IOWA HIGHWAY RESEARCH BOARD (IHRB)

Minutes of July 29, 2016

Regular Board Members Present

A. Abu-Hawash
M. Kennerly
S. Okerlund
R. Knoche
P. Hanley
W. Weiss
D. Miller
K. Mayberry
M. Parizek
T. Wipf

Alternate Board Members Present

D. Sprengeler

Members with No Representation

K. Jones
R. Stutt
P. Assman
L. Roehl

Secretary – V. Goetz

Visitors

Tammy Bailey	Iowa Department of Transportation
Francis Todey	Iowa Department of Transportation
Nicole Fox	Iowa Department of Transportation
Bob Younie	Iowa Department of Transportation
Sunghwan Kim	Iowa State University
Kasthurirangan Gopalakrishnan	Iowa State University
Chris Williams	Iowa State University
Ashley Buss	Iowa State University
Basak Bektas	Iowa State University
David Jeong	Iowa State University
Darla Hugaboom	Federal Highway Administration
Sean Litteral	Federal Highway Administration
Steve Tritsch	National Concrete Pavement Tech Center

The meeting was held at the Iowa Department of Transportation Ames Complex, Materials East/West Conference Room, on Friday, July 29, 2016. The meeting was called to order at 9:00 a.m. by Chairperson Sarah Okerlund with an initial number of 11 voting members/alternates at the table.

1. Agenda review/modification

2. Motion to approve Minutes from the May 26, 2016 meeting

Motion to Approve by M. Parizek; 2nd R. Knoche
Motion carried with 11 Aye, 0 Nay, 0 Abstaining.

3. **Final Report:** TR-637**,** "Development of a Wireless MEMS Multifunction Sensor System", Halil Ceylan, Iowa State University, ($248,960).

BACKGROUND

Pavement tends to deteriorate with time under repeated traffic and environmental loading. The structural health monitoring (SHM) concept can be applied as a systematic method for assessing the structural state of pavement infrastructure systems and documenting their conditions.

The development of novel "smart" structures achieved by embedding sensing capabilities directly into construction material during the manufacturing and deployment processes has attracted significant attention in the context of autonomous SHM. Advancements in MEMS technology and wireless sensor networks provide opportunities for long-term, continuous, real-time structural health monitoring of pavements and bridges at low cost within the context of sustainable infrastructure systems.

OBJECTIVES

The primary objectives of this two-pronged research study were as follows:
• Deploy some of the promising commercial off-the-shelf (COTS) MEMS sensors developed for monitoring concrete pavement in a live field project
• Develop a wireless MEMS multifunction sensor (WMS) system capable of real-time, remote monitoring of strain, moisture content, and temperature in pavement concrete.

DISCUSSION

Q. Has the power system issue been resolved?
A. Yes, we added a new power system.
Q. Do you have to lay the sensor in one direction?
A. We can develop sensors for multiple directions. One sensor can detect strain in six different directions.
Q. Can the sensors be damaged?
A. No, they have not shown any damage.
Q. Can the sensor measure strains?
A. Yes, the sensors detect any strain.

Motion to Approve by R. Knoche; 2nd A. Abu-Hawash
Motion carried with 11 Aye, 0 Nay, 0 Abstaining.

4. **Final Report:** TR-667**,** "Validation of Gyratory Mix Design in Iowa", Chris Williams, Iowa State University, ($150,173).

BACKGROUND

The use of asphalt pavements, which cover about 94% of paved roads, has gradually increased since the late 19th century (Brown et al. 2009). The mix design of asphalt pavements has undergone continual evolution since initial development, relying heavily on empirical knowledge.

In the US, Superior Performing Asphalt Pavement (Superpave) mix design is used in a majority of states. One of the most important factors in mix design is the compaction effort, or number of gyrations, of the asphalt mixture, which is denoted as the design number of gyrations (Ndesign). Ndesign is one of the most significant design considerations/parameters in the laboratory and is selected based on the corresponding equivalent single-axle load (ESAL) levels for the proposed pavement structure.

