Special issue on multiscale computations for solids and fluids

Preface

This special issue seeks to provide a more lasting result of ECCOMAS MSF 2023, the sixth in the series of International Conferences focusing upon Computational Methods in Solids and Fluids, which is held every two years in different countries in Europe. This one and previous meetings have all been organized under umbrella of ECCOMAS, 'The European Community on Computational Methods in Applied Sciences', as the sponsor of ECCOMAS conference series. The institutions organizing ECCOMAS MSF 2023 were Faculty of Civil Engineering and Faculty of Mechanical Engineering of University of Sarajevo, in collaboration with University of Technology Compiegne, a member Alliance of Sorbonne University. The ECCOMAS MSF 2023 was held from June 25 to 27, 2023 in Sarajevo after the short course offered to young participants held from June 21 to 24, 2023. The Conference provided a platform for learning from some of the world leading specialists in numerical methods, coming from different engineering disciplines and applied mathematics.

The ECCOMAS MSF 2023 venue was Sarajevo, the capital of Bosnia-Herzegovina. In former Yugoslavia, city of Sarajevo was known for most vibrant music scene, 1984 Winter Olympic Games, and the long siege in 1990's during the break-up of the country. Presently, Sarajevo has fully regained its status as the crossroad between East and West and a new tourist 'must-see' destination with well-known 'Sarajevo-Film-Festival'. The travel guide series, Lonely Planet, has ranked Sarajevo as one of the top ten cities to visit in 2010. In 2011, Sarajevo was nominated to be the European Capital of Culture in 2019, hosting European Youth Festival in 2019.

In the former Yugoslavia, city of Sarajevo was known for most vibrant music and sport scene, with a number of rock-groups and basketball champions, which successfully organized Winter Olympic Games in 1984. Presently, Sarajevo has become the most important city in the region, as the high destination for winter sports (mountains Bjelasnica or Jahorina) and a crossroad to beautiful sea-side destinations (Dubrovnik in Croatia or Budva in Monte-Negro). Sarajevo is also a very pleasant place to spend some leisure time as a new tourist 'must-see' destination.

2. Conference topics, distinguished lectures and MS

The main idea of this ECCOMAS MSF 2023 Conference was to examine recent advances in numerical methods in currently most active research domains, with applications to interface and/or interaction of Civil and Mechanical engineering and other pertinent disciplines. The multi-physics models and methods of this kind are often bridging the phenomena taking place at multiple scales in space and time, which ought to be placed in interaction or accounted for simultaneously in order to provide the most reliable results explanations. This class of problems calls for the development and combination of different modeling tools and computational methods in order to advance the field towards currently relevant industrial applications. A number of different schools have developed in various domains, both in engineering sciences and mathematics, with sometimes very

little or no interaction between them. It is an explicit goal of this ECCOMAS MSF 2023 Conference to bring all the different communities together, in the truly open scientific spirit, and thus provide a sound basis for a fruitful exchange and cross-fertilization of ideas among them.

The main conference topics were quite diverse: *Heterogeneous materials*, *Masonry structures*, *Complex structures*, *Material and structure failures*, *Adaptive modeling*, *Mechanics of porous media*, *Fluid-structure interaction*, *Multi-phase flows*, *Turbulence*, *Wave propagation*, *Stochastic Processes*, *Uncertainty Propagation*. The conference regrouped renowned invited speakers: Pierre Ladeveze (ENS-Paris-Saclay), Herbert Mang (TU Vienna), Roger Ohayon (CNAM-Paris), Paulo Pimenta (University Sao Paulo), Dragan Damjanovic (EPFL-Lausanne), Nikos Stergiopulos (EPFL-Lausanne), Christian Hellmich (TU Vienna), Ludovic Chamoin (ENS-Paris-Saclay), Patrizia Trovalusci (Sapienza – University of Rome), Hermann Matthies (TU Braunschweig) and Adnan Ibrahimbegovic (UT Compiegne-Alliance Sorbonne University & IUF). Each one delivered a distinguished lecture giving overview of both current research in his fields and still open questions and explorations to come. We review briefly these distinguished lecturers in alphabetic order of the lecturer.

