MnROAD Research Advancements through National Partnerships

December 12, 2018
Ben Worel – MnROAD Operations Engineer
MnROAD Research Advancements through National Partnerships

Why Research

MnROAD Background

Partnerships/Advancements

Outreach/Future
First of All – Thank you Illinois

Current Pooled Funds (MnDOT)
- National Accessibility
- Clear Roads
- National Road Research Alliance
- Enhancement Intelligent Construction Data Management System (Veta)
- NCAT Pooled Fund
  - Cracking Experiment
  - Preservation Experiment

Past Pooled Funds
- Low Temperature Cracking (phase-I and II)
- 2008 MnROAD Phase-II Research
- Wide Based Tires
- Many others + University of Illinois Studies
Why Invest into Pavement Research?

Minnesota Highway System

Bar graph showing the percent roadway miles by remaining service life in years. The average remaining service life (RSL) in 2000 is 13.7 years.
Why Invest into Pavement Research?

Minnesota Highway System

- 2013 Average RSL = 9.4 years
- 2000 Average RSL = 13.7 years
MnROAD History

- MnROAD Owned and Operated by Minnesota DOT
- 23-Years of Long Term Customer Service
  - Minnesota Department of Transportation
  - Minnesota Local Road Research Board
  - SHRP II / NCHRP / FHWA
  - Pooled Funds Efforts (States) / Industry

- HMA and PCC Pavements
- Major Experiments
  - Phase I (1994-2006)
  - Phase II (2007-2016)
  - Phase III (2017 - )

NRRA
MnROAD and Minnesota Test Sections

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
- (MN - City and Counties)
- 19 Studies / 49 test sections

Additional Offsite Test Sections
- Partnership - National Center Asphalt Technology (NCAT)
  - US-169 and CSAH-8
  - 70th and 80th Street (2019)
MnROAD Operations Research Support

- Research Development
- Partnerships
- Construction

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

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

- MnROAD Database
Plow and Salt
Interstate 94 – Bare Pavement Policy
Low Volume Road – Like a county road

Limited Performance Monitoring
National Research Initiatives

National Pavement Preservation Study
Development of a National HMA Cracking Test
MnROAD/NCAT Partnership

• Partnership
  • Build Off of Lee Road 159 Experience
  • 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)
  • Construction Consistency
  • Provide consistently collected data / analysis
  • Quantify the life extending benefits
Preservation Group (PG) Experiment

- Performance = $f$ (condition, traffic, climate)
- Good team(!), materials, designs, placements
- Design verifications using actual onsite materials
- All rates pre-calibrated and verified as placed
- MAP-21 (cracking, rutting, roughness) focus
- Many other non MAP-21 performance measures
- Consistent Contractor
- MnDOT Lead State for Phase-II
## Roadway Details

<table>
<thead>
<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Traffic volume</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>High</td>
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<tr>
<td>Thickness (inch)</td>
<td>5.5</td>
<td>9.9</td>
<td>7.0</td>
<td>6.5</td>
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<tr>
<td>Section length (feet)</td>
<td>100</td>
<td>528</td>
<td>528</td>
<td>528</td>
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<td># Test Sections</td>
<td>23</td>
<td>34</td>
<td>22</td>
<td>21</td>
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<tr>
<td>Age (Years) @placement</td>
<td>14</td>
<td>9</td>
<td>6</td>
<td>6</td>
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</table>
### Northern Layout of US-169/CSAHi-8

#### Traffic Layers
- **7.5" HMA**
- **PG58-28**
- **12" Granular Base**
- **Clay Subgrade**

#### Section Numbering
- 169
- 000
- 169
- 001
- ... so on
- 8
- 001
- 8
- 002
- ... so on

#### Control Treatments
- **Control - High IRI**
- **Control - Low IRI**
- **Control**

#### Microsurfacing Treatments
- **Microsurfacing (Type II)**
- **Microsurfacing (Type II with fibers)**
- **Double Microsurfacing (Type II over Type II)**
- **Triple Chip Seal (FA 2 over FA 2.5 over CA-70)**
- **Double Chip Seal (FA 2 over FA 2.5)**
- **Single Chip Seal (FA 2.5)**
- **Crack Seal / Transverse Mastic**

#### Other Treatments
- **Scrub Seal (FA 2.5)**
- **Microsurfacing (Type II) over Scrub Seal (FA 2.5)**
- **Fibermat Chip Seal (FA 2.5)**
- **Triple Chip Seal (FA 2 over FA 2.5 over CA-50/70)**
- **Double Chip Seal (FA 2 over FA 2.5)**
- **Single Chip Seal (FA2.5) over Crack Seal / Transverse Mastic**

