MnROAD Research Facility & NRRA

2017 WAPA Annual Meeting
Presented by Barry Paye, P.E. (WisDOT)
Written by Benjamin Worel, P.E.
States Needs

Minnesota Highway System

- 2013: Average RSL = 9.4 years
- 2000: Average RSL = 13.7 years
MnROAD Background

• MnROAD Owned and Operated by Minnesota DOT
• 23-Years of Long Term Customer Service

• HMA and PCC Pavements
• New and Rehabilitation

• Major Experiments
  • Phase I (1994-2006)
  • Phase II (2007-2016)
  • Phase III (2017-??)
MnROAD Initial Layout

Existing I-94
MnROAD Mainline (Started 1994)

MnROAD “Mainline”, Westbound Interstate-94

W.B. I-94 Traffic Diverted (3 days / month)
MnROAD Low Volume Road (Started 1994)
MnROAD I-94 Westbound (Started 2010)
**MnROAD Traffic Loading**

**Low Volume Road**
- 5-axle Tractor-Trailer Truck
- 80,000 Inside Lane = 5 days/week
- Outside Lane Environmental

<table>
<thead>
<tr>
<th>Type</th>
<th>Rigid ESALs/yr</th>
<th>Flexible ESALs/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rigid</td>
<td>~ 25,500</td>
<td>~ 16,000</td>
</tr>
</tbody>
</table>

**Interstate Mainline**
- I-94 WB Public Traffic
- 29,700 AADT -- 13% HCAADT (2013)

<table>
<thead>
<tr>
<th>Type</th>
<th>Rigid ESALs/yr</th>
<th>Flexible ESALs/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rigid</td>
<td>~ 1.2 Million</td>
<td>~ 0.8 Million</td>
</tr>
</tbody>
</table>
MnROAD Test Sections / Studies

MnROAD Overall Studies
- 35 unique ongoing studies
- 141 unique test sections

Interstate 94 Westbound
- Mainline (3.5 miles)
  - 12 ongoing studies / 44 test sections
- Old Westbound (3.5 miles)
  - 4 ongoing studies / 48 test sections

Low Volume Road
- Local Road Research Board
- (Minnesota City and Counties)
- 19 Studies / 49 test sections

Additional Offsite Test Sections
- Partnership - National Center Asphalt Technology (NCAT)
- 50 Test Sections south of Milaca – US-169 and CSAH-8
MnROAD Operations

- Research Development / Partnerships
- Coordination of Construction

- Traffic Loadings
- Performance Monitoring
  - Cracking / Rutting / Ride / FWD, ..... 

- Sensors
  - Static (Environmental)
  - Dynamic (Traffic Loading)

- MnROAD Database

- Technology Transfer
MnROAD Benefits

Phase-1

**9:1** B/C Ratio

Seasonal Load Restrictions; Low Temp Cracking

Phase-2

**5:1** B/C Ratio

- Surface Characteristics (HMA/PCC), Pervious Pavements, **Implements Husbandry, Stabilized Full Depth Reclamation**, Lightly Surface Roadways, Chip Seal Video, Whitetopping, Thin PCC, Optimal Timing of Preventive Maintenance, **Low Temperature Cracking II, Quiet Rumble Strips, Drainable/Stabile Bases**
MnROAD NCAT Partnership
National Research Initiatives

National Pavement Preservation Study
Development of a National Cracking Test
2015 Pavement Preservation Research Sponsors

Pooled Fund Study
3-Year
(2015-2018)
$120K / Year

15 States + Industry
MnROAD NCAT Preservation

• **Partnership**
  - MnROAD (North) / NCAT (South)
    - **Offsite** Low and High Volume Road Installations
  - FP² / National Center for Pavement Preservation
  - Government / Academia / Industry involvement

• **Goals**
  - National Study (Climatic zones)
  - Provide consistently collected data / analysis
  - Quantify the life extending benefits
Northern Layout of US-169/CSAH-8

Mille Lac County

Northern High Traffic Preservation on US-169 4 mile

Northern Low Traffic Preservation CSAH-8 2.5 mile
2015 HMA Performance Test
Research Sponsors

