Outline

- Communication Knowledge Transfer
- PGAC and Recovered Asphalt Cement
- Various ways of using RAP
- Changes in Asphalt Specifications, Regression Method, Edge Compaction
- Mix Performance Testing, Tack Coat
Communication Knowledge Transfer

• One point contact through MTO Contract Management & Operations Branch (CMOB)
• MTO OAPC Hot Mix Subcommittee Meetings
• Partners in Quality Road Tour
• OAPC Fall Seminar
• Webinars:
  • Regression method held on October 22, 2019
  • Recovered asphalt cement held on October 24, 2019
Performance Graded Asphalt Cement (PGAC)

SSP111F09
Already on contracts in 2019

- Tightened high and low temperature grade limits for Minor Borderline
- DENT testing at 15°C for all PG grades

20 hrs PAV:
Cross-Over Temperature ($T_{δ45}$) and Low Temperature Critical Spread ($ΔT_c$) collected for information purposes

40 hrs PAV:
DENT, Cross-Over Temperature ($T_{δ45}$) and Low Temperature Critical Spread ($ΔT_c$) collected for information purposes
LS-319: Cross-Over Temperature ($T_{\delta 45}$)
### LS-320: Low Temperature Critical Spread ($\Delta T_c$)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creep Stiffness (S), 3 significant digits</td>
<td>MPa</td>
<td>239</td>
</tr>
<tr>
<td>Slope (m-value), nearest 0.001</td>
<td>-</td>
<td>0.304</td>
</tr>
<tr>
<td>Creep Stiffness (S), 3 significant digits</td>
<td>MPa</td>
<td>458</td>
</tr>
<tr>
<td>Slope (m-value), nearest 0.001</td>
<td>-</td>
<td>0.263</td>
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<tr>
<td>Stiffness Critical Temperature When $S = 300$ MPa</td>
<td>°C</td>
<td>-20.1</td>
</tr>
<tr>
<td>Slope Critical Temperature When $m-value = 0.300$</td>
<td>°C</td>
<td>-18.5</td>
</tr>
<tr>
<td>Low Temperature Critical Spread ($\Delta T_c = Ts - Tm$)</td>
<td>°C</td>
<td>-1.6</td>
</tr>
</tbody>
</table>
Recovered Asphalt Cement (RAC)

NSSP BITU0027 (SSP111F09M)
Already on contracts in 2019

LS-284 Rev 33 using only the Rotary Evaporator

Fines in recovered AC are limited to 1% using ash content

Recovered asphalt treated as RTFO residue

High and low temperature grading for acceptance

Other parameters collected for information purposes
Improvement of Extraction/Recovery Procedure

**LS-284 Rev33**

- **RAC**
- **Ash Content ≤ 1%?**
  - **YES**
  - **Pressure Aging Vessel (PAV)**
    - DSR on RTFO residue
    - DSR on PAV residue
    - Ex BBR on PAV residue
  - **BBR on PAV residue**
  - **DENT on PAV residue**
- **NO**
  - 4-6 Passes
  - **Fines Removal**
  - **Extraction**
  - **Recovery**
Various Ways of Using RAP

• Reclaimed Asphalt Pavement (RAP) is allowed in binder course mixes
• A phased-in approach to allow RAP in surface course mixes based on recovered asphalt cement properties and mix performance testing
• Hot In-Place Recycling (HIR)
• Cold In-Place Recycling (CIR)
• Cold In-Place Recycling with Expanded Asphalt (CIREAM)
• Plant produced Cold Recycled Mix (CRM)
HMA Specification Changes

111F06 (1151)
- RAP content expressed in terms of % Binder Replacement
- Asphalt film thickness to be submitted with mix design: using LS-321 & Form PH-CC-251

103F03 (313)
- Clarified lift thickness acceptance for m² jobs
- Diamond grinder shall be at least 1.2 m wide
- A lot shall be closed before paving begins on a different lot using the same tender item or the same mix design or both
- Clarified combining repaired and unrepaired areas of sublots
- Added SP9.5 to Table 7 (Macrotexture Ratio)
HMA Specification Changes

