

November 2008 Project Update

PennDOT Project #070202

Project Title: Inspection Methods & Techniques to Determine Non Visible Corrosion of Prestressing Strands in Concrete Bridge Components (LU ID 541671)

Contract #: 355I01

Lehigh University / ATLSS Research Center

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Overview

This interim report provides an update on the progress of PennDOT Project: Inspection Methods & Techniques to Determine Non Visible Corrosion of Pre Stressing Strands in Concrete Bridge Components. The project initiated in December 20, 2007 and is scheduled to be completed on December 19, 2009. This report covers the time period from the October 20, 2008 to November 17, 2008.

Organizational Modifications

As requested the resumes of Lehigh University technicians involved in the project were submitted to PennDOT. No organizational modifications occurred in this time period. The project has continued to operate with the original upper level staff. The project is being conducted by Clay Naito (PI), Stephen Pessiki (co-PI), Richard Sause (co-PI), and Ian Hodgson (co-PI). Brandon Sullivan and Jordan Warncke continue to work as engineering assistants.

Project Tasks

In the past month work has progressed in two areas. These include the half cell evaluation of the beams, PennDOT inspection of the beams, and identification of NDE methods. A summary of the progress on each facet is discussed in detail.

Forensic Evaluation

To assist with forensic evaluation of potential areas of corrosion a half-cell potential inspection of the bottom flange from each beam is being conducted. The basis for this testing method is ASTM C876 Standard Test Method for Half-Cell Potentials of Uncoated Reinforcing Steel in Concrete. The goal of this portion of the study is to find if there is a reasonable means to acquire repeatable potential readings.

Half-cell measurements have been made on four of the seven beams. On each beam, measurements are made along each of the bottom layer strands. Measurements are taken every 12 inches. To obtain repeatable potential readings, it has been found that the concrete surface must be sufficiently damp. A system of wetting the concrete beams has been employed for at least 1 hour prior to the taking of measurements. After several trials, this method was found to produce repeatable measurements and has been used for all the beams. The half-cell measurements are currently continuing on the remaining beams and will be completed in early December 2008.

For each beam, the half-cell measurements will be presented visually in the form of a color contour plot. Initial results suggest that the regions of high potential correspond to locations where existing cracks have been observed.

The existing condition of the beams has been thoroughly documented using photographs and crack map drawings. Details such as the length and width of each crack, as well as the location and size of spalling and exposed strands have been recorded.

PennDOT Inspection

An inspection of the beams acquired for the project was scheduled. The inspection will be conducted by Leon Lai a co-investigator on the project. His engineering firm has a number of PennDOT certified

bridge inspectors with many years of bridge inspection experience, including many prestressed concrete non-composite adjacent box beam bridges.

The goal of the inspection is to summarize the condition of the beams in accordance with Pennsylvania Department of Transportation requirements. This information is being acquired prior to any NDE or destructive testing to create a record of the existing condition of the beams. In addition, the inspection record will be compared to the upcoming destructive and non-destructive evaluations conducted to assess the capability of the standard procedures in identifying problems. This work will be completed in November 2008.

NDE Methods

As mentioned in the October update, Professor Pessiki has taken the lead on identifying and organizing NDE inspections. A request was sent out to NDE inspection companies as well as organizations and individuals which develop inspection equipment. The request resulted in only three organizations that have indicated they will come to test the beams:

1. Physical Acoustics Corporation
2. Professor Al Ghorbanpoor, University of Chicago
3. Malcolm K. Lim, Universal Construction Testing, Ltd

Physical Acoustics Corporation is in the process of determining what process they are going to utilize to identify corrosion. Professor Ghorbanpoor will try out a magnetic flux leakage technique that he has used successfully to test multi-strand post-tensioned beams. To conduct his evaluation we will need to invert the beams once again to allow access for his equipment. Malcolm Lim is developing a new technique which may have potential.

We are in the process of trying to identify someone who is willing to try impact echo to measure the depth of surface opening cracks. An additional request will be made at the ACI Convention in St. Louis in November. Lastly, there is one other multi-sensor stress wave propagation piece of equipment that may help with quantification of corrosion induced cracking. A meeting will be held in St. Louis to discuss their participation in the study.

The goal of the inspection exercise is to assess if any of the three methods are viable with regards to accuracy. As such steps have been taken to simplify evaluation. All beams have been inverted with the bottom flange facing upward. All beams will be moved into the lab to limit the environmental effects on the inspection technique. If the NDE methods prove viable practical applications will be investigated.

The inspections will be conducted in November and December of 2008.

Upcoming Schedule

- The identified NDE methods will be conducted on the beams staged at Lehigh University.
- A PennDOT inspection of the beams will be conducted.
- The half cell potential study will be completed.
- Recommendations for the destructive phase of the forensic investigation will be developed.

The overall schedule is included below. The schedule represents the current status of the project. Start and end dates of completed and future tasks have been modified to represent the work completed to date. The project is progressing well and is expected to be completed on schedule.

NTP: Dec.20, 2007		Months Relative to Notice to Proceed																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
		2008												2009											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Task 1	Literature Search				a		a1		a2		a3														
Task 2	Method Evaluation																								
2a	ID and Beam Prep.							b	b1																
2b	Visual and Material Eval.					c			c	c1	c1	c2													
2d	NDE Evaluation								e1	e1	e1	e2	e2						f						
2e	Destructive Eval. Of Beams													d	d	d	d								
Task 3	T-18 Reporting																								
Task 4	Inspection Training																								
Task 5	Draft Final Report																								
Task 6	Final Report																								
Task 7	Invoicing	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

ID	Est. Due Date	Deliverable
a	Month 4	Synthesis report of findings submitted to PennDOT including database.
a1	Month 6	Draft Literature Review Report submitted awaiting Review
a2	Month 8	Receive Review on Literature Review
a3	Month 10	Submitted Literature Review Report
b	Month 7	Locate, prepare, and deliver beam specimens of varying condition for evaluation
b1	Month 8	Beams Delivered and Staged at Lehigh University
c	Month 8	Visual Inspections of Beams
c1	Month 10	Half Cell potential mapping of beams
c2	Month 11	PennDOT type inspection of beams
e1	Month 10	Identification of NDE methodologies
e2	Month 11-13	NDE evaluation of available technologies
d	Month 13-16	Destructive testing of beams to validate visual inspection, NDE, and other inspections.
f	Month 17	Task Report ranking the candidate methods, including basic operating principles, advantages and disadvantages, operator expertise required, and the degree of qualitative versus quantitative results will be submitted to PennDOT. Visual inspection procedures will be recommended.
g	Bi-Annual	Presentation to AASHTO T-18 Subcommittee and others.
h	Month 21	A written Training Plan, and Specifications and Sample Bid Documents will be provided to PennDOT.
i	Month 20	Draft Final Report will be submitted to PennDOT.
j	Month 24	Final Report submitted to PennDOT.
x	Months 1 - 24	Monthly Invoices to PennDOT.