MTO Bituminous Specification Updates & Other Initiatives

Pamela Marks
Heather Bell
Seyed Tabib
Imran Bashir
Gelu Vasiliu

2019 Partners in Quality Road Tour
Outline

Changes in Asphalt Specifications

ERS Highlights

Updates: SMA Lane Marking, HIR, Edge Compaction, Fibre Reinforcement, Performance Testing

Other Initiatives: Tack Coat, Regression Method, Recovered Asphalt Grading
Specification Changes

**111F06**
- Asphalt film thickness submitted with mix design:
  - using LS-321 & PH-CC-251 to calculate
  - RAP content expressed in terms of % Binder Replacement reported on mix design

**103F03**
- Clarified lift thickness acceptance for m² jobs
- For small quantity rejectable lots, Owner determines a) if it will remain in place without repair; and b) pay adjustment

**111F09**
- Tightened High and Low Temperature grade acceptance tolerances
- DENT testing at 15°C for all PG grades
- Additional AC testing for information purposes
### Changes in PGAC Specification (2019)

#### Performance Grading Requirements and Categories for PGAC

<table>
<thead>
<tr>
<th>Category</th>
<th>Deviation (Note 3)</th>
<th>PGAC Requirements</th>
<th>PGAC Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Year of Tender Opening</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2019</td>
</tr>
<tr>
<td>Minor Borderline</td>
<td>below XX and</td>
<td>$\leq 3.0 , ^\circ C$</td>
<td>$\leq 1.5 , ^\circ C$</td>
</tr>
<tr>
<td></td>
<td>above -YY and</td>
<td>$\leq 3.0 , ^\circ C$</td>
<td>$\leq 1.5 , ^\circ C$</td>
</tr>
<tr>
<td></td>
<td>Sum</td>
<td>$\leq 3.0 , ^\circ C$</td>
<td>N/A</td>
</tr>
<tr>
<td>Major Borderline</td>
<td>below XX and</td>
<td>$\leq 3.0 , ^\circ C$</td>
<td>$\leq 3.0 , ^\circ C$</td>
</tr>
<tr>
<td></td>
<td>above -YY and</td>
<td>$\leq 3.0 , ^\circ C$</td>
<td>$\leq 3.0 , ^\circ C$</td>
</tr>
<tr>
<td></td>
<td>Sum</td>
<td>$&gt;3.0 , ^\circ C \text{ and } \leq 6.0 , ^\circ C$</td>
<td>N/A</td>
</tr>
<tr>
<td>Rejectable</td>
<td>below XX or</td>
<td>$&gt;3.0 , ^\circ C$</td>
<td>$&gt;3.0 , ^\circ C$</td>
</tr>
<tr>
<td></td>
<td>above -YY or</td>
<td>$&gt;3.0 , ^\circ C$</td>
<td>$&gt;3.0 , ^\circ C$</td>
</tr>
<tr>
<td></td>
<td>Sum</td>
<td>$&gt;6.0 , ^\circ C$</td>
<td>N/A</td>
</tr>
</tbody>
</table>
LS Changes / Updates

- LS-101 – Rounding of PWL values to reduce impact of rounding on PWL calculations and ERS
- LS-102 – QA laboratory requirements for new agreements
- LS-284 – Provides guidance in controlling fines in recovered asphalt; solvent drip rates during recovery; and alternate vacuum measurement units
- LS-317 – Allowable Macrotexture Depth added for SP 9.5 to quantify segregation severity
- New LS methods in Rev. 33:
  - LS-319 - Determination of Cross-Over Temperature ($T_{\delta45}$) for asphalt cement
  - LS-320 - Low Temperature Critical Spread ($\Delta T_C$) for asphalt cement
  - LS-321 - Method for calculation of asphalt film thickness
  - LS-322 - Determining fibre content/distribution in fibre reinforced mixes
Changes made to asphalt mix specifications in 2017 & 2018 are expected to extend pavement service life by 10% based on:
- increased compaction of mixes, and
- quantity of asphalt cement in 2017 mixes

The following other 2017 changes are expected to significantly reduce premature pavement cracking:
- full implementation of improved AC quality testing requirements
- use of RAP suspended in surface mixes, and
- use of shingles prohibited in all mixes
Impact on Asphalt Cement Quality

No early premature cracking has been reported on any MTO contracts using Spring 2017 asphalt material requirements.
ERS Highlights

Compaction

Lot Average Compaction

Mix Type

- SP12.5
- SP12.5 FC2
- SP 19

Year
- 2012
- 2013
- 2014
- 2017
- 2018

Values:
- SP12.5: 104, 71, 63, 17
- SP12.5 FC2: 107, 64, 79, 43
- SP 19: 136, 92, 88, 54