Pooled Fund Study
3-Year
(2015-2018)
$210K / Year

14 States
National HMA Cracking Performance Test

• **Partnerships**
  • Utilize both MnROAD / NCAT Test Tracks
    • Top Down / Reflection / LTC cracking Efforts
    • Range of cracking potential mixes
    • Battery of testing of many different existing tests Nationally

• **Goals**
  • We need tests and criteria that relate to performance.
  • We need tests that are practical for both mix design verification and quality control testing purposes.
  • We need tests that accommodate recycled materials, new and future additives, and combinations.
2016 MnROAD Construction
HMA Performance Testing Experiment

MnROAD Test Sections

LTC Cracking
## 2016 MnROAD Mix Designs
### HMA Performance Test Experiment

<table>
<thead>
<tr>
<th>MIX DESCRIPTION</th>
<th>RAP</th>
<th>RAS</th>
<th>CELL</th>
<th>BINDER</th>
<th>Aggregate Size</th>
<th>POLY</th>
<th>CRACK POTENTIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Temp Mix</td>
<td>~30</td>
<td>5</td>
<td>16</td>
<td>PG 64S-22</td>
<td>12.5mm</td>
<td>No</td>
<td>High</td>
</tr>
<tr>
<td>High Temp Mix</td>
<td>&lt;20</td>
<td>3</td>
<td>17</td>
<td>PG 64S-22</td>
<td>12.5mm</td>
<td>No</td>
<td>High</td>
</tr>
<tr>
<td>High Temp Mix</td>
<td>&lt;20</td>
<td>0</td>
<td>18</td>
<td>PG 64S-22</td>
<td>12.5mm</td>
<td>No</td>
<td>Med/High</td>
</tr>
<tr>
<td>High Temp Mix + regressed voids (3.0)</td>
<td>&lt;20</td>
<td>0</td>
<td>19</td>
<td>PG 64S-22</td>
<td>12.5mm</td>
<td>No</td>
<td>Med/High</td>
</tr>
<tr>
<td>Soft Binder Mix</td>
<td>&gt;30</td>
<td>0</td>
<td>20</td>
<td>PG 52S-34</td>
<td>12.5mm</td>
<td>No</td>
<td>Med</td>
</tr>
<tr>
<td>Typical Low-Temp Mix</td>
<td>&lt;20</td>
<td>0</td>
<td>21</td>
<td>PG 58H-34</td>
<td>12.5mm</td>
<td>Yes</td>
<td>Low</td>
</tr>
<tr>
<td>Typical Low-Temp Mix + limestone</td>
<td>&lt;20</td>
<td>0</td>
<td>22</td>
<td>PG 58H-34</td>
<td>12.5mm</td>
<td>Yes</td>
<td>Low/Med</td>
</tr>
<tr>
<td>HiMA Mix</td>
<td>&lt;15</td>
<td>0</td>
<td>23</td>
<td>PG 64E-34</td>
<td>12.5mm</td>
<td>Yes</td>
<td>Low</td>
</tr>
</tbody>
</table>
Phase-II MnROAD and NCAT Partnership
Proposed Research Efforts

Pavement Preservation
3 Year Pooled Fund Study
2019-2021 (MN Lead)
$50K / Year

HMA Performance Test
3 Year Pooled Fund Study
2019-2021 (AL Lead)
$100K / Year
Strategic Implementation Through Cooperative Pavement Research
What is NRRA?

• Pooled fund (Started April 2016 – 5 years)
• Fulfill regional and national road research needs
• Foster innovation with member states, academia and industry
  – Best Utilize
    • Each Members Research Efforts
    • MnROAD Test Track
      – Direct Phase-III of MnROAD Construction
      – $3 million in MnDOT funding
• Develop innovative technologies
• Focus on implementation, technology transfer, and training into research projects from the ground up
• 6 States and 40 Associate Members
• Executive Committee (states)
• 5 Technical Teams (states and associates)
  – Monthly Online Meetings
• Investment in Research
  – 65% Research ~$1,825,200
  – 30% Tech Transfer ~$842,400
  – 5% Administration ~$140,400
Flexible Team

The flexible team is comprised of technical experts in the area of new and rehabilitation of asphalt roadways. Activities include prioritization of short and long term research, development of long term research test sections at MnROAD and providing input to the technology transfer team on what should be marketed.

