SOIL PROPERTIES AND TEXAS CONE PENETROMETER (TCP) VALUES FOR HOUSTON CL SOILS

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Abstract
In this study, variation of liquid limit, moisture content and the Texas Cone Penetrometer (TCP) blow count values for CL soils with depth was investigated. Total of 242 data, up to a depth of 75 feet, from Houston area were used in this analyses and the variation of soil properties and TCP blow counts with depth have been quantified.

Introduction
When performing in-situ tests to determine the soil properties, it is critical to understand the geology of the area to better interpret the test results. There are two geological formations in the Houston, Texas area and these are known as Beaumont and Montgomery formations. Beaumont formation is the recent of the two formations and the depth of soil in this formation in the Houston area could be up to 40 feet. Currently, Texas Department of Transportation (TxDOT) uses the TCP results and type of soil to determine shear strength and bearing capacity of soil for deep foundation and other geotechnical designs [1]. Since deep foundations will be placed in both geological formations, it is of interest to investigate the effect of depth on the soil properties and TCP values in the Houston CL soils. Also depth based analysis can help to identify the differences in the two geological formations.

Researchers at the University of Houston, University of Texas at Arlington and Lamar University are developing a database on TCP and soil properties based on past 10 years of information collected by TxDOT. The information used in this abstract is only a small subset of the database.

Objective
The main objective of this study was to investigate the variation of liquid limit, natural moisture content and Texas Cone Penetrometer (TCP) blow count value with depth in the Houston CL soils.

Sampling and Testing
Geotechnical field data used in this analysis is mainly from the I-10 highway project in Houston, Texas. The data used in this analysis was collected from over 100 bore holes up to 75 feet in depth. The soils were classified using the Unified Soil Classification System (USCS). The water content and liquid limits were determined from laboratory tests.

TCP test: In the Texas Cone Penetrometer (TCP) test, 3 inch (76.2 mm) diameter cone is driven into the ground using a 170 lb (74 kg) hammer dropped two feet (0.61 m) [1]. Blow counts for first six (N_1) and second six-inches of penetrations are recorded typically at 5 feet intervals in the bore hole. For the analysis, total number of blow counts (N_{12}) for twelve inches of penetration is also used.

Analyses and Results

The active zone in the Houston area is considered to be 10 to 15 ft. deep. Hence data collected up to10 ft. was not used in the analysis. The database was mined to get the data at 10 ft. intervals up to 70 ft. Also data at 75 ft. depth was used in the analysis. For the preliminary study, the soil parameters selected were liquid limit and natural moisture content. The TCP values selected for analysis were N_1 and N_{12}. At every depth selected, the average value of the parameter was determined and plotted against the depth in Figs. 1, 2 &3.

Liquid Limit (LL) Vs. Depth(Z): Total of 242 data were used in the analysis. The variation of average liquid limit with depth is shown in Fig. 1. It can be observed that the average LL was almost independent of the depth. The average value of the LL was 37.6% with a standard deviation of 6.6% and a coefficient of variation (COV) of 17.5%. Also the two geological formations didn't significantly affect the LL of CL soils.

Moisture Content Vs. Depth(Z): The variation of average natural moisture content with depth is shown in Fig. 2. It can be observed that the average moisture content increased with depth and the coefficient of correlation was 0.7. The two geological formations didn't significantly affect the natural moisture content of CL soils.

TCP(N_1,N_{12}) Vs. Depth(Z): The variation of average blow counts with depth is shown in Fig. 3. Of the two blow counts, N_{12} showed greater dependence on depth than N_1. The coefficient of correlations for $N_1$and N_{12} with depth was 0.22 and 0.39 respectively. The two geological formations didn't significantly affect the blow counts in CL soils.

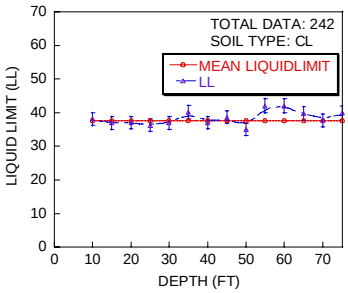

Fig.1. Liquid Limit Vs. Depth

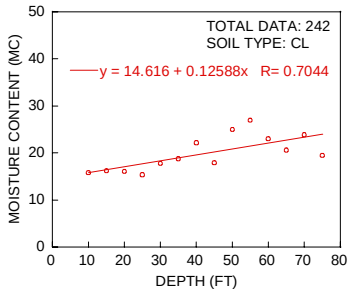

Fig. 2. Moisture Content Vs. Depth

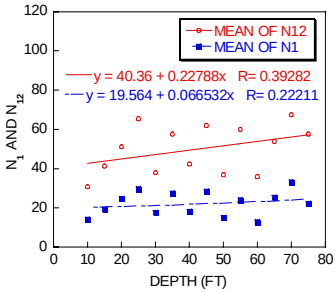

Fig. 3. N_1 and N_{12} Vs. Depth

Conclusions

Based on limited data on CL soils from Houston, Texas, the dependence of liquid limit, moisture content and TCP blow counts on the depth have been quantified. While liquid limit was independent of depth, the moisture content increased with depth. The two geological formations didn't significantly affect the soil parameters and blow counts in CL soils.

Acknowledgement

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References

[1] Geotechnical Manual - Texas Department of Transportation (TxDOT) (2000).