Modifying CIGMAT Penetrometer for Compacted Soil Applications

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Abstract: In this study CIGMAT Down-Hole Penetrometer (DHP-CIGMAT) was modified to CIGMAT Surface Penetrometer (SP-CIGMAT) and adopted to be used for measuring the strength and modulus of compacted soils. Tests were performed on compacted soils varying from soft to very stiff clay, silty soils and sandy soils.

1 Introduction

Compacted soils are the soils in which the in-situ structure of the soil is modified by compaction. The compacted soils can be used at construction of a new embankment, road, earth dam, building foundation or retaining wall back fills soils. Compaction is one of the most common method of soil stabilization and it is a process of mechanical soil improvement. Compaction is used to alter the engineering properties of a soil for a specific application, such as supporting a pavement section, building foundation, or bridge abutment.

In order to monitor how the field compactions are done in the field, it is necessary to do compaction control study for the quality assurance of the work. Currently there is not only one standard field test to determine the strength and modulus of compacted subbase soils, this quality control studies are performed in many ways. The Falling Weight Deflectometer (FWD), Geogauge, Dirt Seismic Pavement Analyzer (DSPA), and laboratory repetitive triaxial tests have been used to determine the pavement layer modulus (Nazarian et al. 2002; Rahim and George 2002; Sawangsuriya et al. 2002). However, there are limitations for each method. As many different sets of layer moduli would satisfy the same FWD deflection bowl, practicing pavement engineers struggle to identify the correct set. Also, the FWD often is unable to determine the extent of a weak base/subgrade layer due to a thick concrete layer that carries most of the load away. Seismic tests are quick and easy, but the seismically determined modulus is very high due to the high frequencies and miniscule loads used. The Geogauge shows some promise, but is highly sensitive to the surface preparation, and it only gives a composite stiffness that includes all layers to some uncertain depth. SP-CIGMAT was developed to remove some of these demands for pavement analysis.

2 Objective

The objective of the study was to modify the DHP-CIGMAT to SP-CIGMAT and use it to find modulus and the strength of compacted subbase material.

3 Testing Procedure and Results

DHP-CIGMAT was modified for compacted soil tests by increasing the piston length and modifying the head coupling unit. SP-CIGMAT field tests were performed to investigate the relationship between penetrometer and undrained shear strength of compacted soil layers which have 8 and 12 inches depths. In the field tests CH, CL and SC were the major soil types.

SP-CIGMAT was mounted to the sampling rig, which was used to obtain samples with Shelby tubes (Fig. 1). After getting samples tests were performed near to that hole as shown in Fig. 2. The location of tests were selected close enough to have similar properties with samples, but also far enough not to effected by opened hole.

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Figure 1. SP-CIGMAT mounted on a sampling rig

Figure 2. SP-CIGMAT performing a field test

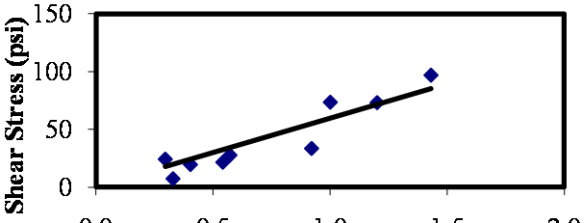

Figure 3. Undrained Shear Strength versus Deflection Relationship for SP-CIGMAT

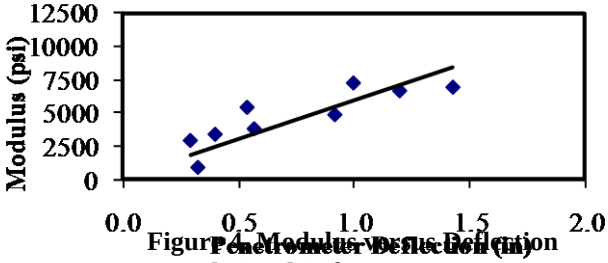

Figure 4. Modulus versus Deflection Relationship for SP-CIGMAT

4 Analysis

The main focus of this study was to investigate the relationship between the undrained shear strength and modulus of soil and the deflection of SP-CIGMAT. Triaxial tests were performed to obtain the undrained shear strength of samples collected from the field (Fig. 2).

After the tests, SP-CIGMAT deflections were recorded immediately by measuring the deflection of penetrometer using a digital caliper with 0.001 in resolution. Based on field test data, the relationship between undrained shear strength (s_u psi) and modulus (E psi) of soil and penetrometer deflection (δ in inch) readings showed good agreement. Based on the analysis of the data, the following correlation was obtained for SP-CIGMAT deflection and undrained shear strength (Fig.3) and modulus of soil (Fig.4), relatively:

$S_u = 59.5\ \delta$ with a R^2 of 0.85 (9 data) (1)

$E = 5909\ \delta$ with a R^2 of 0.63 (9 data) (2)

5 Conclusion

The to evaluate compacted soils and measure the undrained shear strength of soils during or before construction has been developed. This device can be easily adopted with any sampling vehicle during the construction to perform tests in compacted soils. Based on the limited field data, linear correlations between the undrained shear strength and modulus of the compacted soils and deflection of SP-CIGMAT have been developed.

6 Acknowledgements

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7. References

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