Current Projects and Resources

Team Research Development
- Voted on Research Topics - Presented at the EC on July 21st (WORD)

Tech Transfer Write-ups
1. Longitudinal Joint Construction Performance (NRRA Original Statement) - March 2017 (WORD)
   - State of Practice "Longitudinal Joint Construction" - draft March 2017 (WORD)
   - California Longitudinal Joint Treatment Spec (PDF)
   - Illinois Longitudinal Joint Treatment Spec (PDF)
Agency Members

Imad Basheer - Caltrans
Paul Denkler - MoDOT
Shongtao Dai - MnDOT
James Foldesi - St. Louis Co. MN
Kee Foo - Caltrans
John Garrity - MnDOT
Steve Hefel - WisDOT
Kevin Kennedy - MDOT
Dan Kopacz - WisDOT

Dan Oesch - MoDOT
Barry Paye (Chair) - WisDOT
Jim Trepanier - IDOT
Charles Wienrank – IDOT
Ben Worel – MnDOT
Tim Clyne - MnDOT
Dave Van Deusen – MnDOT
Gerry Geib – MnDOT

Develop ◀ Collaborate ◀ Research ◀ Implement ◀ Sustain.
Associate Members

Jay Bianchini – Collaborative Agg.
Gina Buccelato - 3M Transportation
Mike Byrnes - Mathy Const. Co.
Andy Cascione - Flint Hills
Jo Sias Daniel – U of New Hampshire
Kris Hansen - 3M Transportation
Lev Khazanovich - U of Pittsburgh
Mihai Marasteanu - U of Minnesota

Ken Maser - Infrasense
Dave Rettner - AET
Dan Staebell - APA
Brandon Strand - APA
Jill Thomas - MAPA
Randy West - NCAT
Jason Wielinski - ARRA
Zhanping You - Michigan Tech
Short Term Research Investment

Flexible Team
- Effective use of Tack Coats
- Longitudinal Joint Construction Performance

Rigid Team
- Design and Performance of Concrete Unbonded Overlays
- Repair of Joint Associated Distress Pavements

Geotechnical Team
- Larger Subbase Materials
- Subgrade Design for New and Reconstructed

Pavement Preservation Team
- Surface Characteristics of Diamond Ground PCC
- Pavement preservation approaches for lightly surfaced roadways
The purpose of this tech transfer project is to compile a synthesis of best practices being used by NRRA members in the area of tack coats and to identify any gaps in the research.
The construction of longitudinal joints in an asphalt pavement is typically the most difficult to achieve high density due to viscosity of pavements at high temperatures.

The goal of this Tech Transfer would be to compile research and specifications from the NRRA states and others into a synthesis for publication.
<table>
<thead>
<tr>
<th>Team</th>
<th>Projects/Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexible Team</td>
<td>• HMA Overlay of Concrete and Methods of Enhancing Compaction</td>
</tr>
<tr>
<td></td>
<td>• Cold Central Plant Recycling</td>
</tr>
<tr>
<td>Rigid Team</td>
<td>• Fiber Reinforced Concrete Pavements</td>
</tr>
<tr>
<td></td>
<td>• Early Opening Strength to Traffic</td>
</tr>
<tr>
<td></td>
<td>• Optimizing Cement Content for PCC Mixes</td>
</tr>
<tr>
<td>Geotechnical Team</td>
<td>• Recycled Aggregates in Aggregate Base and Larger Subbase Materials</td>
</tr>
<tr>
<td>Pavement Preservation Team</td>
<td>• Maintaining Poor Pavements</td>
</tr>
<tr>
<td></td>
<td>• Partial Depth Repair</td>
</tr>
</tbody>
</table>

Develop Collaborate Research Implement Sustain
Flexible Team - **HMA Overlay and Rehab of Concrete and Methods of Enhancing Compaction**

- University of New Hampshire
- 12 Test Sections + 1 Control
- 7 unique Mixes
- 3/4” - 1.5” - 4” Overlays
- 1 Undersealing PCC

Goal - Designing better asphalt overlay mixes placed on deteriorated concrete. How do different mixtures aid in enhancing compaction and how they may reduce reflective cracking?

