PERFORMANCE COMPARISON OF IN-SERVICE, FULL-DEPTH PRECAST CONCRETE DECK PANELS TO CAST-IN-PLACE DECKS

Quarterly Progress Report
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1. Background and Introduction

The use of full-depth deck panels allows for accelerated construction and repair of bridge superstructures, and in some cases decreased overall project costs. These panels have been used for new construction and rehabilitation since 1965[1]. There are a number of research projects that have been conducted looking into the behavior of different panel and joint details, but there is minimal published work on the performance of in-service full-depth, precast deck panels. The last study looking at the behavior of these panels was conducted in 1995 by Issa, et al. [2]. These researchers surveyed 51 DOTs and determined 13 of them were utilizing or had utilized some type of full-depth precast deck for rehabilitation or new construction. Those responding to the survey highlighted the time savings offered by precast decks. There were some responses that noted leaking, cracking, or deterioration of the joints mainly caused by material quality or the construction procedure. This study did not compare the performance of these full-depth, precast decks with similar CIP decks.

There is a major research effort currently being undertaken to investigate the performance of in-service bridges called the Long-Term Bridge Performance (LTBP) Program[3]. The LTBP Program is developing protocols for bridge inspection and evaluation to standardize the assessment of in-service bridges[4]. The LTBP Program has been looking at bridge decks[5], but their efforts have not included precast panels.

Although full-depth, precast decks have been used alongside conventional CIP decks in bridge construction since 1965, there has never been a formal study to determine if precast deck panels behave the same, better, or worse than CIP decks.

2. Problem Statement

The main objectives of this project are to determine (1) the actual in-service performance of full-depth, precast deck panels compared to conventional CIP decks and (2) successful and problematic details for these members. Additionally, an industry survey will be used to understand the perspective of owners and installers of the full-depth, precast deck panels.

3. Research Approach and Methods

The National Bridge Inventory (NBI)[1] currently contains detailed information on over 610,000 bridges; of these, over 60,000 bridges have concrete precast panels as their deck structure type. The NBI contains some information on the specific deck details and deck condition ratings and will be used to get a broad overview of deck performance. There are additional resources, such as the PCI State-of-the-Art-Report on Full-Depth Precast Concrete Bridge Deck Panels[2], that contain specific examples of in-service bridges utilizing full-depth precast panels. This PCI document contains around 40 examples of such bridges. These bridges will be used as a starting point for a more detailed inspection of the deck panel behavior. Available inspection reports will be used where available and supplemented with new inspections as needed and as project resources allow. Design and construction details will be gathered during this process to allow for a connection to be made between details and performance.

The performance of the bridge decks will be evaluated using similar criteria to those used by the LTBP Program[3]. These criteria may include the following:

1. Deck condition ratings (currently included in NBI)

2. Visual inspection (number, size, or severity of defects or percentage of bridge deck or joint effected)
3. Chain drag results
4. Non-destructive evaluation (NDE) results
5. Concrete density
6. Chloride content (at surface level and depth or reinforcement)

The actual criteria will be determined during Task 3 and Task 4 and will depend on the inspection information that can be gathered.

In addition to the evaluation of the in-service bridges, a national survey will be conducted to determine bridge owner and contractor perspectives on precast panels. The survey data will be used to gain a better understanding of the perceived success of the panels.

A project advisory committee (PAC) will be assembled to oversee the progress of this project, give recommendations and guidance throughout the project, and help with the implementation of the research results. The PAC members will be selected using the procedures in place by the ABC-UTC.

The tasks of this project are outlined in the following sections.

4. Description of Research Project Tasks

The primary objectives of this research project are the following:

1. Compare the long-term performance of full-depth, precast decks to CIP decks (with similar parameters: ADT, spans, location/climates, crossing, etc.)
2. Identify successful and unsuccessful details for full-depth, precast deck panels and joints
3. Identify owner (state DOT) perceptions of full-depth, precast decks and determine perceived successes and challenges

These objectives will be accomplished through the following research tasks.

Task 1 – Collection and Analysis of NBI, LTBP, and Other Available Data

A comprehensive literature review will be conducted to gather available information related to performance of in-service bridge decks. The NBI and LTBP databases will be used as a starting point to understand general national trends related to bridge deck performance. The needed LTBP protocols will also be gathered during this task.

Task 1 Update (12/1): Task 1 was completed. Results from Tasks 1-3 are summarized in the Interim Report.

Task 2 – Industry Survey of Owners

A survey will be developed and administered during the work of this task. The survey will be aimed at bridge owners (state DOTs). The goal of the survey will be to determine several items. From the owners:

1. Number and type of full-depth precast panels used
2. Reasons why precast panels are considered over CIP decks with any specific examples
3. Observed problems with deck system (with panels or joints)
4. Repair techniques used for problematic decks
5. Recommendations for comparison projects for Task 3

The survey will be developed with the guidance of the PAC. Results will be compiled and used to guide the work of Tasks 3 through 6.

