INVESTIGATION OF THE EFFICACY OF HELICAL PILE FOUNDATION IMPLEMENTATION IN ACCELERATED BRIDGE CONSTRUCTION PROJECTS – PHASE II

Quarterly Progress Report
For the period ending June 1, 2022

Submitted by:
PI- Justin Dahlberg, PE

Affiliation: Department of Civil, Construction, and Environmental Engineering
Iowa State University
Ames, IA

ACCELERATED BRIDGE CONSTRUCTION
UNIVERSITY TRANSPORTATION CENTER

Submitted to:
ABC-UTC
Florida International University
Miami, FL

1. Background and Introduction

Bridge construction methodologies have been greatly benefited through the continued pursuit and advancement of accelerated bridge construction technologies. Many of these technologies such as prefabricated elements have been implemented in common bridge projects simply because they have a proven benefit beyond the acceleration of onsite construction.

Despite the overall reduction in onsite construction time, it is clear most of the acceleration can be accredited to changes in superstructure and deck construction methods. The number of current standard foundation options for bridge substructures is limited, thus reducing the potential time savings afforded through newer, less-common technologies. The possibility for additional time savings still exists through the use of other foundation technologies such as helical piles.

Helical pile foundations have become conventional in new commercial building construction and foundation repair applications with numerous foundation contractors now offering helical pile installation as one of their services. To date, this gained popularity has not translated to bridge projects. Few bridge projects have been completed using helical piles even though they have high capacities and are quickly installed using small maneuverable equipment. The required equipment for installation (skid steer, back hoe, or excavator) lends itself to quick deployment and being an economical solution (i.e., excavator vs. crane), an advantage for any bridge project, but particularly for low-volume roads where budgetary considerations tend to be a specific priority.

2. Problem Statement

Many advances have been made in the construction methodology with respect to bridge decks and superstructures, especially with the advent of accelerated bridge construction (ABC) technologies. However, the construction of substructures has largely been left unchanged. There are still opportunities to decrease project duration and reduce disruption to the road users with the adoption of newer foundation technologies. One such technology is helical piles. Helical pile installers tout the simplicity and speed of installation along with the ability to work within areas of limited size with smaller equipment. Research is needed to identify how to best implement helical pile foundations for bridge projects.

3. Objectives and Research Approach

The objectives of this project will be built on the most recent efforts of the researchers who investigated the efficacy of helical pile foundations on bridge projects. It was determined that helical pile technology is fairly well-established by its historical use in non-bridge projects. A concerted effort to introduce the technology to bridge projects has not been made to this point.

4. Description of Research Project Tasks

The following is a description of tasks carried out to date.

Task 1 – Literature Review

<u>Proposed task description</u>

The completion of Phase I of this project has produced a comprehensive literature review. Additional information uncovered through continued searches during Phase II will be incorporated into the overall review. As before, the main objective of this task is to obtain an exhaustive understanding of helical pile use and its potential application to bridge projects.

<u>Description of work performed to this period</u>

Documents and technical guidance regarding helical pile foundation history, use, and application have been gathered. This includes the history of use in industries other than transportation; advantages of helical pile foundations (speed of installation, ability to work within areas of limited space, installation with smaller equipment, and installation in many soil strata types); disadvantages of helical pile foundations (bidding difficulties, unfavorable in rocky sites, and undeveloped installation standards); and an overview of the principals on which the helical piles function (helical bearing and perimeter shear).

Task 2 – Develop a Design Guide for Helical Pile Use on Bridge Projects

<u>Proposed task description</u>

To establish the steps that one would be required to complete the design process for helical pile foundations, a design guide will be developed. Although the research team reserves the right to make changes to the specific guide format, it is envisioned the guide will include the following sections:

1. Overview
2. Preliminary Design
3. Loads
4. Load Application
5. Analysis and Design
6. Detailing
7. Contracting

At this time it is anticipated the preliminary design section will include the decision making framework developed during Phase I for using helical piles in lieu of another foundation system. Among other things, this framework addresses the lateral and vertical demands associated with conventional highway bridges and draws attention to the limitations of helical piles when used in high seismic regions or in areas susceptible to scour. With respect to loads, contact will be made will several key industry stakeholders and practitioners to explore the maximum capacity of helical piles, and the potential increase thereof, as it is anticipated the foundation loads of larger bridge structures will exceed the load capacity of the most typically used piles. The goal will be to increase capacity without unnecessarily increasing the size of equipment so as to maintain quick mobilization in limited space. In total, this format will present the engineer with all of the information needed to transform ideas into design and contract documents. The manual will be prepared in language familiar to engineers with technical information provided in a form similar to commonly referenced AASHTO documents.

<u>Description of work performed to this period</u>

The writing of the design guide is nearing completion. The technical oversight committee will begin their review of the draft this coming reporting period.

Task 3- Identify Bridge Project for Demonstration

Proposed task description

In collaboration with the TAC members from the state and county levels of Iowa, the research team will identify a bridge construction project where helical piles may be used in lieu of traditional foundation types. Since the identified project is likely to have progressed through the preliminary design phase prior to this activity, the decision to use helical piles will be a decision to replace what has already been decided. Despite this fact, the decision matrix developed in Phase I of this study will be used as if the project was first identified as a potential candidate for helical pile use during the early planning stages. This will be done to record how the decision to use helical piles might have been the same or different if the decision matrix was first employed.

Description of work performed to this period

Preliminary discussions have been completed with county engineers from Buchanan County, IA to identify a bridge project that will be constructed in 2023.

Task 4- Collaborate with Design Engineers to Establish Plans and Specifications

Proposed task description

The plans and specifications required to construct the bridge foundations will be developed in collaboration with the design engineers. The task will ensure constructability and will aim to include any necessary requirements to emulate a true accelerated bridge construction project. A focus will be on the small size and quick mobilization of equipment, thus the specifications will include size restrictions for equipment, site restrictions where equipment can be located, and time allowances for installation.

Description of work performed to this period

A draft specification has been prepared and will be modified according to the final selection of the bridge project.

Task 5- Final Report

Proposed task description

The project findings from the previously described tasks will be prepared by means of a final report. This document will include the identified current state-of-the-practice of helical piles, the adoption to an upcoming bridge project, and the recommendations for documentation of construction activities and lessons learned.

Phase I of this study regarding the use of helical piles in bridge foundations of ABC projects provided preliminary guidance. The guidance was based on information collected to assess the expediency, adequacy, and use of helical piles.

Phase II of this project aims to implement helical piles as a deep foundation alternative for a bridge project. Phase II will involve the development of a guide, plans, and specifications necessary for the adoption of helical piles for an upcoming bridge project. This implementation will result in a more comprehensive understanding of the benefits and limitations of helical pile use for bridge foundations.

Description of work performed to this period

No work has been performed on this task to this period.

5. Expected Results and Specific Deliverables

A study regarding the use of helical piles in bridge foundations of ABC projects will be completed and a design guide will be prepared. Plans and specifications for helical pile use on a bridge project will be completed in collaboration with state and county engineers of Iowa.

6. Schedule

Progress of this project is shown in the table below.

Item	**% Completed**
Percentage of Completion of this project to Date	45%