RESEARCH
PROJECT CAPSULE [11-2GT]
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TECHNOLOGY TRANSFER PROGRAM

Field Instrumentation and Testing to Study Set-up Phenomenon of Piles Driven into Louisiana Clayey Soils

JUST THE FACTS:

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SPR

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POINTS OF INTEREST:

Problem Addressed / Objective of Research / Mehodology Used Implementation Potential

PROBLEM

Piles driven into saturated cohesive soils (clays and silts) usually experience a time-dependent increase in pile resistance (mainly frictional) capacity, known as pile setup, which contributes to the long-term capacity of the piles. Field observations showed that pile setup is significant and continues to develop for a long time after installation, especially for fine-grained soils. An increase in pile capacity of up to 12 times, due to setup, has been reported (McManis et al., 1989). Therefore, the assessment of pile setup with time is very important in the design and construction of pile foundations. The construction of the pile foundation is usually expensive. The Louisiana Department of Transportation and Development (LADOTD) spent about $20 million on the construction of driven piles during 1995 (DOTD Weighted Averages, 1996). The cost is expected to be much higher now than in 1995. Therefore, the incorporation of even a small percentage of pile setup into pile design can result in a significant cost savings. The current engineering practice in the design of piles in Louisiana is based on conducting test piles 14 days after driving and ignoring any pile setup after that, leading to a conservative pile design. Therefore, a more reliable load and resistance factor design (LRFD) methodology that accounts for the effect of time-dependant gain on pile capacity is needed. The accurate prediction/estimation of the increase in pile capacity with time can be incorporated into a rational design through reducing the number of piles, shortening pile lengths, reducing pile cross-sectional area (using smaller-diameter piles), and/or reducing the size of driving equipment (using smaller hammers and/or cranes). Incorporating any or a combination of these benefits will result in a cost reduction and savings to LADOTD.

OBJECTIVE

The main objective of this research study is to evaluate the time-dependant increase in pile capacity (or pile setup phenomenon) for piles driven into Louisiana soils through conducting repeated static and dynamic field testing with time on full-scale instrumented piles

for the purpose of incorporating the pile setup into LADOTD design practices. This will include investigating the mechanism of pile setup; studying the effect of soil type/properties, pile size, and their interaction on pile setup phenomenon; and developing a model and its reliability to estimate the increase in pile capacity with time.

METHODOLOGY

The following tasks are identified to accomplish the designated research objectives:

- ***Task 1***: Conduct a literature review on available methods for characterizing pile setup in cohesive soils.
- ***Task 2***: Identify new sites/bridges that have pile load tests; and if possible conduct dynamic load tests and piezocone penetration tests (PCPTs) at different times after pile driving.
- ***Task 3***: Design, construct, install, and test full-scale instrumented test piles on DOTD projects.
- ***Task 4***: Evaluate the vane shear test field measurements.
- ***Task 5***: Analyze the tested pile conducted in 1996 at the Bayou Boeuf Bridge Extension, US 90.
- ***Task 6***: Conduct comprehensive analyses on the field measurements to investigate the mechanism of pile setup.
- ***Task 7***: Conduct comprehensive analyses on pile capacity measurements and develop a model for estimation pile setup with time. Perform reliability analysis to incorporate the model into LRFD design methodology.
- ***Task 8***: Develop a finite element model for pile setup in clay.
- ***Task 9***: Prepare and submit a final report.

IMPLEMENTATION POTENTIAL

It is anticipated that the findings of this research will provide a better understanding of pile setup phenomenon in cohesive soils, hence better estimation of the increase in pile capacity with time. The results of this research are expected to be implemented in the LRFD design of pile foundations through incorporating the estimation setup pile capacity at a specified time after driving (i.e., at time of service) based on exploration-phase field testing. Based on correlations between field test results and measured setup, design guidelines will be developed and provided to DOTD engineers for implementation in the design of pile foundation sections. The implementation of pile setup capacity in the design can result in significant cost savings through reducing the number of piles, shortening pile lengths, reducing pile cross-sectional area (using smaller-diameter piles), or improving project scheduling.