Task 2 Update (12/1): Task 2 was completed. Results from Tasks 1-3 are summarized in the Interim Report.

Task 3- Determine Comparison Projects

The objective of this task will be to select the projects to be included in the performance comparison and to begin to gather information on these bridges. The project selection process will incorporate the bridge selection methodology and clusters and corridors approach adopted by the LTBP Program[4]. This methodology prioritizes and organizes bridges based on:

1. *Type of bridge*: specifically including steel multi-girder, prestressed concrete multi-girder, and prestressed/post-tensioned concrete box girder
2. *Climate*: climate zones from the Department of Energy (DOE) are used
3. *Concentrated geographic areas*: clusters of bridges close to each other are selected to make data collection more cost effective
4. *Traffic*: average daily traffic (ADT) and average daily truck traffic (ADTT)

Data (including plans, inspection reports, and maintenance records) is then collected to an appropriate level of detail for each bridge and cluster. This data is used to select bridges in each cluster to conduct further data collection. The procedure outlined by LTBP will be used as a starting point, but will be customized as needed to reflect the requirements of this project.

The PAC will be involved in this selection procedure.

Task 3 Update: Task 3 was completed. Results from Tasks 1-3 are summarized in the Interim Report.

Task 4- Collect Required Inspection Information

The objective of this task is to collect additional information for the bridges selected during Task 3. This will be limited to currently available information initially, but can be expanded to include new inspection information if additional support for the project can be obtained. Available LTBP protocols will be used when applicable to keep these efforts consistent with current FHWA activities. Inspection information will be organized to facilitate comparison of deck performance and panel and joint details.

Task 4 Update: The researchers are continuing the gather relevant information on the different comparison projects from above. The researchers are planning on partnering with the ABC-UTC project “NDT Methods Applicable to Health Monitoring of ABC Closure Joints” to use NDT

methods to inspect one or two pairs of bridges. This will be decided on pending project location and travel budget.

Task 5- Analysis of Inspection Information

The objective of this task will be to analyze the results gathered under Task 4 and both quantitatively and qualitatively compare the performance of full-depth, precast decks to the similar CIP decks. The deliverable from this task will offer side-by-side performance comparisons for the projects selected in Task 3.

Task 5 Update: Information that is being gathered on comparison projects continues to be analyzed.

Task 6- Design Recommendations

Details on panel and joint design will be gathered during Task 2 and Task 4. The objective of this task will be to suggest panel and joint details that are performing well and are easy to assemble. Recommendations on panel or joint details to avoid will be made when possible, keeping the associated projects anonymous if possible.

Task 6 Update: No work on this task has been accomplished to date.

Task 7- Final Report

A final report will be prepared meeting the RITA requirements for UTC funded projects. The content of the report will contain a detailed summary of the results from the preceding tasks and a recommendation for future phases of the project, if necessary.

Task 7 Update: No work on this task has been accomplished to date.

5. Expected Results and Specific Deliverables

An interim report was developed summarizing the work of Tasks 1-3.

A final report will be developed with the following information: summary of survey and survey results, summary of performance comparison between full-depth precast deck panels and CIP decks, summary of successful design details in full-depth precast deck panels, and recommendations for any future research.

The researchers on this project are partnering with researchers on the Development of Manual for Enhanced Service Life of ABC Projects to develop an ABC Guide for Closure Joints.

6. Schedule

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

	Month																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Kickoff Meeting																		
	x																	
Task 1																		
	x	x	x															
Task 2																		
	x	x	x	x	x													
Task 3																		
	x	x	x	x	x	x	x	x	x									
Task 4																		
							x	x	x	x	x	x						
Task 5																		
Task 6																		
Task 7																		

7. References

[1] Federal Highway Administration (FHWA). (2016, May 5, 2016). *National Bridge Inventory (NBI).* Available: http://www.fhwa.dot.gov/bridge/nbi.cfm

[2] PCI Committee on Bridges and PCI Bridge Producers Committee, "PCI State-of-the-Art Report on Full-Depth Precast Concrete Bridge Deck Panels," SOA-01-1911, 2011.

[3] J. M. Hooks and Y. Rodriguez-Otero, "FHWA LTBP Summary - Findings from the New Jersey Bridge Deck," FHWA-HRT-16-070, 2016.

[4] Federal Highway Administration (FHWA). (2017, February 28). *Long-Term Bridge Performance (LTBP) Program: Data Collection*. Available: https://www.fhwa.dot.gov/research/tfhrc/programs/infrastructure/structures/ltbp/collection.cfm#sec4b