Project Summary

Texas Department of Transportation

0-5824: Correlation of Shallow, Low Blow Count Texas Cone Penetrometer Values and Shear Strength for Texas Soils

Background

The Texas Department of Transportation (TxDOT) routinely performs Texas Cone Penetrometer (TCP) tests as part of soil site investigations. Often data from these tests is the only data available for estimating soil undrained shear strengths for preliminary design. Correlations have existed between blow counts from TCP tests and undrained shear strength; these correlations have frequently been used to estimate undrained shear strengths. However, the previous correlations have been derived primarily for deep foundations and relatively strong soils. The correlations are believed to be conservative and to substantially underestimate the undrained shear strength of soft (< 1000 psf undrained shear strength) soils. This often leads to either costly designs or unnecessary additional testing to establish more reliable strength values. This project was undertaken to develop an improved and more reliable correlation between the undrained shear strength of soils and the TCP blow count for soils with blow counts generally less than 15.

What the Researchers Did

Six sites were selected in the Texas Gulf Coast region where soft (undrained shear strengths of 1000 psf or less) clays were expected. Field explorations, including in situ tests, were conducted at each site. The field tests consisted of TCP tests, "Dutch" piezocone penetration tests, and in situ vane shear tests. Thin-walled tube samples were also taken in borings performed at each of the sites for further laboratory testing. One-dimensional consolidation, unconsolidated-undrained (UU) triaxial, and consolidated-undrained (CU) triaxial compression tests with pore water pressure measurements were performed in the laboratory on the undisturbed field samples. Results from the field piezocone and vane shear tests were combined and compared with the results from laboratory triaxial compression tests to establish representative profiles of undrained shear strength with depth for each of the six sites.

Once the undrained shear strength profiles were established for the sites, the shear strengths were compared with the results of the TCP tests. Based on this comparison, a new correlation between TCP blow counts and undrained shear strength was established.

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Once a correlation was developed, it was used to estimate undrained shear strengths for each of the six sites from the TCP values. Finally, a series of bearing capacity analyses was performed using both the undrained shear strength based on TCP blow counts with the new correlation, and the representative undrained shear strength based on the other field and laboratory test data.

What They Found

Based on the comparison of the variations in depth of TCP blow counts and representative undrained shear strengths derived from the other field and laboratory strength tests, the following relationship between TCP blow counts and undrained shear strengths is proposed:
$s_u = 300+60N$ where s_u is undrained shear strength in lbs. per square foot (psf) and N is TCP blow count.

Bearing capacities calculated using undrained shear strengths from this equation and TCP blow counts were found to, on average, agree very favorably with the bearing capacities calculated using the representative undrained shear strengths derived from the other field and laboratory tests (piezocone penetration, vane shear, and laboratory UU and CU tests). However, there was significant variation from site-to-site and also depending on the width of the loaded area that was considered for the bearing capacity analyses.

What This Means

The new correlation between TCP blow counts and undrained shear strength provides a better estimate of shear strength for low blow count ($N < 15$; $s_u < 1000$ psf) soils. This is recommended over the existing correlations which are believed to be excessively conservative for such soft soils. However, it must be realized that the TCP test provides only a crude estimate of shear strength and higher factors of safety probably need to be used than if shear strengths are obtained by more direct means such as field piezocone and vane shear or laboratory triaxial tests.

For More Information:

0-5824-1 Improved Correlation between Texas Cone Penetrometer Blow Count and Undrained Shear Strength of Soft Clays

0-5824-2 Characterization of Undrained Shear Strength Profiles for Soft Clays at Six Sites in Texas

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