Construction of Cold Central Plant Recycling Sections at MnROAD

64th Annual Asphalt Conference
Dave Van Deusen, PE | Research Operations Engineer
December 6, 2017
CCPR Sections at MnROAD

- NRRA background
- Objectives
- Design
- Construction
- Performance monitoring
- Summary
Acknowledgments

• NRRA pooled-fund Sponsors and Associates
• CS McCrossan
• MnDOT Golden Valley Resident Office
• District 3 Maintenance, Materials, and Surveys
• District M Design
• Midstate Reclamation
• American Engineering Testing, Inc.
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
- Build implementation, technology transfer, and training into research projects from the ground up
NRRA - Agency Members

Develop Collaborate Research Implement Sustain.
NRRA - Universities

NRRA - National Road Research Alliance

[Logos and names of various universities and research centers]

Develop → Collaborate → Research → Implement → Sustain.
NRRA - Associations

NRRA - National Road Research Alliance

IGGA - International Grooving & Grinding Association

Minnesota Asphalt Pavement Association

APA - Asphalt Pavement Alliance

Aggregate & Ready Mix Association of Minnesota

Concrete Paving Association of Minnesota

ARRA
Long Term Research Investment

Flexible Team
• HMA Overlay of Concrete and Methods of Enhancing Compaction
• Cold Central Plant Recycling

Rigid Team
• Fiber Reinforced Concrete Pavements
• Early Opening Strength to Traffic
• Optimizing Cement Content for PCC Mixes

Geotechnical Team
• Recycled Aggregate Bases
• Subgrade Stabilization with Large-sized Aggregates

Pavement Preservation Team
• Maintaining Poor Pavements
• Partial Depth Repair

Develop + Collaborate + Research + Implement + Sustain.
Long Term Research Investment

Flexible Team
- HMA Overlay of Concrete and Methods of Enhancing Compaction
- **Cold Central Plant Recycling**

Rigid Team
- Fiber Reinforced Concrete Pavements
- Early Opening Strength to Traffic
- Optimizing Cement Content for PCC Mixes

Geotechnical Team
- Recycled Aggregate Bases
- Subgrade Stabilization with Large-sized Aggregates

Pavement Preservation Team
- Maintaining Poor Pavements
- Partial Depth Repair

Develop ❡ Collaborate ❡ Research ❡ Implement ❡ Sustain.
Long Term Research

Flexible Team
- HMA Overlay of Concrete and Methods of Enhancing Compaction
- Cold Central Plant Recycling

Rigid Team
- Fiber Reinforced Concrete Pavements
- Early Opening Strength to Traffic
- Optimizing Cement Content for PCC Mixes

Geotechnical Team
- Recycled Aggregate Bases
- Subgrade Stabilization with Large Sized Aggregate

Pavement Preservation Team
- Maintaining Poor Pavements
- Partial Depth Repair

CCPR identified as high priority topic by NRRA

Flexible Pavement Team
• Budget (SRC): $2.5 million

• Designer: Metro

• Contract administration: Metro Golden Valley NW

• Low bid: $3.1 million

• Contractor: CS McCrossan (Midstate Reclamation – CCPR)

• Start: June 5, 2017

• Completion: November 3, 2017
What is CCPR?

- Cold-mixed stabilized base
- Similar to Cold In-Place Recycling (CIR)
  - Uses RAP either previously stockpiled or hauled from project
  - RAP may be further crushed and/or screened
  - Mixed with portable or stationary operation
- Binder, either emulsion or foamed asphalt, is added during mixing
- Placed with conventional paving equipment
- Recent examples: Virginia DOT, National Center for Asphalt Technology
MnROAD NRRA CCPR Sections

• Objectives
  • Evaluate structural performance of MnROAD sections
    • Perform lab and field tests to characterize section properties

