On finite volume method implementation of poro-elasto-plasticity soil model
Accurate prediction of the interactions between the nonlinear soil skeleton and the pore fluid under loading plays a vital role in many geotechnical applications. It is therefore important to develop a numerical method that can effectively capture this nonlinear soil-pore fluid coupling effect. This paper presents the implementation of a new finite volume method code of poro-elasto-plasticity soil model. The model is formulated on the basis of Biot's consolidation theory and combined with a perfect plasticity Mohr-Coulomb constitutive relation. The governing equation system is discretized in a segregated manner, namely, those conventional linear and uncoupled terms are treated implicitly, while those nonlinear and coupled terms are treated explicitly by using any available values from previous time or iteration step. The implicit-explicit discretization leads to a linearized and decoupled algebraic system, which is solved using the fixed-point iteration method. Upon the convergence of the iterative method, fully nonlinear coupled solutions are obtained. Also explored in this paper is the special way of treating traction boundary in finite volume method compared with FEM. Finally, three numerical test cases are simulated to verify the implementation procedure. It is shown in the simulation results that the implemented solver is capable of and efficient at predicting reasonable soil responses with pore pressure coupling under different loading situations.