MnDOT OFFICE OF MATERIALS
RESEARCH PROJECT WORK PLAN

TITLE OF PROJECT: **HMA Surface Characteristics related to Ride, Texture, Friction, Noise, Durability**

LRRB INV 868, SPR Project Number MPR-6(029)

IS THIS A RESPONSE TO A PROBLEM STATEMENT? ☒ NO ☐ YES
IF YES, STATE NAME OF CONTACT PERSON.

PRINCIPAL INVESTIGATOR (LAST, FIRST, MIDDLE) Clyne, Timothy R.

POSITION TITLE/DEGREES
MnROAD Senior Research Engineer (Principal Engineer)
Bachelor Of Science in Civil Engineering, University of Minnesota
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TOTAL BUDGET: **$300,000**

FUNDING SOURCE	AMOUNT
FHWA	**$ 176,632**
MnDOT SPR	**$ 75,000**
LRRB	**$ 75,000**

TOTAL BUDGET PERIOD:
START DATE: **12/1/2007**
END DATE: **6/30/2013 (revised)**
PROJECT LENGTH (MONTHS):**67**

KEY PERSONNEL OTHER THAN PRINCIPAL INVESTIGATOR.

NAME: **Mark Watson**
POSITION TITLE: **Grad Engineer II**
ORGANIZATION: **MnDOT**
DEGREE(S) **BS and MS in Civil Engineering**
ROLE ON THE PROJECT: **Field Data Collection & Analysis**

NAME: **Mark Swanlund**
POSITION TITLE: **Senior Pavement Design Engineer**
ORGANIZATION: **Federal Highway Administration**
DEGREE(S)
ROLE ON THE PROJECT: **TAP Member, FHWA Rep**

PROJECT LIAISONS

TECHNICAL LIAISON:
NAME: **Greg Johnson**
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ORGANIZATION: **Mn/DOT**

ADMINISTRATIVE LIAISON:
NAME: **Bruce Holdhusen**
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ORGANIZATION: **Mn/DOT**

TECHNICAL LIAISON: (Check one electronic approvals accepted)

Work Plan Approved ☒
Work Plan Approved with Changes Noted ☐
Work Plan Not Approved ☐

PRINT NAME:

DATE:

PRINCIPAL INVESTIGATOR:
I agree to accept responsibility for the scientific conduct of this project and to provide the required progress reports.

SIGNATURE OF
PRINCIPAL INVESTIGATOR:

DATE:

MANAGER, ROAD RESEARCH SECTION :

I hereby certify sufficient staff time will be scheduled for the Principal Investigator to complete the research as outlined in the attached work plan.

SIGNATURE OF
MANAGER ROAD RESEARCH SECTION:

DATE:

DIRECTOR OF RESEARCH SERVICES:

SIGNATURE OF
DIRECTOR OF RESEARCH SERVICES:

DATE:

INTRODUCTION

This study focuses on pavement surface characteristics of several types of HMA pavements. The degree of influence of pavement surface parameters can be understood and applied to project management planning in terms of optimizing pavement surface characteristics while retaining durability. Models and algorithms developed will enhance some desirable pavement characteristics such as reduced noise and improved skid resistance.

OBJECTIVES

The following pavement surface parameters can be included in a global tire-pavement interaction algorithm: ride quality observed in the frequency domain, tire-pavement noise, texture, pavement porosity, effective flow resistivity (EFR) or sound absorption, and friction. These factors influence the tire-pavement interaction mechanism. While porous pavements are more sound absorbent than normal pavements, the EFR ratios can be determined. There is an optimal porosity for durability and sound attenuation characteristics. Though it is acknowledged that, in general, pavements with smaller aggregates and more open surface textures provide more noise reduction than typical dense-graded HMA mixtures, the degree of attenuation can be determined through this research.

Research Matrix & Methods

Several hot mix asphalt cells with various mix designs/surface types will be constructed at the MnROAD facility in 2008. Some of these cells may be constructed for other research studies but will also be studied for their surface characteristics.

HMA Surface Type Matrix

Surface Type	MnROAD Location	Cell(s)
4.75-mm Taconite SMA (Composite Pavement surface)	Mainline	6
Porous Asphalt	Low Volume Road	86, 88
Fine Graded Superpave (various binder grades & RAP %)	Mainline	4, 15, 16, 19, 20, 21, 22
Novachip	Mainline	2, 3
Chip Seal (2 size aggregates)	Low Volume Road	27

One of the goals of this project is to track the change in pavement surface characteristics over time. In order to do that, pavement sections will be monitored on a regular schedule (seasonally and annually) according to the following methods:

- Measure noise with on board sound intensity (OBSI) protocol
- Measure friction with ASTM E-274 and/or dynamic friction tester
- Use laser-equipped devices to monitor texture and ride quality (circular texture meter, Robotex, lightweight profiler)
- Measure Effective Flow Resistivity (EFR), or sound absorption
- Monitor pavement durability in terms of raveling and cracking by way of semi-annual LTPP distress surveys

Work plan

Task 1: Literature Review
A literature review will be performed detailing state-of-the-practice and state-of-the-art techniques for measuring, analyzing, and modeling pavement surface characteristics. The interrelationships between noise, texture, ride, friction, and durability will be reviewed.

Deliverable for Task 1: PowerPoint presentation and summary report.
Duration of Task 1: December 2007 - March 2008

Task 2: Test Section Construction and Initial Monitoring
Construction on several MnROAD test cells used for this study will take place during the Summer of 2008. Immediately after construction texture, friction, noise and ride measurements will be performed. This will serve as baseline measurements for comparison in future data collection efforts. Several pieces of equipment and software will be purchased to assist in data collection and analysis.

