Abstract

Developing classical three-dimensional consolidation theories considers the small-strain assumption. This small-strain assumption is inappropriate when studying the consolidation process of soft or very soft clay layers. Instead, this study derives a novel generalized mathematical model describing a three-dimensional finite-strain consolidation process and applies the deep Galerkin method to deduce its novel numerical solution. Developing this mathematical model uses the Reynolds transport theorem to describe mass and momentum balances for clay grain and pore water phases. The governing equation is the sum of the resulting mass and momentum balance equations. Next, the deep Galerkin method is applied to train a deep neural network to minimize the loss function defined by the governing equation and available initial and boundary conditions. The unknowns are the average velocity, effective stress, and pore water pressure. Predicting consolidation settlements is implemented by updating the problem domain using the resulting average velocity. Beneficial from the deep Galerkin method, two real-world examples demonstrate that the current mathematical model provides accurate predictions of consolidation settlements caused by the self-weight of two very soft clay layers. The deep Galerkin method helps resolve ill-posed problems by fitting a family of fields constrained by sampling/regularization rather than physics if the physics is under-determined.