Update on Stone Mastic Asphalt

Pamela Marks, P.Eng.
Materials Engineering and Research Office
Highway Standards Branch, Provincial Highways Management Division
Ministry of Transportation of Ontario

OHMPA 2016 Fall Asphalt Seminar
Vaughan, ON
December 1, 2016
Presentation Outline

- Background
- MTO/ OHMPA SMA Task Group
- MTO SMA Trials
- Reinstatement of SMA
- Specifications
- SMA Contracts and Next Steps
Background

- Stone Mastic Asphalt (SMA) is a gap-graded, highly textured and durable surface mix with a much higher percentage of stone and more asphalt cement than conventional HMA.

- Advantages of SMA over conventional HMA are:
  - excellent durability in terms of rutting resistance and cracking
  - extended pavement life

- The coarse surface texture of the SMA provides improved surface drainage (reduced splash), and noise reduction compared to conventional dense graded HMA.
Background

- MTO adopted the use of SMA as a premium surface course mix on its major highways in 2002 for its durability, resistance to rutting and cracking.

- In 2005 MTO noted:
  - Low initial friction
  - Further testing and analysis showed surface friction improved with traffic wear over time.

- A joint MTO/ OHMPA Task Group was formed in the Fall of 2005 to investigate different alternatives to improve the initial surface friction of SMA pavements (mix design and construction).
MTO/OHMPA SMA Task Group

- Task Group membership evolved over time. Group looked at the impact of various options including:
  - Revising listed of SMA approved aggregates –*not effective*
  - Water blasting the surface –*not effective*
  - Reducing the AC content – *lab testing and modelling led to trials in 2009 with*:
    - Minimum AC content reduced by 0.3%
    - Percent passing the 75 µm sieve from 8-12% changed to 6-9%
    - VMA 17% minimum dropped to 16.5-18%
  - SMA 9.5 mix; aggregate blending

- November 2007 MTO paused the use of SMA to address our concerns with low early age friction
2009-2010 Mix Attribute Evaluation Trials

- **2009:** MTO used the revised SMA mix design on a QEW trial at Red Hill Creek

- **2010:** SMA trial sections were constructed on Highway 400 NB between Highway 407 and Bass Pro Drive using 3 aggregate sources and 2 filler sources

- Uncoated grit was sprayed over a compacted mat

- These mix changes and the uncoated grit on compacted mat trials did not improve the initial friction of the SMA surface
2011 SMA Embedded Grit Trials

- Based on other agencies' practices, MTO next tried embedded grit on:
  - Contract 2007-2026 QEW at Burloak North Service Rd 200m EB Lanes 2 & 3
  - Contract 2007-2125 QEW at Third Line EB Lane 2
Gritting Non-Standard SP

- Grit gradation specification was liberal:
  - No oversize and 0 to 3% passing the 75 micron
  - Coated and uncoated application used:
    - 1.0% AC for coated grit
    - Delivered hot

- Used a rate of about 1.0 kg/m²
  - Demonstration constructed to optimize spread rate and control

- No grit placed in vicinity of lane marking
- Removal of excess grit
QEW, North Service Road Demonstration

Coated Grit

Uncoated
2011 SMA Embedded Grit Trials

QEW – EBL 3, Coated/Uncoated
2011 SMA Embedded Grit Trials

- Contract 2007-2026, QEW at Burloak
  - Used different uncoated application rates (1.0kg/m² and 0.75 kg/m²)
  - Used different coated application rates (0.9 and 0.50 kg/m²)

- Contract 2007-2125, QEW
  - Used 1% AC coated Ontario Trap Rock DFC Fines and Milton Quarry high stability sand, 0.75 kg/m²

- Coated grit definitely better: less dust, no pick-up issues, no removal of excess grit required!
2011 MTO Trials with Embedded Grit

Findings

- Placing the 0.8 to 1% asphalt cement coated sand immediately after initial compaction and then embedding it into the mat using normal compaction rollers was found to be effective in improving SMA low initial friction.

- Within 6-8 weeks, friction values for both the gritted and ungritted sections were about the same.
2012-2013 SMA Contracts Gritted

- MTO next constructed entire SMA contracts with coated gritting on:
  - Highway 6 in West Region in 2012, and
  - Highway 401 at Renforth in Central Region in 2013
- Highway 401 used the original SMA mix requirements
- Tests indicated acceptable initial friction for both contracts
Reinstatement of SMA

- October 2014: with the endorsement of the SMA Task Group, MTO re-instated SMA for use as a premium surface course mix for roadways where traffic levels warrant its’ use and MTO’s Surface Course Directive (PLNG-C-003) was updated

- Any SMA placed requires:
  - the application of hot grit, coated with 1% asphalt cement during mix placement
  - use of the original SMA mix requirements
Specifications

