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MODELLING SOIL-WATER-STRUCTURE INTERACTION IN GEOMECHANICS WITH THE MATERIAL POINT METHOD

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ABSTRACT

The Material Point Method (MPM) has emerged as a powerful computational framework for addressing challenging geotechnical problems involving large deformations, extreme loading conditions, and complex multi-physics interactions [1]. Its ability to naturally capture coupled processes, soil-fluid-structure interaction, contact mechanics, and highly non-linear constitutive behaviour has led to rapid adoption across geomechanics and hazard engineering applications. Recent advances in MPM formulations, stabilization techniques, constitutive modelling, and high-performance computing are significantly expanding the range and fidelity of problems that can be simulated.

The purpose of this Invited Session is to highlight recent advances and emerging directions in the application and development of MPM for geotechnical and geoenvironmental engineering problems involving soil-water-structure interaction. Topics of interest include, but are not limited to, multi-phase and multi-body formulations; coupled hydro-mechanical and thermo-hydro-mechanical processes; soil-structure and fluid-structure interactions; constitutive modelling for geomaterials; and scalable computational strategies for large-scale simulations. Applications may include slope failures, landslides, erosion and internal instability, offshore and coastal geotechnics, installation problems, tunnelling, penetration and impact, underground explosions, tailings dam failures, liquefaction, and other natural or engineered hazards. Contributions addressing the accuracy, stability, robustness, and efficiency of MPM formulations are particularly encouraged, including benchmark studies, verification and validation efforts, and comparisons with experimental observations or field-scale events. The session also welcomes interdisciplinary contributions that demonstrate how MPM can advance predictive capabilities for resilient infrastructure, hazard mitigation, and performance-based geotechnical engineering.

REFERENCES

[1] Fern, E., Rohe, A., Soga, K., Alonso, E., 2019. The material point method for geotechnical engineering: A practical guide. DOI: 10.1201/9780429028090