TECHSUMMARY February 2016

State Project No. 30001425 / LTRC Project No. 14-2GT

Testing Protocol for Predicting Driven Pile Behavior within Pre-bored Soil

INTRODUCTION

The Louisiana Department of Transportation and Development (DOTD) uses deep foundations, consisting of precast concrete piles, open- or closed-end steel pipe piles, steel H-piles, or auger-cast piles to support buildings, highway bridges, and other infrastructure systems. The piles at a project site derive their load carrying capacity from "side bearing" along their embedded lengths as well as from "end resistance." Pre-boring is a method used to facilitate driving of large displacement piles in hard/dense soils. A pilot hole, generally smaller in size than the pile to be installed, is first bored to a specified depth. By pre-boring a pilot hole, the "end bearing" and "side friction" within the pre-bore zone are reduced, thus aiding the driving of the pile. However, pre-boring complicates the prediction of long-term pile capacity (specifically side friction) within the pre-bored zone and the Wave Equation Analysis of Pile (WEAP) analysis, which aims to predict pile drivability. It is assumed that long-term end bearing within the pre-bored zone will not be an issue, as current DOTD specifications prohibit predrilling to the pile tip elevation. However, there are three major unknowns that accompany the pre-bored zone: (1) reduction of end bearing as it pertains to pile driving within the zone, (2) reduction of side friction as it pertains to pile driving within the zone, and (3) reduction of side friction as it pertains to long-term pile capacity within the zone.

It is expected that the relative strength of the soil as well as the diameter of the pilot hole relative to the pile will have an impact on pile drivability and its long-term load carrying capacity. Quantifying such an impact will greatly help geotechnical design engineers to understand the interactions among the factors of pre-boring, pile size, soil conditions, pile driving, etc. and improve the design and construction qualities of pile foundations in hard/dense soils.

OBJECTIVE

The objective of this research was to compile the state-of-the-art and best practice results available on the subject of pre-bored piles and develop a testing and instrumentation plan for field data collection and select multiple pile driving sites representing different soil strengths for the state of Louisiana.

SCOPE

A review of standard specifications for construction of bridges and highways of all state highway agencies was performed to investigate current practices related to pre-bored pile installation. Geologic characteristics of Louisiana were reviewed to select multiple pile driving sites representing different soil strengths and subsurface stratigraphy. A plan was developed to test instrumented piles and evaluate the effects of pre-bored hole diameter and length on long term pile capacity and ease of drivability.

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METHODOLOGY

To achieve the objectives of this research study, the following major tasks were performed:

- Conduct a comprehensive literature survey of published material and ongoing research projects related to the effects of pre-bored hole on pile capacity and pile drivability.
- Conduct a comprehensive review of the standard specifications for construction of bridges and highways of all state highway agencies to investigate current practices related to pre-bored pile installation.
- Conduct a review of geologic characteristics of Louisiana to recommend multiple pile driving sites for future testing to represent different soil strengths and subsurface stratigraphy.
- Develop a plan for driving multiple test piles at each site using differently sized predrill holes with no predrilling as control for comparison.
- Develop an instrumentation plan during pile driving and restrikes using pile dynamic analyzer (PDA), and static load tests as well as vibrating wire strain gauges.
- Prepare final report that documents and summarizes the study results.

CONCLUSIONS

Based on the results of this study, the following conclusions can be drawn:

- Different state highway agencies follow different guidelines related to the use of pre-bored hole during installation of pile foundations.
- Based on Louisiana's geologic characteristics, a plan was developed for driving multiple test piles at different locations within the state using differently sized pre-bored holes with no predrilling as control for comparison.
- An instrumentation plan was recommended during test pile driving and restrikes using pile dynamic analyzer and static load tests as well as vibrating wire strain gauges.
- The data obtained from the field testing and instrumentation plan will benefit DOTD and consulting engineers in reducing uncertainty in long-term pile capacity prediction and constructability issues when using a pre-bored hole for pile installation.

RECOMMENDATIONS

The following initiatives are recommended in order to facilitate the implementation of this study:

- The field testing and instrumentation data collection should be performed by experienced geotechnical engineers or their representatives with adequate knowledge of the procedures.
- The data obtained from the field should be analyzed immediately to determine the effectiveness of the testing protocol and adjust the scope of future testing.
- The implementation of the results obtained from the recommended field testing and instrumentation study should be added into the design manual for use by DOTD engineers.