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MULTISCALE MECHANICS AND PHYSICS OF CIVIL ENGINEERING POROUS MATERIALS

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TULIO HONORIO [*], LAURENT BROCHARD [†], JULIEN SANAHUJA[††] AND KATERINA IOANNIDOU[§,£,¥]

[*] LMT, ENS Paris-Saclay, CNRS, Université Paris-Saclay
61, avenue du Président Wilson, F-94235 Cachan, France.
tulio.honorio-de-faria@ens-paris-saclay.fr

[†] Université Paris-Est, Laboratoire Navier (UMR 8205), CNRS, ENPC, IFSTTAR
6 & 8 avenue Blaise Pascal, 77455 Marne-la-Vallée, France.
laurent.brochard@enpc.fr

[††] EDF lab, département MMC
Site des Renardières - Avenue des Renardières, 77818 Moret sur Loing, France.
julien.sanahuja@edf.fr

[§]Laboratoire de Mécanique et Génie Civil, CNRS–Université de Montpellier
34090 Montpellier, France.
aikaterini.ioannidou@umontpellier.fr

[£]The Massachusetts Institute of Technology/CNRS/Aix-Marseille University Joint Laboratory
Cambridge, MA 02139, USA.

[¥]Department of Civil and Environmental Engineering, Massachusetts Institute of Technology
Cambridge, MA 02139,USA.

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ABSTRACT

Concrete, geomaterials (soils, rocks) and wood are porous materials that are ubiquitous in civil engineering. A relevant description of the behaviour of these materials requires accounting for the multiscale nature and hierarchical microstructure of the material, as the engineering behaviours often emerge from mechanisms occurring at the nano- or micro-scale. Composition-(micro)structure-property correlation is the central paradigm in (1) the understanding of material behaviour in (infra-)structures, building envelopes and/or environmental processes; and (2) in tailoring materials properties according to performance specifications. Multiscale approaches enable to identify the physical origins of physical phenomena and quantify their repercussions across scales. Such information is crucial in the design of more durable and resilient (infra-)structures, in the extension of the service lives of existing infrastructures

exposed to degradation and ageing, in the optimization of the use the Earth's critical zone (especially for energy production), as well as in the development of new materials engineered to achieve a given performance. Regarding length-scales, industrial applications and environmental processes require a robust description of macroscopic properties whereas the mechanisms giving rise to the properties of interest cannot generally be understood at that macroscopic scale. Bridging timescales is also a major challenge in the comprehension of the behaviour of these materials, especially when one focuses on delayed or time-dependent behaviours (such as creep/relaxation and degradation processes inducing microstructure changes) that are observed in cement-based materials, clays and wood. Furthermore, the hierarchical porosity of these materials plays a major role in their thermo-hydro-mechanical behaviour. There are critical open questions regarding the role of sorption, fluid confinement, capillary effects, pore size dependency and specific ion effects on the physical properties of civil engineering porous materials.

We are interested in contributions tackling the modelling and simulation of the multi-physics behaviour of civil engineering porous materials including nano- and micromechanics, atomistic and particle-based simulations, theoretical and multi-technique (e.g. combining experimental and modelling) approaches.