
Lessons Learned from the New PGAC Specifications

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By

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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

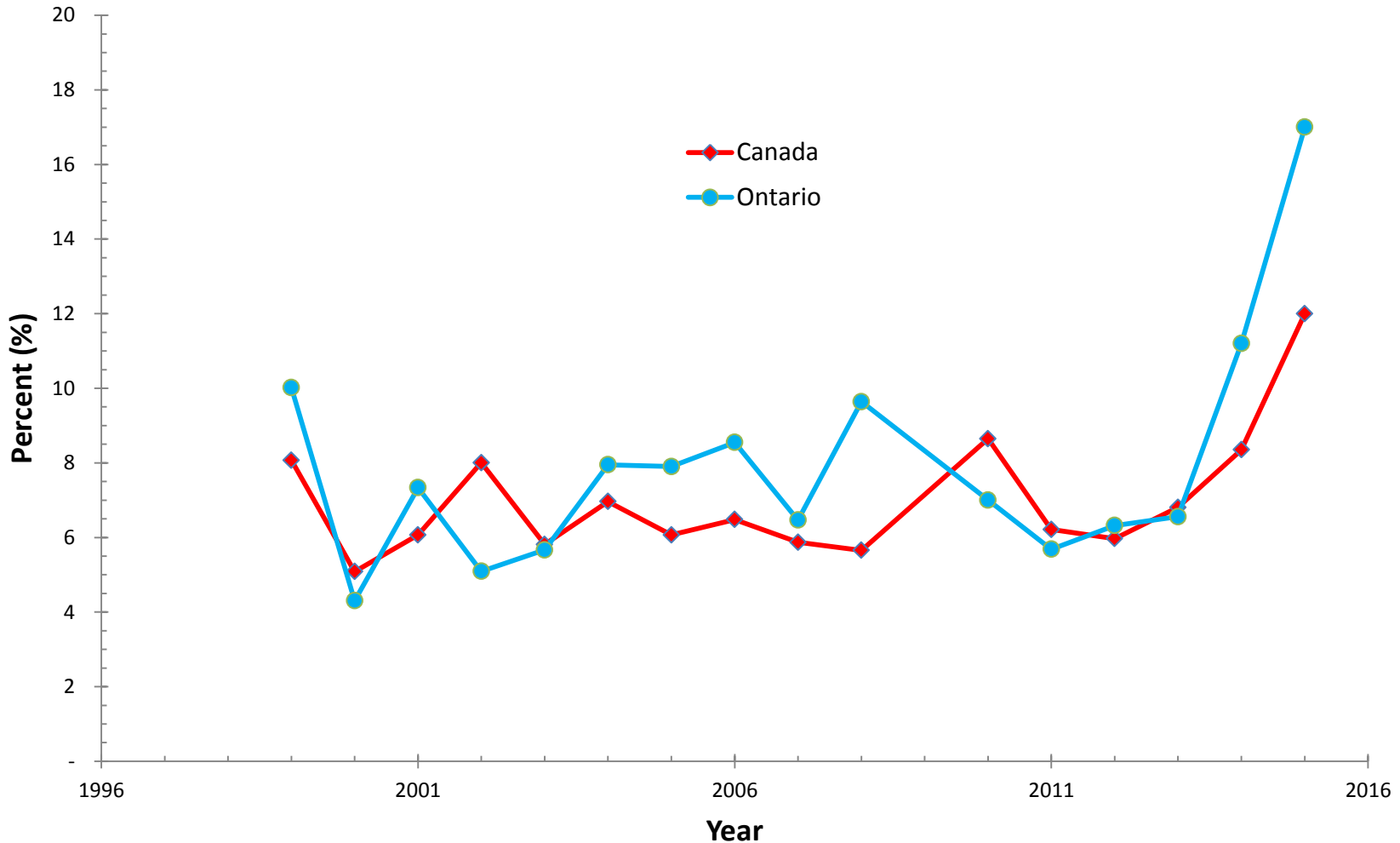


- Produces and paves with asphalt mix using asphalt cement binder supplied by Terminal Supplier / Modifier
- Contractually responsible for quality
- Contractor requires “Just – In – Time” supply

AC Specification Changes (2009 – 2016) Driven Primarily By Premature Pavement Cracking Concerns

