SUMMARY PAGE

Project Title: Early Opening of Concrete Pavements to Traffic

Person Submitting Proposal: Lev Khazanovich

Proposed Funding Period: 12/01/2019-07/31/2021

Project Duration: 20 months

Project Cost: $175,068
Project Title: Early Opening of Concrete Pavements to Traffic

Problem Statement:

The current empirical methods for determining traffic-opening criteria can be overly conservative causing unnecessary construction delays and user costs. These criteria require wait periods after concrete placement or achievement of certain levels of compressive and/or flexural strength of concrete. The proposed research will develop innovative mechanistic-based procedures for quantifying the risk of premature failure and long-term damage caused by traffic opening at various concrete strength levels. A methodology for the accurate monitoring of in-situ concrete early age development will be proposed. It will utilize recent developments in nondestructive testing of concrete.

Project Objectives:

The objective of the research is to develop a strategy that can be implemented by IRISE members for the optimal timing of the opening of new concrete pavements to traffic.

Project Scope:

The scope of the project includes literature review, lab and field testing, development of a mechanistic-empirical model for prediction of concrete pavement damage due to early opening, and recommendations for early opening data analysis.

Proposed Work:

The objectives of this project will be realized through the completion of the following tasks:

Task A: Literature review

A literature review of the current criteria and mechanistic models for traffic opening and assessment of damage from early opening will be conducted. The research team will also review the methods for nondestructive evaluation of concrete properties and their application for concrete pavement assessments (maturity measurements, ground penetrating radar, and ultrasound tomography).

Task B: Laboratory and field testing

Concrete cylinder and beam specimens will be collected on a concrete paving project and tested 1, 2, 3, 7, and 28 days after casting. Non-destructive testing using maturity and ultrasound methods will be conducted to determine in-place concrete strength development as well as special variability of the concrete strength at 1, 2, 3, 7, and 28 days after concrete placement. In addition, concrete maturity and concrete shear wave velocity will be measured for the in-situ concrete pavement for the first 7 days after concrete placement. The laboratory tests results will be used to develop relationships between concrete maturity and concrete strength, as well as concrete shear wave velocity and concrete strength. These relationships will be used to develop procedures for the assessment of the in situ concrete pavement properties required for modeling the pavement behavior at early age and its ability to withstand axle loadings.
Task C: Develop mechanistic-empirical model

A mechanistic-empirical model for estimation of the damage from the early opening will be developed. The procedure will consider the effect of concrete strength and stiffness on the ability of the pavement to resist stresses induced by wheel loadings for typical Pennsylvania conditions. The nondestructive methods and corresponding analysis techniques for assessment of concrete strength based on the concrete maturity measurements and/or shear wave velocity measurements will be recommended. In addition to accounting for the concrete strength development, the procedure will analyze the effect of early age axle loadings on the stresses induced in the concrete pavement. The recommendations for determining the optimal timing for the traffic opening will be developed.

Task D: Conduct traffic simulation

Traffic simulations for various scenarios of early traffic openings will be conducted to quantify the benefits in reducing user delay costs for a concrete pavement constructed with a typical PA concrete mix. The procedure developed in Task C will be used to determine the timing of the traffic opening for various scenarios, such as opening to car traffic first and to truck traffic at a later time or opening to car and truck traffic at the same time. The results will be compared with simulations conducted using the current criteria for traffic opening.

Task E: Draft Final Report

A draft final report will be prepared to document project activities, findings and recommendations. The final report will also include recommendations for implementation of the procedure developed in this study.

Task F: Final Report

A Final Report taking into consideration comments that were received on the Draft Final Report will be prepared.

Deliverables:

The following deliverables will be provided based on completion of the above tasks.

- **Deliverable #1** – A memo summarizing the literature review, due 4-months-days after project initiation.
- **Deliverable #2** – A memo summarizing the results of laboratory and field testing, due 12-months after project initiation.
- **Deliverable #3** – A memo report with the description of the mechanistic-empirical procedure for evaluation of the effect of joint opening, due 16-months after project initiation.
• **Deliverable #4**– A memo report summarizing the results of the traffic simulations of various traffic opening scenarios and corresponding user delay cost, due 16-months after project initiation.

• **Deliverable #5**– A draft final report, due 17-months after project initiation.

• **Deliverable #6**– Final report, due 20-months after project initiation.

**Key Personnel:**

**Principal Investigator:** Dr. Khazanovich is to provide the technical expertise, project management and oversight on all project activities.

**Co-Principal Investigator:** Dr. Vandenbossche is to provide the technical expertise on tasks B, E, and F of this project and assist the Principal Investigator in project management and oversight on all project activities.

**Co-Principal Investigator:** Dr. Mark Magalotti will provide the technical expertise in task D.

**Other Personnel:**

Two graduate students will contribute to the successful completion of this research effort as described below.

Grad Assistant 1 (Katelyn Kosar) is a graduate student who will assist in task A, B, C, E, and F.

Grad Assistant 2 (TBN) is a graduate student who will assist in traffic simulation in task D.

**Undergraduate student 1** (TBN) will assist in field and laboratory testing.

**Undergraduate student 2** (TBN) will assist in field and laboratory testing.

**Schedule:**

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<tr>
<th>Months</th>
<th>2020</th>
<th>2021</th>
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<tr>
<td>Task A: Literature review</td>
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<td>Deliverable 1: A memo summarizing the literature review</td>
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<td>Task B: Field data collection and lab testing</td>
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<td>Deliverable 2: A memo summarizing the results of laboratory and field testing</td>
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<td>Task C: Development of mechanistic-empirical model</td>
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<td>Deliverable 3: A memo report with the description of the mechanistic-empirical procedure</td>
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<td>Task D: Traffic simulations</td>
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<td>Deliverable 4: A memo report summarizing the effect of traffic simulation</td>
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<td>Task E: Draft Final Report</td>
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<td>Deliverable 5: A Draft Final Report</td>
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<td>Task F: Final Report</td>
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<td>Deliverable 6: Final Report</td>
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**Budget:** The total project cost is $175,068.