AASHTO / ASTM Update to DSR-PAV (|G*|sinδ)

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Why Change DSR-PAV ($|\boldsymbol{G}^*| \sin \delta$) ?

- SHRP developed SuperPave™ PG System in late 80s
  - Validated based on binders available at the time
  - Based on climate, selecting high and low temperature limits

- Why was DSR-PAV needed
  - Needed to capture area where roads were transitioning between season – Intermediate temperature
  - Focus at the intermediate temperature was fatigue performance

- DSR-PAV Challenges
  - Test is shown to have high variability **(~28% d2s% - AASHTO)**
  - Intermediate temperature based on (high PG T + low PG T)/2+4 °C - Not necessarily where cracking occurs
  - $|\boldsymbol{G}^*| \sin \delta$, is the loss modulus, G'' - not clear how parameter can identify sensitivity to cracking
  - Limit of 5000 kPa was created from estimates of 1950s road trial data

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What was done to improve DSR-PAV ($|\boldsymbol{G}^*|\sin\delta$)

Industry task force was created to evaluate test

1. Modify T315 test protocol to reduce the test variability to acceptable level
   - Thermal equilibrium time & plate size/strain

2. Review scientific validity of DSR-PAV parameter |G*|sin δ

3. Review ability of DSR-PAV test to discriminate poor performers
   - 40 binders covering wide range & compositions

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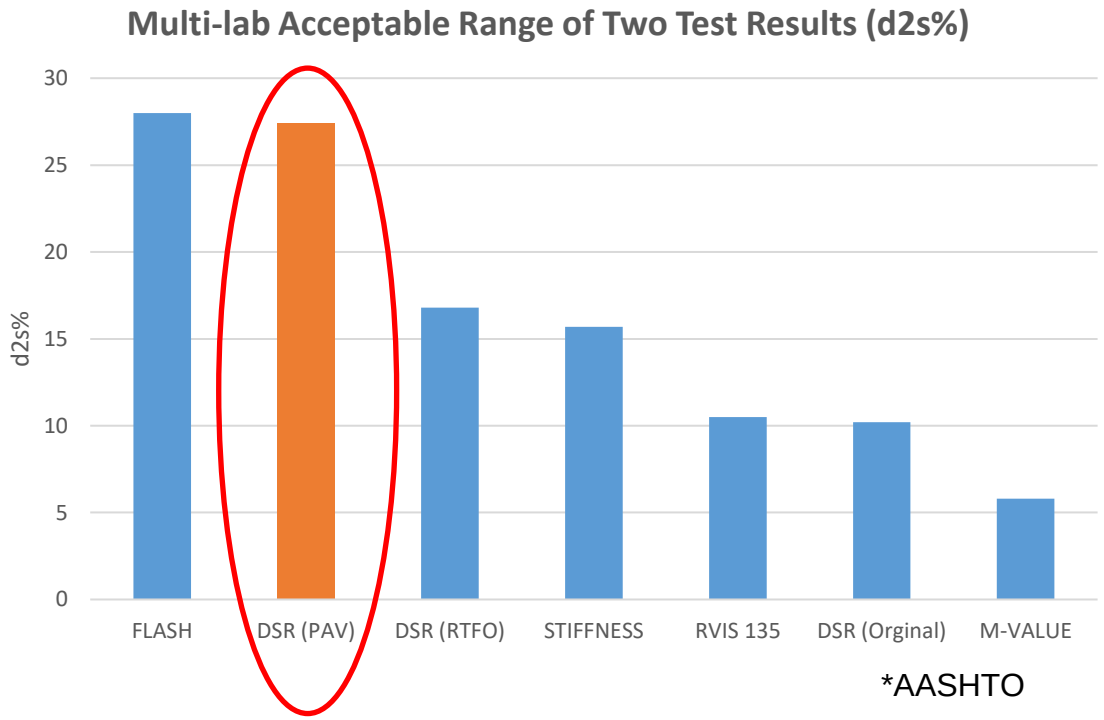
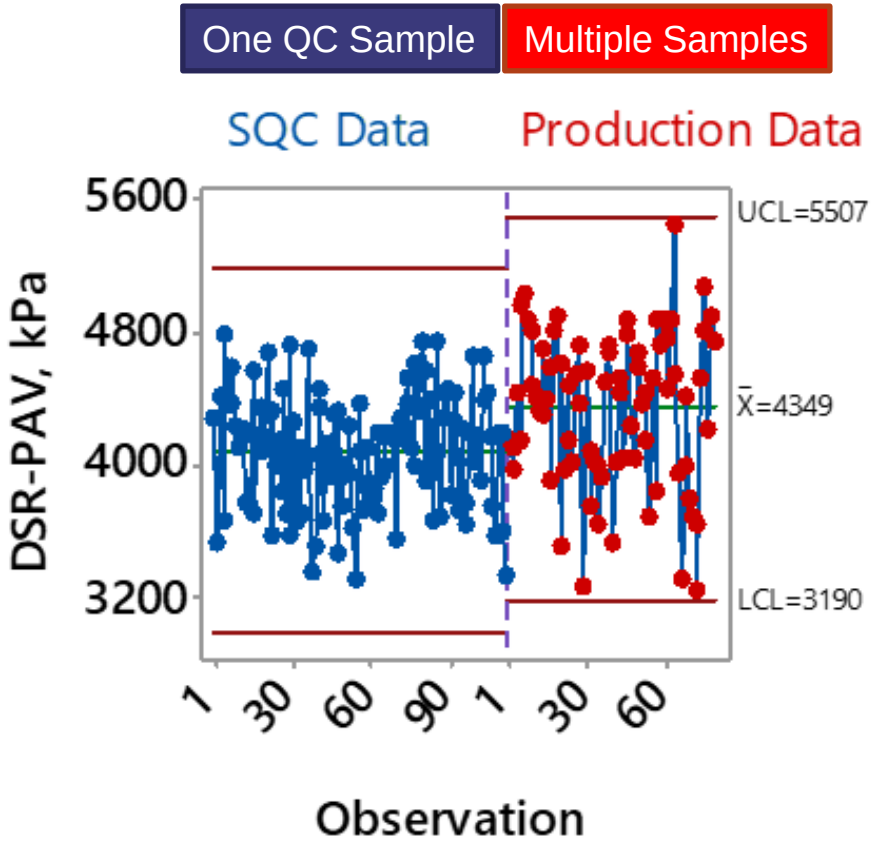
Findings 1: Testing Improvements

