

ABSTRACT

Chakraborty, Tanusree. PhD, Purdue University, May, 2009. Development of a clay constitutive model and its application to pile boundary value problems. Major Professor: Rodrigo Salgado.

This thesis addresses the solution of certain key boundary-value problems of piling engineering, namely the determination of the shaft capacity of drilled shafts and the analysis of pile setup for jacked piles in clay, using the finite element method. In order to capture soil behavior accurately during the analysis, a bounding-surface clay constitutive model is proposed. The constitutive model is based on the critical state soil mechanics framework. The model has a non-associated flow rule. Particular emphasis has been placed on capturing the residual state behavior of clay at large strain levels under prolonged shearing and the strain-rate-dependent clay behavior. These are important for simulation of pile installation and shearing due to loading. The constitutive model simulates the mechanical response of clays at small and large strains and takes into account the effect of the intermediate effective stress. The constitutive model was implemented in the finite element code SNAC.

The analysis of limit shaft resistance of non-displacement piles (drilled shaft) in clay is done using SNAC. The analysis includes simulation of the installation of drilled shafts in clay, the development of setup afterwards and loading of the drilled shaft after

installation. In clay, consolidation is the main cause of setup. Biot consolidation theory is used in SNAC to model the coupled consolidation process. A separate thesis addresses installation of jacked piles and the changes to soil state around the pile caused by it. In this thesis, the end of installation stress state, void ratio and pore pressure conditions of the ground is taken as the starting point. The thesis concludes with proposal of design equations for the shaft capacity of drilled shafts and jacked piles in clay at the end of setup.