Average: 92
ERS Highlights

% Asphalt Cement Content

Year
2012 2013 2014 2017 2018
Lot Average - JMF AC Content
113 108 118 84 18
-0.1 -0.05 0 0.05 0.1 0.15

SP12.5
SP12.5 FC2
SP 19

Materials Engineering and Research Office
ERS Highlights

**PF Gradation**

- **SUP125**: 39, 15
- **SUP125FC2**: 40, 35
- **SUP190**: 58, 52

Pay Factor

**PF Air Void**

- **SUP125**: 39, 15
- **SUP125FC2**: 40, 35
- **SUP190**: 58, 52

Pay Factor
ERS Highlights

**PF Compaction**

<table>
<thead>
<tr>
<th>Material</th>
<th>Pay Factor 2017</th>
<th>Pay Factor 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUP125</td>
<td>0.85</td>
<td>0.85</td>
</tr>
<tr>
<td>SUP125FC2</td>
<td>0.84</td>
<td>0.84</td>
</tr>
<tr>
<td>SUP190</td>
<td>0.88</td>
<td>0.88</td>
</tr>
</tbody>
</table>

**PF Asphalt Cement Content**

<table>
<thead>
<tr>
<th>Material</th>
<th>Pay Factor 2017</th>
<th>Pay Factor 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUP125</td>
<td>1.00</td>
<td>0.96</td>
</tr>
<tr>
<td>SUP125FC2</td>
<td>1.00</td>
<td>0.96</td>
</tr>
<tr>
<td>SUP190</td>
<td>1.00</td>
<td>0.96</td>
</tr>
</tbody>
</table>

**Notes:**
- SUP125: Specification 125
- SUP125FC2: Specification 125 with additional binder content
- SUP190: Specification 190
ERS Highlights

**PF Mix**

- **SUP125**: 15, 77, 88
- **SUP125FC2**: 36
- **SUP190**: 52

**PF Final**

- **SUP125**: 55, 77, 93
- **SUP125FC2**: 110, 72, 88
- **SUP190**: 36, 52

Graphs showing pay factors for different materials over the years 2014, 2017, and 2018.
Updates

- Regression Trials
- Fibre Reinforced Trials
- SMA Lane Marking trials
- Edge Compaction
- HMA Performance Tests
- Evaluating Recovered Asphalt Cement
- Tack coat and Bond Test
- HIR trials
SMA Lane Marking Trials

- Evaluating painting over a gritted Stone Mastic Asphalt (SMA) surface:
  - 1st trial completed September 2018 on Highway 400 SB ramp to Jane Street
  - 2nd trial to be conducted this year
SMA Lane Markings Trials

Continued monitoring of trial lane markings required

Jane Street Off Ramp at Highway 400 Southbound
Changes to HIR Specification

- Increased temperature of underlying pavement in front of paver from 50°C to 60-80°C
- Now required to heat a minimum 150 mm of the previous HIR surface and hot mill 50 to 100 mm
- HIR mix shall be ≥110°C immediately behind the screed
- Field adjustments to the JMF:
  - Submitted within 1 Business Day
  - Unlimited number and scope
  - Must submit new mix design if triggered
- AC Content LL changed from:
  - $AC_{SPEC} - 0.2$
  - $AC_{SPEC} - 0.4$
- Payment reduction for AC content when:
  - $AC < AC_{SPEC} - 0.1$
  - instead of when:
  - $AC < AC_{SPEC} - 0.2$
Potential HIR Contracts

- 1 Contract in 2018
  - Northwestern Region
  - 58 km

- 1 Contract in 2019
  - Northwestern Region
  - 35 km

- 1 potential Contract in 2020
  - Northwestern Region
  - 45.3 km

- 9 potential Contracts beyond 2020
  - Northwestern, Northeastern, and West Regions
# Edge Compaction

<table>
<thead>
<tr>
<th>Modified version of SP 103F03</th>
<th>This year: 3 contracts in Central Region and West Region so far</th>
<th>Requires submission of detailed plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lot compaction pay factor combination of edge and lane</td>
<td>If lane compaction is lower than edge, only lane compaction used</td>
<td>TODRF applied 2019 &amp; 2020 to phase-in</td>
</tr>
<tr>
<td>Edge Compaction Lower Limit 1.5% below lane</td>
<td>Additional information only cores may be taken directly over longitudinal joint</td>
<td></td>
</tr>
</tbody>
</table>
**Improving Joint Quality**

**Eliminate the Cold Joint**
- Echelon/tandem paving
- Hot In-place Recycling

**Scheduling**
- Avoid paving in cooler temperatures
- Defer paving surface course

**Use Fine Graded Mixes**
- More workable
- Reduced segregation at joint /less loss of fines

**Quality Workmanship and**
- Proper amount of tack coat
- Sufficient asphalt material (avoid starving the joint)
- Avoid thinning out lift while rolling unconfined edge of mat

**Use of Technology**
- Joint heaters
- Joint tapes
- Extruded joint bond material
- Warm mix
Fibre Reinforced HMA Trial Locations

- 2016
- 2017
- 2018
- 2019
- Potential
The plant temperature may need to be increased in order to melt the bags / Sasobit wax.

