Material Benefit Comparison

Microsurfacing, SMA and HT Asphalts in St. Albert, AB

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Presented by:

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Transportation Branch
Agenda

• Introduction & Overview
• Test Section & Construction
• Testing & Results
• Conclusions
• Current State (1 Year)
• Acknowledgements
Introduction & Overview

• Since 2015, The City of St. Albert has been working updating approach to pavement material selection and management:
  • Reviewing current practices
  • Researching new materials
  • Updating data within its pavement management system
Introduction & Overview

• With the help of the Alberta Pavement Managers User Group (APMUG), research began through a survey questionnaire that identified:
  
  • Agency use of traditional methods such as mill and inlay, reconstruction are most prevalent in agency decision making
  
  • Activities such as FDR, CIR and Microsurfacing were less common
Roadway Treatment Usage in Alberta

Treatment Type in Alberta

- Hot Mix Asphalt Overlay: 100.00%
- Crack Sealing: 92.31%
- Full Reconstruction: 92.31%
- Spray Injection: 84.62%
- Microsurfacing: 69.23%
- Full Depth Reclamation: 53.85%
- Chip Sealing: 30.77%
- Hot In Place Recycling: 23.08%
- Cold In Place Recycling: 23.08%
- Restorative Seals - Eg: Fog Seal: 7.69%
- Cold In Place Recycling: 7.69%
Introduction & Overview

• City wanted to review different materials for several metrics. But how to go about it?
  • Solution:
    • Create a test section employing different materials in controlled conditions
    • Pilot the preservation method in different circumstances across the City
    • Partner with University of Alberta, City of Edmonton and Stantec to perform monitoring and testing
Introduction & Overview

City of St. Albert Pavement Test Section (CoSA, 2017)
• According the City of St. Albert Transportation Master Plan, this section’s needs are set to grow over the next 25 years.
Introduction & Overview

2014 PM Peak Traffic Volumes (COSA, 2017)
Introduction & Overview

Projected 2042 PM Peak Traffic Volumes (COSA, 2017)
Introduction & Overview

• The pavement test section included the following materials:
  • Stone Mastic Asphalt
  • High Traffic Asphalt
  • Microsurfacing

• The section had a mix of distresses including:
  • Block Cracking
  • Longitudinal/Transverse Cracking
  • Rutting
• **Goal of Study:**
  
  • Determine the differences in pavement quality and deteriorations
  
  • Determine secondary impacts (eg: noise, grip/friction)
  
  • Determine specific information related to pavement design (layer coefficients)
Test Section & Construction

- Section 1: SMA
- Section 2: SMA
- Section 3: HT
- Section 4: Micro
- Section 5: Micro

Note: there is small section of HT ahead of Section 1 not pictured on the map
Pre Construction Photos

SMA Pre Construction

HT Pre Construction

Micro Pre Construction
## Summary of distresses is below

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Length of Material (m)</th>
<th>Max Rut Depths (mm)</th>
<th>Description of Surface Distresses</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMA</td>
<td>505.8</td>
<td>28</td>
<td>• High Severity Rutting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• High Block Cracking</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• High Transverse Cracking</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Moderate Patching</td>
</tr>
<tr>
<td>HT</td>
<td>175.5</td>
<td>13.6</td>
<td>• Low Severity Rutting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Moderate Block Cracking</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Moderate Transverse Cracking</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Low Edge Cracking</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Low to Moderate Patching</td>
</tr>
<tr>
<td>Microsurfacing</td>
<td>858.7</td>
<td>16.3</td>
<td>• Moderate Severity Rutting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Moderate Block Cracking</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Moderate Transverse Cracking</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Low Edge Cracking</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Low to Moderate Patching</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Moderate Shoving</td>
</tr>
</tbody>
</table>
Materials Selected

- **SMA** is a gap graded asphalt using 16 mm aggregate and a PG 76-28 binder
- **HT** is a dense graded asphalt using a 10 mm aggregate and a PG 64-28 binder
- **Type III Microsurfacing** uses a 5 mm aggregate and is applied at 16-18 kg/m²
Test Section & Construction

Aggregate Gradation of Materials

Sieve (mm) on the x-axis and % Passing on the y-axis. The graph shows the percentage of material passing through different sieve sizes, with three different materials: SMA - Average, Micro - Average, and HT - Average. The lines are color-coded for easy distinction.
# Test Section & Construction

