Lessons Learned from the New PGAC Specifications

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Asphalt Cement Supply Chain

**Refiner**
- Supplies base asphalt cement binder
- Available supply of asphalt cement binder may not match government user agency specifications

**AC Terminal Supplier / Modifier**
- Stores & terminals asphalt cement binder from multiple refineries
- Manufactures enhanced/modified grades of asphalt cement to meet government owner agency specifications
- Contractually responsible for quality if owner agency purchases AC, otherwise contractor is responsible

**Contractor**
- Produces and paves with asphalt mix using asphalt cement binder supplied by Terminal Supplier / Modifier
- Contractually responsible for quality
- Contractor requires “Just – In – Time” supply

<table>
<thead>
<tr>
<th>Base Specification</th>
<th>PG + Specs Adopted In Varying Combinations</th>
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<tbody>
<tr>
<td><strong>PGAC</strong> (AASHTO M320)</td>
<td>DENT</td>
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<tr>
<td></td>
<td>Extended BBR</td>
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<td></td>
<td>MSCR Percent Recovery</td>
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<td>MSCR Jnr</td>
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<td>Ash Content</td>
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<td></td>
<td>Multiple Versions of Recipe Specifications</td>
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<td></td>
<td>Listing Permitted &amp;/or Non-Permitted Modifiers</td>
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<td></td>
<td>Elastic Recovery</td>
</tr>
<tr>
<td><strong>Full MSCR</strong></td>
<td>Ash Content</td>
</tr>
</tbody>
</table>
Specifications Driving Increasing Modified Asphalt Cement Use in Ontario

Modified Asphalt Cement as Percent of Total Paving Grade Asphalt Cement Used in Canada and (1999-2015)
Based on AC Supplier Survey Information (no data available for 2009)
“Starbucks Asphalt” Effect
Numerous Differing Customized Specifications & Grades

I’ll have a 64-34, warm, with ½ MSCR, add the DENT and ExBBR, easy on the Ash...
Asphalt Cement Grade Proliferation

• Multiple versions of different PGAC grades
  – Limited tank availability at Asphalt Hot Mix Plant and AC Terminal
  – Additional tank capacity may be required
  – Strains asphalt plant – “just in time” delivery model
  – Additional planning required when switching between grades at asphalt plant
  – Minimize and plan to deal with partially full tank of left over product when switching to new grade

• OPPORTUNITY TO STANDARDIZE SPECIFICATIONS AND REDUCE NUMBER OF ASPHALT CEMENT GRADES
**Binder Nomenclature**

<table>
<thead>
<tr>
<th>Standardized</th>
<th>Standardized</th>
<th>Not Standardized</th>
</tr>
</thead>
<tbody>
<tr>
<td>PGAC</td>
<td>MSCR</td>
<td>PG +</td>
</tr>
<tr>
<td>AASHTO M320</td>
<td>AASHTO M332</td>
<td>Non-Standard Nomenclature</td>
</tr>
</tbody>
</table>

Examples:
- 64-28
- 64-34
- 58-34
- 70-28
- 52H-34
- 58S-28
- 58V-28
- 58H-34
- 58V-34
- MSCR % Recovery
- DENT
- Extended BBR
- Varying Ash Content Limits
- Elastic Recovery
- Recipe Spec Requirements

- Non-standard terminology for binders which include PG+ parameters (no standard PG + grading system)

- **OPPORTUNITY** TO STANDARDIZE GRADE NOMENCLATURE IN SPECIFICATIONS
"Quite obviously this specifies a PGAC binder meeting requirements for Ash Content, MSCR % Recovery but not Jnr, DENT, but not Extended BBR. If however the binder is PG 58-28 or PG 52-34 then none of this except for Ash Content applies. What grade is required you ask? Excellent question – we will need to consult a different table..."
Case Study

OPSS.MUNI 1101 is amended by the addition of Table 1.

### Table 1

<table>
<thead>
<tr>
<th>PGAC Grade</th>
<th>Property and Attributes (Unit)</th>
<th>Test Method</th>
<th>Results Reported Rounded to the Nearest</th>
<th>Acceptance Criteria</th>
<th>Major Borderline</th>
<th>Rejectable</th>
</tr>
</thead>
<tbody>
<tr>
<td>All PGAC Grades</td>
<td>Ash Content, % by mass of residue (%)</td>
<td>LS-227</td>
<td>0.1</td>
<td>≤ 0.8</td>
<td>N/A</td>
<td>&gt; 0.8</td>
</tr>
<tr>
<td></td>
<td>Non-recoverable creep compliance at 3.2 kPa (J_{rr-3,2}) (kPa⁻¹)</td>
<td>Multiple Stress Creep and Recovery (MSCR) testing according to AASHTO TP 70 testing conducted at a temperature of 55 °C</td>
<td>0.01</td>
<td>&lt; 4.0</td>
<td>N/A</td>
<td>≥ 4.0</td>
</tr>
<tr>
<td></td>
<td>Average percent recovery at 3.2 kPa (R₁₂) (%)</td>
<td></td>
<td></td>
<td>&gt; the lesser of [(29.371) (J_{rr-3,2})⁻₀.2633] or 55</td>
<td>N/A</td>
<td>≤ the lesser of [(29.371) (J_{rr-3,2})⁻₀.2633 - 10] or 55</td>
</tr>
<tr>
<td></td>
<td>Average critical crack tip opening displacement (A) (mm)</td>
<td>LS-299</td>
<td>0.1</td>
<td>&gt; 10</td>
<td>&lt; 6.0 and ≥ 4.0 (Note 1)</td>
<td>&lt; 4.0</td>
</tr>
</tbody>
</table>

