PROJECT TITLE: DEVELOPMENT OF GUIDELINES FOR SELECTION OF SUBSTRUCTURE FOR ABC PROJECTS

Quarterly Progress Report
For the period ending November 30, 2018

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ACCELERATED BRIDGE CONSTRUCTION
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Submitted to:
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1. Background and Introduction

The concept of Accelerated Bridge Construction (ABC) using precast and prefabricated bridge elements are gaining popularity among transportation agencies primarily to minimize traffic delays and costs. Some other benefits associated with the ABC techniques are reduced on-site construction time, reduced impact on mobility, better work zone safety and improved quality. Previously, the focus of the ABC techniques was limited to specific prefabricated bridge elements such as bridge decks and pier caps. However, with the recent advancement in construction methods, many projects are using precast and prefabricated elements for other bridge elements such as substructures and foundations. In case of a new bridge construction, substructure design by ABC technique will allow rapid construction to accommodate superstructure installation. For replacing an existing bridge, the substructure construction by ABC technique will cause minimum interference with existing bridge operation. Currently, a number of potential ABC technologies are available to design and construct bridge substructures and foundations. A guideline will help the transportation agencies to select the suitable techniques for their specific need.

2. Problem Statement

A number of previous studies are available focusing on the use of precast, prefabricated bridge superstructure elements. On contrary, only few studies can be found focusing on the design and construction of substructure and foundation by ABC method as most of the time it is assumed that the substructure already exists and ready to receive the load from superstructure. However, substructure construction can be the most time-consuming work for a bridge construction. There is a need to have specific guidelines for design and construction of substructures and foundations for new bridges to obtain full benefits of ABC method. Also, guidelines are needed for consideration of reusing, strengthening, and modification of substructure and foundations of an existing bridge. In addition, new, innovative and non-interruptive substructure and foundation design methods need to be explored and documented.

3. Research Approach and Methods

The overall approach of this project is to conduct an extensive literature search and document the ABC technologies available for design and construction of substructure and foundation. The current evaluation techniques of an existing substructure and foundation and problems associated with the evaluation techniques will also be investigated for replacing an existing bridge. Also, methods for strengthening or modifying an existing substructure will be discussed. The issues with the state-of-the art practices of ABC techniques for constructing a new bridge will be identified and potential solutions will be proposed based on the literature review. Attempts will be taken to present few examples of new and innovative techniques of substructure and foundation construction. A survey will be conducted to find out the challenges faced by stakeholders during construction of bridge. The acceptability of new practices such as installation of prefabricated foundation elements, retrofitting etc. will be investigated through this survey.

4. Description of Research Project Tasks

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

Task 1 – Develop Outline for the Guideline

Proposed task description:

An outline will be proposed as a first step of developing a guide for substructure and foundation by ABC method. The outline will broadly encompass the topics related to substructure and foundation by ABC method such as ABC definitions, design methodologies for new and existing bridges, materials for bridge construction by ABC method, evaluation techniques of existing bridge elements and new methods of substructure and foundation construction. The outline will be updated periodically to prepare a comprehensive guide.

Description of work performed up to this period:

An initial outline has been developed. The outline will be updated periodically, as needed.

Task 2 – Conduct Literature Search on Pertinent Topics.

Proposed task description:

A comprehensive literature review will be conducted focusing on the design and construction of substructure and foundation by ABC techniques. Sources of literature include, but not limited to TRB, FHWA, NCHRP, and DOTs. Other sources such as society journals will be consulted. Moreover, national and international conferences, symposia and workshops will be reviewed. The literature review will be continued throughout the duration of this project.

Description of work performed up to this period:

The following articles are examples of the reviewed papers during the reporting period.

i. The Federal Highway Administration (FHWA) and American Association of State Highway and Transportation Officials (AASHTO) organized a geotechnical engineering scan tour to Europe in June 2002. A report was prepared by Dumas et al. (2003) based on the findings of this scan tour. The purpose of this tour was to identify and evaluate innovative European technology for accelerated construction and rehabilitation of bridge and embankment foundations. The team met with leaders from different European countries to acquire detailed design and construction information for possible application in the United States. Approximately 30 technologies and 15 processes were identified which exhibited potential for accelerating construction and rehabilitation of bridge and embankment foundations. The relative ranking of all the technologies based on their anticipated improvements in construction time, cost, and quality was presented in tabular format. It was found that the continuous flight auger (CFA) piles with automated computer control for installation and quality control might offer an improved alternative to the current bridge foundation practices of United States. Also, bored cased secant pile (CSP) technique was found to be another alternative for accelerated construction and can be used

for both bridge support and excavation support in cut situations. The scan team suggested to use column-supported embankments to accelerate embankment foundation construction over soft, compressible soils.

ii. The objective of the study conducted in NCHRP Project 20-68A (Scan 11-02) was to identify the connection details for bridge elements that were used in the United States for accelerated bridge construction. A desk scan was conducted at the beginning of the project which included review of the relevant reports, papers, and web materials. Also, an extensive survey was conducted during the desk scan process. The scan team observed a number of ABC connection types that had been used by various states. The scan team identified three types of precast connections during the scan: column to pier cap, column to pile cap, and column to pile shaft. It was observed that, in one connection type, the column was embedded into the adjacent member (i.e., pile shaft, footing, or cap beam). Grouted couplers were used in another connection type. In the third connection type, extended longitudinal bars from precast column were inserted into corrugated metal ducts of the adjacent member and the duct was filled with grout. The scan team observed the need for more research and standardization of the connection details and process in the United States.

