Multiscale modeling of large deformation in saturated granular media

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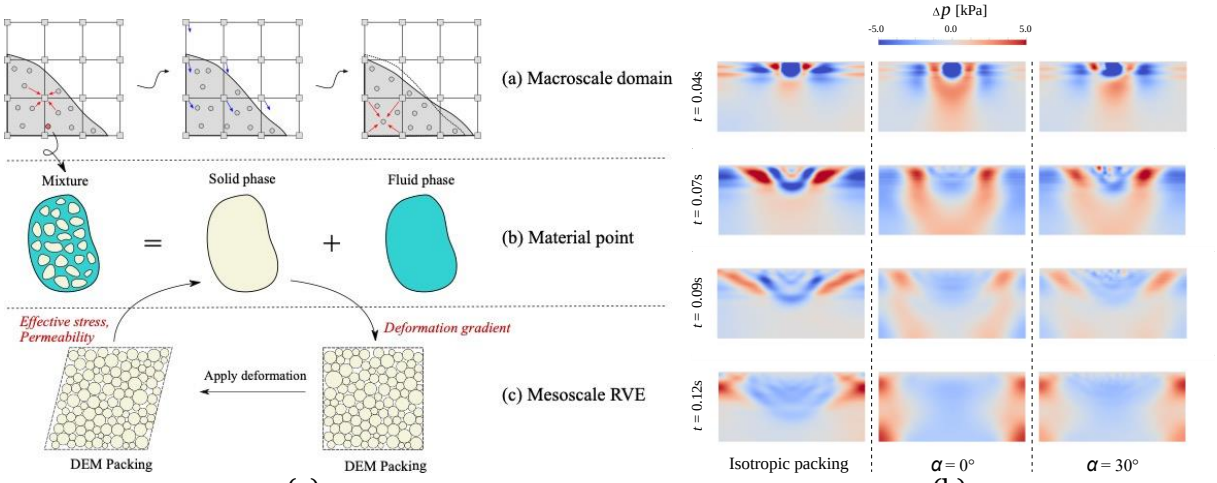
Keywords: Multiscale modeling; saturated granular media; large deformation; MPM x DEM

A multiscale scheme based on coupled material point method (MPM) with discrete element method (DEM) (MPM x DEM) is developed to model the quasi-static or dynamic hydro-mechanical coupling responses of saturated granular media in large deformation (Liang et al., 2023). A two-phase MPM with u–v–p formulation is used to solve the solid–fluid interactions for the macroscopic domain of a boundary value problem, where the material response is fed by a DEM assembly comprised of arbitrarily shaped granular particles at each material point. The proposed approach is validated by the 1D consolidation problem and is further used to simulate a range of geotechnical problems, including the cyclic shaking test, the column collapse, and wave propagation in anisotropic saturated porous media. The proposed 2-phase MPMxDEM approach is robust in capturing the complicated quasi-static and dynamic multiphysics interactions in saturated granular media in various engineering settings.



(a) (b)

Figure 1 (a) Hierarchical multiscale coupling scheme between a 2-phase MPM with DEM; (b) Simulated propagation of excess pore pressure for a saturated granular soil domain with different bedding-plane anisotropies subjected to a dynamic punch at ground center.

References

W. Liang, J. Zhao, H. Wu, K. Soga (2023) Multiscale, multiphysics modeling of saturated granular materials in large deformation, *Computer Methods in Applied Mechanics and Engineering*, 405:115871

Acknowledgements

The work was financially supported by RGC/GRF 16207319 & France/RGC JRS F-HKUST601/19.