OBJECTIVES

Evaluate the ultimate in-place densities on 300,000 to 30,000,000 ESAL design-level surface mixes in Iowa by performing volumetric testing

• Determine the compatibility of mixes under the existing mix design procedures by recalculating the gyratory slope from the quality control and quality assurance (QC/QA) data

• Estimate and compare the post-construction compaction effort (PCCE) for each selected project and determine the theoretical Ndesign at construction and post-construction

• Evaluate the optimum asphalt contents and aggregate structures due to different Ndesign values adopted for the mixtures under three different traffic levels.

Motion to Approve by D. Miller; 2nd M. Parizek
Motion carried with 11 Aye, 0 Nay, 0 Abstaining.

5. **Final Report:** TR-668, "Impact of Curling and warping on concrete Pavement", Halil Ceylan, Iowa State University, ($119,997).

BACKGROUND

Temperature and moisture variations across the depth of portland cement concrete (PCC) pavements result in unique deflection behavior that has been characterized as pavement curling and warping since the mid-1920s. Repeated slab curvature changes due to curling and warping, combined with traffic loading, can accelerate fatigue failures, including top-down and bottom-up transverse, longitudinal, and corner cracking.

Numerous studies have reported premature transverse cracking resulting from slab curling and warping in concrete pavements, such as the recent series of cracks observed in a section of I-80 near Adair County, Iowa. This is not only a safety issue, but also costs transportation agencies time and money to implement repair solutions.

It is, therefore, of paramount importance to measure the actual magnitude of curling and warping taking place in concrete pavements to develop performance measures and critical threshold magnitudes and gain a better understanding of their relationship to diurnal and seasonal temperature/moisture changes and long-term pavement performance.

OBJECTIVES

• Conduct field investigations to survey the degree of curling and warping in Iowa PCC pavements

• Identify the impact of curling and warping on performance of Iowa PCC pavements

• Identify the effects of the concrete mixture, pavement design, construction details, and climate on curling and warping behavior

• Develop recommendations to mitigate the amount of curling and warping in concrete pavements

DISCUSSION

Q. Are there different thicknesses?

A. Our study was with 10 to 12 inches thick pavements; our next phase will be a wider range.

Motion to Approve by D. Sprengeler; 2nd R. Knoche
Motion carried with 11 Aye, 0 Nay, 0 Abstaining.

6. Final Report: TR-679, "Upgrading Bridge Rails on Low-Volume roads in Iowa" Zach Hans, Iowa State University, ($50,000).

BACKGROUND

A previous study for the Iowa Highway Research Board (IHRB TR-592) provided an overview of the nation's bridge and approach rail state of practice and of a statewide crash analysis of bridge rails and approach guardrails on low-volume road (LVR) bridges in Iowa. The study found that LVR bridge crashes were rare events, occurring more frequently on bridges with widths of less than 24 ft. Crash rates were found to be higher on bridges with a narrower width compared to the approach roadway width.

Partly as a result of TR-592, changes were made to the guardrail exceptions in I.M. 3.213 to increase the average daily traffic (ADT) exception from 200 vehicles per day (vpd) to 400 vpd and add an exception for bridges with widths greater than the approach roadway width. However, no significant changes were made to the detailed bridge rail rating system component of I.M. 3.213, which is used to determine necessary bridge rail upgrades by assigning points to bridges based on crash history, ADT, width, length, and type of bridge rail. Thus, the current study was a follow-up to and builds on the results of TR-592.

OBJECTIVES

The study confirmed a previous research finding that crashes with bridges on secondary roads are rare, low-severity events. The study did find that crashes are somewhat more frequent on or at bridges possessing certain characteristics:

- Traffic volume greater than 400 vehicles per day (vpd) (paved) or greater than 50 vpd (unpaved)
- Bridge length greater than 150 ft (paved) or greater than 35 ft (unpaved)
- Bridge width narrower than its approach (paved) or narrower than 20 ft (unpaved)
- Bridges older than 25 years (both paved and unpaved)

No specific roadway or bridge characteristic, including paved or unpaved, was found to contribute to more serious crashes.

Motion to Approve by W. Weiss; 2nd D. Miller
Motion carried with 11 Aye, 0 Nay, 0 Abstaining.

