



Preface

**Claudia Comi · Elias Cueto · Paolo Luchini ·
Anna Pandolfi**

Accepted: 17 August 2025 / Published online: 26 September 2025
© Springer Nature B.V. 2025

The ICTAM-100 Special Issue was promoted by the Italian Association of Theoretical and Applied Mechanics to celebrate 100 years of the International Congress in Theoretical and Applied Mechanics, following the congress held in Daegu, Republic of Korea, on 25th–30th August 2024.

The call for the SI addressed, in particular, a group of researchers that have been collaborating with the journal for several years or have expressed a clear interest in contributing to the journal. The call was also open to the participants to the ICTAM-100 conference in Daegu. The success of the initiative is testified by the rather high number of papers, 26 in total, that surpasses the average number for a SI in *Meccanica* (about 15).

According to the historical organization of *Meccanica*, accepted contributions covered the general fields of Mechanics of Solids, Mechanics of Fluids, Mechanics of Machines, and General Mechanics. Several dominant themes emerge from the collection, reflecting current research directions in applied mechanics and material modelling. The

Issue confirms a steady interest on variational principles and phase-field formulations, particularly in the study of fracture and large deformation phenomena, and on multiscale approaches and homogenization techniques to connect microscale structural features with macroscopic mechanical behaviours. The focus of the collection has broadened to include non-classical materials—metamaterials, porous solids, foams, membranes, and biological tissues—revealing a shift toward modelling systems with complex internal architectures or multifunctional properties. Emphasis on experimental validation has emerged across several contributions, where physical testing is used to inform, calibrate, or challenge computational predictions. Furthermore, statistical mechanics and entropy-based approaches are offering new tools for capturing uncertainty, complexity, and emergent behaviours in both materials and structures.

All the contributions are of outstanding quality and together offer a heartfelt tribute to *Meccanica*'s long-standing dedication to fostering rigorous and meaningful scientific work.

The list of the contributions of the Special Issue, grouped according to common topics and research field in Mechanics, is reported in the following.

1 Nonlinear and variational mechanics

1. *Ichiro Ario and Ma Dong* explore bifurcation phenomena via a modified stiffness method

C. Comi · A. Pandolfi (✉)
Politecnico di Milano, Milan, Italy
e-mail: anna.pandolfi@polimi.it

E. Cueto
Universidad de Zaragoza, Zaragoza, Spain

P. Luchini
Università di Salerno, Fisciano, Italy

informed by group-theoretic imperfections—relevant to symmetry-breaking in structures.

2. *Anne-Sophie Sur, Laura De Lorenzis and Odd Sture Hopperstad* propose a phase-field approach for ductile fracture that incorporates hydrostatic stress sensitivity, enhancing predictive failure modeling.
3. *Enrico Babilio and Stefano Lenci* revisit beam theory using Newtonian versus variational frameworks, shedding light on when classical beam equations stem from variational principles.

2 Advanced material modeling

4. *Andrea Bacigalupo, Paolo Badino, and Luigi Gambarotta* study dynamic homogenization in multi-layered chiral metamaterials.
5. *Ali Ketata, Julien Yvonnet, Nicolas Feld, Fabrice Detrez, and Augustin Parret-Freaud* develop an adaptive zoom model combining mesh refinement and homogenization for linear composites.
6. *Ahmed Benallal and Antonio R. Ferreira* investigate dissipation in anisotropic porous solids through linear transformation frameworks.

3 Bio-mechanics and soft structures

8. *Gaia Caruso, Miguel Ángel Martínez, and Estefanía Peña* analyze how aneurysm and thrombus properties influence abdominal aortic aneurysm outcomes.
9. *Nicolás Laita, Miguel Ángel Martínez, Manuel Doblaré, and Estefanía Peña* compare constitutive models for myocardium under complex loading, highlighting implications for medical simulations.
10. *Matteo Bottacchiari, Mirko Gallo, Marco Bussoletti, and Carlo Massimo Casciola* develop a diffuse interface model for fluid lipid vesicles with area-difference elasticity.
11. *Stephanie Heyden and Michael Ortiz* explore densely packed membrane configurations, likely with implications for biological and synthetic systems.

4 Structural dynamics and vibration

12. *Yuki Chikahiro, Seiya Zenzai, Ichiro Ario* present a new method to estimate natural frequencies of scissors-type bridges via hammering tests and numerical simulation.
13. *Vyacheslav N. Burlayenko, Tomasz Sadowski, and Liviu Marsavina* perform vibration analysis on functionally graded CNT-reinforced beams with variable cross-sections.
14. *Filipe Meirelles Fonseca and Paulo Batista Gonçalves* analyze hyperelastic prestressed arches.
15. *Nicola Nodargi and Paolo Bisegna* assess seismic fragility of free-standing rocking-sliding blocks.
16. *Song Liang and Zaihua Wang* provide a full characterization of the critical stability curves of linear multi-delayed systems.

5 Fluid-structure and flow mechanics

17. *Federico Dalla Barba and Francesco Picano* simulate porous media breakup in laminar flows, capturing complex fluid–structure interactions.
18. *Sergei Chernyshenko* derives energy dissipation bounds for flow in complex geometries.
19. *Alessandro Bottaro, Giulia Innocenti, and Essam Nabil Ahmed* model drag-reduction in riblet-covered surfaces via a slip-transpiration-vortex framework.
20. *Cesare Davini and Paolo Podio-Guidugli* delve into mathematical models of 2D fluid foams.
21. *Chilin Wei, Ruichao Hao, Delan Zhu, Ximu Zhao, Nazarov Khudayberdi, and Changxin Liu* present a study on biphasic water–gas flow patterns in aeration pipeline.

6 Design and fabrication innovations

22. *Sören Bieler and Kerstin Weinberg* assess energy absorption in eco-friendly lattice structures under compression.

23. *Marco Fava, Vincenzo Parenti-Castelli, Michele Conconi, and Nicola Sancisi* present a novel manufacturing method for compliant Cardan joints.
24. *Alessio Biffi, Massimiliano Gobbi, and Gianpiero Mastinu* offer experimental and theoretical insight into rolling resistance via a custom-built trailer.
25. *Claudia Comi, Jean-Jacques Marigo, and Marco Moscatelli* analyze general features of the band-gap structure in 1D quasi-periodic lattices.
26. *Lizhi Niu, Mario Di Paola, Antonina Pirrotta, and Wei Xu* introduce a new method using complex fractional moments to manage the maximum entropy principle.
27. *Andrea Pedrini, Epifanio G. Virga, Andrea Marziali, and Anna Malagó* propose a multipolar framework for representing wind distributions, likely blending fluid dynamics and statistical modeling.

7 Mathematical and statistical mechanics

25. *Claudia Comi, Jean-Jacques Marigo, and Marco Moscatelli* analyze general features of the band-gap structure in 1D quasi-periodic lattices.
26. *Lizhi Niu, Mario Di Paola, Antonina Pirrotta, and Wei Xu* introduce a new method using com-

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.