Study Objectives

• Compare high friction aggregate sources with accelerated lab friction testing
• Compare Test Track friction performance with previous OK DOT Test Track sections
• Compare tack coat performance
Aggregate Selection Using Accelerated Lab Friction

DFT(40) Measurements

NCAT TWPD Cycles (x1000)

DFT(40) friction

- Flint OK slab 2
- Flint OK slab 3
- Hanson OK slab 1
- Hanson OK slab 2
- Sawyer OK slab 1
- Sawyer OK slab 3
- Snyder OK Slab 1
- Snyder OK Slab 2
Mix Design and Construction

- OGFC
- 12.5 mm NMAS
- Sandstone
- 7% PG 76 -28
- 0.3% fiber
- 19.00 mm thick
Micro-mill Existing Surface
N9 Surface Changes

Feb 2016  July 2016  April 2017
Plant Mix Slab TWPD Polishing

Accelerated Friction Testing
Plant Mix - 2 Lab Slabs

DFT(40) Friction

TWPD polishing cycles
Friction and Texture Performance

N9 OGFC Friction Performance

- SN40R
- DFT(40)
- laser MTD
- CTM MPD

Friction (SN40R)(DFT40 x100)

Texture (MTD)(MPD) mm

Time:
- 09/03/15
- 05/10/16
- 01/15/17
- 09/22/17
Bond Strength Study

N9B tack rate = 0.15 gal/sy  N9A tack rate = 0.08 gal/sy
# Field Pull-out Test Results

<table>
<thead>
<tr>
<th>Date</th>
<th>Surf Temp</th>
<th>Tack Rate</th>
<th>Load (kN)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug-21 (day 7)</td>
<td>132 F</td>
<td>Low</td>
<td>NA</td>
<td>Broke in OGFC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High</td>
<td>NA</td>
<td>Broke in OGFC</td>
</tr>
<tr>
<td>Aug-28 (day 14)</td>
<td>80 F</td>
<td>Low</td>
<td>0.2</td>
<td>Broke at tack interface</td>
</tr>
<tr>
<td></td>
<td></td>
<td>high</td>
<td>0.3</td>
<td>Broke in OGFC</td>
</tr>
<tr>
<td>Sep-17 (day 34)</td>
<td>65 F</td>
<td>Low</td>
<td>0.7</td>
<td>Broke at tack interface</td>
</tr>
<tr>
<td></td>
<td></td>
<td>high</td>
<td>1.0</td>
<td>Broke in OGFC</td>
</tr>
<tr>
<td>Oct-19 (day 66)</td>
<td>60 F</td>
<td>Low</td>
<td>0.6</td>
<td>Broke at epoxy interface</td>
</tr>
<tr>
<td></td>
<td></td>
<td>high</td>
<td>0.6</td>
<td>Broke at epoxy interface</td>
</tr>
</tbody>
</table>
Field Pull-out Test
Reflective Cracks
Full Depth Core Damage
Approach Transition Repair
N9 General Performance

![Graphs showing IRI and cracks with Equivalent Single Axle Loadings (ESALs) in millions.](image-url)

- Mean IRI (m/km)
- Laser Rut (mm)
- Cracking (% Lane)
THANKS!

Any questions?
Reach me at
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2018 NCAT Test Track Conference
FHWA High Friction Asphalt Bound Alternatives

Mike Heitzman PE, PhD
Scope of Study

Can thin asphalt surface treatments perform similar to high friction surface treatments (HFST)?
What is HFST?

• AASHTO PP 79-14
  ▶ Polymer binder resin 25-32 ft<sup>2</sup>/gal
  ▶ Calcined bauxite 12-15 lb/yd<sup>2</sup> (Al<sub>2</sub>O<sub>3</sub> 87%, LA Abr 20%)
  ▶ SN40R of 65 minimum post construction

• Challenges
  ▶ Bauxite gradation is fixed (passing No.6, retained No.16)
    ▶ Challenge-aggregate blending
  ▶ Bauxite cost is high: ($300/ton)
    ▶ Challenge-aggregate surface exposure
# Surface Type Selection

<table>
<thead>
<tr>
<th>Surface</th>
<th>Binder Cost</th>
<th>Aggregate Amount</th>
<th>Macro-texture</th>
<th>Service Life (yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HFST</td>
<td>$$$$</td>
<td>Low</td>
<td>Very high</td>
<td>6-8</td>
</tr>
<tr>
<td>Dense-graded</td>
<td>$$</td>
<td>High</td>
<td>Very low</td>
<td>10</td>
</tr>
<tr>
<td>SMA</td>
<td>$$</td>
<td>High</td>
<td>Low</td>
<td>10</td>
</tr>
<tr>
<td>OGFC</td>
<td>$$</td>
<td>High</td>
<td>High</td>
<td>10</td>
</tr>
<tr>
<td>Micro-surfacing</td>
<td>$</td>
<td>Low</td>
<td>Moderate</td>
<td>4-6</td>
</tr>
<tr>
<td>Chip seal</td>
<td>$</td>
<td>Low</td>
<td>high</td>
<td>3-5</td>
</tr>
</tbody>
</table>
W7 Micro-surfacing with calcined bauxite
W7 Objectives