Base Specification	PG + Specs Adopted In Varying Combinations
<p style="text-align: center;"><i>PGAC (AASHTO M320)</i></p>	DENT
	Extended BBR
	MSCR Percent Recovery
	MSCR Jnr
	Ash Content
	Multiple Versions of Recipe Specifications Listing Permitted &/or Non-Permitted Modifiers
	Elastic Recovery
<p style="text-align: center;"><i>Full MSCR</i></p>	Ash Content

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
1/2 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

Standardized

PGAC
AASHTO M320

Examples:

64-28
64-34
58-34
70-28

Standardized

MSCR
AASHTO M332

Examples:

52H-34
58S-28
58V-28
58H-34
58V-34

Not Standardized

PG +
Non-Standard Nomenclature

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

AC Binder Specification “Literacy”

Table 1

Additional Testing Requirements and Acceptance Criteria for PGAC Grades

PGAC Grade	Property and Attributes (Unit)	Test Method	Results Reported Rounded to the Nearest	Acceptance Criteria	Major Borderline	Rejectable
All PGAC Grades	Ash Content, % by mass of residue (%)	LS-227	0.1	≤ 1.0	N/A	>1.0
All PGAC Grades except PG58-28 and PG52-34	Low temperature limiting grade (LTLG) ($^{\circ}\text{C}$)	LS-308	0.5	N/A Testing carried out only for information purpose		
	Grade Loss ($^{\circ}\text{C}$)	LS-308 and Form B of LS-308	0.5			
	Non-recoverable creep compliance at 3.2 kPa ($J_{nr-3.2}$) (kPa^{-1})	Multiple Stress Creep and Recovery (MSCR) testing according to AASHTO TP 70 testing conducted at a temperature of 58°C	0.01	< 4.0	N/A	≥ 4.0
	Average percent recovery at 3.2 kPa ($R_{3.2}$) (%)		0.1	$>$ the lesser of $[(29.371)(J_{nr-3.2})^{-0.2633}]$ or 55	N/A	\leq the lesser of $[(29.371)(J_{nr-3.2})^{-0.2633} - 10]$ or 50
	Percent difference in non-recoverable creep compliance between 0.1 kPa and 3.2 kPa, $J_{nr\text{diff}}$ (%)		0.1	N/A Testing carried out only for information purpose		
Average critical crack tip opening displacement (δ_c) (mm)	LS-299	0.1	≥ 10 mm	< 6.0 mm and ≥ 4.0 mm (Note 1)	< 4.0 mm	

Notes:

1. The PGAC is considered deficient and the Contractor shall submit a Non-Conformance Report (form PH-CC-859).

“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
Additional Testing Requirements and Acceptance Criteria for PGAC Grades 54-34 and 64-28P

PGAC Grade	Property and Attributes (Unit)	Test Method	Results Reported Rounded to the Nearest	Acceptance Criteria	Major Borderline	Rejectable
All PGAC Grades	Ash Content, % by mass of residue (%)	LS-227	0.1	≤ 0.8	N/A	>0.8
	Non-recoverable creep compliance at 3.2 kPa ($J_{nr-3.2}$) (kPa^{-1})	Multiple Stress Creep and Recovery (MSCR) testing according to AASHTO TP 70 testing conducted at a temperature of 58 °C	0.01	< 4.0	N/A	≥ 4.0
	Average percent recovery at 3.2 kPa ($R_{3.2}$) (%)		0.1	> the lesser of [(29.371) ($J_{nr-3.2}$) ^{0.2633}] or 55	N/A	≤ the lesser of [(29.371) ($J_{nr-3.2}$) ^{0.2633} -10] or 50
	Average critical crack tip opening displacement (δ_t) (mm)	LS-299	0.1	> 10	< 6.0 and ≥ 4.0 (Note 1)	< 4.0