Notes:
1. The PGAC is considered deficient and the Contractor shall submit in writing a detailed proposal on how he will address this non-conformance.

- Developer solicited proposal from 3rd party paver for residential paving project
- 3rd party paver solicited materials from hot mix asphalt producer for mix design verification
- “Assumption” made throughout communication chain that PG+ specs do not apply
- Caught in mix design stage – 58-34 did not meet DENT PG+ spec requirement which prompted specification review
- Contract specifications refer to PG 54-34 (typo?) and 64-28P (trade name?)
AC Binder Literacy

• Complexity of binder related terminology and proliferation of different specifications
  – Does the contractor know the correct grade to bid with?
  – Is the contractor ordering the correct grade?
  – Does the AC hauler know the correct grade to pick up?
  – Is the QA consultant testing for the correct acceptance properties?
  – Binder literacy impacts extent to which meaningful technical discussions on AC binders may be held between owner agencies and other stakeholders

• OPPORTUNITY TO FURTHER EDUCATE STAKEHOLDERS ON AC BINDER SPECIFICATIONS
Rigorous communications protocol required

- Numerous grades, specs, and non-standard nomenclature for AC grades
- Schedule production and testing of modified binder
- Supply on just-in-time basis to contractor who must ensure tank space is avail.
- Additional communication protocols required (CA, QA Consultant, Owner Agency)
Statistical Variation in Specification Acceptance Test Results

- Enhanced challenges when Reproducibility of test exceeds Specification Limits

- Certain PG+ specs suffer from poor reproducibility between laboratories
  - Specifications do currently make some accommodation for testing variation
• Clean and representative sample is critical
  – Account for bottoms/residue in tankers, pipes, tanks
  – Certification tests based on a few grams to a few hundred grams
• Consider replicate QC sampling along side of QA/Referee sampling along with sample cataloguing and retention program at asphalt plants
Laboratory Mixing and Compaction Temperatures

- New specifications are increasing content of polymer modifiers in asphalt cement
- Suspect laboratory compaction influenced by lubricity (polymers increase lubricity?) and viscosity
- NCHRP 648 – Mixing and Compaction Temperatures in HMA
  - DSR Steady Shear Flow Viscosity
  - DSR Phase Angle Method
- Other methods
  - High shear rate viscosity, zero shear viscosity, mixture workability/compaction

Equiviscous Temperature Method

Laboratory mixing and compaction temperatures for modified asphalt cements are lower than predicted by Equiviscous Temperature Method.
Currently no universally accepted standard method to determine mixing/compaction temperatures for modified binders.
Recipe Specifications

• Several versions of “recipe” specifications listing permitted and non-permitted asphalt cement modifiers are in use

• Owner agencies require a reasonable means of ensuring compliance

• Current chemical analysis techniques are subject to interpretation and testing error (small sample size/sample heterogeneity, testing variation, confounding factors)
  – Documented case study in which “outlier” chemical analysis result resulted in incorrect conclusions about material supplied to project

• POTENTIAL GAP BETWEEN CHEMICAL ANALYSIS TECHNIQUES AND ABILITY TO CONFIDENTLY AND CONSISTENTLY ASSESS COMPLIANCE TO RECIPE SPECIFICATION
Recovered Binder Testing

• Purpose?
  – Check compliance to asphalt cement specifications?
    OR
  – Require a recovered binder specification (i.e. move away from specifying required asphalt cement grade)

• Owner agencies require a reasonable means of ensuring supplied materials meet specifications

• Recovered binder testing can be problematic
  – Results can be influenced by test method
  – AC material properties alone cannot ensure desired specifications will be met (results influenced by plant processing, transportation, and placement variables)
  – Influence of design recycle content
  – Highly variable reproducibility (between different labs)
  – Difficult to interpret results
Expectations for 2017

• MTO Provincial Specifications
  – Expanded implementation of Extended BBR
  – DENT, MSCR % Recovery, Reduced Ash Content
  – Limits on PPA modifier

• Municipal Specifications
  – Updated OPSS.MUNI 1101 Material Specification for Performance Graded Asphalt Cement
  – Extended BBR, DENT, MSCR % Recovery, Ash Content
  – Very extensive restrictions on permitted PGAC Modifiers
  – Optional Appendix for Full MSCR Specification
QUESTIONS & DISCUSSION

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