<table>
<thead>
<tr>
<th>Original Asphalt</th>
<th>HT Asphalt</th>
<th>SMA Asphalt</th>
<th>Microsurfacing</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Original Asphalt" /></td>
<td><img src="image2" alt="HT Asphalt" /></td>
<td><img src="image3" alt="SMA Asphalt" /></td>
<td><img src="image4" alt="Microsurfacing" /></td>
</tr>
</tbody>
</table>
Test Section & Construction

• SMA was placed on a fresh matt of base course asphalt. (65 mm Base Course with 50 mm SMA)
• HT was placed to a depth of 50 mm
• Micro was placed at an application rate of 16-18 kg/m2 (~16 mm)
Test Section & Construction

Existing Asphalt: Varies 380-450 mm

SMA
(50 mm Depth)

20 mm B
(65 mm Depth)
Test Section & Construction

Existing Asphalt: Varies 380-450 mm

- Microsurfacing
  - 16 KG/M2 Rut Fill
  - 18 KG/M2 Surface Coarse

Wheel Ruts
(Max 16 mm Depth)
Test Section & Construction

Microsurfacing Core Sample
Test Section & Construction

• SMA Construction Timelines
  • Milling work began July 11, 2017
  • Final Paving Completed: August 2, 2017
  • Total days onsite: 21
  • ~7,547 m2 of new road surface with SMA
  • ~3,135 m2 of new road surface with HT
  • ~6,610 Tonnes of new asphalt material
Test Section & Construction
Test Section & Construction
Test Section & Construction

• Microsurfacing Construction Timelines
  • Base coat applied September 10-11
  • Surface coat applied September 12
  • Total days onsite: 3
  • 10,336 m² of area covered in Type III Microsurface
Test Section & Construction
Test Section & Construction
Before and after construction the following tests were conducted on the pavement test section:

- Pavement Condition Assessment
- Grip Test
- On Board Sound Intensity (OBSI)
- Road Side Noise Monitoring
- Laboratory Testing (University of Alberta Lab)
Testing & Results

Quality Metrics

\[
\text{Strength} + \text{Bumpiness} + \text{Cracking/Defects} = \text{Reported Quality}
\]

\[
\text{SAI} \text{– Structural Adequacy Index} + \text{RCI} \text{– Ride Condition Index} + \text{SDI} \text{– Surface Distress Index} = \text{PQI} \text{– Pavement Quality Index}
\]
Testing & Results

- Condition Results
- The following results show the PQI, RCI, SDI before and after

Table 5: Multi Lane Condition Assessment Results (Stantec, 2017)

<table>
<thead>
<tr>
<th>Metric</th>
<th>Pre Construction</th>
<th>Post Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>PQI</td>
<td>69.06</td>
<td>87.83</td>
</tr>
<tr>
<td>RCI</td>
<td>61.71</td>
<td>72.83</td>
</tr>
<tr>
<td>SDI</td>
<td>53.25</td>
<td>95.91</td>
</tr>
</tbody>
</table>
Testing & Results

- By using the pre/post survey results, improvements to roadways can be measured

Table 6: Pavement Metrics Improvements (Stantec, 2017)

<table>
<thead>
<tr>
<th>Material / Metric</th>
<th>SMA</th>
<th>HT</th>
<th>Microsurface</th>
</tr>
</thead>
<tbody>
<tr>
<td>PQI</td>
<td>19</td>
<td>21.5</td>
<td>14.2</td>
</tr>
<tr>
<td>SDI</td>
<td>46.4</td>
<td>34.6</td>
<td>45.5</td>
</tr>
<tr>
<td>RCI</td>
<td>11.9</td>
<td>14.7</td>
<td>3.8</td>
</tr>
</tbody>
</table>
Testing & Results