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>CELL</th>
<th>DEPTH (inch)</th>
<th>MIX DESCRIPTION (NMAS, mm)</th>
<th>BINDER</th>
<th>DESIGN Voids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Section</td>
<td>983</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>HMA over PCC (1 lift)</td>
<td>984</td>
<td>1.50</td>
<td>Superpave (9.5)</td>
<td>58H-28</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>985</td>
<td>1.50</td>
<td>Superpave (12.5)</td>
<td>58H-28</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>986</td>
<td>1.75</td>
<td>Superpave (12.5)</td>
<td>58H-28</td>
<td>4.0</td>
</tr>
<tr>
<td>HMA over PCC (2 lifts)</td>
<td>987</td>
<td>1.50</td>
<td>Superpave (9.5)</td>
<td>58H-28</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.50</td>
<td>Superpave (19.0)</td>
<td>58H-28</td>
<td>4.0</td>
</tr>
<tr>
<td>HMA over PCC (2 lift)</td>
<td>988</td>
<td>1.75</td>
<td>Superpave (12.5)</td>
<td>58H-28</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.25</td>
<td>Superpave (19.0)</td>
<td>58H-28</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>989</td>
<td>1.75</td>
<td>Superpave 95/5 (12.5)</td>
<td>58H-28</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.25</td>
<td>Superpave (19.0)</td>
<td>58H-28</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>990</td>
<td>1.75</td>
<td>Regressed voids design (12.5)</td>
<td>58H-28</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.25</td>
<td>Superpave (19.0)</td>
<td>58H-28</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>991</td>
<td>1.75</td>
<td>Superpave (9.5)</td>
<td>58H-28</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.25</td>
<td>Superpave (19.0)</td>
<td>58H-28</td>
<td>4.0</td>
</tr>
<tr>
<td>HMA over PCC w/interlayer</td>
<td>992</td>
<td>1.50</td>
<td>Superpave (9.5)</td>
<td>58H-28</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.00</td>
<td>Crack inhibiting interlayer (4.75)</td>
<td>58E-34</td>
<td>2.0-3.0</td>
</tr>
<tr>
<td>HMA over PCC w/PASSRC</td>
<td>993</td>
<td>1.50</td>
<td>Superpave (9.5)</td>
<td>58H-28</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.00</td>
<td>Permeable interlayer mix</td>
<td>64S-22</td>
<td>-</td>
</tr>
<tr>
<td>HMA over PCC (1 lift)</td>
<td>994</td>
<td>1.50</td>
<td>Ultra-Thin Bonded Wearing Course with PCC/Soil Stabilization</td>
<td>58V-34</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>995</td>
<td>0.75</td>
<td>Superpave (9.5)</td>
<td>58H-28</td>
<td>4.0</td>
</tr>
</tbody>
</table>
Overlay Cells

Cell 995 – Tacking Paver

Cells 989/990 – Superpave 5/Regressed
Goal - Demonstrating the use of cold central plant mix recycling technology to best utilize RAP stockpiles into new roadway layers.

- American Engineering and Testing
- 4 Test Sections
  - Foam vs Emulsion
  - 2X Chip vs 1.5” HMA Overlay

How can states be green in recycling but not impact long term performance?
Cold Central Plant Recycling

Cell 133 Chip Application

Cell 233 Fog Seal

Develop ↔ Collaborate ↔ Research ↔ Implement ↔ Sustain.
How to Get Involved

• **Research Pays Off Seminar Series**
  - Every 3rd Tuesday
  - 10-11 am
  - Started in June 2015

• **NRRA**
  - Follow NRRA on LinkedIn
  - May 23-24, 2018 Conference
  - States Membership – 150K
  - Associates Membership – 2K

• **MnROAD / NCAT Phase-II**
  - March 27-29, 2018 Conference
  - NCAT Opportunities
  - HMA Performance Test – 100K
  - Pavement Preservation – 50K

• **Research Partnerships**
  - Looking for opportunities
  - Offsite pavement studies
  - Sharing of Materials
  - Track / Track / HVS.....
Questions?
Benjamin Worel
ben.worel@state.mn.us

Barry Paye
Barry.paye@dot.wi.gov

NRRA Website
www.dot.state.mn.us/mnroad/nrra/