MTO Bituminous Specification Updates & Other Initiatives

Gelu Vasiliu and Seyed Tabib

2020 OAPC Partners in Quality Webinar

May 11th, 2020
Tack Coat SSP103F08 (OPSS 308)

- Included SS-1H in addition to SS-1 and SS-1HH
- Increased minimum residue requirement
- Field application rate ASTM D2995 (Option A)

AASHTO TP114: Louisiana Interlayer Shear Strength Tester (LISST)

Cores tested for information purposes
Specification Changes

SSP111F09 (OPSS1101M)
Already on contracts

- DENT testing at 15°C for all PG grades
- Tightened High and Low Temperature grade limits for Minor Borderline
- New Reporting Form PH-CC-250

20 hrs PAV:
Cross-Over Temperature ($T_{645}$) and Low Temperature Critical Spread ($\Delta T_C$) collected for information purposes

40 hrs PAV:
DENT, Cross-Over Temperature ($T_{645}$) and Low Temperature Critical Spread ($\Delta T_C$) collected for information purposes
PH-CC-250

Ontario

PGAC Test Reporting Sheet

Contract No: ________________________________
Laboratory: ________________________________
AC Supplier: ________________________________
Specified PG Grade (PG XX-YY): ____________________
PGAC Lot: ________________________________

Region: ________________________________
Sample No: ________________________________
Sample Type (QA or Referee): ____________________
Mix Type: ________________________________
HMA Lot, HMA Sublot: ________________________________
WBCMS Testing Code(s): ________________________________

Date: ________________________________
Security Tag No: ________________________________

Notes:
1. This form is to be used on Contracts with SSP-111F06 or otherwise instructed.
2. The information in the blue cells are to be filled out by the Laboratory.
3. The yellow cells are to be filled out by the Contract Administrator according to the Contract Documents.
4. The PG Continuous Grade and deviations will be automatically populated.
5. Submit this form in EXCEL format (.xlsx) along with the reporting sheets for DENT (PH-CC-835 or PH-CC-836) and Extended BBR (PH-CC-824), as posted on RAQS.

PGAC Compliance
Performance Grade (AASHTO R 280):
PG Continuous Grade (PG XX-YY) (Note 4)
High Temperature Deviation (under XX)
Low Temperature Deviation (above YY)

Specified Tests and Binder Characteristics

<table>
<thead>
<tr>
<th>Specified Tests and Binder Characteristics</th>
<th>Test Temperature °C</th>
<th>Measuring Unit</th>
<th>Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ORIGINAL AC</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASTM D227: Ash content (% by mass)</td>
<td></td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>AASHTO T315-12, Rotational Viscosity (nearest 0.01)</td>
<td>135</td>
<td>Pa$s$</td>
<td></td>
</tr>
<tr>
<td>AASHTO T316-13, Rotational Viscosity (nearest 0.02)</td>
<td>205</td>
<td>Pa$s$</td>
<td></td>
</tr>
<tr>
<td>AASHTO T332-12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamic Shear Rheometer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Complex Shear Modulus, G' (nearest 0.01)</td>
<td></td>
<td>Ipa</td>
<td></td>
</tr>
<tr>
<td>• Phase Angle, δ (nearest 0.1)</td>
<td></td>
<td>degree</td>
<td></td>
</tr>
<tr>
<td>• G'/sin δ (nearest 0.01)</td>
<td></td>
<td>Ipa</td>
<td></td>
</tr>
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<td></td>
</tr>
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<td>• G'/sin δ (nearest 0.01)</td>
<td></td>
<td>Ipa</td>
<td></td>
</tr>
<tr>
<td>• Predicted Failure Temperature when DSR, G'/sin δ = 1.0 Ipa</td>
<td></td>
<td>degree (°C)</td>
<td></td>
</tr>
</tbody>
</table>
Recovered Asphalt Cement (RAC)
NSSP BITU0027 (SSP 111F09M)
NSSP BITU0028 (SSP 103F03M)

- LS-284 Rev 34 Rotary Evaporator Only
  Fines limited to 1%
- Recovered asphalt treated as RTFO residue
- Initial Year of Tender Opening to include 2020

- High and Low temperature grading for acceptance
- Other parameters collected for information
- Some contracts in 2020 allow RAP in surface course
# TABLE 1

