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

Organized by:

Mathematical Institute of the Serbian Academy of Sciences and Arts

Faculty of Mechanical Engineering, University of Belgrade

Faculty of Mechanical and Civil Engineering in Kraljevo, University of Kragujevac

Institute for Information Technologies, University of Kragujevac

Supported by:

Ministry of Education, Science and Technological Development of the Republic of Serbia

METALFER STEEL MILL, Serbia

SHIMADZU, Serbia

Belgrade, 2022

Booklet of abstracts “1st International Conference on Mathematical Modelling in Mechanics and Engineering”, Belgrade, 08.-10. September 2022.

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Publisher: University of Belgrade - Faculty of Mechanical Engineering, Kraljice Marije 16, Belgrade, Serbia

For publisher: Prof. dr Vladimir Popović, Dean

FME editor: Prof. dr Dragoslava Stojiljković

Approved for printing by dean’s decision No. 16/2022 dated 16.08.2022.

Print: CopyPlanet, Belgrade, Serbia

Circulation: 130 copies

Belgrade, 2022

ISBN 978-86-6060-127-0

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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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DELAY DIFFERENTIAL EQUATIONS GOVERNING DYNAMICS OF A LANDSLIDE MECHANICAL MODEL

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Keywords: time delay, friction, landslide

ABSTRACT

In present paper we analyze dynamics of a mechanical model of accumulation landslide, initially proposed by Davis [1] using standard bifurcation analysis:

$$m_1\dot{V}_1 = W_1 sin\beta_1 - S_1 - F$$
$$m_2\dot{V}_2 = W_2 sin\beta_2 - S_2 + F$$
$$\dot{F} = k(V_1 - V_2) + c\left(\dot{V}_1 - \dot{V}_2\right) \quad (1)$$

where W - block weight; g - acceleration of gravity; S - sliding resistance on failure surface,; F - combined elastic and viscous forces; k - spring constant; c - dash pot constant; and β_i = slope angle. In our analysis, starting model (1) is expanded by introducing the effect of time delay between the motion of accumulation and feeder slope, and the heterogeneous friction conditions along the potential sliding surface (Coulomb-like and cubic friction force):

$$\frac{dU_1(t)}{dt} = V_1(t)$$
$$\frac{dV_1(t)}{dt} = \frac{1}{m}\left[k\left(U_2(t-\tau) - U_1(t)\right) - \left[1 - \alpha + \sqrt{N(V_0+V_1)}\right]\frac{(V_0+V_1)}{\sqrt{\varepsilon+(V_0+V_1)^2}} + \left[1 - \alpha + \sqrt{N(V_0)}\right]\frac{V_0}{\sqrt{\varepsilon+V_0^2}}\right] \quad (2)$$
$$\frac{dU_2(t)}{dt} = V_2(t)$$
$$\frac{dV_2(t)}{dt} = \frac{1}{m}\left[k\left(U_1(t-\tau) - U_2(t)\right) - \left[a(V_0+V_2)^3 - b(V_0+V_2)^2 + c(V_0+V_2)\right] + a(V_0)^3 - b(V_0)^2 + cV_0\right]$$

where $N(V) = \varepsilon = 4max(|V| - p, 0)^2 + \alpha^2 max(p - |V|, 0)^2$, and α and ε are friction parameters (Coulomb like friction force), a, b and c are friction parameters (cubic friction force). Results obtained indicate the occurence of irregular aperiodic behavior with the increased values of parameter a and time delay τ, providing the conditions for which the slope instability is triggered. Further increase of parameter a leads to stabilization of sliding, while the increase of parametrs b and c leads to occurrence of periodic oscillatory regime. Similar effect is observed for the action of parameters ε and α.

REFERENCES

[1] Davis, R.O. **(**1992**),** Modelling stability and surging in accumulation slides. *Engineering Geology*, 33, 1-9