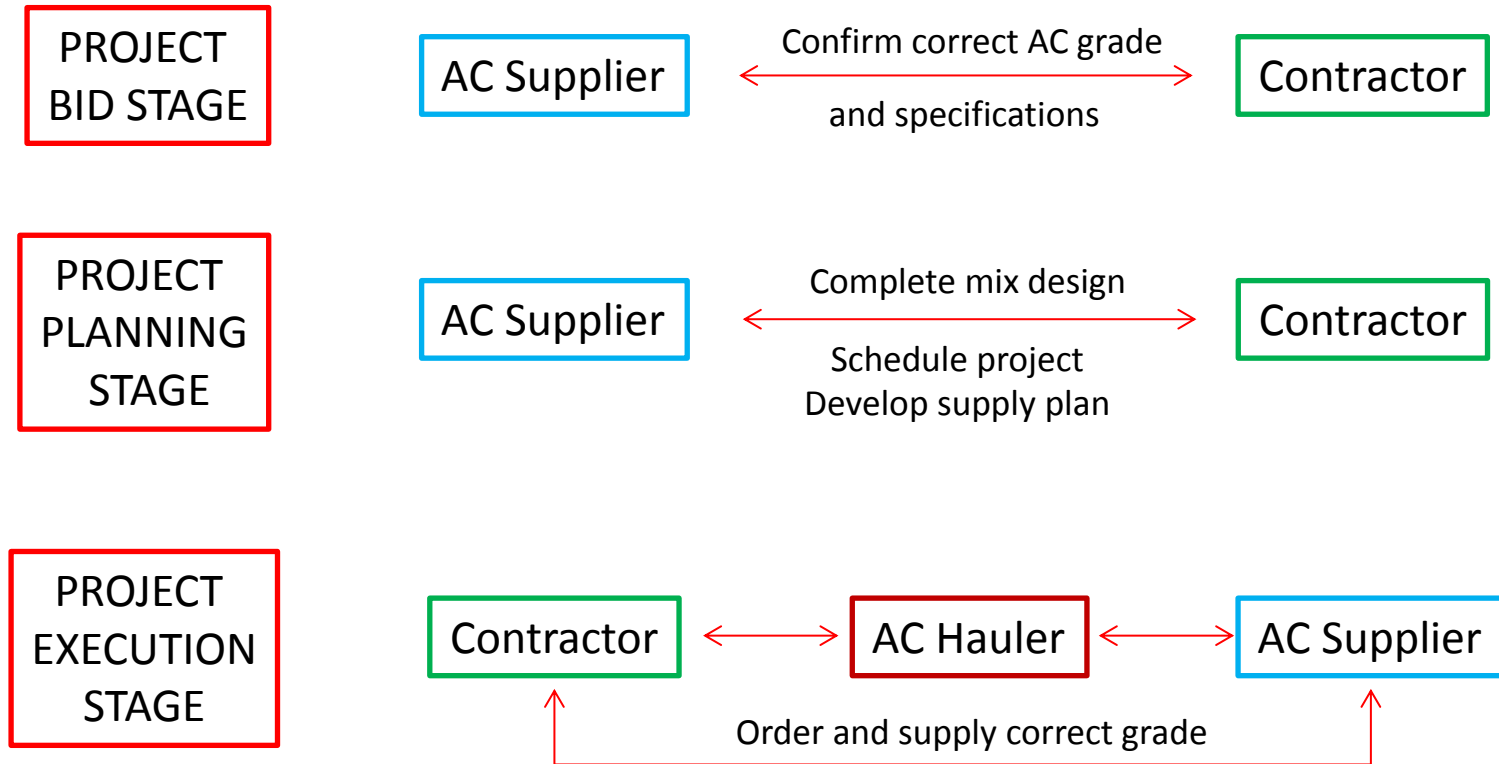
Notes:
1. The PGAC is considered deficient and the Contractor shall submit in writing a detailed proposal on how he will address this non-conformance.

- 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

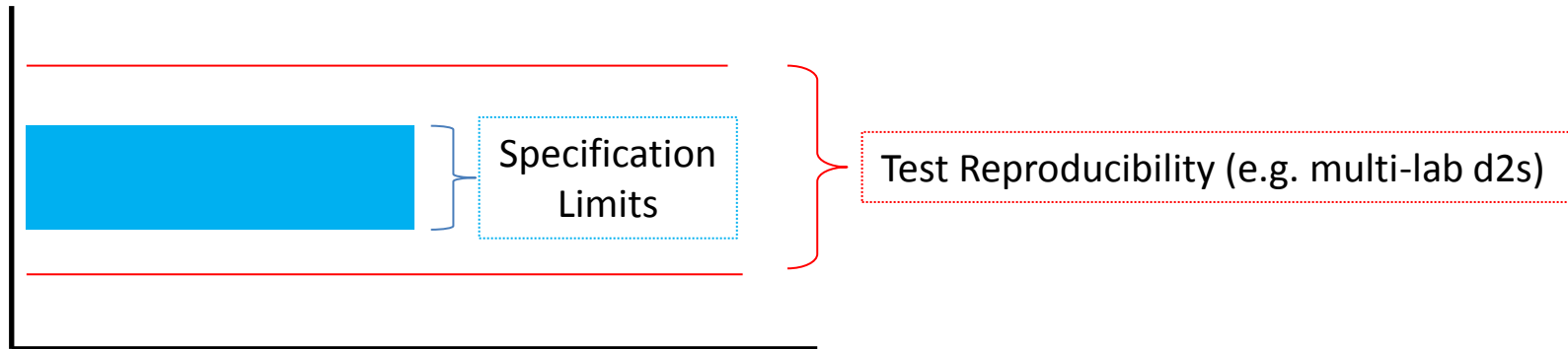
- Complexity of binder related terminology and proliferation of different specifications
 - Does the contractor know the correct grade to bid with?
 - Is the contractor ordering the correct grade?
 - Does the AC hauler know the correct grade to pick up?
 - Is the QA consultant testing for the correct 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 Communication Protocols



