Modeling Dynamic Rock-Fluid Interaction Applied to Hydraulic Plucking in Dam Spillways

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Abstract

Erosion of rock by hydraulic forces is an important element of natural evolution of the landscape and this process can have a significant impact on engineered structures. Dam spillways, bridge abutments, and tunnels are all subject to water erosion and the resulting damage can cost millions of dollars to repair and, in the worst case, cause loss of life. Specifically, scour of rock is a challenging and interesting problem that combines rock mechanics and hydraulics of turbulent flow. This presentation will highlight how this interaction between a blocky rock mass and water is analyzed by directly modeling the solid and fluid phases. The individual polyhedral blocks are modeled using the Discrete Element Method (DEM) while the water is modeled using the Lattice Boltzmann Method (LBM). The LBM mesh is entirely independent of the DEM discretization, making it possible to refine the LBM mesh such that transient and varied fluid pressures acting on the rock surfaces are directly modeled. This provides the capability to investigate the effect of water pressure inside the fractured rock mass and along potential sliding planes.

About the Speaker

Michael Gardner is an Assistant Professor at the University of Nevada, Reno, in the Department of Geological Sciences and Engineering. He received his BS in Civil Engineering and his MS and PhD in Geotechnical Engineering from the University of California, Berkeley. He was a postdoctoral scholar at the NHERI SimCenter where he worked on developing open-source software for natural hazards engineering before joining the faculty at UNR in January, 2020. Prior to pursuing his graduate studies, he worked as a geotechnical engineer in San Francisco and prior to attending university he served in the US Army as a combat engineer. His professional and research interests include geological engineering, rock mechanics, natural hazards engineering, and the application of numerical and stochastic methods to shallow earth processes and engineering analysis. His research focuses on quantifying how geologic setting and infrastructure design interact, informing both engineering design and disaster preparedness. He actively develops open-source tools that incorporate advances in computing technology that can be used by the research community as well as practitioners.