A SCALABLE NONLINEAR SOLVER FOR MODELING COUPLED HYDROMECHANICAL PROCESSES IN RAINFALL-TRIGGERED LANDSLIDES

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Worldwide, rainfall-triggered landslides are responsible for thousands of deaths and severe infrastructure damage each year. The triggered failure of soil slopes is a coupled hydromechanical process involving tight interactions between subsurface fluid flow and geomechanical deformation. Furthermore, natural hillslope geometries are intrinsically three-dimensional, and defy simple two-dimensional approximations. As a result, computational models for these events are computationally demanding, and require scalable nonlinear solvers. In this work, we discuss two coupled formulations for this class of problem. In both, nonlinear mass and momentum balances for the solid/fluid/air mixture are solved simultaneously. The formulations differ, however, in the choice of primary unknowns and the treatment of the air phase. These multi-field formulations lead to block-structured Jacobian systems that must be solved during each Newton update. Effective block-structured preconditioners are devised for these systems. We then test the robustness and scalability of the solvers using detailed topographic and rainfall data for a real field site which failed during a large rainstorm event in 1996. This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.