- The Owner no longer specifies the mix type for temporary HMA
- The Contractor is responsible to select an HMA type suitable for its intended use
- No sampling involved
- No QA/Referee testing
- Acceptance is based on visual reviews after paving
- Repairs apply
- No AC price index adjustments apply
- CDED has been revised to clarify the usage of this mix
HMA Regression Mix Design Method

HMA Regression Method means:
- the mix design asphalt cement (AC) content, selected at 4.0% air voids, is increased for production purposes, to an amount that will correspond to 3.5% air voids
- taken from the air voids versus AC content plot in the submitted mix design

BITU0025 (SP 103F03M)
BITU0026 (SP 111F06M)

Paved 5 projects in 2019;
4 projects planned for 2020
Determining Regressed AC Content
Regression Method – Specification Requirements

Memo to be submitted with mix design specifying:
a) Regressed AC content,
b) Aggregate gradation, and
c) VMA of the mix corresponding to the regressed AC content

Regressed VMA should not be more than 2% greater than the VMA given in Table 3 of OPSS1151

The VMA should also not be greater than the original VMA corresponding to 4% air voids
Regression Method – OPSS 1151 Table 3

<table>
<thead>
<tr>
<th>Traffic Category (Note 1)</th>
<th>% of Theoretical Maximum Specific Gravity</th>
<th>VMA % minimum</th>
<th>VFA (Note 2) %</th>
<th>Dust to Binder Ratio (Note 3)</th>
<th>Minimum Tensile Strength Ratio %</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>N&lt;sub&gt;Initial&lt;/sub&gt;</td>
<td>N&lt;sub&gt;design&lt;/sub&gt;</td>
<td>N&lt;sub&gt;max&lt;/sub&gt;</td>
<td>Nominal Maximum Aggregate Size mm</td>
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<tr>
<td>A</td>
<td>≤ 91.5</td>
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<td></td>
<td></td>
<td>11.0</td>
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<tr>
<td>B</td>
<td>≤ 90.5</td>
<td>96.0</td>
<td>≤ 98.0</td>
<td></td>
<td>11.0</td>
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<tr>
<td>C</td>
<td>≤ 89.0</td>
<td></td>
<td></td>
<td></td>
<td>11.0</td>
</tr>
<tr>
<td>D</td>
<td>≤ 89.0 (Note 5)</td>
<td></td>
<td></td>
<td></td>
<td>11.0</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.0</td>
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Regression Method – Specification Requirements

Air Voids Acceptance: LL: 2.0% UL: 5.0% (vs. 2.5 to 5.5)

Sublot with air voids ≤1.5% is rejectable

Separate End Result Spec (ERS) Sheet was supplied with regressed AC content used for calculation of PWL (Percent Within Limits)

2-year warranty for flushing and bleeding
Regression Method - ERS Highlights

Avg ERS Compaction (%)

<table>
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<tr>
<th>Contract</th>
<th>2017</th>
<th>2018</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td>Avg ERS Compaction (%)</td>
<td>93.74</td>
<td>93.43</td>
<td>93.87</td>
<td>95.03</td>
<td>94.06</td>
<td>93.54</td>
<td>93.35</td>
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Compaction
Regression Method - ERS Highlights

Air Voids

<table>
<thead>
<tr>
<th>Contract</th>
<th>Avg ERS Air Voids (%)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>3.23</td>
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<tr>
<td>2</td>
<td>2.63</td>
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<tr>
<td>3</td>
<td>3.49</td>
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<tr>
<td>4</td>
<td>4.19</td>
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<td>5</td>
<td>3.31</td>
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Regression Method - ERS Highlights

Pay Factor Final

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<th>Contract</th>
<th>Avg PF Final</th>
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<td>1</td>
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<tr>
<td>2</td>
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<tr>
<td>3</td>
<td>0.99</td>
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<tr>
<td>4</td>
<td>1.00</td>
</tr>
<tr>
<td>5</td>
<td>1.00</td>
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</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Avg PF Final</th>
</tr>
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<tbody>
<tr>
<td>2017</td>
<td>0.98</td>
</tr>
<tr>
<td>2018</td>
<td>0.97</td>
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</tbody>
</table>
Regression Method - Conclusions