7. RFP Proposal IHRB-16-06: "Optimizing Maintenance Equipment Life Cycle for Local Agencies", David Jeong, Iowa State University

BACKGROUND

Equipment life can be mathematically defined in three different ways: physical life, profit life, and economic life (Mitchell 1998). While profit life is not directly applicable to public agencies, physical

and economic life are and both must be defined and calculated when considering equipment life because they furnish two important means to approach replacement analysis and to ultimately make an equipment replacement decision (Douglas 1975). The concepts of depreciation, inflation, investment, maintenance and repairs, downtime, and obsolescence are all integral to replacement analysis and will be explored in the proposed research. Combining these concepts and processes allows the equipment manager to properly perform maintenance optimization and replacement analysis to make reasonable equipment maintenance and replacement decisions.

Schexnayder (1980) identified selling price, used equipment prices, and obsolescence as extrinsic factors that affect ownership value because they are influenced by external drivers such as technological changes, inflation rate, and economic environmental effects. The study of the external factors is essential to help agencies predict the probable equipment future value. Additionally, there are other factors that affect the ownership costs such as equipment depreciation, investment cost, insurance, taxes, and storage costs (Gransberg and O'Connor 2015). The operating costs are also affected by maintenance and repair costs, tire costs, consumable costs, equipment operator costs, and special items costs (Gransberg and O'Connor 2015). The identification of the aforementioned factors is important to this research in order to collect the right data from local agencies and accurately estimate equipment life cycle costs.

OBJECTIVES

The project has six objectives to accomplish the ultimate goal of providing guidance for local agencies to determine the optimal time to update their equipment, including guidance on whether to replace, refurbish, or lease for a variety of vehicles and special purpose equipment.

a. Collect and analyze equipment related data from local agencies.
b. Develop a framework for analyzing a variety of typical equipment types given input such as initial purchase price, actual hours of usage, maintenance and repair costs, fuel consumption, etc.
c. Develop a methodology to assess the values of repairing, replacing, or retaining a given piece of equipment to generate the options available to the equipment manager. The methodology will minimize the life-cycle cost of equipment fleet.
d. Develop a spreadsheet based decision aid tool for selecting the most appropriate option that can be used by local agencies in a stand-alone mode or in conjunction with other parameters currently in use.
e. Conduct case studies using the tool developed in this project and validate the tool.
f. Train local agency engineers (if required) for rapid dissemination of the tool

Motion to Approve by R. Knoche; 2nd W. Weiss
Motion carried with 11 Aye, 0 Nay, 0 Abstaining.

Motion later rescinded. See New Business Section below.

8. RFP Review:

a. **IHRB-16-10**, Evaluation of Alternative Abutment Piling for Low Volume road Bridges.
b. **IHRB-16-12**, Beam End Repair for Prestressed Concrete Beams.
c. **IHRB-16-13,** Construction of New Substructure beneath Existing Bridges.
d. **IHRB-16-16,** Use of Polymer Overlays or Sealers on New Bridges.

Motion to Approve by D. Miller; 2nd A. Abu-Hawash
Motion carried with 11 Aye, 0 Nay, 0 Abstaining.

9. Presentation: RB35-013, "Holding Strategies for Low Volume State Routes", Chris Williams, ISU.

10. New Business

a. IHRB Sponsored attendance to Innovations Conference in August for City and County Engineers.
We have five County Engineers and four City Engineers attending.

b. We are looking for representatives for the Everyday Account Initiative on October 25-26, 2016 conference in Minneapolis. FHWA is funding this conference.

c. We will be voting on the 2017 Topics in September. Also, Vanessa will send out a solicitation for Topics for the STIC Funding.

d. Three projects sent to FHWA STIC Funding have been approved.
   - Implementation of E-Construction at the Iowa DOT
   - Support for the Innovations Conference
   - Development of an Open Data Center

e. Bob Younie discussed the DOT's Project on Optimization for Replacement for Trucks and Equipment fleet. Based on this information, the approval has been rescinded for **RFP Proposal IHRB-16-06: "**Optimizing Maintenance Equipment Life Cycle for Local Agencies", David Jeong, Iowa State University. Further discussion on lessons learned from the DOT project will occur and the board will revisit this proposal at a later date.

11. Adjourn

Motion to Approve by R. Knoche; 2nd D. Miller
Motion carried with 11 Aye, 0 Nay, 0 Abstaining.

The next meeting of the Iowa Highway Research Board will be held Friday, September 30, 2016 in the East/West Materials Conference Room at the Iowa DOT. The meeting will begin promptly at 9 a.m.

Vanessa Goetz, IHRB Secretary