#### Preservation Treatments
- **Crack Seal / Transverse Mastic**
- **Control**
- **Control**
- **Control**

#### High Traffic Preservation on US-169

#### Low Traffic Preservation CSAH-8
Test Section Layout - Assessment
Test Sub-Sections
Test Sub-Sections

Utilizing FHWA Performance Measures
Benefits = \( f(\text{Pretreatment Condition}) \)
Crack Sealing
Chip Seal Over Crack Sealing
Chip Seal
Double Chip Seal
Triple Chip Seal
Virgin Thinlay
ABR Thinlay
UTB Thinlay
Open Graded Friction Coarse “OGFC”

OGFC/PCC conventional tack
OGFC/PCC ultrafuse tack
OGFC/HMA ultrafuse tack
OGFC/HMA conventional tack

August 2016 – Harddrives Contractor
Alabama Study Observations

- **Lee Road – 159 Initial Analysis Starting Place**
  - Developing the subsection analysis
  - Tied to FHWA performance measures

- **Route and Seal – Good as a stand alone treatment**

- **Overbanding – Good with Treatment Combinations**

- **3X Chips (High Vol) – Bleeding tendency**

- **Thinlays good performance**

<table>
<thead>
<tr>
<th>Category</th>
<th>% Cracking</th>
<th>Rutting, mm</th>
<th>IRI, in/mi</th>
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<tr>
<td>Good</td>
<td>&lt; 5</td>
<td>&lt; 5</td>
<td>&lt; 95</td>
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<tr>
<td>Fair</td>
<td>5 – 20</td>
<td>5 – 10</td>
<td>95 – 170</td>
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<tr>
<td>Poor</td>
<td>&gt; 20</td>
<td>&gt; 10</td>
<td>&gt; 170</td>
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</tbody>
</table>
Minnesota Study Observations

- Early – only 2 winters
- Thermal Cracking Observations
- Snow Plow Damage
- Development of a MicroSurfacing Field Test
Northern Cold Recycle, HIR, FDR
Cracking Group (CG) Study

Alabama Lead State for Phase-II
### 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>
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<tr>
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<td>5</td>
<td>16</td>
<td>PG 64S-22</td>
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<td>High</td>
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<tr>
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<td>3</td>
<td>17</td>
<td>PG 64S-22</td>
<td>12.5mm</td>
<td>No</td>
<td>High</td>
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<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>
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<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>
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<tr>
<td>Soft Binder Mix</td>
<td>&gt;30</td>
<td>0</td>
<td>20</td>
<td>PG 52S-34</td>
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<td>No</td>
<td>Med</td>
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<tr>
<td>Typical Low-Temp Mix</td>
<td>&lt;20</td>
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<td>21</td>
<td>PG 58H-34</td>
<td>12.5mm</td>
<td>Yes</td>
<td>Low</td>
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<tr>
<td>Typical Low-Temp Mix + limestone</td>
<td>&lt;20</td>
<td>0</td>
<td>22</td>
<td>PG 58H-34</td>
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<td>Low/Med</td>
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<tr>
<td>HiMA Mix</td>
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<td>23</td>
<td>PG 64E-34</td>
<td>12.5mm</td>
<td>Yes</td>
<td>Low</td>
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National Road Research Alliance

Pooled Fund Project
• Phase-I (2016-2019)
• 7 States
• ~50 Associates

Membership
• Big States – 150K/year
• Small States – 75K/year
(based on more/less than MnDOT SPR $)

Associate Members
(Universities, Industry, Associations, Consultants)
• 2K/year

Looking for future partners -
http://www.dot.state.mn.us/mnroad/nrra/index.html
National Road Research Alliance

How it works

- **Funded So Far:**
  - 8 Long Term Research Projects
  - 8 Short Term State of Practice
  - Implementation
  - Technology Transfer
  - 6-8 more projects in 2019

- **Proposed Future Use**
  - NCAT type of overall pooled fund expected in 2021

Looking for future partners -
http://www.dot.state.mn.us/mnroad/nrra/index.html
Looking for future partners - http://www.dot.state.mn.us/mnroad/nrra/index.html
## Technology Transfer
### Short Term Research

