CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY

Texas Department of Transportation

0-6603: Long-Term Performance of Drilled Shaft Retaining Walls

Background

The design of drilled shaft retaining walls in expansive soils is challenging because the effects of soil wetting and drying over the long term is not well understood. A wide range of different assumptions are being made in current design practice, resulting in a wide range of wall designs that may be over-conservative or under-conservative. The objective of this research was to provide field-scale data about the long-term behavior of drilled shaft retaining walls in expansive soils.

What the Researchers Did

Project 0-6603 began in 2009 by constructing and instrumenting a full-scale drilled shaft retaining wall in a highly plastic, overconsolidated clay in Manor, Texas. The behavior of this wall was then monitored and analyzed over a 3.5-year period, including its response to excavation of the soil from one side, natural wetting and drying of the clay due to seasonal variations (including the driest year on record), and artificial inundation of the soil around the wall with water. In the final year of the project, a limiting case of long-term loading with the wettest possible conditions for the soil around the wall was achieved. Field measurements versus time included inclinations, deflections, strains and temperatures in the wall; water contents and electrical resistivity in the soil; inclinations in the retained soil behind the wall; and piezometric levels in the soil. Both finite difference and finite element method analyses were conducted to interpret the field measurements.

What They Found

The project was able to shed light on the behavior of a drilled shaft retaining wall in a highly plastic, overconsolidated clay. The key findings include the following:

- The maximum earth pressures applied to the wall from the retained soil under long-term loading corresponded to active earth pressures with a mobilized shear strength in the soil approximately equal the fully softened, drained shear strength. Even though the expansive soil around the wall experienced an extreme range of moisture contents from the driest year on record to full inundation with water, there was no evidence of applied pressures greater than the active earth pressures.
- Under long-term loading, the passive soil resistance provided by the foundation soil below the depth of the excavation corresponded to p-y curves estimated from the drained shear strength of the foundation soil with a mobilized strength between the peak and full-softened strengths.

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- During excavation, the soil and wall responded immediately to the relief of stress, causing the wall to tilt as a rigid body with the movement of the soil. This behavior could be captured in a finite element method analysis if the anisotropy of the soil from the large in situ lateral stresses caused by overconsolidation was considered, and the stiffness of the soil estimated from small-scale measurements and large-scale but small strain measurements was reduced.

What This Means

This research supports the current TxDOT design practice to use active earth pressures to estimate loading from the retained soil on a drilled shaft retaining wall in expansive clay. It suggests that a more realistic and more conservative assumption for the lateral resistance provided by the foundation soil is to use drained rather than undrained shear strengths. This research also highlights that immediate response of a drilled shaft retaining wall due to stress relief from excavation in overconsolidated clays may also be an important factor to consider in design.

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