Large-scale discrete element simulations of soil drilling process

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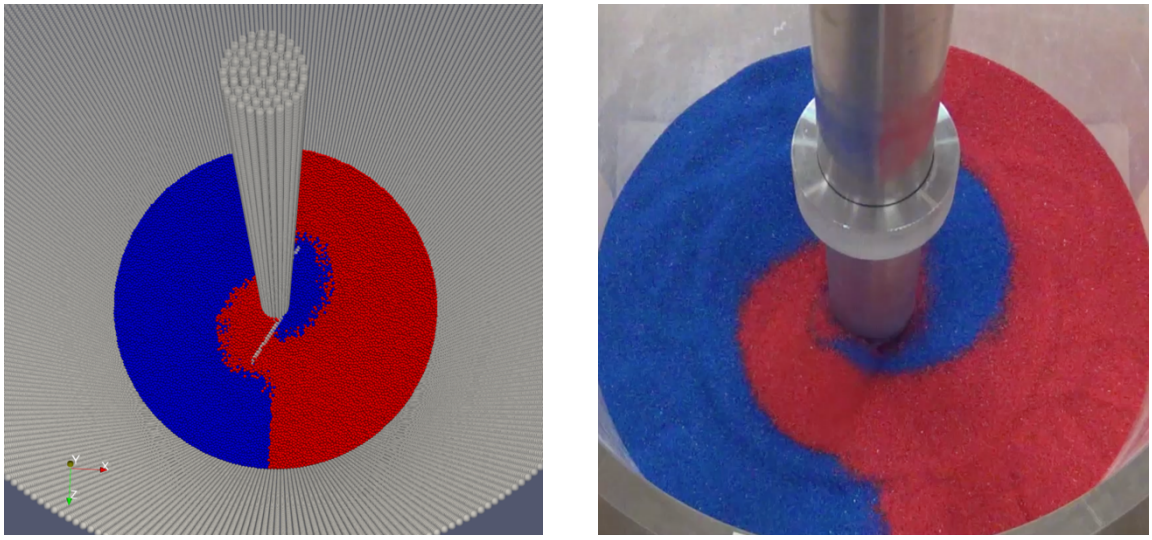
Abstract

A drilling process is common in geotechnical engineering and geoscience, for obtaining soil samples and for excavating natural resources such as minerals, oils, gas etc. Conventionally, the interactions between soils and the drill bits are estimated from empirical laws, the applicable range of which might be limited. In this study, we apply a high-performance-computing-based DEM code [1]-[2] to simulate the drilling processes. Using DEM for both soils and drilling tools allows efficient large-scale simulations for assessing the effectiveness of drilling and optimizing the design of tools. By carrying out numerical studies and corresponding experimental validations, we explore the effects of particle parameters, boundary effects and drill bit shapes on the efficiency of drilling processes.



(a) (b)

Fig. 1 (a) DEM simulation (the container and drill bits are in white and the particles are in red and blue); (b) Experimental setup (the acrylic container is transparent while the particles dyed with red and blue)

References

[1] Furuichi, M., Nishiura, D., Asai, M., and Hori, T., The first real-scale DEM simulation of a sand-box experiment using 2.4 billion particles. The International Conference for High Performance Computing, Networking, Storage and Analysis, Denver, CO, 2017.

[2] Nishiura, D., Sakaguchi H. and Yamanoto S., Multibillion particle DEM to simulate centrifuge model tests of geomaterials, Proceedings of the 9th International Conference on Physical Modelling in Geotechnics 2018, volume 1, pp.227-232.