• So far, the contracts with regression specification (i.e., BITU0025 and BITU0026) have been successful
  • All (but one) received full pay
  • No rejectable sublots due to low air voids
  • No flushing or bleeding
• Increased compaction and AC content are expected to extend pavement service life
• At least 4 jobs planned for 2020 paving, looking for more
• Contractor change proposals will be considered
• Collecting HMA samples for mix performance testing for info
Edge Compaction

Modified version of SP 103F03

Trials: 4 contracts (NE, Central, and West Regions)

Requires submission of detailed plan

Lot compaction pay factor: combination of edge and lane

If lane compaction is lower than edge: only lane compaction used

TODRF (Tender Opening Date Reduction Factor) applied 2019 & 2020 to phase-in

Edge compaction Lower Limit 1.5% below lane compaction

Additional cores may be taken directly over longitudinal joint for information
Mix Performance Testing

MTO is evaluating performance tests and is committed to developing acceptance criteria for post-production asphalt mix.

Asphalt mix design is more complex with the increased use of recycled materials and various additives.

Superpave mix design allows the mix designer to select a mix with less asphalt cement & decreased durability.

Objective is to use mix performance tests that provide a balance between resistance to cracking and rutting.
Mix Performance Testing

Investigating various performance tests to predict cracking and rutting for acceptance

- Semi-Circular Bend (SCB) Flexibility Index test (intermediate temperature crack resistance)
- Hamburg Wheel-Track test (rutting resistance and moisture damage)
- Disk-Shaped Compact Tension (DCT) test (low-temperature crack resistance)
Semi-Circular Bend (SCB) Flexibility Index Test

According to AASHTO TP124

Test Temperature: 25°C
Specimen Thickness: 50 mm
Notch Depth: 15 mm
Monotonic loading: 50 mm/min

Outcome:
Fracture Energy (J/m²)
Flexibility Index (FI)
Semi-Circular Bend (SCB) Flexibility Index Test

Load-Displacement curve of SCB

Slope at post-peak inflection point (m)
SCB Specimen Preparation

1. Cutting into discs
2. Cutting discs in half
3. Cutting the notch
SCB Load vs. Displacement Curves

[Graph showing four different curves labeled Mix A, Mix B, Mix C, and Mix D. Each curve represents a different mix and shows the load (in kN) on the y-axis and displacement (in mm) on the x-axis.]
Disk-Shaped Compact Tension (DCT) Test

According to ASTM D7313

Test Temperature: 10°C higher than low PG grade

Crack Mouth Opening Displacement (CMOD) Rate: 1mm/min

Outcome:

Fracture Energy (J/m²)

Fracture Energy ($G_f = W_f/\text{(thickness}\times\text{ligament)}$)
DCT Specimen Preparation

1. Cutting into discs
2. Cutting the edge of discs
3. Marking the holding holes
4. Coring the holding holes
5. Cutting the notch
6. Gluing the knife edges
Hamburg Wheel-Track (HWT) Test

According to AASHTO T324

Samples submerged in water

Test Temperature: 50°C

Number of cycles: 10000 cycles

Outcome:

Rut depth vs. # of load cycles

According to AASHTO T324

Samples submerged in water

Test Temperature: 50°C

Number of cycles: 10000 cycles

Outcome:

Rut depth vs. # of load cycles
Mix Performance Testing - Implementation

Phased-In approach starting 2020:
Targeting select contracts for information purposes
Also conducting SCB correlation

Semi-Circular Bend (SCB) Flexibility Index Testing on post-production samples
Hamburg Wheel-Track Testing on post-production samples

Contractors are encouraged to use balanced mix design
Tack Coat Specification Changes

SSP103F08 (OPSS 308)

Changes will include:

- minimum percent residue requirement
- verification of field application rate
- assessment of tack coat coverage
- bond strength testing for info
Tack Coat Specification Changes

- MTO will collect pavement cores for bond strength testing for information purposes

- AASHTO TP114: Louisiana Interlayer Shear Strength Tester (LISST)
  - Displacement Rate: 2.54 mm/min
  - Test Temperature: 25°C
Closing Remarks

MTO is committed to sustainability and will continue to promote and implement innovative pavement recycling techniques.

Ontario is currently using improved asphalt cement testing for acceptance.

MTO is actively evaluating mix performance tests for future acceptance specifications.
Questions

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