This research investigates an accurate application-specific formulation of the MPM with levelset and barrier method for geo-interface problems. The barrier method with frictional resistance has been previously well-explored in FEM for general contact problems (Zhao et al., 2022). The MPM with levelset and barrier method has been recently proposed in MPM (Zhao et al., 2023), where the levelset method allows for nonconforming interfaces with complex geometry. The barrier method applies a logarithmic normal coupling force, scaled by a 'barrier stiffness', as a material point (MP) travels through the 'barrier thickness'. The original implementation uses a blended PIC-FLIP velocity and a 'friction smoothing function' which ramps from zero based on a 'cumulative slip threshold' (Zhao et al., 2022, 2023).

In the current research, the MPM with levelset and barrier method is improved for geo-interface problems, where a large contact area is expected with sliding dominant (rather than bouncing or rolling). The improved method includes an estimation of contact velocity, which can be locally calculated as a smoother PIC velocity regardless of global velocity update scheme. This is used to reduce 'bouncing', helping MPs to quickly reach an 'equilibrium height' within the barrier thickness, by damping coupling forces for MPs exiting the barrier. It is also used to estimate the contact force and ensure that the portion of potential tangential resistance applied never exceeds the actual (negative) tangential contact force. Given the high importance of total stress analysis in geotechnical problems involving rapid deformations, an adhesion contact resistance is also implemented to model undrained strength.

The Oso Landslide case study will incorporate the improved levelset approach to model the interface between the background terrain and the sliding materials, reducing the number of MPs required in 2D by approximately ¾. This large-deformation problem includes multiple combinations of sliding and interface materials.

CITATIONS:

Zhao, Y., Choo, J., Jiang, Y., & Li, L. (2023). Coupled material point and level set methods for simulating soils interacting with rigid objects with complex geometry. *Computers and Geotechnics*, *163*, 105708. https://doi.org/10.1016/j.compgeo.2023.105708

Zhao, Y., Choo, J., Jiang, Y., Li, M., Jiang, C., & Soga, K. (2022). A barrier method for frictional contact on embedded interfaces. *Computer Methods in Applied Mechanics and Engineering*, *393*, 114820. https://doi.org/10.1016/j.cma.2022.114820