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: Long-term Testing and Analysis on Asphalt Mix Rejuvenator Field Sections		
Name of Project Manager(s): PI: Jo E. Sias Co-PI: Eshan V. Dave PC: Debbie Sinclair TL: Michael Vrtis	**Phone Number:** 603 862-3277 603 862-5268	**E-Mail** jo.sias@unh.edu eshan.dave@unh.edu
Lead Agency Project ID: NRRA LT1	**Other Project ID (i.e., contract #):** MnDOT Contract No. 1036343 Work Order 01	**Project Start Date:** August 24, 2020
Original Project End Date: August 31, 2024	**Current Project End Date:** August 31, 2024	**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
148,981	9,287	25%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
5%	7,850	20%

Project Description:
Asphalt rejuvenators/recycling agents (RAs) are used to incorporate higher amounts of Reclaimed Asphalt Pavement (RAP) in Hot Mix Asphalt (HMA) without detrimentally impacting the long-term performance of the pavement. RAs are relatively new in the HMA industry and there are many different products marketed to transportation agencies. However, most of these products have limited field and laboratory test data available to support their effectiveness over time. Several recent research efforts have shown that some products, while effective immediately after production, show rapid decrease in effectiveness with aging. Therefore, there is a need for a better understanding of how various RAs perform over time through both laboratory and field evaluations to help guide engineers on appropriate usage of these materials.

The National Road Research Alliance (NRRA) Flexible Team constructed field test sections as part of a mill and overlay project on Trunk Highway 6 (TH6) located in Emily, MN in August of 2019. These field sections include wearing courses with 40% RAP that incorporate seven different RA products, with the dosage determined by the supplier to meet a target extracted and recovered performance grade (PG) of XX-34. In addition to the RA test sections, there are control sections with 40% RAP and 30% RAP (the maximum level allowed on remainder of this project).

The objective of this research project is to evaluate the effectiveness of the seven RA products over time and evaluate their performance as compared to the control mixtures. This will be accomplished through a combination of binder and mixture characterization and performance testing using different laboratory aging levels, field core testing, and performance monitoring of the field sections over time.

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):
Specific progress for various study tasks is provided below.

Task 1 Technical Advisory Panel (TAP) Update/ Monitoring Coordination:
This task is complete. The research team submitted the Task 1 report to the project TAP for review on March 1st, 2021. The report presented: 1) the summary of literature review regarding the available tools and techniques to assess various RA treated asphalt binders/mixtures, as well as the concerns for their long-term performance; 2) the summary of various laboratory aging conditioning methods for simulation of asphalt pavement aging in field, and the discussion of the additional long-term mixture aging level that will be selected for this project. Comments from the project TAP have been requested by the end of March.

Task 2 Annual Interim Update 1st Year -Initial Construction Results.
The research team is working with MnDOT staff to transfer the pavement construction information (including the mix design information and pavement structure details, etc.) for the different field sections, gathered pavement performance data, and completed test results.

Task 3 Plant Produced Mixture and Field Core Testing.
The majority of testing conducted by NRRA agencies has been completed and analyzed by the research team and was presented in the previous quarterly report. The Disk-shaped Compact Tension (DCT) testing on sampled plant-produced mixtures has been completed by MnDOT, testing on mixtures with 6 hrs.@ 135°C aging conditioning level is underway. The research team has completed the complex modulus (E*) testing on the sampled plant-produced mixtures and mixtures with 6 hrs.@ 135°C aging condition. The direct tension cyclic fatigue (DTCF) testing is currently underway. Table 1 below indicates the status of various tests.

Table 1 Status of Laboratory Tests on Sampled Plant Produced Mixtures and Field Cores

Mixture Performance Test	Laboratory Conditioning			Field Cores
	Unaged	6 hrs.@135°C	Additional long-term condition	
Disk-shaped Compact Tension (DCT)				--
Hamburg Wheel Track Testing (HWTT)		--	--	--
Tensile Strength Ratio (TSR)			--	--
Ideal Cracking Test (CT-Index)			--	--
Complex Modulus (E*)				
Direct Tension Cyclic Fatigue (DTCF)				
Stress Sweep Rutting (SSR) Test		--	--	--

Completed Ongoing Not Started

Task 4 Binder Testing:
The research team has completed the rheological characterization (temperature and frequency sweep test using a Dynamic Shear Rheometer (DSR)) and the Fourier-transform Infrared Spectroscopy (FTIR) analysis on the field sampled binders (tank binder and the inline sampled binders; with unaged, RTFO and 20 hrs. PAV conditions) and the binders extracted and recovered from the plant-produced mixtures (with unaged, 20 hrs. PAV, 40 hrs. PAV and 60 hrs. PAV conditions). Table 2 below indicates the status of the rheological and FTIR characterization on project binder samples.