• Grip testing was completed using an MK2 Grip Tester
## Testing & Results

### Grip Testing Results

<table>
<thead>
<tr>
<th>Lane</th>
<th>Material</th>
<th>Pre-Construction</th>
<th>Post Construction</th>
<th>Change</th>
<th>Average Pre</th>
<th>Average Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>HT</td>
<td>0.55</td>
<td>0.59</td>
<td>0.03</td>
<td>0.55</td>
<td>0.57</td>
</tr>
<tr>
<td>Middle</td>
<td>HT</td>
<td>0.55</td>
<td>0.55</td>
<td>0.00</td>
<td>0.55</td>
<td>0.57</td>
</tr>
<tr>
<td>Left</td>
<td>HT</td>
<td>0.55</td>
<td>0.57</td>
<td>0.02</td>
<td>0.55</td>
<td>0.57</td>
</tr>
<tr>
<td>Right</td>
<td>Micro</td>
<td>0.55</td>
<td>0.64</td>
<td>0.09</td>
<td>0.56</td>
<td>0.64</td>
</tr>
<tr>
<td>Middle</td>
<td>Micro</td>
<td>0.58</td>
<td>0.66</td>
<td>0.08</td>
<td>0.56</td>
<td>0.64</td>
</tr>
<tr>
<td>Left</td>
<td>Micro</td>
<td>0.54</td>
<td>0.63</td>
<td>0.10</td>
<td>0.55</td>
<td>0.56</td>
</tr>
<tr>
<td>Right</td>
<td>SMA</td>
<td>0.55</td>
<td>0.56</td>
<td>0.01</td>
<td>0.55</td>
<td>0.56</td>
</tr>
<tr>
<td>Middle</td>
<td>SMA</td>
<td>0.54</td>
<td>0.56</td>
<td>0.02</td>
<td>0.55</td>
<td>0.56</td>
</tr>
<tr>
<td>Left</td>
<td>SMA</td>
<td>0.56</td>
<td>0.56</td>
<td>0.00</td>
<td>0.55</td>
<td>0.56</td>
</tr>
</tbody>
</table>
Testing & Results

• OBSI measures to tire pavement interaction
  • Uses 4 microphones installed near the tire
  • Tests were conducted as per T360-16 & TP76-11
Testing & Results

- Roadside noise monitoring /noise monitors placed along the corridor

Road Side Microphones
Testing & Results

• OBSI was taken at night both before and after construction

• Road sides were also done in conjunction with traffic counters to count the exact number of traffic
  
  • Total of 8 microphones were placed at selected sites adjacent to the test section
  
  • 1 microphone was placed after the SWCA bridge in an area that would not receive treatment to provide a “control”
## Testing & Results

### Road Side Noise Sensor Results

<table>
<thead>
<tr>
<th>Location</th>
<th>Material Type</th>
<th>Average Daily Traffic</th>
<th>Pre-Construction</th>
<th>Post-Construction</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control</td>
<td>19,094</td>
<td>71.5</td>
<td>72.4</td>
<td>+0.9</td>
</tr>
<tr>
<td>2</td>
<td>Microsurfacing</td>
<td>19,094</td>
<td>72.5</td>
<td>71.4</td>
<td>-1.1</td>
</tr>
<tr>
<td>3</td>
<td>Microsurfacing</td>
<td>22,025</td>
<td>72.2</td>
<td>70.9</td>
<td>-1.3</td>
</tr>
<tr>
<td>4</td>
<td>HT</td>
<td>19,816</td>
<td>72.2</td>
<td>70.1</td>
<td>-2.1</td>
</tr>
<tr>
<td>5</td>
<td>SMA</td>
<td>18,075</td>
<td>68.1</td>
<td>67.7</td>
<td>-0.4</td>
</tr>
<tr>
<td>6</td>
<td>SMA</td>
<td>21,913</td>
<td>69.1</td>
<td>67.2</td>
<td>-1.9</td>
</tr>
<tr>
<td>7</td>
<td>SMA</td>
<td>20,554</td>
<td>66.5</td>
<td>66.4</td>
<td>-0.1</td>
</tr>
<tr>
<td>8</td>
<td>HT</td>
<td>20,554</td>
<td>67.7</td>
<td>65.0</td>
<td>-2.7</td>
</tr>
</tbody>
</table>

24 hr LAeq [dB]
# Testing & Results

## OBSI Results 2017 - dbA

<table>
<thead>
<tr>
<th>Material</th>
<th>Pre-Construction</th>
<th>Post-Construction</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>HT</td>
<td>97.5</td>
<td>92.2</td>
<td>-5.3</td>
</tr>
<tr>
<td>SMA</td>
<td>97.5</td>
<td>95.8</td>
<td>-1.7</td>
</tr>
<tr>
<td>HT</td>
<td>97.5</td>
<td>92.1</td>
<td>-5.4</td>
</tr>
<tr>
<td>Microsurfacing</td>
<td>97.5</td>
<td>94.8</td>
<td>-2.7</td>
</tr>
</tbody>
</table>

