Construction of New Substructures Beneath Existing Bridges

tech transfer summary

This study explored the approaches used to either construct new or rehabilitate existing bridges with new foundations for accelerated bridge construction.

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RESEARCH PROJECT TITLE
Construction of New Substructures Beneath Existing Bridges

SPONSORS
Iowa Highway Research Board (IHRB Project TR-716)
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Background

To minimize traffic impact during accelerated bridge construction (ABC) projects, it is sometimes desirable to construct the new substructure underneath an existing bridge prior to its demolition and road closure. Installing a new substructure under an existing bridge creates challenges during construction, primarily due to the low overhead space and stability concerns for the existing foundation.

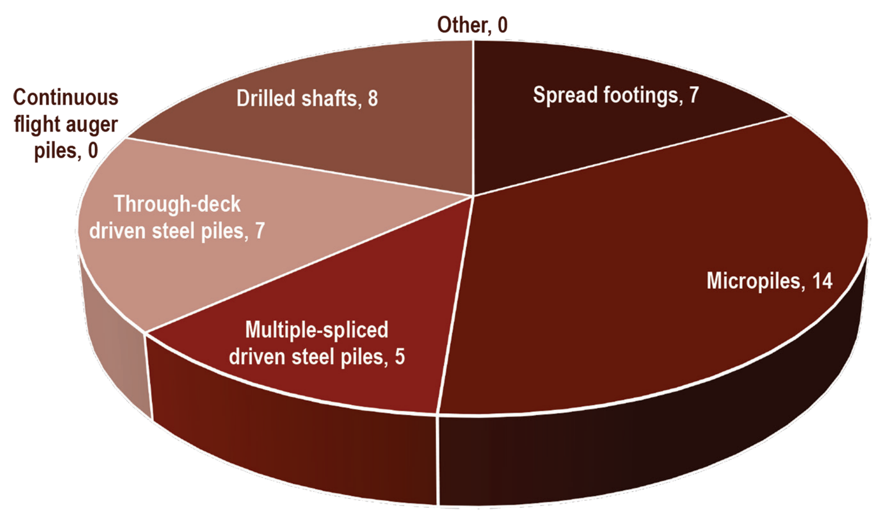
Problem Statement

A preliminary literature search revealed that documentation of the technical details for methods that can be used during the construction of new substructures underneath existing bridges are not readily available. This limited availability of documentation indicates the methods are not likely to be used by state departments of transportation (DOTs), local agencies, consultants, or contractors.

Objectives

The objectives of this project included three main focus areas:

- Document through a literature search and survey, methods (including but not limited to multi-splicing and micropiles) for constructing new substructures beneath existing bridges
- Evaluate proven methods in terms of design considerations, constructability, and cost
- Document the project findings and develop method selection recommendations/guidelines



Survey results for types of solutions agencies use when constructing a new foundation beneath an existing bridge

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The Bridge Engineering Center (BEC) is part of the Institute for Transportation (InTrans) at Iowa State University. The mission of the BEC is to conduct research on bridge technologies to help bridge designers/owners design, build, and maintain long-lasting bridges.

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Research Description

A literature review was first completed to obtain knowledge about different foundation methods and their application in ABC projects. The findings are presented as brief case studies in the final report.

In the next step of this study, a survey was developed and distributed via email to investigate methods utilized by other DOTs in the construction of new foundations on ABC projects. The survey included questions about the common methods for bridge foundation construction.

Key Findings

Foundations for bridges are divided into two main categories: shallow foundations and deep foundations. Shallow foundations include spread footings and mats. Driven piles, drilled shafts, continuous flight auger piles, and micropiles are categorized as deep foundations. Each method has its own advantages and limitations.

Spread footings can be an economical and practical approach for bridge foundations, but this method is not applicable for high structural loads or weak soil conditions. Although ground conditions can be improved by different methods to accommodate spread footing foundations, that may not have economic justification.

Driven piles with various types of material, cross sections, and driving methods are one of the approaches in bridge foundation construction. Through-deck pile driving is a method that can be used on ABC projects when there is restricted space under the existing bridge.

Drilled shafts can provide proper axial and lateral resistance to loads induced from the superstructure. However, they can only be installed outside of the existing bridge footing, while there is also some newer equipment for spaces with low headroom.

Continuous flight augur piles are another approach to install piles for bridge foundations that can be utilized under existing bridges.

The last method from the deep foundation family is micropiles. Micropiles have a small diameter but can resist significant axial loads and moderate lateral loads. The installation equipment for micropiles is relatively small and can be mobilized easily. However, the cost of micropiles usually exceeds other piling systems.

Conclusions

According to the recorded information from the email survey, 47 DOT respondents opened the survey link and 19 states answered at least one of the questions.

- According to the survey results, state DOTs use common methods for bridge foundation construction on ABC projects, and there is no new method in use
- Using a soil strengthening method is not used in most states
- The continuous flight auger method does not appear to be a common method among state DOTS
- The average height for minimum headroom for micropiles is nearly 13 ft
- The average height for minimum headroom for a drilled shaft is nearly 27 ft
- The average height for minimum headroom for steel pile driving is nearly 35 ft
- The disruption of through-deck piling on traffic flow is evaluated as high

Implementation Readiness and Benefits

Documenting proven techniques for constructing new substructures beneath existing bridges and comparing their design considerations, constructability, and costs will help engineers determine the most appropriate application of these techniques. This could help engineers make more consistent, efficient, and cost-effective decisions and reduce the risk in using the techniques on ABC projects.