Monday 3/13/2017

12:15–1:45 p.m.

Pile, Shaft and Pier Foundations 2

Chairs: Aaron Budge, Minnesota State University, Mankato; Allen Cadden, Schnabel Engineering LLC

Elastic Analysis of Differential Settlement for Steel Storage Tank Foundations

Suranga Gunerathne, Hoyoung Seo, William Lawson, and Priyantha Jayawickrama, Texas Tech University

Estimation of differential settlements for large steel storage tanks is a very important design consideration; however, there is a lack of readily available analysis tools which can be used to accurately and conveniently compute tank differential settlements under various bottom plate dimensions and soil stiffnesses. This paper presents a continuum-based, elastic analysis model for a uniformly loaded, circular tank foundation resting on soil. The analysis captures the three-dimensional nature of the soil-structure interactions and produces settlement profiles of the tank foundation and the surrounding soil. The soil is assumed to behave as a linear-elastic material in a semi-infinite half space, and the foundation is modeled as a circular plate with a finite thickness. The governing differential equations are derived based on energy principles and calculus of variations. Input parameters for the analysis model are the plate diameter, plate thickness and elastic constants of the soil and plate. Model validation includes comparing results from this study with those from the literature and from finite element analyses, and these comparisons show good agreement. Parametric studies are then carried out to investigate the effects of plate diameter, plate thickness, and soil stiffness on differential settlement between the center and the edge of the circular plate. Based on the results from the parametric studies, design charts for use in preliminary design of circular tank foundations are proposed to estimate the differential settlement for given soil properties and plate geometry.

Sustainable Slope Protection and Cut-off Wall Installation in Densely Populated Areas by the Press-in Pile Driving Method

Takefumi Takuma and Shigeru Kambe, Giken America Corp.

The Press-in Pile Driving Method utilizes hydraulic force to push piles into the ground by holding onto previously driven piles. The hydraulic force is provided by a sound-attenuated power pack. It generates very low noise and almost no vibration. It is also suited for physically constrained projects and for projects with limited access. Some urban projects require pile driving in low head room or with very small clearance from existing structures. In other cases, pile driving may have to be conducted without an access road to the piling location. This paper will discuss the solutions for those otherwise very difficult levee embankment upgrade and earth retaining projects with pressed-in sheet pile and pipe pile walls.

Load-Carrying Capacity of Slab-on-Grade Foundations Supporting Rack Post Loads

Xiaochao Tang and Mohamad Jlilati, Widener University

Industrial slabs-on-grade are commonly used for warehouse facilities such as storage, retail, and distribution centers. Typical industrial floor slabs are essentially unreinforced concrete usually poured directly onto compacted subgrade. A limited number of studies have shown that the current common practice of design may be overly conservative and yields an excessively high slab thickness, which leads to a high cost of the floor slab. This study aims to experimentally investigate and verify a newly emerged design method that typically results in a smaller slab thickness and significant cost savings. Laboratory-

scale slabs-on-grade were built inside a concrete-lined testing box using local soils and aggregates. A total of four 6 ft by 6 ft concrete slabs representing three different concrete mix designs and two slab thicknesses were tested under static loads that simulate storage rack post loads. Based on the limited number of tests, a preliminary finding was that the traditional design method seems to be overly conservative while the newer method may be too liberal.

A Semi-analytical Solution for Analysis of Axially Loaded Pile Groups in Layered Elastic Soil

Faraz Tehrani, Deltares; Rodrigo Salgado and Monica Prezzi, Purdue University

A semi-analytical solution is presented in this paper for analysis of axially loaded pile groups embedded in multilayered elastic soil profiles. The proposed method links the soil displacement around a pile group to the axial displacement of the piles in the group through displacement decay functions assigned to the piles. The product of the axial displacement of each pile and its associated decay function is then summed up for all piles in the group. Principle of virtual work and calculus of variations are used to derive the governing differential equations that describe the response of the soil and piles. The governing differential equations that predict the response of the piles are solved analytically using the method of eigenvalues and eigenvectors, whereas the differential equations that describe the soil decay functions are solved numerically using the finite-difference method. The method produces displacement fields that are very close to those produced by the finite element method but with less computational effort.

Laboratory Study of the Effect of Pile Surface Roughness on the Response of Soil and Non-displacement Piles

Faraz Tehrani, Deltares; Fei Han, Purdue University; Rodrigo Salgado, Purdue University; Monica Prezzi, Purdue University

This paper presents the results of axial load tests performed on instrumented model piles with different surface roughnesses. The model piles were pre-installed in a large-scale, half-circular chamber with a viewing window in its flat-side wall. Uniform silica sand samples in dense and medium dense states were prepared using dry pluviation. Digital image correlation technique (DIC) was used to study the effects of pile surface roughness and soil density on the response of the soil during loading of the model piles. Test results show that the extent of the zone next to the pile that is affected by loading of the pile increases as the pile surface roughness and soil density increase. The development of a shear band next to the pile shaft was also studied by carefully analyzing images taken with a digital microscope during loading of the model piles. Furthermore, the shaft resistances of the loaded piles were measured during the loading tests to investigate the effect of soil density and surface roughness on the response of the model piles.

The Sensitivity of Settlement Predictions for an Axially Loaded Drilled Shaft to ε50

Kevin Stanton, Maryam Ostovar, and Ramin Motamed, University of Nevada, Reno

A blind prediction of the load-settlement response of an axially loaded drilled shaft in Santa Catarina, Brazil, was carried out in June of 2015. The original results were developed using “best-estimate” soil properties within a t-z analysis framework developed by Norris (1986) and modified by Ashour et al. (1998). However, this approach relies heavily on the estimation of the axial strain at 50% of maximum deviatoric stress, termed ε50. Thus, a thorough literature review was carried out on published ε50 values and empirical relationships. The original estimates of ε50 were also varied in this study to explore

how sensitive the prediction results are in this regard. It was found the average root mean squared error between the predicted and measured results were significantly affected by changes in ε50 and that the t-z style predictions were substantially influenced by the estimates of ε50, highlighting the need for proper and careful estimation of this important parameter.