Florida Department of Transportation Research

Effect of Proximity of Sheet Pile Walls on the Apparent Capacity of Driven Displacement Piles, Phase 2

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Current Situation

A temporary steel sheet pile wall (SPW) is frequently used to stabilize the excavation of pile cap foundations. An SPW is installed prior to the installation of the production piles. Typically, the perimeter piles of the foundation unit are installed very close to the SPW. The proximity of the wall affects the stress conditions for the driven piles and therefore may affect the pile side friction and the pile tip resistance. Both placement and removal of an SPW changes the soil mechanics for a driven pile and may affect the pile's bearing capacity. To properly evaluate the capacity of the driven piles, the effect of a sheet pile wall on the bearing capacity of a driven pile must be fully understood.

The use of a sheet pile wall to stabilize soil for further construction might be permanent or temporary.

Research Objectives

University of Florida researchers investigated the effects of installation and removal of sheet pile walls on piles driven into granular soils.

Project Activities

In Phase 1 of this project (FDOT project BDV31-977-26), the researchers developed a method for analyzing the effect of a single SPW on the bearing capacity of a nearby driven pile. In this project, they extended those methods to the case of two perpendicular SPWs, to simulate the corner conditions in a rectangular cofferdam or rectangularly arranged SPW. The researchers simulated this construction situation by combining finite element methods with discrete element methods (FEM-DEM) in order to explicitly capture the mechanical behavior of the pile-soil-SPW system.

Three relevant physical scenarios were studied: (1) driving a pile into sand; (2) installing two SPWs, one at a time, followed by pile driving into sand; and (3) installing two SPWs, pile driving, and subsequent SPW removal, one at a time, in reverse order of installation. The Davisson and ultimate capacities of the driven pile were assessed in the presence of a driven SPW cofferdam, as well as in a soil from which the SPW structure has been recently removed. Because the response of the pile was shown to be dependent on geometrical parameters of the system, a parametric study was performed with respect to the ratio of the SPW cofferdam's embedment depth versus the driven pile's embedment depth. The components of total resistance were studied with respect to the pile's tip resistance and side friction. The relationships of these components to the presence or removal of the SPWs at various embedment depths were recorded. The results were condensed into a series of simple design charts which quantify the effects of the SPW cofferdam in scenarios 2 and 3 on the bearing capacities of the pile. Recommendations for the use of these graphical tools were presented for the easy quantification of these influences for the engineer facing relevant design decisions.

Project Benefits

This project provides engineers with improved tools to determine the pile capacity changes due to the installation and removal of temporary sheet pile walls that are installed to support the excavation forthe foundation the pile group.

For more information, please see www.fdot.gov/research/.