<table>
<thead>
<tr>
<th>NRRA Team</th>
<th>Topic</th>
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<tbody>
<tr>
<td><strong>Flexible</strong></td>
<td><strong>Tack Coats</strong></td>
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<tr>
<td></td>
<td><strong>Longitudinal Joint Construction Performance</strong></td>
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<tr>
<td><strong>Rigid</strong></td>
<td><strong>Design and Performance of Concrete Unbonded Overlays</strong></td>
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<td><strong>Repair of Joint Associated Distress Pavements</strong></td>
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<tr>
<td><strong>Geotechnical</strong></td>
<td><strong>Larger Subbase Materials</strong></td>
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<td><strong>Subgrade Design for New and Reconstructed Roadways</strong></td>
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<tr>
<td><strong>Pavement Maintenance</strong></td>
<td><strong>Surface Characteristics of Diamond Ground PCC Surfaces</strong></td>
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<td><strong>Pavement Preservation Approaches for Lightly Surface Roadways</strong></td>
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**SRF Consulting**
<table>
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<tr>
<th>Team</th>
<th>Project</th>
<th>Contractor</th>
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</thead>
<tbody>
<tr>
<td>Flexible</td>
<td>HMA Overlay of PC and Methods of Enhancing Compaction</td>
<td>University of New Hampshire</td>
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<td>Cold Central Plant Recycling</td>
<td>American Engineering and Testing</td>
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<tr>
<td>Rigid</td>
<td>Fiber Reinforced Concrete</td>
<td>University of Minnesota Duluth</td>
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<td>Early Opening Strength to Traffic</td>
<td>University of Pittsburg</td>
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<td></td>
<td>Optimizing Concrete Mix Components</td>
<td>Iowa State</td>
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</table>
# Long Term Research

## Geotechnical Team

### Pavement Maintenance Team

<table>
<thead>
<tr>
<th>Team</th>
<th>Project</th>
<th>Contractor</th>
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<tbody>
<tr>
<td>Geotechnical</td>
<td>Recycled Aggregates</td>
<td>Iowa State</td>
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<tr>
<td></td>
<td>Large Stone Subbase</td>
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<tr>
<td>Pavement Maintenance</td>
<td>Maintaining Poor Pavements</td>
<td>SRF Consulting</td>
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<tr>
<td></td>
<td>Partial Depth Repair</td>
<td>Braun Intertec</td>
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</table>
MnROAD Construction Tools

- **Veta Software** TPF-5(334)
- HMA Rolling Patterns
- Paver Operations / IR Temperature Bar
- 3D GPR / Rolling Density Meter
National Request for Ideas

- New Test Sections
  - New Construction
  - Rehabilitation
  - Maintenance
  - NRRA or Other Interests

- Research Ideas
  - NRRA Funding
  - Ties other funding

MnROAD Website or
http://www.dot.state.mn.us/mnroad/newideas.html
2019 NRRA Ideas

NRRA teams developing ideas to be funded
- Each Teams ~$180,000 each – contracted this winter 2019
- Intelligent Construction Technology Team ~$480,000

Ideas being considered (both Technology Transfer / Long Term)
- Flexible Group
  - Mix Rejuvenator Synthesis
  - Mix Rejuvenator Test Sections
- Pavement Maintenance
  - Service life enhancement of substrates overlaid with thin overlays (UTBWC, chip seals, & micro surfacing) – 30K
  - Synthesis in spray surface rejuvenators – 20K
  - Test sections with rejuvenators – 100K
  - PCC Rehabilitation Project – 30K
Full Depth Reclamation (Industry Partnership)

- **Road Science Partnership**
  - 3 Cells (mainline) / 1 Cell (LVR)
- **Observations**
  - 2.75” Interstate surface on engineered FDR
  - Engineered emulsion → balance stiffness/flexibility
- **Benefits**
  - Design for distressed pavements/Full depth repairs

Sustainable practice
Importance of Drainage

Asphalt
– Deterioration asphalt
– Increased roughness (ride)

Concrete
– ML Observations (high traffic)
  • None - PASB used
  • Some - Class-5 / well sealed joints / edge drain
  • High amount - Class-5 / no edge drains
– LVR Observations (low traffic)
  • If sealed class-5 is not as destructive
  • If not-sealed class-5 can develop joint damage

Benefits
– Importance of drainable bases / sealing
– Effect on ride
MnROAD Partnership
October 2018 - Cargill and Hardrives

2 Mix Designs / 4 New Test Sections
• Control - 25% RAP Superpave (SPWEB540 / PG 58S-28)
• High RAP - 45% RAP Superpave (SPWEB540 / PG 58S-28 / Anova)
• Lab Testing / Long Term Monitoring

Example of successful partnership for both industry and the state
MnROAD and LTPP InfoPave
FHWA and i-Engineering

MnROAD Access
- Data
- Pictures
- Reports/Software

Ties to
- LTPP Data
- Westrack
- C-SHRP

MnROAD Website Soon!
TRB 2019
Autonomous Bus Testing at MnROAD

Salt

Snow / Ice
Technology Transfer Efforts

Research Pays Off Seminar Series
• Every 3rd Tuesday
• 10-11 am

NRRA
• Follow NRRA on Linkedin
• May 22-23 2019 Workshop

Newsletters
• Highlight Members
• Highlight NRRA Projects
• Highlight Emerging Technology

NCAT Partnership Meetings
• 2019 Spring (NCAT)
• 2019 Fall (Minnesota)