Evaluation of Alternative Abutment Piling for Low-Volume Road Bridges

tech transfer summary

This project evaluated alternative abutment piling for low-volume road bridges through a state-of-the-practice review and a survey of Iowa county engineers and industry engineers in many other states.

September 2019

RESEARCH PROJECT TITLE
Evaluation of Alternative Abutment Piling for Low-Volume Road Bridges

SPONSORS
Iowa Highway Research Board
(IHRB Project TR-718)
Iowa Department of Transportation
(InTrans Project 17-600)

PRINCIPAL INVESTIGATOR
Behrouz Shafei, Structural Engineer
Bridge Engineering Center
Iowa State University
shafei@iastate.edu / 515-294-4058
(orcid.org/0000-0001-5677-6324)

MORE INFORMATION
intrans.iastate.edu

Bridge Engineering Center
Iowa State University
2711 S. Loop Drive, Suite 4700
Ames, IA 50010-8664
515-294-8103
www.bec.iastate.edu

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.

IOWA STATE UNIVERSITY
Institute for Transportation

Objectives

- Study the application and cost-effectiveness of alternative abutment pilings for low-volume road bridges
- Study the strength and bearing resistance of alternative piles as well as pilings driven with vibratory equipment

Background and Problem Statements

Alternatives to driving H-piles are being utilized by a number of states and private industry. Helical/screw pilings are used, and the load bearings are listed as 5 to 50 tons per piling. Micropiles are also used with 90-ton bearing resistance typical per piling. Either of these two options can offer cost-effective and/or quick construction alternatives to driving H-piles

However, there is limited data available for tests on the strength of alternative piles or vibratory-driven piles. There is also a need to utilize safe, cost-effective pile driving systems to reconstruct or repair bridges, especially those for low-volume roads. Vibratory pile driving is a method to accomplish this goal.

Research Description

Currently used alternative abutment piling systems were identified and investigated in this project through a literature review. These systems included micropiles, helical screw piles, grouted helical piles, ductile iron piles, drilled displacement piles, and geopier foundations. The investigations of these systems covered their descriptions, typical bearing resistances, advantages, limitations, and a local road bridge construction project in which each has been used.

Design guidance, construction methods, and acceptance criteria for helical piles and vibratory-driven piles were included in this study. These involve using several methods to predict the drivability and bearing resistance of a pile to be installed, and, then, using other methods to confirm the bearing resistance of the pile after installation.

The popularity of the alternative systems and vibratory-driven piles was investigated through a survey that was sent to two groups of respondents. The first group consisted of all county engineers in Iowa. The second group consisted of industry engineers from the companies that are active in the design and construction of piling systems in many other states. Follow-up phone calls were made and email messages were sent to some of the companies.

Key Findings

- From the 99 counties in Iowa, 73 responded to the survey.
- Among the 40 selected companies contacted, 24 responded to the survey.
- The survey results showed that most of the counties in Iowa have not endeavored to use alternative abutment piling systems, even though staff might be aware of the systems.
- The survey results confirmed that all the abutment piling systems studied, as well as vibratory-driven piles, have been successfully used for many projects in the US.

Cost Comparisons and Findings

- In terms of project costs, the advantages and limitations of the alternative abutment piling systems indicate that micropiles and drilled displacement piles can be the most expensive alternatives. This is usually true when any of the other alternative abutment piling systems are also feasible solutions for the project.
- The total cost of a 39 ft long bridge using helical piles as the foundation was $270,000. The total cost of a 32 ft long bridge using micropiles as the foundation was $1,065,282.
- The total project cost for grouted helical piles, ductile iron piles, drilled displacement piles, and geopier foundations were not successfully obtained. However, from the information given in the literature review and survey, it is interpreted that the project cost for grouted helical piles, ductile iron piles, drilled displacement piles, and geopier foundations falls within the same range as that for helical piles and micropiles ($270,000 to $1,065,282).

Implementation Readiness and Benefits

This project documented design guidance, construction methods, and acceptance criteria for using alternative abutment piling systems for local roads. The study showed these have the potential to be considered for low-volume roads in Iowa.

The results of the survey highlight the importance of further investigating alternative abutment piling systems to reduce the cost and improve the quality and ease of construction of low-volume road bridges in Iowa.