Performance Grading Requirements and Categories for PGAC and RAC

<table>
<thead>
<tr>
<th>Category</th>
<th>Deviation (Note 3)</th>
<th>PGAC Requirements</th>
<th>RAC Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>2019 2020 2021 2021-2022+</td>
</tr>
<tr>
<td>Acceptance Criteria (Note 1)</td>
<td>below XX and above -YY</td>
<td>( \leq 0.0 , ^\circ C )</td>
<td>( \leq 4.0 , ^\circ C ) ( \leq 3.5 , ^\circ C ) ( \leq 3.0 , ^\circ C )</td>
</tr>
<tr>
<td>Minor Borderline (Note 1)</td>
<td>above -YY</td>
<td>( \leq 0.0 , ^\circ C )</td>
<td>( \leq 4.0 , ^\circ C ) ( \leq 3.5 , ^\circ C ) ( \leq 3.0 , ^\circ C )</td>
</tr>
<tr>
<td></td>
<td>below XX and above -YY and</td>
<td>( \leq 3.0 , ^\circ C )</td>
<td>( \leq 6.0 , ^\circ C ) ( \leq 5.0 , ^\circ C ) ( \leq 4.0 , ^\circ C )</td>
</tr>
<tr>
<td></td>
<td>Sum</td>
<td>( \leq 3.0 , ^\circ C )</td>
<td>N/A ( ) N/A ( ) N/A ( )</td>
</tr>
<tr>
<td>Major Borderline (Note 1)</td>
<td>below XX and above -YY and</td>
<td>( \leq 3.0 , ^\circ C )</td>
<td>( \leq 8.0 , ^\circ C ) ( \leq 6.0 , ^\circ C ) ( \leq 5.0 , ^\circ C )</td>
</tr>
<tr>
<td></td>
<td>Sum</td>
<td>( &gt; 3.0 , ^\circ C ) and ( \leq 6.0 , ^\circ C )</td>
<td>N/A ( ) N/A ( ) N/A ( )</td>
</tr>
<tr>
<td>Rejectable (Note 2)</td>
<td>below XX or above -YY or</td>
<td>( &gt; 3.0 , ^\circ C )</td>
<td>( &gt; 8 , ^\circ C ) ( &gt; 6.0 , ^\circ C ) ( &gt; 5.0 , ^\circ C )</td>
</tr>
<tr>
<td></td>
<td>Sum</td>
<td>( &gt; 6.0 , ^\circ C )</td>
<td>N/A ( ) N/A ( ) N/A ( )</td>
</tr>
</tbody>
</table>
# PH-CC-249

## RAC Test Reporting Sheet

### Ontario

<table>
<thead>
<tr>
<th>Contract No:</th>
<th>Region:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Laboratory:</th>
<th>Sample No:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AC Supplier:</th>
<th>Sample Type (QA or Referee):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specified RAC (PG XX-YY):</th>
<th>Specified PGRC (PG XX-YY):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date:</th>
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</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mix Type:</th>
<th>HMA Lot, HMA Sublot:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WBCM Testing Code (s):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

### Notes

1. This form is to be used on Contracts with SSP111F09M/BITU0307 or otherwise instructed.
2. The information in the blue cells are to be filled out by the Laboratory.
3. The yellow cells are to be filled out by the Contract Administrator according to the Contract Documents.
4. The RAC Continuous PG Grade and deviations will be automatically populated.
5. Submit this form in EXCEL format (.xlsx) along with the latest reporting sheets for DENT (PH-CC-855 or PH-CC-856) and Extended BBR (PH-CC-824), as posted on RAQS.

### RAC Classification

<table>
<thead>
<tr>
<th>RAC Performance Grading (AASHTO R-29)</th>
<th>Test Results (Note 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAC Continuous PG Grade (PG XX-YY)</td>
<td></td>
</tr>
<tr>
<td>High Temperature Deviation (under XX)</td>
<td></td>
</tr>
<tr>
<td>Low Temperature Deviation (above -YY)</td>
<td></td>
</tr>
</tbody>
</table>

### Specified Tests and Binder Characteristics

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<th>Test Temperature ºC</th>
<th>Measuring Unit</th>
<th>Test Results</th>
</tr>
</thead>
</table>

#### RAC as RTFO RESIDUE (AASHTO T240-13)

<table>
<thead>
<tr>
<th>ASTM D8878-16</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Ash Content (nearest 0.01)</td>
<td>%</td>
</tr>
<tr>
<td>Complex Shear Modulus, G (nearest 0.01)</td>
<td>kPa</td>
</tr>
<tr>
<td>Phase Angle, δ (nearest 0.1)</td>
<td>degree</td>
</tr>
<tr>
<td>(G°) / sin δ (nearest 0.01)</td>
<td>kPa</td>
</tr>
<tr>
<td>Complex Shear Modulus, G* (nearest 0.01)</td>
<td>kPa</td>
</tr>
<tr>
<td>Phase Angle, δ (nearest 0.1)</td>
<td>degree</td>
</tr>
<tr>
<td>(G°) / sin δ (nearest 0.01)</td>
<td>kPa</td>
</tr>
<tr>
<td>Predicted Failure Temperature when DSHL (G°) / sin δ = 2.20 kPa (nearest 0.1)</td>
<td>degree (ºC)</td>
</tr>
</tbody>
</table>

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8 Materials Standards and Specifications Office
Recovered Asphalt Cement (RAC)

**LS-284**

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

Materials Standards and Specifications Office
2019 RAC Correlations

High Temperature Grading
COV(%) [Graph with bars for Feb-19, Jul-19, Dec-19, AASHTO 315 RTFO DSR]