No issues paving or rolling, but harder to rake.

May require some additional cleaning of equipment.
Fibre Reinforced HMA Lessons Learned

Many sections are performing similarly to the control.

Two started exhibiting reflective cracking within a few months of being placed.

Continued monitoring is required to determine long term benefits.
Fibre Reinforced HMA Lessons Learned

- Based on very limited testing, no significant difference in fracture properties between fibre and control.

- Rut resistance increased with addition of fibres.

- Fibre reinforced mix does not assure a delay in propagation of working cracks.

- MTO is still in the exploratory phase regarding reinforced fibre mixes.
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 performance tests that provide a balance between both resistance to cracking and rutting.
MTO investigating various performance tests available to predict cracking and rutting.

The following tests are being evaluated based on their potential to evaluate post-production mix for acceptance:

- Semi-Circular Bend (SCB) test
  (intermediate temperature crack resistance)
- Disk-shaped Compact Tension (DCT) test
  (low-temperature crack resistance)
- Hamburg Wheel Tracking test
  (rutting and moisture damage)
- Cyclic Fatigue test
  (fatigue crack resistance)
HMA Performance Testing

- Received loose mix and pavement cores for 19 mixes - more to come
- Tested both:
  - Superpave gyratory specimens
  - Pavement cores obtained during construction
- Data analysis underway
HMA Performance Testing: Findings

- Disk-shaped Compact Tension (DCT) Test:
  - RAP mixes have lower Fracture Energy values
  - Lower variability noted for DCT field cores compared to gyratory specimens

- Semi-Circular Bend Illinois Flexibility Index Test (SCB I-FIT):
  - RAP mixes have lower FI values
  - SCB’s I-FIT was more variable for field cores compared to gyratory specimens

- Lower variability noted for DCT than SCB I-FIT
HMA Performance Testing: Next Steps

- Carry out Hamburg Wheel Track Testing at a lower temperature of 44°C for PG 52-XX grades
- Evaluate fracture test variability for:
  - SCB
  - DCT
- U of Waterloo and MTO partnering through a HIIFP grant to find a solution that allows QA/QC laboratories to run SCB testing using a TSR loading frame and SCB jig
HMA Performance Testing: Implementation

- Focusing on:
  - SCB for intermediate temperature cracking
  - DCT for low temperature cracking
  - Hamburg Wheel Track testing for rutting and moisture damage
  - Cyclic Fatigue testing also being evaluated for intermediate temperature fatigue performance

- Phased in approach to be used starting in 2020
  - MTO expects to target 5 to 10 contracts for acceptance based on mix performance testing
  - Contractors will be encouraged to use balanced mix design
HMA Performance Testing: Balanced Mix Design

“Asphalt mix design using performance tests on appropriately conditioned specimens that address multiple modes of distress taking into consideration mix aging, traffic, climate and location within the pavement structure.”

Basically, a mix is designed for an intended application and service requirement.
Other Initiatives: Tack Coat

OPSS 308

*Changes expected to include:*
  - minimum percent residue requirement
  - verification of field application rate
  - assessment of tack coat coverage
Other Initiatives: Tack Coat

• MTO is collecting pavement core samples and testing bond strength for information purposes

• Louisiana Interlayer Shear Strength (LISS) Test –AASHTO TP114
Other Initiatives: Regression Method Mix

AC content at 4% air voids is increased for production purposes to an amount that corresponds to 3.5% air voids.

SP 111F06 M
SP 103F03 M

Memo submitted with mix design specifying Regressed AC
Air Void acceptance limits 2.0 to 5.0
Sublot with air voids ≤1.5 rejectable
Expect 7 projects in 2019
2 year warranty for flushing and bleeding
Recovered Asphalt Cement (RAC)

- LS-284 using only the Rotary evaporator
  - SSP 111F09 M
  - Expect on some contracts this year

- Recovered Asphalt treated as RTFO residue
- High and Low Temperature Grading for acceptance
- Fines in recovered AC are limited using Ash Content
# RAC Performance Grading Requirements

