AVAILABLE ABC BRIDGE SYSTEMS FOR SHORT SPAN BRIDGES – COURSE MODULE

Quarterly Progress Report
For the period ending May 31, 2019

Submitted by:
PI – Armin Mehrabi.
Graduate Student- Ana Torrealba.

Affiliation: Department of Civil and Environmental Engineering
Florida International University
Miami, FL

ACCELERATED BRIDGE CONSTRUCTION
UNIVERSITY TRANSPORTATION CENTER

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

1. Background and Introduction

With the use of prefabricated bridge elements and systems, Accelerated Bridge Construction (ABC) promises significant reduction in on-site construction time and traffic interruptions. It also improves the life cycle cost by better control over schedule, and normally by the higher quality of elements resulting in better life-cycle performance. ABC is especially beneficial for short-span bridges that are more receptive of standardized prefabricated elements. In most such cases, the entire span of the bridge can be covered using prefabricated deck elements, modular decks, or systems encompassing the entire bridge width. Furthermore, the substructures in these bridges could avoid special treatment and can be accommodated by prefabricated elements. For shorter spans, prefabrication of the entire bridge consisting of substructure and superstructure is also an option. Various construction methods ranging from installation using customary cranes to the use of Self-Propelled Modular Transport (SPMT) units for moving the entire superstructure, or the use of slide-in methods can be employed for construction of the short span ABC bridges. There are various definitions as what span length constitutes short span. Some define bridges with a span of 20-45 ft. as short-span (FDOT), others span of up to 70 ft., and some attribute spans as long as 100 ft. The proposed course module will introduce the ABC concept and review its applications to short-span bridge construction. It will categorize and describe short-span bridges based on various factors such as access, topographic and geographic conditions, roadway functional category, span length, elements and systems, time constraints, and construction methods. Design and detailing of the bridge and joints will also be discussed in the course. Performance of these bridges will be reviewed based on the information available in the literature. Decision-making on the use of ABC in general and type of elements, systems, and construction method will be briefly discussed in this course. Further, the course will cover new and ongoing developments that can affect the future of ABC for short-span bridges. Inspection of short-span bridges will also be one of topics discussed in this course.

2. Problem Statement

The main goal of ABC is to use the advantages of prefabrication to the extent possible for reducing on-site construction activities and impact on mobility. In this, short-span bridges represent an ideal case basically allowing implementation of a wide variety of ABC solutions and methods. There are various definitions as what span length constitutes short span. Some define bridges with a span of 20-45 ft. as short-span (FDOT), others span of up to 70 ft., and some attribute spans as long as 100 ft. Solutions ranging from prefabrication at element and member level to pre-construction of the entire bridge can be employed for short-span bridges.

3. Research Approach and Methods

The primary objective of development of this course is to provide a general knowledge about the application of ABC for short-span bridges covering various aspects of decision-making, construction methods, available elements and systems, performance and inspection, design, detailing and connections. It is envisioned that the course will be developed in several modules of about 20 to 40 minutes progressing from introduction and outline to various modules on specific topics.

4. Description of Research Project Tasks

An overview of the study tasks is given below;

Task 1 – Literature review.

Literature on application of ABC to short-span bridges will be reviewed to gather information needed to construct the course.

For this task, an extensive literature review is being performed to cover any information about ABC technologies for short span bridges.

Task 2 – Develop the outline of the course.

Based on the results of the literature search, an outline for the modules will be prepared and shared with research advisory panel for their comments.

A tentative list of the topics/modules is as follows;

Module 1- Introduction to ABC for short-span bridges and Outline of the course.

The primary objective of development of this course is to provide a general knowledge about the application of ABC for short-span bridges covering various aspects of decision-making, construction methods, available elements and systems, performance and inspection, design, detailing and connections.

For the time being, this report subscribes to a definition for short span bridges delimited with span lengths up to 70 ft and maximum prefabricated bridge module weight equal to 90,000 lb. [1]. This definition helps to distinguish better the limitation in selection of ABC components as well as a better explanation for the scope of work by parties performing the project.

Module 2- Types of elements and subsystems.