• Research Project Contract (American Engineering Testing, Inc.)
  • Laboratory materials testing – fundamental properties, performance tests
  • Analyze performance data – deflection, profile, distresses
  • State-of-practice survey
  • Provide NRRA member agencies with resources to develop their own CCPR specification
• Cells 33, 34, and 35
  • ~1,700 of roadway
  • Acid-modified asphalt mix experiments, constructed 2007
  • 4 in. HMA / 12 in. Class 6 aggregate base / clay loam soils
  • Performed very well to date
  • Four sections ~425 ft in length
CCPR Test Sections

Outside lane – Environment and light traffic only

133  233  135  235

Inside lane – 80 kip, 5-axle combo
~60 laps per day
~17,000 BESALs / year
<table>
<thead>
<tr>
<th>CELL</th>
<th>SURFACE</th>
<th>SPEC</th>
<th>BINDER</th>
<th>LTC req.</th>
</tr>
</thead>
<tbody>
<tr>
<td>133</td>
<td>Double chip seal</td>
<td>Emulsion</td>
<td>CIR-EE (H)</td>
<td>-21.4 °C*</td>
</tr>
<tr>
<td></td>
<td>FA-3/FA-2.5</td>
<td>(58S-28)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>233</td>
<td>Double chip seal</td>
<td>Foam</td>
<td>58S-28</td>
<td>-21.4 °C*</td>
</tr>
<tr>
<td></td>
<td>FA-3/FA-2.5</td>
<td>(58S-28)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>135</td>
<td>1.5” HMA</td>
<td>Foam</td>
<td>52-34</td>
<td>-21.4 °C</td>
</tr>
<tr>
<td></td>
<td>SPWEB340C</td>
<td>(XX-34)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>235</td>
<td>1.5” HMA</td>
<td>Emulsion</td>
<td>CIR-TEC M*</td>
<td>-21.4 °C</td>
</tr>
<tr>
<td></td>
<td>SPWEB340C</td>
<td>(XX-34)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*All binders from FHR except CIR-TEC M, supplied by Meigs
**CCPR Test Sections**

<table>
<thead>
<tr>
<th>CELL</th>
<th>SURFACE</th>
<th>SPEC</th>
<th>BINDER</th>
<th>LTC req.</th>
</tr>
</thead>
<tbody>
<tr>
<td>133</td>
<td>Double chip seal</td>
<td>Emulsion (58S-28)</td>
<td>CIR-EE (H)</td>
<td>-21.4 °C*</td>
</tr>
<tr>
<td></td>
<td>FA-3/FA-2.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>233</td>
<td>Double chip seal</td>
<td>Foam (58S-28)</td>
<td>58S-28</td>
<td>-21.4 °C*</td>
</tr>
<tr>
<td></td>
<td>FA-3/FA-2.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>135</td>
<td>1.5” HMA</td>
<td>Foam (XX-34)</td>
<td>52-34</td>
<td>-21.4 °C</td>
</tr>
<tr>
<td></td>
<td>SPWEB340C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>235</td>
<td>1.5” HMA</td>
<td>Emulsion (XX-34)</td>
<td>CIR-TEC M*</td>
<td>-21.4 °C</td>
</tr>
<tr>
<td></td>
<td>SPWEB340C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*All binders from FHR except CIR-TEC M, supplied by Meigs*
## Mix Design Results

<table>
<thead>
<tr>
<th>BINDER TYPE</th>
<th>Emulsion</th>
<th>Foamed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CELL</strong></td>
<td>133</td>
<td>233</td>
</tr>
<tr>
<td><strong>SURF</strong></td>
<td>DCS</td>
<td>1.5&quot; SP</td>
</tr>
<tr>
<td><strong>PG</strong></td>
<td>58S-28</td>
<td>XX-34</td>
</tr>
<tr>
<td><strong>ADD BINDER</strong></td>
<td>2.0%</td>
<td>1.5%</td>
</tr>
<tr>
<td><strong>Voids @ Opt</strong></td>
<td>10.5</td>
<td>10.6</td>
</tr>
<tr>
<td><strong>Max Dens @ Opt</strong></td>
<td>133.1</td>
<td>133</td>
</tr>
<tr>
<td><strong>FAA</strong>*</td>
<td></td>
<td>45</td>
</tr>
<tr>
<td><strong>IDT @ CC Temp</strong></td>
<td>155</td>
<td>158</td>
</tr>
</tbody>
</table>

