigation of Mechanical and Thermal Effects in TiNi SMA during Transformation-Induced Creep Phenomena", *Materials*, 12, 6, 883
- [5] Pieczyska, E., Staszczak, M., Dunić, V., Slavković, R., Tobushi, H., Takeda, K. (2014) "Development of stress-induced martensitic transformation in TiNi Shape Memory Alloy", *Journal of Materials Engineering and Performance*, 23, 7, 2505-2514

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