A Meshfree Hydromechanical Approach to Large Deformation Modeling of Natural Hazards Involving Localized Geomaterial Failure

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Date: Friday January 31st, 2025 **Time:** 11:00am PST **Location:** Huang 305

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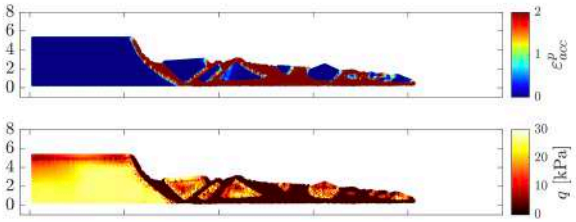
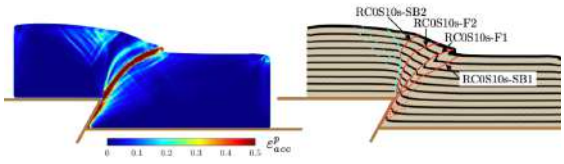
Abstract:
With climate change and increasing climate volatility, it is imperative to be able to model the post-failure behavior of geomaterials to mitigate risks posed by natural hazards on our aging and increasingly overwhelmed infrastructure, particularly dams and levees. At the same time, there is a mounting need to design "safe-to-fail" infrastructure to achieve resiliency goals. However, the traditional finite element method commonly used in engineering analysis struggles with the large deformations characteristic of the post-failure regime due to mesh distortion. In this presentation I demonstrate that smoothed particle hydrodynamics (SPH), a meshfree continuum-based particle method, together with some of my recent contributions including verifying new boundary conditions, critical state type constitutive models, and exploiting the method's nonlocal properties, can excellently handle the computationally challenging transition from localized failure to large deformation seen in many geomaterials. This research has furthered understanding of faulting in geologic materials and other localized failure modes affecting hydrocarbon production and CO_2 storage. In this talk I also present hydromechanical frameworks for coupled solid-fluid deformation for SPH developed in my work and show how through high-resolution numerical simulations they are adept at modeling various geohazards studied in geotechnics including fault rupture, landslides, and embankment failures.

Thompson River Valley Slide, Canada.

Reverse fault scarp, 1999 Chi-Chi Earthquake, Taiwan.



Retrogressive landslide in sensitive clay simulation.



Reverse fault propagation through sand simulation.