Coupled Hydro-Mechanical Numerical Simulation of a Staged Highway Embankment Construction

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Abstract: Construction on soft clays is typically faced with challenges, such as settlement magnitude and rate, and the risk of undrained failure of the foundation soils. Settlement magnitude can be mitigated by ground improvement, and settlement rate can be accelerated by shortening the drainage paths using drains. The undrained failure is eschewed by carefully planning staged construction to ensure safe project execution. A coupled hydro-mechanical finite element simulations were performed to optimize the design of the construction stages for the embankments along I69 extension in southern Indiana. The height of the embankment along the extension varied from about 50 ft to 125 ft. The foundation soils consisted mainly of highly compressible fine grained soils. A hardening soil constitutive model was used to model the foundation soil layers, while the embankment soils and the bed rock were modeled as elastic-perfectly plastic with MC yield criteria. The site was well instrumented during construction, which allowed for monitoring of settlements and porewater pressure dissipation. The estimated settlement and porewater pressure response from the simulations reasonably agree with the data collected from the instrumentation program. In the presentation, various aspects of the project will be demonstrated with focus on the modeling elements, comparison with instrumentation data and conclusions will be discussed.