Fluid-Solid Modeling of Geomechanical Slope Failures

Colby C. Swan, Assistant Professor
Young-Kyo Seo, Graduate Research Assistant (Ph.D candidate)
Department of Civil & Environmental Engineering
Computational Solid Mechanics Laboratory
The University of Iowa, Iowa City, IA

Seepage induced earthen slope failures occur in concert with meteorological events when large quantities of groundwater are channeled into slopes through infiltration. The presence of flowing groundwater in earthen slopes can induce ground failures that result in significant property damage and potential loss of life. Seepage induced earthen slope failures represent a serious problem in geotechnical engineering. The ongoing research activity applies existing fluid-solid numerical modeling capabilities to study and predict seepage induced earthen slope failures. Study of the targeted application holds potential for much needed advances in geotechnical engineering analysis technology which could be used to design more effective engineering slope stabilization interventions.

This research is motivated by the realization that soils are porous media whose mechanical properties are strongly influenced by the presence of interstitial fluids. Realistic mechanical modeling of soils requires the capability to treat coupled fluid-solid media with both solid stresses (or “effective stresses”) and fluid stresses (or “pore pressures”). Using state of the art porous media computer modeling capabilities which represent both extensions and specializations of classical Biot theory, basic engineering science issues pertaining to seepage-induced earthen slope failures are being studied. It is not uncommon for earthen slopes to fail catastrophically causing both property damage and loss of life following meteorological events that channel water into the ground (major rainstorms, or rapid snow melt, etc.). The introduction of groundwater in earthen slopes increases the likelihood of failure by: increasing the weight of the soil; creating pore pressures which reduce grain-to-grain soil effective stresses; and exerting drag or seepage forces in the flow direction. The basic issues being addressed in this research effort are:

a. whether or not our numerical modeling capabilities can be used to predict seepage induced slope failures; and

b. whether or not such improved modeling capabilities can be used to assess the efficacy of engineering slope stabilization interventions.