*Apparent RAP source: I-494, Maple Grove

**All four mixes exceeded the CC temp reqs
Pavement removal by milling
SIEVE SIZE | % PASS (JMF) | TOLERANCE (+/-)
---|---|---
1 1/2" (37.5 mm) | 100 | 
1" (25.4 mm) | 100 | 
3/4" (19 mm) | 91 | 8 |
1/2" (12.5 mm) | 73 | 
3/8" (9.5 mm) | 62 | 8 |
#4 (4.75 mm) | 41 | 8 |
#8 (2.36 mm) | 27 | 
#30 (0.6 mm) | 7 | 
#200 (0.075 mm) | 2.5 | 2 |
• Source
  • Millings from MnROAD not permitted

• Specified
  • 100% passing 1.5-inch sieve
  • 2-9% passing #200 sieve

• JMF tolerances
  • 8%: 0.75-in, 0.375-in, and #4 sieves
  • 2.0%: #200 sieve
• Proposed
  • Use nuclear density gage in a grid pattern over entire area
  • Compare to laboratory gyratory density with production mix

• Issue
  • Relatively short window for CCPR mix
  • Logistical problems with accessing gyratory compactor close to construction site

• Reality
  • Use nuclear density gage to monitor changes with roller coverage
CCPR Production, Paving, and Surfacing

• August 16, 2018
  • Foamed asphalt sections, Cells 233 and 135

• August 18, 2018
  • Emulsified asphalt sections, Cells 133 and 235

• September 6, 2017
  • Double chip seals, Cells 133 and 233

• September 19, 2017
  • Superpave SPWEB340C, Cells 135 and 235
Mix Production

- Test strips and test sections paved on same days using a portable plant
Test Strips

- Constructed at Contractor’s plant site
- Verify constructability and placement
- Identify rolling pattern
<table>
<thead>
<tr>
<th>SIEVE SIZE</th>
<th>% PASS (JMF)</th>
<th>TOLERANCE (+/-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/2&quot; (37.5 mm)</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>1&quot; (25.4 mm)</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>3/4&quot; (19 mm)</td>
<td>91</td>
<td>8</td>
</tr>
<tr>
<td>1/2&quot; (12.5 mm)</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td>3/8&quot; (9.5 mm)</td>
<td>62</td>
<td>8</td>
</tr>
<tr>
<td>#4 (4.75 mm)</td>
<td>41</td>
<td>8</td>
</tr>
<tr>
<td>#8 (2.36 mm)</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>#30 (0.6 mm)</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>#200 (0.075 mm)</td>
<td>2.5</td>
<td>2</td>
</tr>
</tbody>
</table>
CCPR Thickness

- MIT-SCAN T2
  - Plates installed top of base

- Compacted CCPR thickness
  - Plan: 4 inches
  - Average: 3.5 inches
  - Range: 2.9 to 3.9 inches
Binder: CRS-2P
First course: FA-3
Second course: FA-2.5
Fog: CSS-1H
First course swept ~1 hour after placement
Fog seal applied to DCS surface
Initial Performance

• Initial ride
  • Post-CCPR:
    • 140 in/mile overall
  • Post-surface:
    • DCS: 102 in/mile
    • HMA 102 in/mile

• Deflection
Performance Monitoring

• Ride

• Deflection (falling weight deflectometer)
  • Layer properties

• Laboratory performance testing
  • SCB
  • IDT
  • E*

• ME Design
Future Work

• NRRA contract
  • Anticipated start date February, 2018
• Extracted binder properties – RAP and mixture
• Continued performance testing and monitoring
• Changes to in place properties over time
Thank You

For more information:

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

Dave Van Deusen, PE

dave.vandeusen@state.mn.us

651-366-5524