Low Temperature Grading
COV(%) [Graph with bars for Feb-19, Jul-19, Dec-19, AASHTO 313 BBR,S, AASHTO 313 BBR,m]
- LS-220 – Provided clarification and guidance for use of calcium chloride dihydrate
- LS-284- Removed Abson Method
- LS-292-Aligned with ASTM D6307-19
- LS-316 – Clarified application of one-point mix check (Figure 1) and independent mix verification (Figure 2)
- New LS method in Rev. 34:
  - LS-229 – Residue by Evaporation for Asphalt Emulsions
Last field guide published in 2017
- Major updates made to harmonize with various specification changes
- Bituminous initiatives covered in the appendices
- To be published in May 2020
Green Initiatives

- Reclaimed Asphalt Pavement (RAP) is allowed in binder course mixes
- Phased-in approach to allow RAP in surface course based on recovered AC 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)
- Plant produced Hot Recycled Mix (HRM)
- Warm Mix Asphalt (WMA)
- Use of Low or Non VOC Products
  VOC - Volatile Organic Compound
Green Initiatives

Toolbox: Science without Borders

- Fourier Transform Infrared Spectroscopy (FTIR)
- Differential Scanning Calorimetry (DSC) and Thermogravimetry (TGA)
- X-ray Fluorescence Spectroscopy (XRF)
- Nuclear Magnetic Resonance Spectroscopy (NMR)
- SARA Analysis (Saturates, Aromatics, Resins and Asphaltenes)
- Atomic Force Microscopy (AFM)
Hot-In-Place Recycling (HIR)

- 1 Contract in 2018
  - Northwestern Region
  - 120 lane.km

- 1 Contract in 2019
  - Northwestern Region
  - 70 lane.km

- 1 Contract in 2020
  - Northwestern Region
  - 53 lane.km

- 10+ potential Contracts beyond 2020
  - All MTO Regions
  - ~1000 lane.km
Expanding use of Warm Mix Asphalt (WMA)

- Collaborative work between MTO and OAPC to expand the use of WMA
- Looking at a phased-in approach to implement WMA
- WMA to be specified with some requirements:
  - List of allowable WMA technologies
  - Temperature restrictions at plant or at paver
  - Emissions restrictions at plant and paving site
  - Provisions for time of year
  - Mix performance tests (Flow Number, Hamburg, TSR, etc.)
Other Initiatives

Edge Compaction

BITU0024
Modified version of SSP 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

Separate ERS Sheet

Additional cores may be taken directly over longitudinal joint for information

Materials Standards and Specifications Office
HMA Regression Method
BITU0025 (SP 103F03M)
BITU0026 (SP 111F06M)

Mix design: Air Voids vs Asphalt Cement (AC) content plot
AC content selected at 4.0% air voids
Regressed AC content corresponding to 3.5% air voids

2019 Paved 5 projects
2020 4 potential projects
Change proposals?
Other Initiatives

Determining Regressed AC Content
Regression Method - 2020 changes:

**BITU0025:**
- waxed-based WMA technologies not permitted
- for SP12.5FC 2: the regressed VMA can be up to 2.5% greater than the minimum VMA

**BITU0026:**
- additional warranty for bleeding and flushing no more required
- Table 2: sampling of loose HMA mix for mix performance testing for information
- Table 4: list of mix performance tests
Regression Method – Observations to Date

- Increased AC content
- Increased field compaction
- No rejectable sublots due to low air voids
- No flushing or bleeding
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.
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)
Other Initiatives

Mix Performance Testing
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)
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 Chart]

\[ G_f = \frac{W_f}{(\text{thickness} \times \text{ligament})} \]

Disk-Shaped Compact Tension (DCT) Test

Mix Performance Testing

Materials Standards and Specifications Office
Hamburg Wheel-Track (HWT) Test

According to AASHTO T324

- Samples submerged in water
- Test Temperature: 50°C or 44°C
- Number of cycles: 10000 cycles

Outcome:

Rut depth vs. # of load cycles

Materials Standards and Specifications Office
Phased-In approach starting 2020: Collecting post-production samples from select contracts Testing for information purposes

SCB Flexibility Index Testing
Hamburg Wheel-Track Testing
DCT testing

SCB correlation ongoing

Contractors are encouraged to use balanced mix design

2 CTAA papers underway
Lowering Number of Gyrations

- Many agencies have reduced the # gyrations from those stated in the original Superpave mix design method
- MTO is looking at dropping the # of gyrations for Cat E and D mixes as another way to increase AC content
- A few contractors’ labs have volunteered to conduct a comparison between 125 and 100 gyrations for Cat E mixes. Also to compare between 100 and 85 gyrations for Cat D
- Discussions with OAPC are underway to develop a procedure and reporting forms for consistency
Closing Remarks

MTO is committed to sustainability and will continue to promote and implement green initiatives.

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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