In particular, Ibrahimbegovic (2023) presents a research work entitled 'Computational structural mechanics: natural intelligence vs. artificial intelligence', which focused upon the role of fundamental contributions between multi-scale structural mechanics models and machine learning approach to building a model. It was concluded that the former can be used to build a model (including a new model), whereas the latter can validate and/or verify tell us which model is most suitable for the given quantity-of-interest (interpolated between existing model). Hellmich (2023) presented a research work entitled 'Complex biomechanics: from atoms to patients', which found out that smart classical concepts of applied mechanics and physics continue to show an unparalleled potential for solving pressing global problems in the context of computational modelling of living systems, by combining the interaction of atoms within a short thread of DNA modelled with beams and compliance of sets of patients to the lethal effect of SARS-COV-2, modeled with integro-differential equations reminiscent of those introduced by Boltzmann in the context of creep (or hereditary) mechanics. Damjanovic (2023) presents a research work entitled 'Complex functional materials and opportunities for multi-scale and multi-coupling computations', which focused upon two particular illustrations, the first one regarding multi-properties coupling in presently best performing materials for solar cells in terms of organometallic perovskites, and the second one regarding electro-mechanical interaction of grains in a piezoelectric ceramic. He concludes with high expectations that computations should make quantitative predictions for a specific phenomenon and material, or at least more likely very helpful but generic, semiquantitative models.

Mang (2023) presents a research work entitled 'Conditions for extreme values of the stiffness of proportionally loaded structures', which focused upon a thorough explorations on the conditions to impose on the tangent stiffness matrix in exploring the stability of structures. (H. Matthies 2023) presents a research work entitled 'Random tensor fields adapted to elasticity cases', which focused upon different reduced representations of elasticity tensor to imposed the isotropy and reduce the sampling work in defining the random fields that may be used for characterizing an elastic material. Chamoin (2023) presents a research work entitled 'In situ structural damage tracking and monitoring from advanced sensing techniques and hybrid twins', which focused upon going from smart materials to smart structures is in the monitoring of large complex engineering systems. The challenge raised is dealing with large noisy data sets, and in the prediction of the structural behavior involving localized multiscale and highly nonlinear damage phenomena. The goal is to explore an innovative concept of a synergistic dialog between advanced structural sensing (from embedded

optic fibres) and command (from the structure actuators) on the one hand, and the most powerful modeling and simulation tools of computational mechanics on the other hand.

Stergiopulos (2023) presents a research work entitled 'Inverse problem-solving method for stroke volume estimation' which focused upon stroke volume as a major biomarker of cardiac function, reflecting ventricularvascular coupling. There is proposed a mathematical inverse-problem solving method for acquiring non-invasive estimates of SV using age, weight, height, and measurements of brachial BP and carotid-femoral pulse wave velocity, which shows its utility in the clinical setting and highlights the importance of physics-based mathematical modeling in improving predictive tools for SV monitoring. Trovalusci (2023) presents a research work entitled 'Discrete to scale-dependent continuous formulations for the constitutive modelling of materials with microstructures', which focused upon mechanical behavior of complex materials, characterized at finer scales by the presence of heterogeneities with an idea to build-up a refined non-local intermolecular potential based on appropriate, physically based, complex discrete systems to define case by case. Pimenta (2023) presents a research work entitled 'Recent advances on the development of simple shell elements for thin and very thin shells', which focused upon presentation of new shell elements that exhibit superior performance against other elements, especially in the case of very thin shells. Ladeveze (2023) presents a research work entitled 'A general non-invasive PGD reduction method in nonlinear computational solid mechanics', which focused upon presenting a revised version of the LATIN-PGD method, which is slightly less efficient than the current version, yet less invasive with regard to industrial finite element calculation software. Finally, Ohayon (2023) presents a research work entitled 'Structure-structure and internal liquid-structure interaction: projection based reduced order model', which focus upon primal-dual dynamic aspects of this interaction with sloshing effects also taken into account.

The keynote and standard lectures of each of the conference days, which addressed a number of issues concerning computational methods in wide variety of topics, where grouped in 17 Mini-Symposia: 1) Challenges and Recent Developments in Computational Mechanics, 2) Modeling of fracture and failure of materials and structures; 3) Recent Trends and Challenges in Computational Modeling of Fibrous Materials and Composites; 4) Experimental Mechanics; 5) Mechanics, resilience and people: engineering applications and social opportunities; 6) Experimental investigation and numerical modeling of reinforced concrete structural elements; 7) Sustainable Development of Water Resources and Environmental Engineering; 8) Steel Structures; 9) Instability of Structures; 10) Physical and Numerical Modeling in Geotechnics; 11) Stochastic identification; 12) Multiscale Modeling of Complex Materials; 13) Biomechanics and applications; 14) Structural assessment of existing buildings: Modeling, Analysis, Structural versus Aesthetical; 15) Computer simulation of urban climate and pollutant dispersion; 16) Uncertainty Quantification in material and structural sciences; 17) Numerical simulations for the security related applications.

