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STANDARDIZING THE PRESSUREMETER TEST FOR DETERMINING P–Y CURVES FOR LATERALLY LOADED PILES

BACKGROUND

The Florida Department of Transportation (FDOT) recommends using standard cone penetrometer equipment to push the PENCEL Pressuremeter (PPMT), manufactured by ROCTEST, Inc., to the desired test depth to determine *in situ* soil properties for analysis and design of laterally loaded piles. Reduced PPMT data is used to estimate the *p-y* curves for these computations. This field-testing device, originally developed in the 1950's by Ménard and modified by Briaud in the 1970's, needed to be upgraded with current computer and instrumentation capabilities, and the field testing procedure needed to be standardized to enable uniform data collection.

The PENCEL has several advantages over other PMT's, the most important of which is it can be pushed to the desired depth using the equipment on Cone-Penetrometer rigs. Automating the process would produce additional benefits. Field-testing with the PPMT in the extreme heat associated with Florida summers can be especially difficult on the operators. Conventional testing requires approximately 30 minutes: automation would significantly reduce this time. During a test, operators are required to determine the extent of the linear stress-strain response range in order to unload and reload the soil, in addition to recording pressures and injected volumes. Effectively automating and simplifying the entire testing protocol would yield more precise data and ease operator requirements.

The PPMT test is conducted by placing the 1.35-inch diameter probe into a properly sized test hole. Once at the required depth, the probe is injected with water in 5 cm^3 increments. The resulting pressures are recorded after waiting 30 seconds for the system to stabilize. A typical test requires about 30 minutes. The PPMT consists of a probe, a control unit with pressure and volume counters, thick-walled nylon tubing, and a calibration tube. The entire unit is approximately $8,000. Corrections are applied to the pressures and volumes, and the reduced data can be displayed on a stress-strain plot. The resulting in *situ* stress-strain curves can be used to determine data needed to analyze settlement, bearing capacity, and vertically and laterally loaded piles.

OBJECTIVES

The objective of this study is to develop a standard cone-pushed PPMT test method that automates the PPMT and enables the field operators to more rapidly and accurately conduct the standardized tests for the analysis and design of laterally loaded piles.

FINDINGS AND CONCLUSIONS

The PPMT control unit has been economically instrumented to enable digital pressures and volumes to be recorded. This digital information is now acquired through a stand-alone data acquisition

software package that incorporates the required calibrations to provide engineers with instantaneously reduced data along with pertinent engineering strength and stiffness parameters.

Pushed-in PPMT tests were performed in Florida sands and clays to standardize the FDOT testing procedure. The tests were conducted in soundings advanced using the FDOT Cone Penetrometer (CPT) testing rig. Pushing the PPMT in an automated process allows engineers to efficiently use reduced stress-strain data to determine elastic moduli, limit pressures, and lift-off pressures. These parameters were evaluated and proven to be realistic when compared to conventional PMT and dilatometer (DMT) data.

PPMT and DMT data from the Florida soils were used to determine p-y curves based on Robertson's methods (1986, 1989). These curves were compared and found to produce similar results.

The PMT and DMT tests from seven historical field sites with instrumented and tested laterally loaded piles were evaluated. P-y curves, again based on Robertson's methods from PMT (six of seven from PPMT testing) and DMT were developed and used with the FBMultiPier software to yield ground-line load-deflection data. The PMT and DMT predicted data were compared to measured load-deflection data from the instrumented piles. The PMT testing from these historical sites was performed without following a standard procedure; the comparisons showed that the inconsistent testing produced highly variable predictions, highlighting the need for a standard PPMT test procedure. The PMT testing that was conducted according to the standard procedures recommended by this study produced predictions that were comparable to both DMT and measured data..

BENEFITS

The Department will benefit from this research in several ways. First, the developed standard procedure will enable more consistent designs to be developed for review by the Department. Second, better designs will result in cost savings, because engineers will have more confidence in their solutions, thus allowing lower safety margins to be used. The software packages combined with the instrumentation will improve the accuracy of all Pushed Pressuremeter data. Numerous geotechnical consultants have already expressed sincere interest in this improved system.

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