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MULTI-PHYSICS & MULTI-SCALE METHODS IN GRANULAR MATERIALS MODELING

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ABSTRACT

Granular materials are the second most used material by industry on earth. Unlike other materials usually found in nature these novel materials can easily transition from one state to another, i.e., they can bear load like solids, then flow like a viscous fluid, and/or undergo gas-like behaviour, all these just by being subjected to slightly different boundary or initial conditions [1]. These facts as well as their widespread use make them not only an interesting material to study but also a complex material to model and simulate.

On the other hand, these materials tend to naturally interact with other materials such as water or air, which, in many cases, change their behaviour in drastically different ways, giving, for instance, raise to chemical activity on the grain's surface that, in turn, generates other important physical effects such as electrostatic fields that induce attraction among grains creating natural strength or cohesion.

Thus, their heterogeneous shapes and sizes [2], different physical behaviours, easy interaction with other substances and materials [3] as well as their discrete nature [4], open a big range of ways of looking at their behaviour: from experimental characterization to discrete [5] and continuum [6] modelling that can be combined between them [7], and, in the same manner, with single to multi-physics schemes, these materials provide researchers and engineers with a set of numerous puzzling questions about their behaviour that demand a response in order to take advantage of their novel aforementioned features.

Hence, this mini-symposium aims to gather the best researchers in the field which will provide a insightful upgrade on the state of the art and share new ideas, paradigms, technics

and developments that can set the research path for the next ten years in the following topics related to the subject:

- Statistical Mechanics and homogenization theory
- Micro-mechanics and contact mechanics
- Classical Continuum and Cosserat Continuum Mechanics
- Multi-scale modelling
- Multi-physics modelling
- New experimental techniques

REFERENCES

[1] H. Hinrichsen and D. E. Wolf, *The Physics of Granular Media*, Wiley-VCH, 2006.

[2] A. X. Jerves, R. Y. Kawamoto and J. E. Andrade, "Effects of grain morphology on critical state: a computational analysis", *Acta Geotechnica*, Vol. **11,** Iss. 3, pp. 493−503, (2016).

[3] S. A. Galindo-Torres, "A coupled Discrete Element Lattice Boltzmann Method for the simulation of fluid-solid interaction with particles of general shapes", *Computer Methods in Applied Mechanics and Engineering*, Vol. **265**, pp. 107−119, (2013).

[4] J. E. Andrade and C. F. Ávila, "Granular element method (GEM): linking inter-particle forces with macroscopic loading", *Granular Matter*, Vol. **14,** Iss. 1, pp. 51−61, (2012).

[5] B. Cambou, M. Jean and F. Raadjaï, *Micromechanics of Granular Materials*, ISTE-Wiley, 2009.

[6] R. I. Borja, *Plasticity: Modeling & Computation*, Springer, 2013.

[7] M. Oda and K. Iwashita, *Mechanics of Granular Media: an introduction*, A. A. Balkema, 1999.