TPF 5-(134) POOLED FUND STUDY
STRATEGY FOR THE EXECUTION OF ROLLING RESISTANCE TESTING AT MNROAD

1) PROJECT TASKS & DELIVERABLES

Synopsis

As part of pooled fund study TPF 5-(134) with the participation of Minnesota and Texas departments of transportation and Federal Highway (FHWA), a strategy to measure rolling resistance of all the pavement surfaces at the MnROAD test facility is discussed. Rolling resistance is a pavement surface characteristic that is indicative of fuel efficiency based on tire pavement interaction. Proficiency in the measurement of rolling resistance (RR) is rare and resides primarily with the Technical University of Gdansk Poland as well as VTI Sweden with Professor Jerzy (Jurek) Ejsmont and Professor Ulf Sandberg as the respective experts in these institutions.

Scope

This project will measure rolling resistance and provide a detailed report as well as results of the measurements taken on all the cells at MnROAD as well as the identified surface(s) in the network near the MnROAD facility. At present, 18 surface types are identified at MnROAD as shown in the accompanying table (Table 1) and one surface type absent from the MnROAD facility is situated at a moderate distance from MnROAD.

Prior to measurement, all necessary equipment will be shipped by air from Poland. The air shipment option is preferred to the alternative because of the time saving it offers. During the testing, Mn/DOT will provide the required minivan and/or sport utility vehicle (SUV) to which the RR equipment shall be articulated and used for testing. Mn/DOT will also provide a designated person to assist Jerzy Ejsmont during the testing. Mn/DOT will provide closure to the MnROAD Lanes during testing at MnROAD and traffic controls for moving operations on US Highway 212 for the Stone Matrix Asphalt (SMA) test section outside MnROAD.

After the testing of the identified cells, test results from each cell and a test report for the RR testing project shall be shall be submitted to the Mn/DOT project manager. Mn/DOT will place data in the Mn/DOT data base and publish the test report according to the format of the Mn/DOT research services. The equipment shall be shipped back to Gdansk after the testing. If the research team suspects that RR may be correlated to any other surface variable, a list of surface characteristics measurements conducted at MnROAD is attached for convenience. Data from routine tests are available in the database and shall be provided by Mn/DOT upon request.

Project Execution

This texting shall be executed as an additional task in the data analysis contract with Minnesota State University, Mankato. Minnesota State University will ensure that the testing and reporting as well as the shipments that facilitate the testing are carried out.

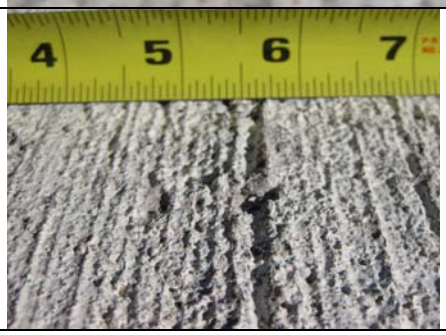
Project Duration and Deliverables

Mn/DOT provides an extended lane closure in September 2011 with a possible flexibility to extend closure by a few days to ensure that this testing is conducted. Shipments and clearing protocols shall be performed prior to September 2011 to utilize this window. Test results may be submitted to Mn/DOT immediately after testing but a test report may be submitted at least 4 weeks after the completion of testing.

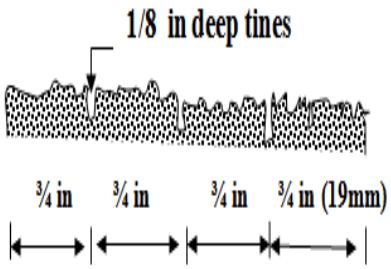
2) PAVEMENT SURFACES

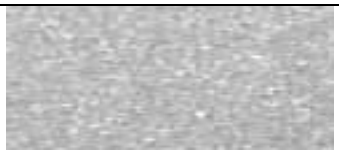
Pavement Surfaces to be measured are described in table 1. Of the Surfaces described only the stone Matrix asphalt surface is located outside of the MnROAD Tracks.

Table 1
Pavement Surfaces for Rolling Resistance Testing at MnROAD and Network

TEXTURE TYPE	PICTURE	GEOMETRIC/ OTHER FEATURES
Conventional Diamond Grind Cells 5, 8, 37 (TS3) and 71 (Passing)		• Groove Width – 3.75 mm • Groove Depth – 1.2 mm • Asperity Interval – 6
Innovative Diamond Grind Cells 7 and 37 (TS1 and 2)		• Groove Width – 3.75 mm • Groove Depth – 1.25 mm • Asperity Interval – 12.5 • TS1 – 1 Pass • TS2 – 2 Pass
Ultimate Diamond Grind Cell 9		• Groove Width – 3.75 mm • Groove Depth – 8 mm • Asperity Interval – 15
2010 Ultimate Diamond Grind Cells 37 (TS5) and 71 (Driving). Replicate of I-35 Duluth Grind		• Groove Width – 3.75 mm • Groove Depth – 8 mm • Asperity Interval – 15
Longitudinal Turf Drag Cells 13, 32, 52, 54, 60, 61,62 and 63		• Groove Width – 2 mm • Groove Depth – 1 mm • Asperity Interval – 2

TEXTURE TYPE	PICTURE	GEOMETRIC/ OTHER FEATURES
Transverse Tine Cells 12, 36, 37 (TS4 and Inside), 38 and 96		• Groove Width – 5 mm • Groove Depth – 1.5 mm • Asperity Interval – 18
Longitudinal Broom Drag Cell 14		• Groove Width – 2 mm • Groove Depth – 1 mm • Asperity Interval – 2
Transverse Broom Drag Cell 53		Inside • Groove Width – 2 mm • Groove Depth – 1 mm • Asperity Interval – 2 Outside • Groove Width – 3 mm • Groove Depth – 1.5 mm Asperity Interval – 2
Exposed Aggregate Cell 72		• Groove Width – 4 mm • Groove Depth – 2 mm • Asperity Interval – 8mm
Pervious Concrete Cells 64, 85 and 89		Used CA-70 with 13 to 18 percent porosity.

