HMA Surface Permeability for HMA Acceptance

Don Rowat, P.Eng., Area Contracts Engineer
Imran Bashir, P.Eng., Bituminous Engineer
Ministry of Transportation Ontario

AMIR/TRAK Asphalt Compaction Technology Demonstration Day
Long Sault, ON August 22, 2019
Outline

- Background
- Development of Field Permeability Test Equipment
- Permeability Limits for HMA Acceptance - Jurisdictional Scan
- Development of Field Permeability Criteria for Ontario
- Next Steps
Background

❖ 2012: First AMIR trials started with MTO / Carleton
❖ 2014 to 2016:
  • 4 bridge decks compacted side by side using conventional compaction equipment (static steel roller) and AMIR
❖ 2013-2019: Two HIIFP Studies awarded to Carleton University
  • Objectives were to develop permeability criteria for hot-mix asphalt pavements and develop in-situ permeability apparatus for use with a new surface permeability specification
❖ Nov. 2017: Field trial at Didsbury Road (Ottawa) was constructed using various available compaction technologies and gather permeability test data
❖ Nov. 2018: Hwy 401 at LaRue Mills
Development of Field Permeability Test Equipment

- Previous equipment was NCAT
  - Difficult to achieve a seal, messy, time consuming
  - Plastic
  - Readings done visually
Development of Field Permeability Test Equipment

- Iterative approach:
  - Needs to be heavy to seal; seal to be reusable material (not silicone, plumbers putty)
Development of Field Permeability Test Equipment

- Too Heavy, seal material hand cut
Development of Field Permeability Test Equipment
Development of Field Permeability Test Equipment

- Carleton developed software to be used with electronic sensors to facilitate readings that are now done automatically and objectively.
Lab Permeability Test Equipment

- Lab test to establish how each mix will perform under ideal conditions for permeability

- Target:
  - Permeability at 8% air voids; corresponding to asphalt compaction meeting MTO specification

- Florida DOT test method FM 5-565
Jurisdictional Scan: Permeability Limits for HMA Acceptance

- NCHRP Report 531: Relationship of Air Voids, Lift Thickness, and Permeability in Hot Mix Asphalt Pavements

<table>
<thead>
<tr>
<th>State</th>
<th>Critical Permeability (cm/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Mexico (Proposed)</td>
<td>125E-5</td>
</tr>
<tr>
<td>Florida</td>
<td>125E-5</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>125E-5</td>
</tr>
<tr>
<td>Virginia</td>
<td>125E-5</td>
</tr>
</tbody>
</table>

Source: Rafi Tarefder, University of New Mexico
Development of Field Permeability Criteria for Ontario

- Field permeability test data collected from Didsbury Road and 5 others bridge paving trials
  - Test data analyzed to establish/validate criteria for field permeability for Superpave 12.5 mixes
- Lab permeability testing also carried out on field cores and lab compacted samples from loose mix collected from the site
- Varied mat thicknesses (40mm to 100mm)
## Results:

<table>
<thead>
<tr>
<th>Trials</th>
<th>Mix Type</th>
<th>Ave. Permeability (x10^{-5})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Steel</td>
</tr>
<tr>
<td>Didsbury Rd</td>
<td>12.5FC2 Cat E</td>
<td>390</td>
</tr>
<tr>
<td>Hwy 28</td>
<td>12.5 FC1 Cat C</td>
<td>360</td>
</tr>
<tr>
<td>Hwy 417/34 bridge</td>
<td>12.5 FC2 Cat D</td>
<td>640</td>
</tr>
<tr>
<td>Hwy 401 Holt Rd bridge</td>
<td>12.5 FC2 Cat E</td>
<td>1010</td>
</tr>
<tr>
<td>Hwy 520 Distress River bridge</td>
<td>12.5 WMA Cat B</td>
<td>560</td>
</tr>
</tbody>
</table>
Low permeability specification is incentive based to raise the compacted asphalt quality bar

- No penalty
- Any contractor can try to meet the requirements
- No equipment specified
- Other types of equipment / processes other may also be able to produce lower permeability asphalt

No incentive if mix is rejectable for other ERS mix attributes
Low Permeability Surface Incentive Criteria

- The application of the low permeability surface incentive will be assessed based on the lot Incentive Factor based on the lot average field permeability and average laboratory permeability.

### Permeability Criteria and Lot Incentive Factors

**(When Lot Lab Permeability** $(LP_L) \leq 25 \times 10^{-5}$ cm/s)**

<table>
<thead>
<tr>
<th>Field Permeability of Lot $(FP_L)$, $10^{-5}$ cm/s</th>
<th>Lot Incentive Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>$FP_L &lt; 125$</td>
<td>1</td>
</tr>
<tr>
<td>$126 \leq FP_L \leq 250$</td>
<td>0.75</td>
</tr>
<tr>
<td>$251 \leq FP_L \leq 350$</td>
<td>0.50</td>
</tr>
<tr>
<td>$351 \geq FP_L$</td>
<td>0</td>
</tr>
</tbody>
</table>
Permeability Criteria and Lot Incentive Factors
(When Lot Lab Permeability $\geq 25 \times 10^{-5}$ cm/s)

<table>
<thead>
<tr>
<th>Lot Field Permeability ($FP_L$), $10^{-5}$ cm/s</th>
<th>Lot Incentive Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>$FP_L &lt; (2 \times LP_L)$</td>
<td>1</td>
</tr>
<tr>
<td>$(2 \times LP_L) +0.1 \leq FP_L \leq 3 \times LP_L$</td>
<td>0.75</td>
</tr>
<tr>
<td>$(3 \times LP_L) +0.1 \leq FP_L &lt; 4 \times LP_L$</td>
<td>0.50</td>
</tr>
<tr>
<td>$(4 \times LP_L) +0.1 \geq FP_L$</td>
<td>0</td>
</tr>
</tbody>
</table>

Testing Requirements

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Testing Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Permeability</td>
<td>MTO test procedure using automated Carleton In-Situ Permeability Apparatus (CIPA)</td>
</tr>
<tr>
<td>Lab Permeability</td>
<td>Florida DOT test method FM 5-565</td>
</tr>
</tbody>
</table>
Acceptance Testing for Determining Low Permeability Surface Incentive

• In-Situ Permeability measurements shall be conducted on the compacted HMA surface, from each sublot after the completion and prior to opening to the traffic
• 1 test per sublot, 10 sublots per lot, Ave. for the lot = Field permeability
• Lab permeability is the permeability of a Superpave gyratory compacted specimen, compacted to 8% air voids
  - 3 gyratory samples compacted to approximately 6, 8 and 10% air voids
  - Permeability at 8% air voids is interpolated from a laboratory plot
Next Steps

❖ Finalize draft low permeability incentive specification
❖ Implement permeability specification in select contracts on a trial basis
❖ Monitor low permeability trials performance and continue to update specification
Questions?

Don Rowat, P.Eng.
Area Contracts Engineer
Eastern Region - Operations
Ministry of Transportation, Ontario
1355 John Counter Blvd.,
Kingston, Ontario K7L 5A3
(613) 331-5651
Don.Rowat@ontario.ca

Bituminous Engineer
Materials Engineering and Research Office
Ministry of Transportation, Ontario
145 Sir William Hearst Avenue, Room 238
Downsview, Ontario M3M 0B6
(416) 721-6351
Imran.Bashir@ontario.ca