Deliverable for Task 2: PowerPoint presentation and summary report.
Duration of Task 2: 6 months from construction

Task 3: Subcontracts for Additional Measurements and Analysis
Outside researchers/consultants will be hired to perform additional surface characteristic measurements that Mn/DOT is not currently equipped to perform. These measurements may include statisical pass by (noise), effective flow resistivity (sound absorption), Robotex (3-D surface texture), rolling resistance (fuel efficiency), and others. In addition, consultants may be hired to perform advanced data analysis on certain surface characteristic measurements (e.g., the effect of texture on sound absorption). Finally, temporary techician staff may be hired at Mn/DOT to perform basic data collection and analysis activities.

Deliverable for Task 3: A summary report and PowerPoint presentation submitted by the subcontractor for each subcontract or activity.
Duration of Task 3: April 2009 - June 2012

Task 4: Seasonal Measurements of Surface Characteristics (2009)
The surface characteristics measurements will be taken at least twice per year for four years in order to quantify the seasonal variation in the parameters and how those parameters change over time. Noise will be measured with On Board Sound Intensity (OBSI) protocol and the sound absorption tube. Texture will be measured with the sand volumetric technique or a laser device. Ride will be measured with the triple and single laser of the lightweight profiler. Friction will be measured with a skid trailer according to ASTM E 274 procedure, the dynamic friction tester, and other devices if they become available. Durability will be measured in terms of pavement raveling and cracking according to a Mn/DOT-modified LTPP distress survey.

Deliverable for Task 4: PowerPoint presentation and summary report.
Duration of Task 4: January - December 2009

Task 5: Seasonal Measurements of Surface Characteristics (2010)
Surface characteristics (noise, texture, friction, ride, durability) will be measured seasonally throughout the year. Comparisons will be made across both time and test section for each measure.

Deliverable for Task 5: PowerPoint presentation and summary report.
Duration of Task 5: January - December 2010

Task 6: Seasonal Measurements of Surface Characteristics (2011)
Surface characteristics (noise, texture, friction, ride, durability) will be measured seasonally throughout the year. Comparisons will be made across both time and test section for each measure.

Deliverable for Task 6: PowerPoint presentation and summary report.
Duration of Task 6: January - December 2011

Task 7: Seasonal Measurements of Surface Characteristics (2012)
Surface characteristics (noise, texture, friction, ride, durability) will be measured seasonally throughout the year. Comparisons will be made across both time and test section for each measure.

Deliverable for Task 7: PowerPoint presentation and summary report.
Duration of Task 7: January - December 2012

Task 8: Analysis of Experimental Data
The field data collected during the project will be analyzed graphically and analytically. Relationships between the various pavement surface characteristics will be identified and characterized. Enhancements to the Traffic Noise Model (based on pavement texture, porosity, roughness, and noise characteristics) will be proposed to the Federal Highway Administration.

Deliverable for Task 5: PowerPoint presentation and summary report.
Duration of Task 8: September 2008 - December 2012

Task 9: Deployment and Implementation
A technical brief will be written and distributed to interested parties both locally and nationally. Revised protocols and/or specifications will be proposed for asphalt mixtures (Mn/DOT Bituminous Office) and noise mitigation techniques (Mn/DOT Office of Environmental Services).

Deliverable for Task 9: PowerPoint presentation and summary report.
Duration for Task 9: October 2012 - March 2013

Task 10: Draft Final Report
A draft final report will be written that documents all of the results of the study. The report will be subject to technical and editorial review.

Deliverable for Task 10: Draft Final Report
Duration of Task 10: October 2012 - March 2013

Task 11: Final Report Completion
As appropriate, the PI will incorporate the comments from the Technical Liaison and members of the Technical Advisory Panel into a Final Report for publication.

Deliverable for Task 11: Draft Final Report
Duration of Task 11: April 2013 - June 2013

BUDGET BY TASK:

Task	Description	Salaries	Consultants	Equipment	Due Date
1	Literature Review	$16,000			March 2008
2	Test Section Construction and Initial Monitoring	$18,000		$50,625*	June 2008
3	Subcontracts for Additional Measurements & Analysis		$76,632		June 2013
4	Seasonal Measurements of Surface Characteristics (2009)	$15,000			December 2009
5	Seasonal Measurements of Surface Characteristics (2010)	$15,000			December 2010
6	Seasonal Measurements of Surface Characteristics (2011)	$15,000			December 2011
7	Seasonal Measurements of Surface Characteristics (2012)	$15,000			December 2012
8	Analysis of Experimental Data	$50,000			December 2012
9	Deployment and Implementation	$20,000			March 2013
10	Draft Final Report	$20,375			March 2013
11	Final Report	$15,000			June 2013
	SUBTOTAL	**$199,375**	**$76,632**	**$50,625**	
	TOTAL	**$326,632**			

* Includes LISA Upgrades ($10,000), OBSI Upgrades ($8000), OBSI Tires ($2000), Dynamic Friction Tester ($30,000), Traffic Noise Model Software ($625)

Project Timeline

Task	Description	07	2008				2009				2010				2011				2012				2013	
		1	4	7	10	13	16	19	22	25	28	31	34	37	40	43	46	49	52	55	58	60	63	66
		D	M	J	S	D	M	J	S	D	M	J	S	D	M	J	S	D	M	J	S	N	M	J
1	Literature Review																							
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