3. Selected CSM papers

The conference proceedings (Ibrahimbegovic *et al.* 2023), containing 87 extended abstracts, can be consulted (Fig. 1) for the full-size presentation of the results that ECCOMAS MSF 2023 managed to achieve. In this double special issue, we have selected among these abstracts, and invited full-size paper contributions, which jointly more than touch upon all different ECCOMAS MSF 2023 conference topics. With such a topic-wise diversity, perhaps the best order is the random one, with respect to the alphabetic order and date of arrival of each particular contribution for this double

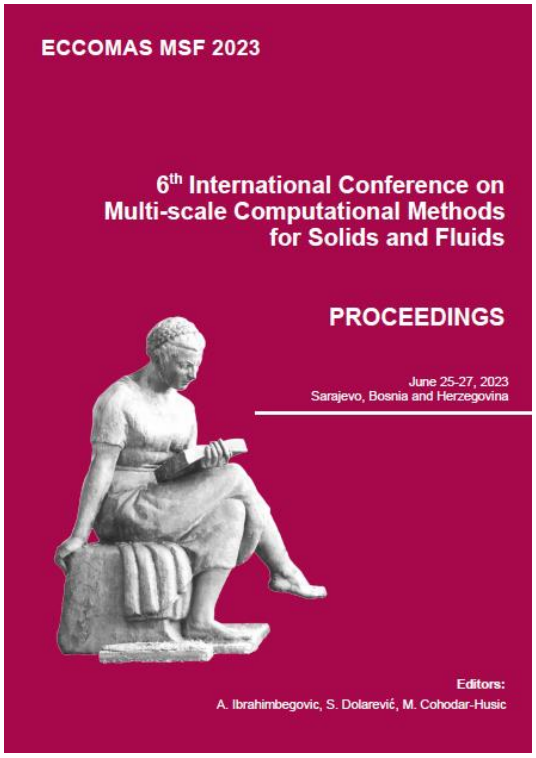

Fig. 1 Thematic Conference From Series ECCOMAS-European Community on Computational Methods in Applied Sciences; https://eccomas.gf.unsa.ba/Eccomas_2023_proceedings.pdf

special issue.

In particular, in this work (Šeruga *et al.* 2023) study several aspects of a coupled simulation of parametric porous microstructure and stress-strain behavior in mechanical components under variable cyclic mechanical loads and constant temperature. This is nowadays frequently encountered in engineering practice. The comparison presented in this work between the simulation results shows a considerable elastoplastic stress-strain response in the vicinity of pores whilst the surface of the gauge-length of the specimen remains in the elastic region. Also, the distribution of the pore sizes seems more influential to the stress-strain field during the loading than their radial position in the gauge-length. The contribution from (Kožar *et al.* 2023) provides a very efficient approach to dealing with new developments of a viscoelasticity model for asphalt. The model should allow estimating the parameters of such a viscous material from indirect tensile tests. The identification is performed by using the Levenberg-Marquardt method.

Several other papers deal with providing solution to inverse problems and accounting for probability aspects, such as (Bartolini *et al.* 2023), who study masonry structure parameters in the context of 2D finite elements continuum models. A special attention is given to the shear behavior of masonry walls by applying a plane-stress FE continuum model with the Modified Masonry-like Material. The contribution of (Zaplatić *et al.* 2023), dealing woven composite complex shaped specimen, study how to perform identification by hybrid infrared-visible multiview correlation to study damage, which is of current interest for Aerospace Engineering.

Couple of papers study more classical topics in Civil Engineering. First, the contribution by

(Soelarso *et al.* 2023) study the problem of structure-foundation interaction to simulate free vibrations and behavior under seismic loads of a RC building supported by a particular shallow foundation. Another contribution from the same domain by (Suárez *et al.* 2023) elaborate a novel numerical formulation of a solid-jayer finite element to simulate reinforced-concrete structures strengthened by over-coating.

The contribution of (Vrgoč *et al.* 2023) elaborates upon different manners to use the temporal interpolations within the context of 4D full-field measurements over the entire loading history. This work can be of interest to identification problem solution for long-term loading. The paper by (Kožar and Šuran 2023) provides a computational model for layered glass structures, which is of direct interest to modern buildings.

The final contributions is made by (Lukovac *et al.* 2023) who studied the control problem of geometrically exact beam, with particular strategy based upon time-varying LQR method.

For more details on this collection of papers, I invite the readers to carry on with their own explorations, and I wish they be very fruitful. Last but not least, I wish to thank to all the authors of this special issue for contributing to the worthy goal of providing a more lasting impact of ECCOMAS MSF 2023 with their full-size papers.

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Prof. Adnan Ibrahimbegovic
Université de Technologie Compiègne–Sorbonne Université, Laboratoire Roberval de Mécanique,
Centre de Recherche Royallieu, Compiègne, France
Institut Universitaire de France (IUF)
Academy of Sciences and Arts BiH
E-mail: adnan.ibrahimbegovic@utc.fr