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Special issue on multiscale computations for solids and fluids

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Abstract. This special issue contains selected papers first presented in a short format at the 3rd International Conference ECCOMAS MSF 2017-Multiscale Computations for Solids and Fluids, organized in Slovenian capital Ljubljana, September 20-22, 2017.

Keywords: multiscale computations; solid mechanics; fluid mechanics

1. Introduction

The story of this special issue is worthy to tell. After two successful meetings under auspices of ECCOMAS gathering together experts on computational multiscale methods for solids and fluids, the first one organized in the suburb of Paris, Cachan, and the second one in Bosnian capital Sarajevo, we have decided to carry on with organization of the 3rd International Conference ECCOMAS MSF in Slovenian capital Ljubljana (see Fig. 1). First of the reasons for this choice of venue is cultural: the charm of Ljubljana is confirmed by the travel guide series branding it as one of the prettiest small capital cities in Europe, with a fairytale, picture-perfect old town of pastel colored baroque and art nouveau buildings, tree-lined river, and medieval castle perched on a hill. The city is compact and laid-back, with what feels like more bikes than cars, a youthful artsy population, and delicious food. Each year, over 10,000 cultural events take place in the city, including ten international theater, music, and art festivals. The second reason was scientific, for we had a potential for gathering many European participants, since Ljubljana can easily be reached by a direct flight from most European capitals (some 320 kilometers south of Munich, 470 kilometers east of Zürich, 250 kilometers east of Venice, 350 kilometers southwest of Vienna, 220 kilometers south of Salzburg and 400 kilometers southwest of Budapest). Indeed, that has allowed us to put together a fruitful meeting on interdisciplinary research topics with a critical mass of over roughly 100 participants.

Hence, we can easily reach the worthy goal of this thematic conference, which is to examine recent advances from mechanics and applied mathematics in a currently very active research domain of multi-scale modeling and computations in solid and fluid mechanics. The latter involves

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methods which bridge phenomena taking place at multiple scales in space and time and which ought to be placed in interaction or accounted for simultaneously in order to provide the most reliable explanations. This class of problems calls for the development and combination of different analytical tools (homogenization, asymptotic analysis) and computational methods (parallel computing, stochastic analysis) in order to advance the field towards currently relevant nonlinear applications. A number of different schools have developed in various domains of fluids and solids, both in mathematics and mechanics, with sometimes very little or no interaction between them. It is an explicit goal of this thematic conference, in the true spirit of ECCOMAS, to bring these different communities together, and thus provide a sound basis for a fruitful exchange of ideas among them.

Fig. 1 Thematic Conference from Series ECCOMAS-European Community on Computational Methods in Applied Sciences

2. Selected papers

The conference also managed to provide a platform for learning from some of the worlds' leading specialists in analysis and design of complex engineering structures and systems, coming from aerospace, civil and mechanical engineering, material science, and in the design and analysis of numerical algorithms from applied mathematics. The main goal is elaborating the multi-field and multi-physics approach, which has significantly modified previously firm frontiers among these traditional engineering disciplines. 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 proceedings (Ibrahimbegovic *et al*. 2017) containing roughly 100 extended abstracts can be consulted for the full-size presentation of the results that ECCOMAS MSF 2017 managed to achieve. In that special issue, we have selected among these abstracts, and invited full-size paper contributions, which jointly more than touch upon all different ECCOMAS MSF 2017 Conference topics. With such a topic-wise diversity, perhaps the best order is the random one, with

respect to the date of arrival of each particular contribution for this special issue.

In particular, in their work (Moreno-Navarro, Ibrahimbegovic, Perez-Aparicio, 2017) have provided a fully coupled formulation that gathers in the same framework thermodynamics and electromagnetism, which opens up a host of new applications regarding the smart materials and smart structures. The contribution from (Mejak 2017) deals with homogenization method targeting a special class of problems with high concentration ratio of cubic inclusions.

Several papers deal with predicting the failure mechanism of structures and systems, in agreement with the construction material. In particular, (Hadzalic *et al*. 2017), provide the prediction of failure modes in soils due to structure-foundation interaction effects, with the main novelty of prediction that captures the localized failure as well. The work of Kožar *et al*. 2017) provides an improved modeling of rate-sensitivity response, which plays very important role in a number of applications with high-rate loading. The work of (Lavrenči and Brank 2017) deals with cross-laminated timber plates with the same goal of providing the improved presentation of failure modes. Finally, the contribution of (El houcine *et al*. 2017) provides not only the initial failure modes of reinforced concrete frames, but also the corresponding multibody system type-of-models for subsequent failure phase, with a very worthy goal of establishing the risk for adjacent structures from a planned destruction of a particular frame structure in a densely populated urban zones.

The group of papers also deals with problems of fluid mechanics and fluid-structure interaction. In particular, (Hadzalic *et al*. 2017) deal with influence of the pore-pressure field on increased risk for plastic deformation developement. The contribution of (Krvavica *et al*. 2017) consider two-layer shallow water flow and its relevance to turbulent mixing in estuaries. The work of (Du and Ouahsine 2017) consider how to make the optimal hydrodynamic predictions of static and dynamic states of a ship.

The final contributions consider some modeling issues in complex systems. Namely, (Nikolić *et al*. 2017) study the Influence of ductility classes on seismic response of reinforced concrete structures. (Sarfaraz *et al*. 2017) propose the solution to material parameter identification problems by placing them within the framework of coupled-mechanics-probability and showing how such framework leads to more robust direct computations and provide more comprehensive information with not only parameter values, but also their probability distributions. (Kozar *et al*. 2017) discuss how to use of both experimental and probability methods to solve the inverse problems of bond-slip identification from pull-out tests in fiber reinforced concrete. Finally, (Ibrahimbegovic and Boujelben 2017) consider long-term simulation of large wind-turbines in offshore locations, by using efficient computational tools suitable for parametric studies of preliminary design of such systems.

For more details, I invite the readers to carry on with their own explorations, and I wish they be very fruitfull. 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 2017 with their full-size papers.

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