A variety of element types and subsystems are available, each fitting certain purpose and objective mostly dependent upon the construction method to be used for bridge erection. In addition to parameters influencing selection of the construction methods, e.g.; availability of space, accessibility, roadway functional category, and condition under the bridge, factors such as time constraint, risk and cost, environmental considerations, design constraint and compatibility among superstructure, substructure and foundation as well as availability will determine the type of elements and subsystems to be used for construction of an ABC bridge. This module will introduce and discuss the available elements and subsystems for short-span ABC bridges.

Module 3- Joints and connections.

Regardless of the type of prefabricated elements to be used in construction of ABC bridges, the elements, systems and subsystems need to be made integral with the use of joints and connections established in situ. ABC connections and joints play an important role and their application and limitations need to be understood. This module will deal with identifying the type of joints and connections between the superstructure, substructure, and foundation, and between their prefabricated elements as it applies to short-span bridges.

Module 4- Construction methods.

An important feature of ABC is using innovative structural placement and construction methods to improve safety, quality, and reduce the construction time. In this module discussion of construction method applicable to short span bridges will be included.

Module 5- Inspection and performance

Prefabricated elements and systems are expected to have better quality and performance due to their construction in controlled environment and under stricter quality control than cast-in-place elements. Therefore, most performance issued in relation with ABC bridges will focus on the joints and connections that are established in situ. Cast-in-place closure joints may introduce a potential for weak link within Accelerated Bridge Construction (ABC) structures. The quality of the joints, expected to become serviceable quickly, depends on the concrete mix design, reinforcement and enclosure details, and is influenced by placement and curing procedure [2]. Despite the efforts to prevent weaknesses in these critical elements, potential exists that defects or anomalies are left in the joints during construction or develop later during the life of the structure [2]. In this module, a review of performance of ABC short-span bridges with an emphasis on joints will be carried out. Moreover, information on performance of general ABC construction and summary of deterioration patterns for bridges that have been in service for less than five years will be discussed. Additionally, inspection methods and means applicable to ABC short-span bridges will be explored. Based on the reported surveys, most of these problems have been observed in the connections between deck panels and between deck panels and piers or abutments. Therefore, inspection and performance evaluation of joints, particularly closure joints, should be emphasized for short-span bridges.

Module 6 - Decision making process

Decision-making on the use of ABC in general and the type of elements, systems and construction methods in specific is essential for an effective project initiation, management and contractual aspects. This module will introduce available decision-making methods applicable to ABC short-span bridges. This will include decisions on the use of ABC as an alternative to conventional method, selection of construction method most applicable, and determination of type of elements and subsystems, as well as selection of the type of inspection required.

Module 7 - New developments

For this module new and ongoing developments that can affect the future of Accelerated Bridge Construction will be discussed with a focus on short-span bridges.

Next step for this task will be to develop outline and content for each of the modules described above. To affirm the findings and direction of the project to date, an interview was conducted with Mr. Michael Culmo who graciously agreed to be part of our advisory panel.

Task 3- Develop course modules.

The course modules will be developed based on the outline in previous task and comments received. The format of the course material will be in PowerPoint presentation. Each module will be also video recorded from the PowerPoint presentations.

No progress made at this time.

Task 4- Conducting a trial course for FDOT

FDOT will be contacted to possibly arrange a trial course in their offices or online. Alternatively, the course can be presented in an ABC webinar format online.
No progress made at this time.

5. Expected Results and Specific Deliverables

The main deliverable for this project is course material covering application of ABC in short-span bridges.

6. Schedule

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

Research Task	2019										2020	
	M	A	M	J	J	A	S	O	N	D	J	F
Task 1 - Literature Review												
Task 2 - Develop the outline of the course												
Task 3 - Develop course modules												
Task 4 - Conducting a trial course for FDOT												

Work Performed
Work To be Performed

7. Advisory Panel Member

Michael P. Culmo, PE

8. References

1. Council, N.R., *Innovative Bridge Designs for Rapid Renewal: ABC Toolkit*. 2013: Transportation Research Board.
2. Farhangdoust, S., S.F.A. Mosawi, and A. Mehrabi, *NDT METHODS APPLICABLE TO HEALTH MONITORING OF ABC CLOSURE JOINTS*. 2019. https://abc-utc.fiu.edu/wp-content/uploads/sites/52/2019/04/2013-C3-FIU04-NDT-FinalReport.pdf