Florida Department of Transportation Research

Comparison of Standard Penetration Test (SPT) N-value with Alternative Field Test Methods in Determining Moduli for Settlement Predictions

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Project Managers
Larry Jones
FDOT Geotech Office

Principal Investigators
Manoj Chopra
Luis Arboleda-Monsalve
University of Central Florida

Current Situation

Settlement is a major issue for any structure, including transportation structures, which are often massive and cover a significant area. To predict settlement, the soil stiffness is measured, characterized by a parameter called the modulus of elasticity, symbolized as E. A variety of methods can be used to determine E, including standard or cone penetration tests, dilatometers, pressuremeters, and geophysical seismic tests. Published values of E from these tests can be used in structural designs, matching the most appropriate values to the construction site. Because there is some uncertainty in this match, engineers often design for less stiff soil than the best literature matches. This leads to overdesigning to assure structural integrity, with significant additional cost.

The gradual building up of a large cone of soil provides valuable data for determining soil settlement at a construction site.

Research Objectives

University of Central Florida (UCF) researchers conducted a comprehensive evaluation of methods used to determine E and calculate short-term settlement for soil conditions of central Florida.

Project Activities

To measure short-term settlement in a typical Central Florida soil profile, full-scale conical load tests were conducted at a UCF site extensively studied in past projects concerned with deep foundations. Comprehensive laboratory testing was also conducted for two soil types commonly found in Central Florida: the Cypresshead Formation and the Hawthorn Group.

The conical load test consisted of gradually constructing a conical mound of soil on the test site while monitoring short- and long-term soil stresses and ground movements. This test represents a reliable field procedure that, at relatively low cost, provides accurate insight into the compressibility of soils. This direct method of testing applies large enough pressures to cause revealing shear strains, and it is preferable to the indirect methods listed above.

Laboratory testing assessed properties and mechanical behavior of soil samples retrieved from the project site, including gradation, water content, specific gravity, consolidation tests using incremental loading and constant rate of strain, triaxial tests, X-ray diffraction, and scanning electron microscopy. Other soil laboratory characterization included ASTM tests such as natural water content, soil gradation and hydrometer tests, and Atterberg limits tests.

The testing program resulted in the determination of the most appropriate published correlations between E and immediate settlement. The researchers advised that long-term settlement should be considered separately and added to short-term settlement. A series of detailed recommendations for the determination of short-term settlement were given.

Project Benefits

Improved guidance about which correlations to use for E versus short-term settlement can lead to significant savings in time and money for new transportation structures in Florida while assuring structural integrity.

For more information, please see www.fdot.gov/research/.