

The benefits of heuristic computational models in geomechanics

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Computational research in geomechanics has focused on constructing advanced numerical models that rigorously consider all the fundamental balance equations and employ accurate constitutive models. Albeit this undeniably important task, the nature of many geotechnical problems is demanding and requires a delicate treatment of challenging issues due to aspects such as the enormous material flow and distortion. Internal irreversible processes such as fracture, grain crushing and grain plasticity require the implementation of unconventional constitutive models that are capable of considering the irreversibility in a thermodynamically admissible way. In fact, geotechnical researchers often straggle to settle on the right description of even reversible processes; a famous example includes the tricky notion of effective stress in unsaturated soil mechanics. Combining all these complex challenges into a single package is called ‘geomechanics’. It is therefore not a surprise that the majority of the computational models nowadays in geomechanics is so intractable and often involves many layers of approximations and assumptions; the aim is often to get something that works. Of course, this often comes with a heavy cost of inaccuracies, the initial intention of such complex models.

With all this in mind, my talk will attempt to motivate the construction and use of heuristic computational models in geomechanics – simple models aimed at studying intractable or previously untouched problems. I will present a few of such models, including a cellular automaton to study grain segregation, a stochastic lattice model to study combined effects from mixing of segregation and grain crushing, and a spring lattice model to study dynamic compaction bands. Undoubtedly, in future more advance computational models may be useful to further explore those problems, but the knowledge gained from such heuristic models will be shown to be extremely powerful.