Benefits?
1. Lightweight
2. High Friction
3. Deck Sealant
4. Fast Cure Time
Purpose of Research?
Outline

- Construction
- Aggregate Quality Testing
- Bridge Site Visits
- Accident Data Analysis
- Conclusion
Construction
Surface Preparation
Joint Preparation
Epoxy Layer
Adding Aggregate
Aggregate Quality Testing
Aggregate Gradation

Percent Passing (%)

Sieve Size

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

0.375 #4 #8 #16 #50

Basalt Flint Taconite A Taconite B SafeLane MnDOT Upper Limit MnDOT Lower Limit

19
Bridge Site Visits
Interstate 94 in Moorhead Bridge
9066 & 9067
PolyCarb System (Flint)
Highway 53 in Virginia
Br 69006
PolyCarb System (Taconite)
Interstate 35 in Atkinson
Br 9832
PolyCarb System (Basalt)
Interstate 1-94 in Barnesville
Br 14809 & 14810
SafeLane
TH 101 & CSAH 36 in Otsego
Br 27758, 86013, & 86019
NovaChip
Penn Ave in Minneapolis
Br 27758
Transpo T-48
TH 243 in Osceola
Br 6347
Transpo T-48
Field Testing

- Permeability Test (Water sealant)
- Torque Bond Test (Bond to bridge deck)
- Sand Patch Test (Friction)
- Surface Friction (Friction)
Permeability
## Permeability Results

<table>
<thead>
<tr>
<th>Bridge</th>
<th>Permeability (cm/sec)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wheel Path</td>
<td>Non-Wheel Path</td>
</tr>
<tr>
<td>69006</td>
<td>0</td>
<td>1.0x10^{-6}</td>
</tr>
<tr>
<td>9832</td>
<td>9.0x10^{-7}</td>
<td>2.0x10^{-7}</td>
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<tr>
<td>4190</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>9036</td>
<td>2.2x10^{-7}</td>
<td>1.9x10^{-7}</td>
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<tr>
<td>6066</td>
<td>0</td>
<td>2.1x10^{-7}</td>
</tr>
<tr>
<td>6067</td>
<td>1.8x10^{-7}</td>
<td>N/A</td>
</tr>
<tr>
<td>14810</td>
<td>3.8x10^{-6}</td>
<td>N/A</td>
</tr>
<tr>
<td>86013</td>
<td>9.8x10^{-5}</td>
<td>5.5x10^{-6}</td>
</tr>
</tbody>
</table>
Torque Bond Strength
Torque Test Results

- **Br 69006**: Non-Wheel Path - 450 N·m, Wheel Path - No Data
- **Br 3823**: Non-Wheel Path - 500 N·m, Wheel Path - No Data
- **Br 4190**: Non-Wheel Path - No Data, Wheel Path - No Data
- **Br 9036**: Non-Wheel Path - 300 N·m, Wheel Path - No Data
- **Br 9066**: Non-Wheel Path - No Data, Wheel Path - No Data
- **Br 9067**: Non-Wheel Path - No Data, Wheel Path - No Data
- **Br 14810**: Non-Wheel Path - 550 N·m, Wheel Path - No Data

Legend:
- ▼ Non-Wheel Path
- ▲ Wheel Path

*Note: All wheel path data is indicated as 'No Data' except for one.*
Sand Patch
Br 14810 Passing vs. Driving Lane

<table>
<thead>
<tr>
<th>Position on Roadway</th>
<th>Average Mean Texture Depth (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing Lane</td>
<td>0.07</td>
</tr>
<tr>
<td>Non-Wheel Path</td>
<td></td>
</tr>
<tr>
<td>Passing Lane</td>
<td>0.06</td>
</tr>
<tr>
<td>Wheel Path</td>
<td></td>
</tr>
<tr>
<td>Driving Lane</td>
<td>0.05</td>
</tr>
<tr>
<td>Non-Wheel Path</td>
<td></td>
</tr>
<tr>
<td>Driving Lane</td>
<td>0.04</td>
</tr>
<tr>
<td>Wheel Path</td>
<td></td>
</tr>
</tbody>
</table>
Surface Friction