TEXTURE TYPE	PICTURE	GEOMETRIC/ OTHER FEATURES
Pervious Overlay Cell 39		Used CA-70 with 18 to 21 percent porosity.
Longitudinal Tine Proposed for Cell 6 June 2011		• Pre-textured with Astro Turf Drag • Tine at ¾ inch Interval • 1/8 inch tine depth
Ultra Thin Bonded Wearing Course Cells 2 and 3		• Gap graded mixture "Novachip" • 9.5 mm NMAS • PG 64-34 (5.1% AC)
4.75 mm Taconite Cell 6		• Fine graded superpave mix • 4.75 mm NMAS • PG 64-34 (7.4% AC) • Will be removed Summer 2011
Chip Seals (FA-2 and FA-3) Cell 27		• 4.75 or 9.5 mm NMAS • CRS-2P emulsion

TEXTURE TYPE	PICTURE	GEOMETRIC/ OTHER FEATURES
12.5 mm Dense Graded Superpave Cells 1, 4, 15, 16, 17, 18, 19, 20, 21, 22, 23, 28, 31, 33, 34, 35, 70, 77, 78, 79, 83, 84 and 87		• 12.5 mm NMAS • 0, 20, or 30% RAP • 0 or 5% recycled shingles • PG 58-28, 58-34, 64-34 (various binder sources and modifiers) • AC contents 4.8 to 5.7%
12.5 mm Dense Graded Superpave Plus Fog Seals Cell 24		• 12.5 mm NMAS • 20% RAP • PG 58-34, (5.2% AC)
Porous Hot Mixed Asphalt Cells 86 and 88		• Open graded porous mix • 18% air voids • 12.5 mm NMAS • PG 70-28 (5.5% AC)
SURFACES OUTSIDE MNROAD		
Stone Matrix Asphalt **TH 212** • RP 147.59 From W end of Bridge Near County Road 10 Westwards to RP 140 approx	 	• 12.5 mm aggregate size • Inset 2: Transition from Concrete to SMA, East Limits)

3) SURFACE CHARACTERISTICS TESTS

Routine and non-routing surface characteristics tests are conducted on the MnROAD tracks. These tests are briefly described.

ROUTINE SURFACE CHARACTERISTICS TESTS ON MNROAD SURFACES

1) **On Board Sound Intensity (OBSI) AASHTO TP 76-09.**
   Output: Pavement Noise

2) **Sound Absorption (ASTM E-1050 Modified for In-situ Testing).**
   Output: Sound Absorption Coefficient (targeted at flexible pavements and pervious pavements

3) **Mean Profile Depth MPD ASTM E 2157 using the Circular Track Meter:**
   Output: Mean Profile Depth ≈ Mean Texture Depth

4) **Friction using Lock wheel Skid Tester ASTM E-274 Ribbed Tire & Smooth Tire ASTM E501** Output: Friction Number FN (Ribbed) FN Smooth

5) **Pavement Smoothness using Lightweight Profiler ASTM E 950**
   Output: International Roughness index (IRI), RN

6) **Pavement Smoothness using Pathways Surface Van ASTM E950**
   Output: International Roughness index (IRI), RN, Rut Depth, Faulting

NON-ROUTINE SURFACE CHARACTERISTICS TESTS ON MNROAD SURFACES

1) **Friction using Grip Tester**
   Output: Grip Number (Only a few data points so far)

2) **Friction Using Dynamic Friction Tester ASTM E-1911:**
   Output: International Friction Number (IFI), FN

3) **Friction Using British Pendulum: ISO**
   Output British Pendulum Number (BPN)

4) **Pavement Smoothness using SurPro Walking Profiler ASTM E-1364**

Output: International Roughness index (IRI)

5) **Texture Measurement with Sand Volumetric Technique ASTM E-965**
Output: Mean Texture Depth (MTD)

4)ADDITIONAL INFORMATION FROM TEST CELLS

MnROAD provides a whole gamut of pavement and environmental as well as traffic variables (1) (2) (3). For instance the low volume road outside lane is environmentally loaded (no –traffic) whereas the inside lane is loaded 80 times a day 5 days a week with an 80 kilo-pound 5-axle semi-trailer. The mainline driving and passing lanes are equipped with Weigh in Motion (WIM) devices that have shown that the traffic levels are remarkably different between driving and Passing lanes.

From the referenced cell structure and surface layout, variability in design, construction, pavement structure and pavement types becomes evident. MnROAD is also equipped with a weather station that facilitates weather monitoring.

However, data on surface condition are not continuously collected. Occasionally our pavement inspection vehicle records surface rating approximately 2 times a year. The MnROAD operations team occasionally does a distress survey as well.

REFERENCES

1) Minnesota Department of Transportation. Layout of MnROAD Mainline URL http://www.dot.state.mn.us/mnroad/testsections/mainline.html. Assessed 2/22/11

2) Minnesota Department of Transportation. Layout of MnROAD Mainline URL http://www.dot.state.mn.us/mnroad/testsections/lowvolume.html Assessed 2/22/11

3) Minnesota Department of Transportation. Layout of MnROAD Farm Loop. URL http://www.dot.state.mn.us/mnroad/testsections/farmloop.html. Assessed 2/22/11