Coupled FEM-DEM Methods for Modeling Variably Saturated Granular Media

Chris Kees* Manuel Quezada de Lunaa* Yong Yang * Milad Rakhsha†
Leo Nouveau ‡ Guglielmo Scovazzi ‡

Abstract

There has been increased interest in understanding the dynamics free surface flows interacting with dynamic structures ranging from floating offshore platforms to granular media in partially and fully saturated conditions. These applications include both low and high Reynolds numbers. We have used two-phase incompressible flow models for modeling air/water flows interacting with moving vessels and vehicles, porous solids, and flexible vegetation using continuous finite elements for multiphase flow and several approaches to coupling to the solid motion, include conforming Arbitrary Lagrangian Eulerian formulations with deforming, boundary-fitted meshes and immersed methods. We follow the method [1] to solve the incompressible Navier-stokes equations and use the level-set method and signed distance function to model air/water interface and granular phase. In the current research, we focus on the coupling between different phases in order to avoid instability and get high accuracy and robustness during solid-solid contacts. While we enforce the no-slip boundary condition using a weak (Nitsche-type) method, we test several options for applying it on conforming meshes, implicit boundaries using a smoothed Dirac penalization, and the recently developed shifted boundary method [2]. We will present results for modeling such immersed solids in two-phase flows, results on the comparison between conforming and nonconforming approaches, and results on the comparison between immersed boundary method and shifted boundary method.

References

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*US Army, ERDC-CHL
†University of Wisconsin
‡Duke University