KJ Law (Dynatest) Skid Trailer

Source: http://www.dot.state.mn.us/mnroad/data/pdfs/MnROAD%20Friction%20(KJ%20Law)%20FINAL.pdf
Bridge 14810 (Barnesville, MN) Avg Friction Numbers

Friction Number vs Year Tested

- 2007 (Pre)
- 2007 (Post)
- 2008
- 2009
- 2010
- 2011
- 2012

Ribbed Tires
Smooth Tires
Average Ribbed Tire Friction Number over Time

<table>
<thead>
<tr>
<th>Average Friction Number</th>
<th>Years in Service</th>
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<tbody>
<tr>
<td>Turf Drag PCC</td>
<td>69006</td>
</tr>
<tr>
<td>9066</td>
<td>9067</td>
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<tr>
<td>14809</td>
<td>27758</td>
</tr>
<tr>
<td>14810</td>
<td>27019</td>
</tr>
</tbody>
</table>
Analysis of Accident Data
Analysis of Accident Data

- Public Safety Database
- 2003-2013
  - *Incomplete data in 2003 and 2013 for Metro bridges*
- 293 Reported Accidents were analyzed
- Bridge 86019: No reported accidents (On Ramp)
- Bridge 27758: 1 reported accident (Penn Ave)
Surface Conditions

- Dry: 37%
- Ice Packed Snow: 9%
- Snow: 7%
- Wet: 5%
- Slush: 3%
- Other: 3%
Overlay Cross-Section
Overlay Cross-Section
Overlay Cross-Section
Weather during Ice Packed Snow Surface Conditions

- **Clear** 21%
- **Cloudy** 34%
- **Snow** 27%
- **Sleet** 5%
- **Blowing Snow** 6%
- **Rain** 5%
- **Other** 2%

Total: 100%
Number of Crashes per Million Vehicles

Before Installation

After Installation

Number of Crashes per Million Vehicles

9066  9067  9832  14809  14810  69006  27019  86013  6347
Accidents Compared to Total Accidents in MN

Average Percentage of Annual Crashes in Minnesota

<table>
<thead>
<tr>
<th>Location</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>9066</td>
<td>0.07%</td>
<td>0.00%</td>
</tr>
<tr>
<td>9067</td>
<td>0.08%</td>
<td>0.01%</td>
</tr>
<tr>
<td>9832 S</td>
<td>0.06%</td>
<td>0.02%</td>
</tr>
<tr>
<td>9832 N</td>
<td>0.05%</td>
<td>0.03%</td>
</tr>
<tr>
<td>14809</td>
<td>0.04%</td>
<td>0.04%</td>
</tr>
<tr>
<td>14810</td>
<td>0.03%</td>
<td>0.03%</td>
</tr>
<tr>
<td>69005</td>
<td>0.02%</td>
<td>0.02%</td>
</tr>
<tr>
<td>69006</td>
<td>0.01%</td>
<td>0.01%</td>
</tr>
<tr>
<td>27019</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>27020</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>86013</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>6347</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
</tbody>
</table>
Summary: Site Visits

- All currently performing satisfactorily
- Negligible permeability
- Sufficient bond strength between bridge deck and system
- Mean texture depth steadily decreases after installation
- Friction numbers have decreased due to these distresses
Summary: Accident Analysis

- Most conditions occurred with dry or ice packed snow surface conditions when the high friction has very little effect.
- Over half of the ice packed snow conditions occurred with clear or cloudy weather.
- There is a marginal reduction in accidents.
- Accident rates are similar to bridge decks without an epoxy overlay system.
Special Thanks To MnDOT

- Funding for this project
- Coordination for site visits
- Setting up traffic control
- Providing data for analysis
Thank You For Your Time!
Questions?