- 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)¹

Statistical Variation in Specification Acceptance Test Results



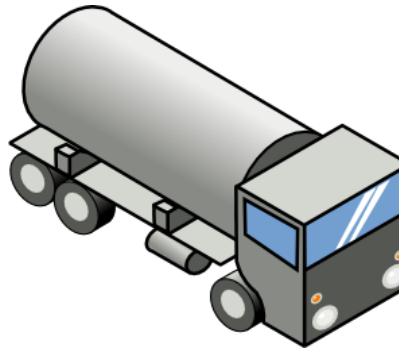
- Enhanced challenges when Reproducibility of test exceeds Specification Limits
- Certain PG+ specs suffer from poor reproducibility between laboratories
 - Specifications do currently make some accommodation for testing variation

Asphalt Cement Sampling

AC TERMINAL



DELIVERY



ASPHALT MIX PLANT

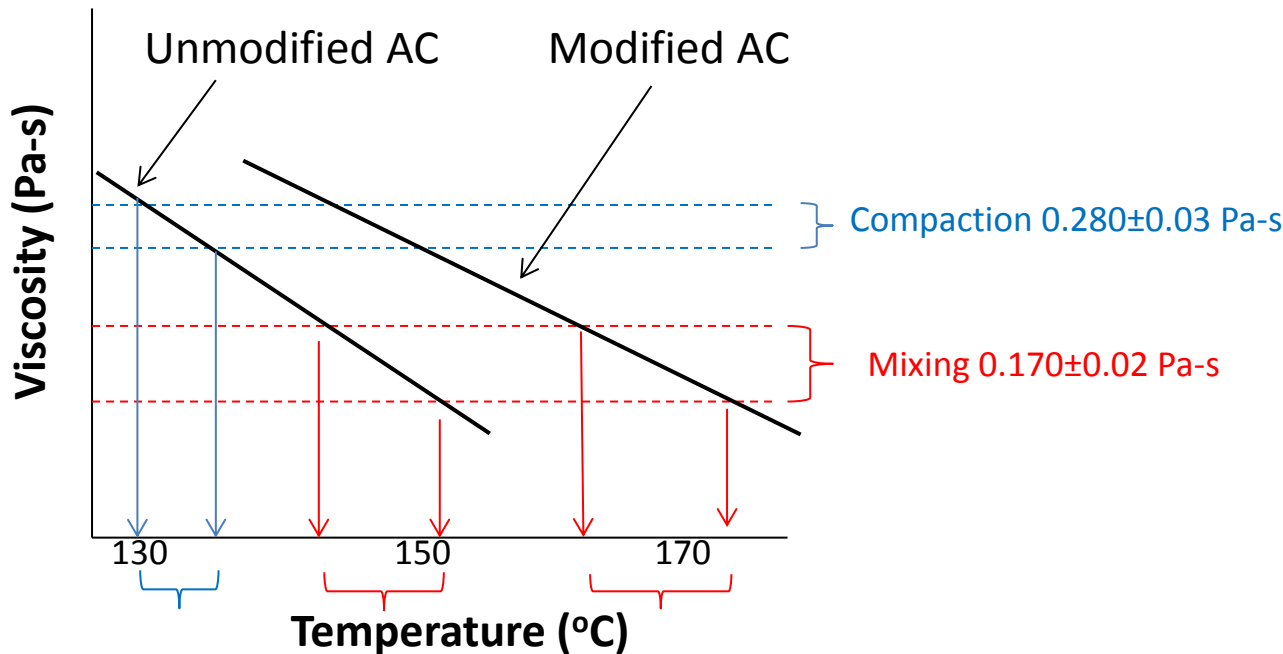
QA/Referee
Sampling



- 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

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

- 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

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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