<table>
<thead>
<tr>
<th>Category</th>
<th>Deviation (Note 3)</th>
<th>2018</th>
<th>RAC Requirements</th>
<th>Year of Tender Opening</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PGAC Requirements</td>
<td></td>
<td></td>
<td>2019</td>
</tr>
<tr>
<td><strong>Acceptance Criteria</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>below XX and</td>
<td>≤ 0.0 °C</td>
<td>≤ 3.0 °C</td>
<td>≤ 1.5 °C</td>
<td>≤ 0.0 °C</td>
</tr>
<tr>
<td>above YY and</td>
<td>≤ 0.0 °C</td>
<td>≤ 3.0 °C</td>
<td>≤ 1.5 °C</td>
<td>≤ 0.0 °C</td>
</tr>
<tr>
<td><strong>Minor Borderline</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>below XX and</td>
<td>≤ 3.0 °C</td>
<td>≤ 6.0 °C</td>
<td>≤ 4.5 °C</td>
<td>≤ 3.0 °C</td>
</tr>
<tr>
<td>above YY and</td>
<td>≤ 3.0 °C</td>
<td>≤ 6.0 °C</td>
<td>≤ 4.5 °C</td>
<td>≤ 3.0 °C</td>
</tr>
<tr>
<td>Sum</td>
<td>≤ 3.0 °C</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Major Borderline</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>below XX and</td>
<td>≤ 3.0 °C</td>
<td>≤ 8.0 °C</td>
<td>≤ 6.0 °C</td>
<td>≤ 4.5 °C</td>
</tr>
<tr>
<td>above YY and</td>
<td>≤ 3.0 °C</td>
<td>≤ 8.0 °C</td>
<td>≤ 6.0 °C</td>
<td>≤ 4.5 °C</td>
</tr>
<tr>
<td>Sum</td>
<td>&gt; 3.0 °C and ≤ 6.0 °C</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Rejectable</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>below XX or</td>
<td>&gt; 3.0 °C</td>
<td>&gt; 8 °C</td>
<td>&gt; 6.0 °C</td>
<td>&gt; 4.5 °C</td>
</tr>
<tr>
<td>above YY or</td>
<td>&gt; 3.0 °C</td>
<td>&gt; 8 °C</td>
<td>&gt; 6.0 °C</td>
<td>&gt; 4.5 °C</td>
</tr>
<tr>
<td>Sum</td>
<td>&gt; 6.0 °C</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
## 2019 Recovered Asphalt Correlation-Round 1
### Rotary Evaporator Method - % Variation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>1s%</th>
<th>d2s%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fines≤ 2%</td>
<td></td>
<td>195.2</td>
</tr>
<tr>
<td>High Temperature Grade(No RTFO) (°C)</td>
<td>4.0</td>
<td>11.4</td>
</tr>
<tr>
<td>Low temperature Grade(PAV aged) (°C)</td>
<td>4.1</td>
<td>11.5</td>
</tr>
<tr>
<td>CTOD (mm)</td>
<td>41.2</td>
<td></td>
</tr>
<tr>
<td>EXBBR Limiting Grade Temperature (°C)</td>
<td>6.3</td>
<td>17.9</td>
</tr>
<tr>
<td>ExBBR Grade Loss (°C)</td>
<td>21.2</td>
<td>60.1</td>
</tr>
<tr>
<td>Δ Tc (°C)</td>
<td>69.0</td>
<td></td>
</tr>
</tbody>
</table>

*Note: Rotary Evaporator Method - % Variation*
2019 Recovered Asphalt Correlation-Round 1
Rotary Evaporator Method-Actual Variation

Fines≤ 2%

High Temperature Grade (No RTFO) (°C)  2.84
Low temperature Grade (PAV aged) (°C)  1.24
CTOD (mm)  2.59
ExBBR Limiting Temperature (°C)  1.49
ExBBR Grade Loss (°C)  1.19
ΔTc (°C)  0.93

Bar Graph Details:
- 1s: Green
- d2s: Yellow

Materials Engineering and Research Office
# Extraction and Recovery

<table>
<thead>
<tr>
<th>Solvent</th>
<th>Energy for Boiling [kJ/mole]</th>
<th>Boiling Point [°C]</th>
<th>Flammability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toluene</td>
<td>37.0</td>
<td>111</td>
<td>Flammable</td>
</tr>
<tr>
<td>TCE</td>
<td>34.7</td>
<td>87</td>
<td>Not flammable</td>
</tr>
</tbody>
</table>


![Extraction](image1)

<table>
<thead>
<tr>
<th>Extraction</th>
<th>Fines Removal</th>
<th>Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image2" alt="Extraction" /></td>
<td><img src="image3" alt="Fines Removal" /></td>
<td><img src="image4" alt="Recovery" /></td>
</tr>
</tbody>
</table>
At maximum vacuum, the temperature increases rapidly to the bath temperature.

- **Toluene**
- **Water**
- **TCE**
Wrap-up

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 tests for future performance acceptance specifications.
Questions

Bituminous Section
145 Sir William Hearst Drive,
Room 238
Downsview, Ontario
M3M 0B6
416.235.4678
Bituminous@ontario.ca