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# Hydromechanical couplings in multiphase granular systems: recent advances and perspectives

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This presentation report recent advances in the framework of the discrete element method (DEM) for multiphase granular media. Computationally efficient methods based on the DEM have been developed for a while for partially saturated materials but they have been generally limited to the pendular regime. In contrast, one hardly avoid expensive direct resolutions of 2-phase fluid dynamics problem for mixed pendular-funicular situations or even saturated regimes. Following previous developments for single-phase flow, a pore-network approach of the coupling problems is described. The geometry and movements of phases and interfaces are described on the basis of a tetrahedrization of the pore space, introducing elementary objects such as bridge, meniscus, pore body and pore throat, together with local rules of evolution [1]. As firmly established local rules are still missing on some aspects (entry capillary pressure and pore-scale pressure-saturation relations, forces on the grains, or kinetics of transfers in mixed situations) a multi-scale numerical framework is introduced, enhancing the pore-network approach with the help of direct simulations [2]. Small subsets of a granular system are extracted, in which multiphase scenario are solved using the Lattice-Boltzman method (LBM). In turns, a global problem is assembled and solved at the network scale, as illustrated by a simulated primary drainage.

## References

[1] YUAN, Chao et CHAREYRE, Bruno. A pore-scale method for hydromechanical coupling in deformable granular media. Computer Methods in Applied Mechanics and Engineering, 2017, vol. 318, p. 1066-1079.
[2] CHAREYRE, Bruno, YUAN, Chao, MONTELLA, Eduard P., et al. Toward multiscale modelings of grain-fluid systems. In : EPJ Web of Conferences. EDP Sciences, 2017. p. 09027.

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