- Compare friction performance of two micro-surfacing treatments using different friction aggregates
- Compare friction performance to HFST
W7A Mix Design using Bauxite

- Mix design by Paragon Technical Services
- India calcined bauxite source (84% Al₂O₃), 25% retained on #8
- 50% bauxite, 49% limestone sand, 1% cement filler
- 12.5% CSS-1HP (HiMA eFlex)
- 72% coarse fraction (+ #16) was 67% bauxite
W7B Mix Design using Sandstone

• Mix design by Paragon Technical Services
• TX sandstone, 47% retained on the #8
• 12% CSS-1HP (HiMA eFlex)
• 68% coarse fraction (+ 16%)
Calcined Bauxite Supply
Bauxite and Limestone Blending
Placing Micro-surfacing
W7 Split Test Sections

W7A Bauxite

W7B TX Sandstone
Preparing Slabs for Lab Testing
TWPD Polishing Micro-surfacing

5000 cycles
60# carriage

< 2000 cycles
90# carriage
W7 Surface Changes

Feb 2016 | July 2016 | Apr 2017
W7 Friction Performance

W7 Microsurfacing with Bauxite

- W8C HFST bauxite
- W7A Micro bauxite
- W7B Micro sandstone
- W8A HFST granite

Friction SN40R

Time (Calendar Date)

09/03/15  03/21/16  10/07/16  04/25/17  11/11/17
W3 SMA using Bauxite
W3 Objectives

• Measure friction performance of SMA with calcined bauxite as the predominant coarse aggregate
• Compare friction performance with HFST sections and previous W3 SMA
• Surface placed April 4, 2017
W3 Mix Design

• Original JMF Sep 2016
  - 4,75 mm NMAS, 50-blow Marshall
  - China bauxite, 7% AC, 4% voids

• Final JMF Mar 2017
  - 4.75 mm NMAS, 50-blow Marshall
  - 40% India bauxite, 59% limestone, 1% filler, 8.3% PG 76-22, 5% voids
  - CA 50% = +No 16 (2:1 bauxite:limestone)
China Bauxite vs India Bauxite
Bauxite Comparison Micro-Deval

Change in FA Mass

Cumulative Mass Loss (percent)

-35.0%
-30.0%
-25.0%
-20.0%
-15.0%
-10.0%
-5.0%
0.0%

 Conditioning Time (minutes)

0 10 20 30

CHINA
INDIA
Bauxite
Opelika Lms
Columbus Grn
LaGrange Grn
Calera Lms
Bauxite Comparison - Friction

SMA Surface Friction Comparison

- China bauxite
- India bauxite

Friction DFT(40)

TWPD polish cycles (x1000)
W3 Construction
W3 Friction and Texture Performance

W3 SMA bauxite Friction and Texture

- SN40R
- DFT(40)
- CTM
- Laser

<table>
<thead>
<tr>
<th>Time (calendar date)</th>
<th>Friction SN40R</th>
<th>Friction DFT(40), Texture (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/6/2017</td>
<td>20.0</td>
<td>0.0</td>
</tr>
<tr>
<td>6/14/2017</td>
<td>40.0</td>
<td>0.2</td>
</tr>
<tr>
<td>9/22/2017</td>
<td>60.0</td>
<td>0.6</td>
</tr>
<tr>
<td>12/31/2017</td>
<td>80.0</td>
<td>0.8</td>
</tr>
</tbody>
</table>
FHWA Friction Summary

W3 SMA and W7 Microsurfacing with Bauxite

Friction SN40R

- W8C HFST bauxite
- W7A Micro bauxite
- W7B Micro sandstone
- W3A SMA bauxite
- W3 pre study SMA

Time (Calendar Date)

07/15/15 01/31/16 08/18/16 03/06/17 09/22/17
FHWA Texture Summary

FHWA Friction Studies
surface texture

Macro-texture, CTM (mm)

Duration:
- W8B HFST bauxite (20+ M)
- W7A micro bauxite (9M)
- W3 4.75 SMA bauxite (4M)
- W9 HFST chert (20+ M)
- W8A HFST granite (20+ M)

Time:
- 9/3/2015
- 5/10/2016
- 1/15/2017
- 9/22/2017
What are Acceptable Surface Criteria?

![Graph showing friction and texture data for different materials.

- W8B HFST bxt 24M ESAL
- W7A Micro bxt 10M ESAL
- W3 SMA bxt, 4M ESAL
- N9 OGFC ss 10M ESAL
- W7B Micro ss 10M ESAL
- S4 4.75 Dense lms 10M ESAL]
THANKS!

Any questions? Reach me at mah0016@auburn.edu