Table 2 Status of DSR and FTIR Tests on Binder Samples

Binder Type	Unaged	Binder Conditioning Levels				Plant Produced Loose Mixture Conditioning Levels	
		RTFO	20 hrs. PAV	40 hrs. PAV	60 hrs. PAV	6 hrs. @ 135°C	Additional long-term condition
Virgin (tank/inline sampled) Binder				--	--	--	--
Binder Extracted and Recovered from Plant Produced Loose Mixture		--					
Binder Extracted and Recovered from Field Cores (top 1/2 inch)		--	--	--	--	--	--

Completed Ongoing Not Started

Task 5 Annual Interim Update 2nd and 3rd Year: No progress to report.

Task 6 Final Report: No progress to report.

Anticipated work next quarter:

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

Task 1: The research team will revise and resubmit the task 1 report once the comments from the TAP are received.

Task 2: The research team will summarize and report as-built details of each field section as well as their current performance provided by MnDOT.

Task 3: Direct tension cyclic fatigue tests conducted on the plant-produced mixtures and the mixtures with 6hrs. @ 135°C aging condition are anticipated to be completed in next quarter. Testing on field cores will be started as well.

Task 4: Linear Amplitude Sweep (LAS) test and SARA (Saturate, Aromatic, Resin, Asphaltene) separation analysis will be conducted on the field sampled binders and the binders extracted and recovered from the sampled mixtures, and with various aging conditions. Characterization of the extracted and recovered binders from field cores is anticipated to begin as well.

Significant Results:

Research team is currently conducting the testing on the project binders and mixtures (as shown in table 1 and 2); the full results and corresponding discussion will be presented in the Task-2 deliverable that is due by the end of August 2021. The DCT results from MnDOT are presented here as a supplement to the other NRRA generated data presented in the previous quarterly report.

Figure 1 below shows the average results (fracture energy G_f) of the DCT test on the plant-produced mixtures performed by MnDOT. RA1-RA7 represents the mixtures with recycling agent (RA) added that were placed on the corresponding field test sections (Cell 6001-6007). 30% RAP indicates the control section with 30% RAP mixture, while 40% RAP represents the mixtures containing 40% RAP with 40% RAP1 shows the mixture sampled from the first day of production and 40% RAP2 indicates the mixture sampled from the second day of production. Generally, higher fracture energy is preferred, indicating the better thermal cracking performance for mixtures. Comparing the three control mixtures (30% RAP, 40% RAP1 and 40% RAP2), mixture 40% RAP1 has the highest G_f value while other two mixtures are comparable. Comparing the mixtures containing RA (RA1-RA7) and the three control mixtures, the RA treated mixtures generally show higher G_f value than the control mixtures (RA7 is lower than 40% RAP1 but is comparable with other two control mixtures). Note that the G_f value for all mixtures evaluated is below the threshold limit of 400 J/m^2.

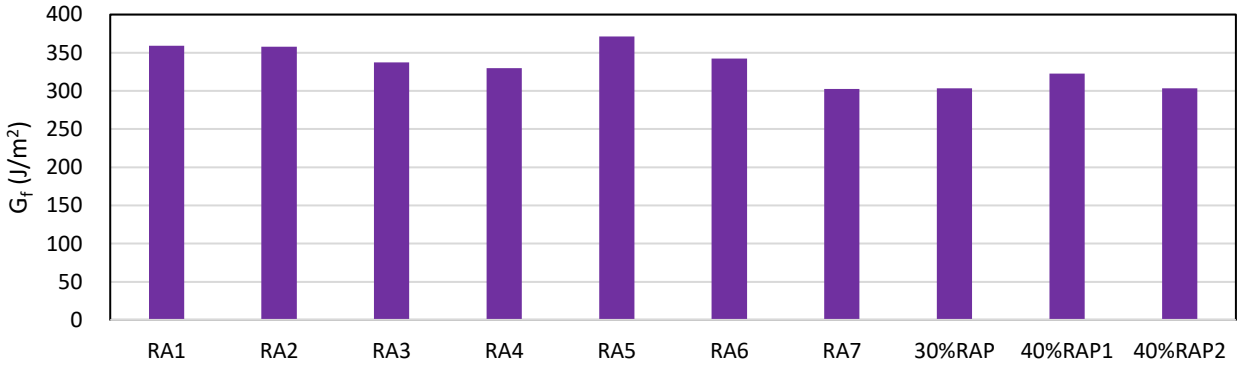

Figure 1 Fracture Energy (G_f) Measured from Disk-shaped Compact Tension (DCT) Test by MnDOT

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).

Nothing to report at this time.

Potential Implementation:

Nothing to report at this time.