TITLE: Capillary Pressure Sensor Testing to Identify Curing Regimen in Freshly Placed Bridge Decks

PROBLEM STATEMENT
The overall performance of concrete in bridge decks can be affected by the curing regimen. The Department now recognizes and allows concrete curing compounds that are lithium based. But, do they outperform the standard curing regimens? With the advent of new testing equipment for freshly placed concrete, Capillary Pressure Sensor System (CPSS), the evaporation effects can be measured. By measuring the capillary pressure during the initial set period after finishing, shrinkage cracks can be avoided by adding moisture and/or curing compound to the concrete surface when the alarm is triggered by threshold pressure limit. Additional curing compound and/or moisture can be added to reduce or mitigate the effects of the evaporation. ARDOT currently allows the use of lithium cure under a special provision when the contractor requests it. This project would use the CPSS to evaluate the different curing regimens the contractor uses and determine which product and/or method works best.

AREA OF STUDY
The objective of this study is to further evaluate how CPSS assesses and monitors concrete maturity prior to initial/final setting during a field evaluation, while alerting end-users when concrete bridge decks require additional moisture or treatments. The risk of plastic shrinkage cracking depends on a variety of influence parameters, including the environmental conditions, the material properties, and the bleeding rate. Current CPSS studies are promising for they have the potential to monitor structural health, and to support the efficient operation and maintenance of civil infrastructure through the simultaneous measurement of multiple properties. The primary objective of this research is to deploy CPSS developed for monitoring concrete bridge decks in a live field project capable of real-time remote monitoring of strain, moisture content, and temperature in concrete bridge decks.
METHOD OF STUDY
This project will consist of a comprehensive review of both internal and external concrete CPSS as they pertain to concrete bridge decks. ARDOT will be responsible for selecting necessary test site locations for concrete bridge deck evaluation. CPSS placement within the test site will be in accordance to manufacturer’s recommendations and specifications, and should have the capability to relay real-time data via wireless communication including, but not limited to, air temperature, concrete temperature, pressure, and Relative Humidity measurements. ARDOT reserves the right to accept or reject any sensors recommended by the Principle Investigator (PI). The PI will provide monitoring, testing, and data collection for all selected test sites. The PI will also be required to provide a cost/benefit analysis to determine whether the internal or external, or both, provides a cost/savings to ARDOT. Depending on the internal sensor’s battery longevity, the PI will continue to monitor and collect data from test sections for the duration of the research project.

BENEFITS
A detailed benefit cost analysis will be included in the proposal. The analysis must include, but is not limited to the following:

1. Detailed cost analysis on savings to the Department with full implementation of the projects findings.
2. Any anticipated benefit not foreseen as a cost savings.

TIME AND FUNDING OF STUDY
Work will begin no earlier than July 1, 2018, contingent upon acceptance of the proposal and availability of research funds. The length of the project will be 24 months. A final report is to be drafted and presented to the Research Subcommittee within 90 days after the completion date of the project. Up to 25% of the estimated project costs will be withheld pending final acceptance of the final report. Failure to deliver the required Final Report within 90 days will result in the cancellation of the project and 25% of the total project cost will be retained by the Department.

REPORTS
Quarterly Progress Reports, Interim Reports, annual Benchmark Reports, and a Final Report conforming to the March 2015 Research manual will be required prior to project
completion. An oral report to the Transportation Research Committee may be required.
In accordance with the March 2015 Research Manual, an Implementation Report which
details the recommended means/techniques for using the project results will be
submitted to the Department six months prior to the research project’s Final Report. In
addition to reports and publications, the Department shall be furnished one (1)
electronic copy of any master’s thesis or doctoral dissertation which is a result of any
investigation or study on this project. The submitting of any report to be published by an
outside publication or presentation on this project before its completion; shall be
submitted for the Department’s approval before submission.

All reports must be in accordance with the March 2015 Research Manual (available at
http://www.arkansashighways.com/System_Info_and_Research/research.aspx or from
the Research Section).

PROJECT DELIVERABLES
The proposed research will provide ARDOT with a final report and implementation plan,
which will discuss how incorporating CPSS could serve as a warning monitoring system
for freshly placed concrete bridge decks. Conclusions should also reflect the
investments of utilizing CPSS, such as the costs to implement and operate vs improved
bridge deck life and reduced maintenance costs due to reduction in early age deck
cracking. Project deliverables would consist of, but not limited to:

- Draft Specifications for Construction Procedures,
- Draft Specifications for Construction Methods,
- Any data collected in the format of Access Databases, Excel Spreadsheets
  through wired and wireless devices, and
- Provide a Cost/Benefit Analysis of Utilizing CPSS in Construction Projects.

AUTHORIZATION TO BEGIN WORK
A letter separate from the contracting documents authorizing the beginning of work will
be transmitted initiating the project. Any cost accrued before the authorization letter is
received, will not be eligible for reimbursement. It is anticipated that the project will
begin work on July 1, 2018.
EQUIPMENT
A complete physical verification of all software and equipment purchased or built for use on this project and the actual location of the equipment will be made each year. An Equipment Capitalization Notice is available from the Research Section for the reporting of software or equipment purchased during the project. All software developed on the project will be completed in open source format and ARDOT shall be provided a copy of the source code. If non-expendable or special equipment is purchased with project funds, the equipment is owned by ARDOT and disposition of the equipment will be determined by the ARDOT at the project’s closeout session.

All rental rates will be approved by ARDOT before the approval of the proposals. Should a subcontract be part of the proposal, ARDOT will not approve the purchase of any equipment in the subcontract. Any equipment purchased through ARDOT’s Transportation-Related Research Grant Program is not eligible for rental rate charges.

All equipment will be purchased in accordance with the State purchasing laws.

PROPOSALS
Proposals shall be submitted in electronic format by the end of business on April 6, 2018. This is a firm deadline. All procedures shall be in accordance with the March 2015 Research Manual and Federal Aid Policy Guide (FAPG). In the event of policy contradiction, the FAPG shall be observed. Upon approval of the electronic version of the Proposal by the Research Subcommittee, two (2) signed copies shall be submitted. Budgets, estimates and resumes shall be prepared in accordance with the March 2015 Research Manual and must be submitted with proposal.

Proposals should be sent to:

Mrs. E. C. Wright-Kehner, P.E.
System Information and Research Division
Arkansas Department of Transportation
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