- OPSS.PROV 313 Construction Specification for Hot Mix Asphalt
- OPSS.PROV 1151 Material Specification for Superpave and Stone Mastic Asphalt Mixtures
- LS-311 Practice for SMA Mix Design
- NAPA Quality Improvement Series (QIS)122 Designing and Construction SMA Mixtures –State-of-the-Practice
- AASHTO M 325-08 Standard Specification for Designing Stone Matrix Asphalt (SMA)
## SMA Gradation Envelope

<table>
<thead>
<tr>
<th>Sieve</th>
<th>SMA 9.5 mm</th>
<th>SMA 12.5 mm</th>
<th>SMA 19 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.0 mm</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>19.0 mm</td>
<td></td>
<td>100</td>
<td>90 – 100</td>
</tr>
<tr>
<td>12.5 mm</td>
<td>100</td>
<td>90 – 100</td>
<td>50 – 88</td>
</tr>
<tr>
<td>9.5 mm</td>
<td>70 – 95</td>
<td>50 – 80</td>
<td>25 – 60</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>30 – 50</td>
<td>20 – 35</td>
<td>20 – 28</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>20 – 30</td>
<td>16 – 24</td>
<td>16 – 24</td>
</tr>
<tr>
<td>75 μm</td>
<td>8 – 12</td>
<td>8 – 11</td>
<td>8 – 11</td>
</tr>
</tbody>
</table>
**SMA Grit Gradation**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.75 mm</td>
<td>100</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>90 - 100</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>50 - 65</td>
</tr>
<tr>
<td>600 µm</td>
<td>25 – 35 *</td>
</tr>
<tr>
<td>150 µm</td>
<td>0 – 5 *</td>
</tr>
<tr>
<td>75 µm</td>
<td>0 – 3 *</td>
</tr>
</tbody>
</table>

* A maximum tolerance of ±3% is allowed on gradation requirements for gritting material
# SMA Contracts

<table>
<thead>
<tr>
<th>Contract</th>
<th>Location (Hwy)</th>
<th>Length (km)</th>
<th>SMA 12.5 (t)</th>
<th>Gritting m²</th>
<th>Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013-2014</td>
<td>401</td>
<td>9</td>
<td>10300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015-2018</td>
<td>401</td>
<td>10</td>
<td>16641</td>
<td>162250</td>
<td></td>
</tr>
<tr>
<td>2014-2038</td>
<td>427/ 401</td>
<td>4</td>
<td>15495</td>
<td>79171</td>
<td></td>
</tr>
<tr>
<td>2014-2044</td>
<td>401</td>
<td>6</td>
<td>7939</td>
<td>9646</td>
<td></td>
</tr>
<tr>
<td>2015-2035</td>
<td>401</td>
<td>11</td>
<td>15178</td>
<td>150482</td>
<td>Central</td>
</tr>
<tr>
<td>2015-2012</td>
<td>QEW</td>
<td>2</td>
<td>5360</td>
<td>5360</td>
<td></td>
</tr>
<tr>
<td>2015-2023</td>
<td>QEW</td>
<td>4</td>
<td>5242</td>
<td>41934</td>
<td></td>
</tr>
<tr>
<td>2015-2021</td>
<td>401</td>
<td>7</td>
<td>29733</td>
<td>179080</td>
<td></td>
</tr>
<tr>
<td>2015-2033</td>
<td>400</td>
<td>4</td>
<td>21220</td>
<td>169763</td>
<td></td>
</tr>
<tr>
<td>2016-2030</td>
<td>403</td>
<td>8</td>
<td>28278</td>
<td>226225</td>
<td></td>
</tr>
<tr>
<td>2016-4014</td>
<td>401</td>
<td>6</td>
<td>16296</td>
<td>130366</td>
<td>Eastern</td>
</tr>
<tr>
<td>2014-3014</td>
<td>401</td>
<td>4</td>
<td>25230</td>
<td>187099</td>
<td>West</td>
</tr>
<tr>
<td>2016-3265</td>
<td>401</td>
<td>22</td>
<td>167</td>
<td>47509</td>
<td></td>
</tr>
<tr>
<td>2016-3003</td>
<td>401</td>
<td>8</td>
<td>25409</td>
<td>203270</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>107</strong></td>
<td><strong>224784</strong></td>
<td><strong>1692919</strong></td>
<td></td>
</tr>
</tbody>
</table>
Next Steps

- Specification be to updated to include:
  - Acceptance and repair criteria
  - Additional SMA mineral filler requirements
  - Gritting material gradation and physical requirements
  - Incorporating the application of coated grit in the standard

- MTO plans to continue to specify the use of SMA when warranted

- MTO will continue monitoring friction and performance of all SMA projects; and will continue to review the developments and practices of other agencies
Questions?

Pamela Marks, P.Eng.
Head, Bituminous Section
Provincial Highways Management

145 Sir William Hearst Avenue, Room 238
Downsview, Ontario
M3M 0B6
(416) 235-3725

pamela.marks@ontario.ca