TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Minnesota Department of Transportation

INSTRUCTIONS:
Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(341) http://www.pooledfund.org/Details/Study/590	**Transportation Pooled Fund Program - Report Period:** ☐Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) ☐Quarter 3 (July 1 – September 30) ☒Quarter 4 (October 4 – December 31)

Project Title:
Developing Best Practices for Rehabilitation of Concrete with Hot Mix Asphalt (HMA) Overlays related to Density and Reflective Cracking

Name of Project Manager(s):	**Phone Number:**	**E-Mail**
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Lead Agency Project ID: NRRA LT1	**Other Project ID (i.e., contract #):** MnDOT Contract 1003326 WO 2	**Project Start Date:** 02/23/2018
Original Project End Date: 02/28/2021	**Current Project End Date:** 02/28/2021	**Number of Extensions:** 0

Project schedule status:

☐ On schedule ☒ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$169,970	$168,536	90%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
99%	$6,770 (4%)	99%

Project Description:
Asphalt overlays are commonly used to rehabilitate deteriorated Portland Cement Concrete (PCC) pavements; however, mechanically or thermally-driven movements at joints and cracks in the underlying pavement usually lead to the development of reflective cracks in the overlay. The formation and propagation of reflection cracking is controlled by the mechanical properties of the asphalt and the condition of the overlaid pavement. The current state of practice for asphalt overlay design is policy oriented and is lacking an engineered design approach. There is need for establishing state of practice in design of overlays as well as for assessment of PCC pavement condition and recommending improvements to existing pavement prior to overlay construction. The objective of the proposed study is to develop a simple decision tree based tool for selecting suitable asphalt mixtures and overlay designs to prolong overlay lives by lowering reflective cracking and improving in-situ density. This research will leverage the current National Road Research Alliance (NRRA) effort of constructing, instrumenting, and monitoring twelve MnROAD test sections, laboratory performance tests on asphalt mixtures from the test sections, and past field performance data. The proposed tool will incorporate field performance data, performance modelling, and life cycle cost analysis to develop best practices for rehabilitation of PCC with asphalt overlays.

Maintenance and rehabilitation of existing roadways uses a significant portion of available transportation funding. It is imperative for agencies to use the most effective tools and approaches to provide the required level of service and long term performance within the available resources. This research will provide specific guidance on the best materials and techniques to use in the rehabilitation of concrete pavements with an asphalt overlay. Recommended guidance from this study will incorporate consideration of constructability (time and effort), performance over time, and life cycle and cost-benefit analysis. It is anticipated that implementation of the tools and materials recommended from the results of this study will translate to savings in construction costs and time, improved serviceability of the roadways for users, and reduced life cycle costs.

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):
General: UNH researchers received updated distress survey data with detailed information on crack severity. Katie Haslett made a presentation on Dec 16th as part of the RILEM International Symposium on Bituminous Materials. The presentation was focused on the evaluation of different performance indices from disk-shaped compact tension testing and leveraged laboratory and field performance data from in-situ density test sections. Specific progress for the various study tasks are provided below.

Task 1 Literature Review: This task is complete. Deliverable was approved by project TL on September 25th, 2018.

Task 2 Gathering Past Performance Data and Laboratory Testing: This task is complete. Deliverable was approved by project TL on August 7th, 2019.

Task 3 Mechanistic Analysis of HMA Overlay: This task is complete. Deliverable was approved by project TL on March 23rd 2020.

Task 4 A large portion of this quarter was dedicated to completing Task-4. The task deliverable was initially submitted on April 28th, 2020 for feedback from the TAP. The deliverable was then revised and re-submitted on May 27th, 2020 and approved on June 10th, 2020.

Task 5 Task draft deliverable was submitted to TAP on 10/2/2020. Revision have been made based on TAP member feedback and the task deliverable is waiting on final approval.

Task 6 Establish State of the Practice for PCC Condition: Significant progress was made during this quarter on compiling the Task-6 deliverable. There were two main focuses included in this deliverable. First, to provide guidelines for assessing the existing PCC pavement condition and determining optimal options for altering PCC condition prior to overlay construction. Second, to provide a preliminary outline of the decision tree tool. Task-6 deliverable is being submitted concurrently with this quarterly report.

Task 7 Establishment of State of Practice for HMA Mixtures and Their Effects on Reflective Cracking: Researchers are continuously working on the development of the decision tree tool. A TAP meeting was held on November 18th, 2020 to receive feedback on the working skeleton of the tool.

Anticipated work next quarter:
Key activities that will be undertaken in the upcoming quarter are the following:

It is anticipated that during the upcoming quarter, researchers will make significant progress on the development of the decision tree tool for selection of asphalt concrete overlay on PCC pavements (Task-7 deliverable). A combination of field performance and predictive simulation results will be used in the development of performance curves and subsequently in a life cycle cost analysis (LCCA) as part of Task 7.

Researchers also plan to perform further field performance data analysis with recently obtained crack severity data. The pavement condition index (PCI) will be calculated using transverse cracking data (low, medium and high) collected by MnDOT staff by means of visual distress surveys.

Finally, during the upcoming quarter, a draft final report for the project will be prepared and submitted to project TAP for review.

Significant Results:
During this past quarter, researchers worked on updating field performance data and corresponding analysis as necessary. Significant results were based on work presented in the Task-6 deliverable. Below is a brief summary of findings from the task deliverable.

- Researches evaluated FWD data further by looking at central deflection (d1) and the surface curvature index (SCI) on the approach and departure side of the joint. Measured deflection in the driving lane was higher compared to the passing lane for all test sections. This is in good agreement with conclusions made base on mean LTE percentages of test sections.

- Based on further finite element (FE) modeling efforts, it was concluded that the controlling factor in the amount of damage from thermal and tire loading is driven by the presence of a void rather than the level of LTE assumed in the model, as there was no change in the damage ratio with the combination of different LTE levels. Furthermore, the impact of assuming a void directly under the joint location resulted in only a slight increase (approximately 2%) in damage for the thicker pavement structure (Cell 990), while an even lower impact on damage results was observed in the thinner pavement structure (Cell 986).

- The impact of thermal stress generation from thermal versus tire loading in FE models was investigated. It was concluded that the contribution of thermal loading raged from 79% to 84% of the total damage ratio. This finding emphasizes that for cold regions, such as Minnesota, thermal loading history comprises a significant portion of the damage ratio and should be considered in FE analysis.

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

Due to the Covid-19 pandemic and continued impacts from it (such as, requirements for remote working and restriction of personnel access laboratory and field facilities) there has been slight delay to the project time-line.

There has also been new data (pavement thermocouple histories, weather station data, and Pathway pavement performance data) provided to researchers. These datasets were not part of original work-plan, however their use is deemed important to improve reliability of research outcomes. Thus, tasks 5, 6 and 7 have taken longer than anticipated. However, it is expected that these increased efforts are not going to significantly impact overall timing of project end date.

Potential Implementation:
Initial recommendations with respect to wear mix types for 4-inch overlay designs as well as for interlayer based overlay designs have been presented at the NRRA Flexible Team online workshop session (June 2020). This information can be implemented by NRRA member agencies in the interim while final project outcomes are being developed.