iii. The objective of the study conducted by Brown et al. (2007) was to develop a state-of-the-art practice manual for the design and construction of continuous flight auger (CFA) piles, augured cast-in-place (ACIP) piles, drilled displacement (DD) piles, and screw piles. The basic mechanisms involving CFA piles, pile types, applications for transportation projects, common materials, construction equipment, and procedures used in the construction of CFA piles were explained. Also, the benefits of using CFA piles were evaluated thorough a comparison with various existing methods used in the United States and Europe. Furthermore, a step-by-step procedure for the selection and design of CFA piles was presented in this manual. The quality control (QC)/quality assurance (QA) procedures and automated performance monitoring procedures for CFA piles were discussed in detail.

iv. Pei et al. (2017) conducted a study to investigate the implementation of accelerated bridge construction (ABC) technologies in South Dakota. The main objective of this study was to develop a systematic method for evaluating ABC techniques to determine their applicability to bridge construction and rehabilitation projects in South Dakota. A detailed catalog of ABC techniques for both substructure and superstructure was presented in this study. The catalog was prepared by conducting an in-depth literature review on current ABC techniques used across the United States. The costs and benefits associated with the use of ABC techniques were estimated using information from different sources. Also, a two-stage decision making process was developed for evaluating the applicability of ABC techniques for bridge construction projects in South Dakota.

Task 3- Identify Stakeholders and Conduct Survey.

Proposed task description:

A survey will be conducted to find out the state of the art practices of foundation design and construction methods by ABC method. Also, the challenges faced by engineers during construction of foundation will be investigated. The acceptability of new practices such as installation of prefabricated foundation elements, retrofitting etc. will be investigated through this survey. The questionnaire will be disseminated among DOTs and personals involve in research using ABC method.

Description of work performed up to this period:

A survey questionnaire form has been prepared with consultation with FIU team members. Currently, the stakeholders for this survey are being finalized. The questionnaire will be disseminated as soon as the stakeholders are identified.

Task 4- Analyze Literature Search and Survey Results

Proposed task description:

The literature reviewed for this project will be summarized and analyzed in order to prepare the guidelines for this project. A report will be prepared on the survey feedback and will be included in the final guideline.

Description of work performed up to this period:

Not pursued during this reporting period.

Task 5- Identify Issues and Potential Solutions

Proposed task description:

Based on the literature review and survey results, issues with the state-of-the art practices of ABC techniques for constructing bridge foundation and substructure will be identified and potential solutions will be proposed.

Description of work performed up to this period:

Not pursued during this reporting period.

Task 6- Develop Draft Guideline

Proposed task description:

One of the deliverables from this project will be a draft guideline on design and construction of bridge foundation and substructure by ABC techniques. The guidelines will be based on the literature search and survey results. The guidelines will cover the topics mentioned in the Task 1.

Description of work performed up to this period:

Not pursued during this reporting period.

Task 7- Prepare Final Report

Proposed task description:

A final report will be prepared based on the outcome of the project. the final report and the draft guideline will be submitted to the ABC-UTC and other professionals for further review.

Description of work performed up to this period:

Not pursued during this reporting period.

5. Expected Results and Specific Deliverables

At the end of the project a user-friendly guideline on design and construction of bridge foundation and substructure by ABC techniques will be available for transportation authorities, engineers and other stakeholders. The specific deliverables from this project will be:

i. Progress reports at the end of every quarter
ii. A draft guideline on design and construction of bridge foundation and substructure by ABC techniques
iii. A final report

6. Schedule

Progress of tasks in this project is shown in the table below.

Research Task	2018												2019					
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
Task 1 – Develop Outline for the Guideline																		
Task 2 – Conduct Literature Search on Pertinent Topics																		
Task 3- Identify Stakeholders and Conduct Survey																		
Task 4- Analyze Literature Search and Survey Results																		
Task 5- Identify Issues and Potential Solutions																		
Task 6- Develop Draft Guideline																		
Task 7- Prepare Final Report																		
	Work Performed								Work to be Performed									

7. References

i. Dumas, C., Mansukhani, S., Porbaha, A., Short, R. D., Cannon, R. R., McLain, K. W., ... & Brown, D. A. (2003). Innovative Technology for Accelerated Construction of Bridge and Embankment Foundations in Europe (No. FHWA-PL-03-014).
ii. Kapur, Jugesh, W. Phillip Yen, Waseem Dekelbab, Alexander Bardow, Michael Keever, Joshua Sletten, Daniel Tobias, and M. Saiid Saiidi. Best practices regarding performance of ABC connections in bridges subjected to multihazard and extreme events. No. NCHRP Project 20-68A. 2012.Hällmark, R., White, H., & Collin, P. (2012). Prefabricated bridge construction across Europe and America. Practice Periodical on Structural Design and Construction, 17(3), 82-92.

iii. Brown, D. A., Dapp, S. D., Thompson, W. R., & Lazarte, C. A. (2007). Design and construction of continuous flight auger piles. Geotechnical engineering circular, 8.
iv. Pei, S., Wehbe, N. I., & McMullen, M. (2017). Implementation guidance for accelerated bridge construction in South Dakota (No. MPC 17-331). Mountain Plains Consortium.