## OBSI Results 2018 - dbA

<table>
<thead>
<tr>
<th>Material</th>
<th>Pre-Construction</th>
<th>2018 Results</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>HT</td>
<td>97.5</td>
<td>95.1</td>
<td>-2.4</td>
</tr>
<tr>
<td>SMA</td>
<td>97.5</td>
<td>97</td>
<td>-0.5</td>
</tr>
<tr>
<td>HT</td>
<td>97.5</td>
<td>94.2</td>
<td>-3.3</td>
</tr>
<tr>
<td>Microsurfacing</td>
<td>97.5</td>
<td>95.4</td>
<td>-2.1</td>
</tr>
</tbody>
</table>
## Testing & Results

### OBSI Results – Maintained Benefit

<table>
<thead>
<tr>
<th>Material</th>
<th>2017</th>
<th>2018</th>
<th>% Benefit Maintained</th>
</tr>
</thead>
<tbody>
<tr>
<td>HT</td>
<td>-5.3</td>
<td>-2.4</td>
<td>45%</td>
</tr>
<tr>
<td>SMA</td>
<td>-1.7</td>
<td>-0.5</td>
<td>29%</td>
</tr>
<tr>
<td>HT</td>
<td>-5.4</td>
<td>-3.3</td>
<td>61%</td>
</tr>
<tr>
<td>Microsurfacing</td>
<td>-2.7</td>
<td>-2.1</td>
<td>78%</td>
</tr>
</tbody>
</table>
Testing & Results

- **Dynamic Modulus Lab Testing**
  - Used on SMA, HT and 20 mm B Samples

Dynamic Modulus (AASHTO, 2018)
Testing & Results

- **Dynamic Modulus Lab Testing**

Dynamic Modulus Results at 20 C

![Graph showing dynamic modulus results](image)

- **20 mm B**
- **SMA**
- **HT**

1.56 hz Dynamic Modulus Results at 20C
Testing & Results

• Dynamic Modulus Lab Testing
  • Using the Dynamic Modulus Data, layer coefficients were estimated using a frequency of 1.59 Hz
  • Described in Prowell, James & Bennert, 2017

<table>
<thead>
<tr>
<th>Material</th>
<th>Elastic Modulus E (MPa)</th>
<th>Elastic Modulus E (PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMA</td>
<td>3,612.88</td>
<td>524,005</td>
</tr>
<tr>
<td>HT</td>
<td>3,256.64</td>
<td>472,337</td>
</tr>
<tr>
<td>20 mm B</td>
<td>5,988.16</td>
<td>868,511</td>
</tr>
</tbody>
</table>
Testing & Results

• Dynamic Modulus Lab Testing
  • Using GPR data, was able to back calculate the layer coefficients
  • Note Alberta Transportation Design Guide assumes a layer coefficient of 0.4

<table>
<thead>
<tr>
<th>Layer Coefficient</th>
<th>SMA</th>
<th>HT</th>
<th>20 mm B</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_n$</td>
<td>0.47</td>
<td>0.45</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Conclusions

- HT asphalt had the highest improvement to overall PQI.
- 20 mm B was measured to have the highest layer coefficient from Dynamic Modulus.
- HT asphalt had the highest immediate benefit to noise attenuation.
- Microsurfacing is maintaining more of its noise attenuation benefit as further testing occurs.
Conclusions

• Microsurfacing improved the friction along the corridor by as much as 15% following construction.

• SMA and HT showed very little measured benefits from the previous asphalt when comparing friction improvements.
Current State – 1 Year Later

• How is the test section 1 year later?
Current State – 1 Year Later

HT Asphalt Section (1 Year Later)
Current State – 1 Year Later

SMA Section (1 Year Later)
Current State – 1 Year Later

Microsurfacing Section (1 Year Later)
Acknowledgements

• University of Alberta
  • Dr. Ali Bayat
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• City of Edmonton Noise and Vibration Team
  • Clarence Stewart
  • Joy Tolsma
  • Bretlyne Friday
  • Jessica Zelinski

• Stantec Consulting for their help on collecting the condition, GPR and grip data

• Alberta Pavement Managers User Group
• If you have questions feel free to email me at bnewstead@stalbert.ca
• Full research available on University of Alberta ERA website
• Results of this work have been presented to TAC, TRB, CTAA and will be presented in ASCE in 2019
• Work has been submitted to the following journals: IJPRT, CJCE
Thank you to all of you!

~Questions?
References

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