MULTI-SPAN LATERAL SLIDE LABORATORY INVESTIGATION: PHASE 2

Quarterly Progress Report
For the period ending June 1, 2022

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1. Background and Introduction

While single span lateral slides have been adopted by many states and are a common ABC method for construction of bridges when short closure durations are needed, multi-span lateral slides are far less common. A multi-span lateral slide incorporates additional construction complexities that must be considered by the designer, agency and contractor. This project will involve the second phase of study recently completed which included planning and beginning phases of laboratory efforts. The proposed second phase will include the identified laboratory work based upon the findings from the first phase of study. Ultimately this will result in a better understanding of critical aspects of multi-span lateral slides, particularly the time-dependent strength of closure pour connections.

2. Problem Statement

Lateral slide-in bridge construction (sometimes referred to as slide-in bridge construction) has gained increasing attention as a viable Accelerated Bridge Construction (ABC) approach. With lateral slide construction, the majority of the bridge superstructure is constructed off alignment, typically parallel to the final position, and usually on a system of temporary works. The construction of this portion of the bridge is often completed while the original bridge is still open to traffic. In some instances, portions of the substructure are also constructed while the original bridge is still open to traffic – a technique designed to further reduce traffic impacts. Common techniques for accomplishing this include building substructure elements outside of the original bridge footprint as well as using innovative techniques to complete construction under the bridge with consideration of clearance limitations, stability of the underlying soil, and others. Once the construction of the superstructure is essentially complete, the original bridge is demolished and new substructure construction is completed. Then, usually over a relatively short period time (hours to a day commonly), the new bridge superstructure is slid laterally from the temporary worksite onto the in-place substructure.

While many DOTs have completed lateral slide construction of single span bridges and have common connection details already established, these details do not directly apply to multi-span slides. The addition of more spans creates a more complex system that will require connections (and other details) that were previously not needed in a single span slide. Further, the fact that the multi-span bridge will need to slide on abutments plus piers (as opposed to just abutments in a single span case) creates possible uplift and overturning scenarios.

This project will involve laboratory testing of closure pour connections between concrete piers and pier diaphragms. The variables that will be addressed by lab testing are driven based upon field findings from a recently completed multi-span lateral slide project in Iowa.

3. Research Approach and Methods

The objectives of this project will be achieved via these three tasks:

1. Summary of Phase I Findings
2. Laboratory Testing
3. Summary and Recommendations

4. Description of Research Project Tasks

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

Task 1 – Summary of Phase I Findings
The work from Phase 1 of this project will be summarized, with the intent of presenting the aspects that will be of interest for the laboratory testing involved in this proposed phase 2 work. This summary will also include recommendations from the project's advisory panel, prioritizing these elements for future study.

Description of work performed to this period

The findings from phase I was completed. These findings were used to inform the final laboratory testing plan.

Task 2 – Laboratory Testing
The focus will be placed on determining the relationship between early-age UHPC strength and lap splice strength development timing for UHPC closure pour applications, based upon input from the Iowa DOT. This is especially critical for ABC projects as determining when sufficient development/strength has occurred greatly impacts closure and construction period lengths. In other words, this aspect of the project will investigate the development of noncontact lap splice strength over time. The goal of this aspect will be to determine when a noncontact lap slice has sufficient strength to either open a bridge or to expose it to additional construction loadings. Table 1 shows the detailed plan for the time-dependent noncontact lap-splice tests.

Table 1. Time-dependent noncontact lap-splice tests

Test I.D.	Specimen Design I.D.	UHPC/HCSC age	# of Specimens
L-1	Design-1	6 hrs	3
L-2	Design-1	12 hrs	3
L-3	Design-1	18 hrs	3
L-4	Design-1	24 hrs	3
L-5	Design-1	48 hrs	3
L-6	Design-1	36 hrs	3
L-7	Design-1	7 days	3
L-8	Design-1	28 days	3
L-9	Design-2	6 hrs	3
L-10	Design-2	12 hrs	3
L-11	Design-2	18 hrs	3
L-12	Design-2	24 hrs	3
L-13	Design-2	48 hrs	3
L-14	Design-2	36 hrs	3
L-15	Design-2	7 days	3
L-16	Design-2	28 days	3
L-17	Design-3	6 hrs	3
L-18	Design-3	12 hrs	3
L-19	Design-3	18 hrs	3
L-20	Design-3	24 hrs	3

L-21	Design-3	48 hrs	3
L-22	Design-3	36 hrs	3
L-23	Design-3	7 days	3
L-24	Design-3	28 days	3
L-25	Design-4	6 hrs	3
L-26	Design-4	12 hrs	3
L-27	Design-4	18 hrs	3
L-28	Design-4	24 hrs	3
L-29	Design-4	48 hrs	3
L-30	Design-4	36 hrs	3
L-31	Design-4	7 days	3
L-32	Design-4	28 days	3

Four types of noncontact lap-splice connections (Design-1, Design-2, Design 3, and Design 4) will be tested in this step: two will be identical to the connection used on the steel girder bridge on IA 1 southwest of Iowa City, Iowa with one using UHPC and the other HCSC as the closure pour material; the others will be designed following the FHWA published guidance (Graybeal 2014) to achieve an efficient and economical solution. Once these connection designs are finalized, they will be load tested similarly to the configuration shown in *Figure 1* used in the research by Graybeal (2018). Test specimens will be made by casting UHPC/HCSC blocks atop a precast concrete slab with a series of protruding rebar. A direct tensile test will be performed on each UHPC block to determine the load at which the UHPC portion loses strength or otherwise separates from the precast concrete slab.

For each design type, 24 specimens will be constructed. Three specimens will be tested for every age milestone to identify the earliest time of achieving the desired strength.

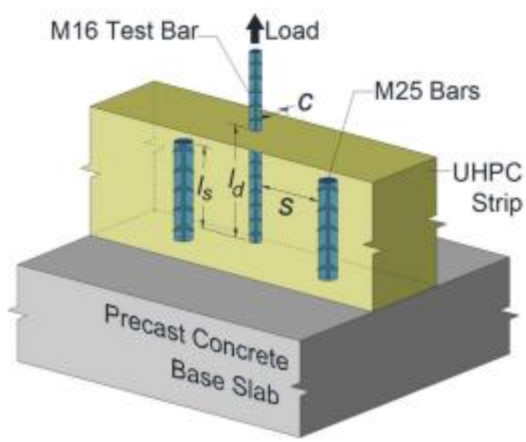

Figure 1 UHPC Connection Load Test Specimen Configuration (Graybeal, 2018)

Description of work performed to this period

The UHPC have been cast and tested up through the 14 day cure period. The base slab and formwork have been completed for the HCSC specimens which will likely be cast in late June or early July.

Task 3 – Summary and Recommendations
The data from Task 2 will be analyzed and summarized via graphs, tables and other data comparison efforts. Based upon those findings, recommendations will be made with respect to the variables that were analyzed in the finalized laboratory testing plan. It is anticipated that this guidance will include diaphragm closure pour details and lap splice development timing for UHPC applications.

<u>Description of work performed to this period</u>

No work has been performed on this task to this period.

Task 4 – Final Report
The project findings from the previously described tasks will be prepared by means of a final report.

<u>Description of work performed to this period</u>

No work has been performed on this task to this period.

5. Expected Results and Specific Deliverables

Time-dependent strength characteristics of varying UHPC/HCSC closure pour details will be provided. This information will directly inform bridge engineers regarding the time required to gain strength between the closure pour and bridge opening to traffic or construction loads

6. Schedule

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

Item	% Completed
Task 1: Summary of Phase I Findings	100%
Task 2: Laboratory Testing	75%
Task 3: Summary and Recommendations	0%
Task 4: Final Report	0%

	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Task 1: Summary of Phase I												
Task 2: Laboratory Testing												
Task 3: Summary and Recommendations												
Task 4: Final Report												