- Inter-lab study showed test variability could not be viably improved

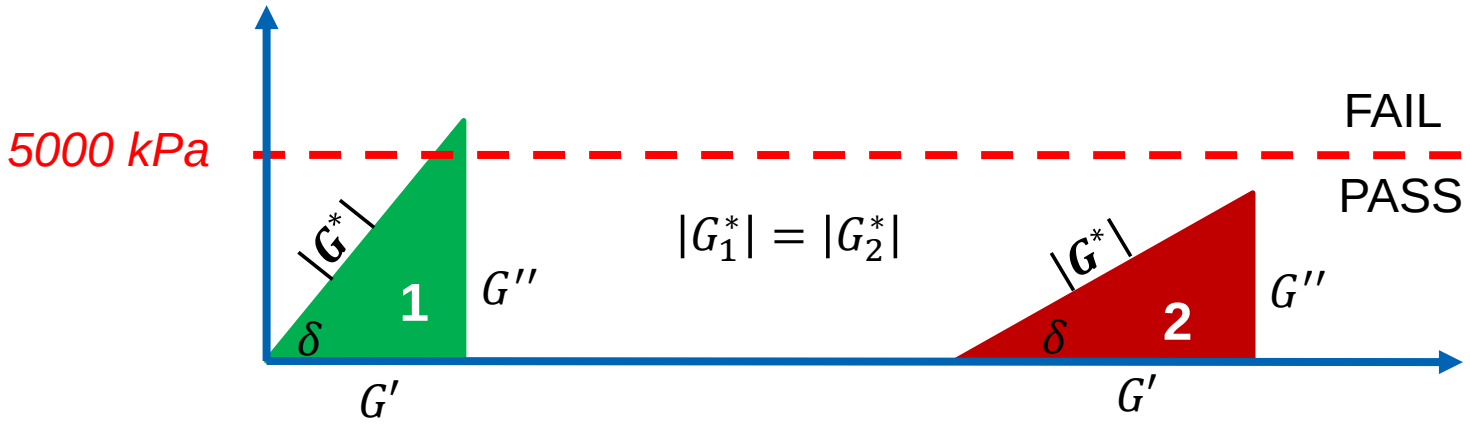




Findings 2: Science Behind DSR-PAV

- |G*|sin δ @ 5000 kPa limit benefits low phase angle (brittle binders)
- High quality ductile binders with high phase angle are disadvantaged

Two binders, same complex modulus, different phase angle



high phase angle = ductile

Fail in previous M320

low phase angle = brittle

Pass in M320

*CTAA 2020 - A Simple Binder Specification Tweak to Promote Best Performers

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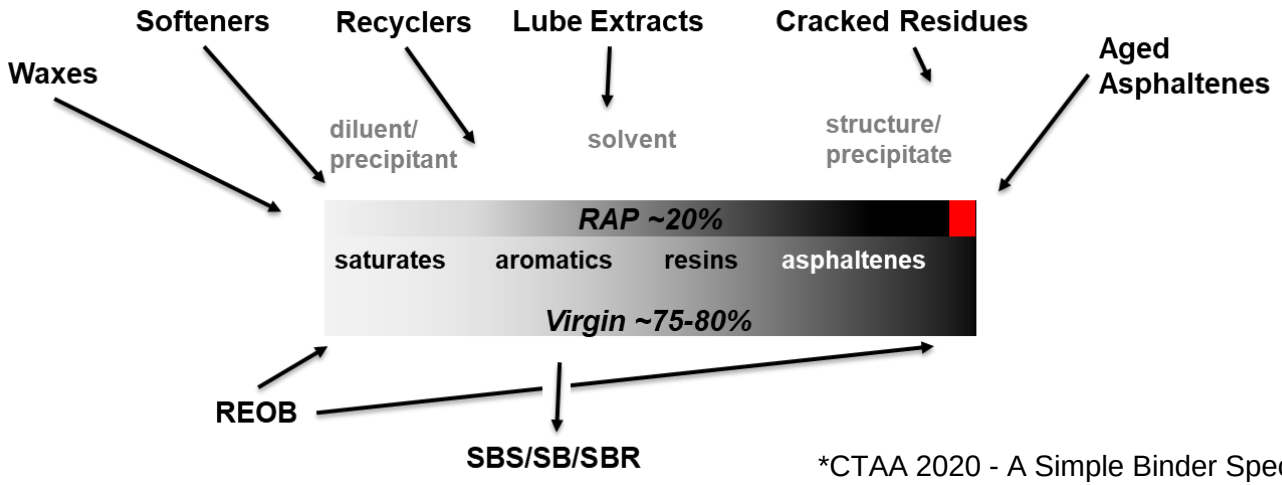
Findings 3: DSR-PAV Ability to Discriminate Poor Asphalts

- Phase instability impedes stress relaxation
  - Demonstrated by more negative delta Tc, higher aging index & lower phase angle
- These parameters correlate to performance as they represent aging & relaxation rates
  - Critical parameters when cracking is considered
- |G*|sin δ was found not to correlate with any of these parameters in study sample set
  - All study samples passed |G*|sin δ limit of 5000 kPa including results w/ delta Tc > -10^{o}C

Items Impacting Asphalt Stability



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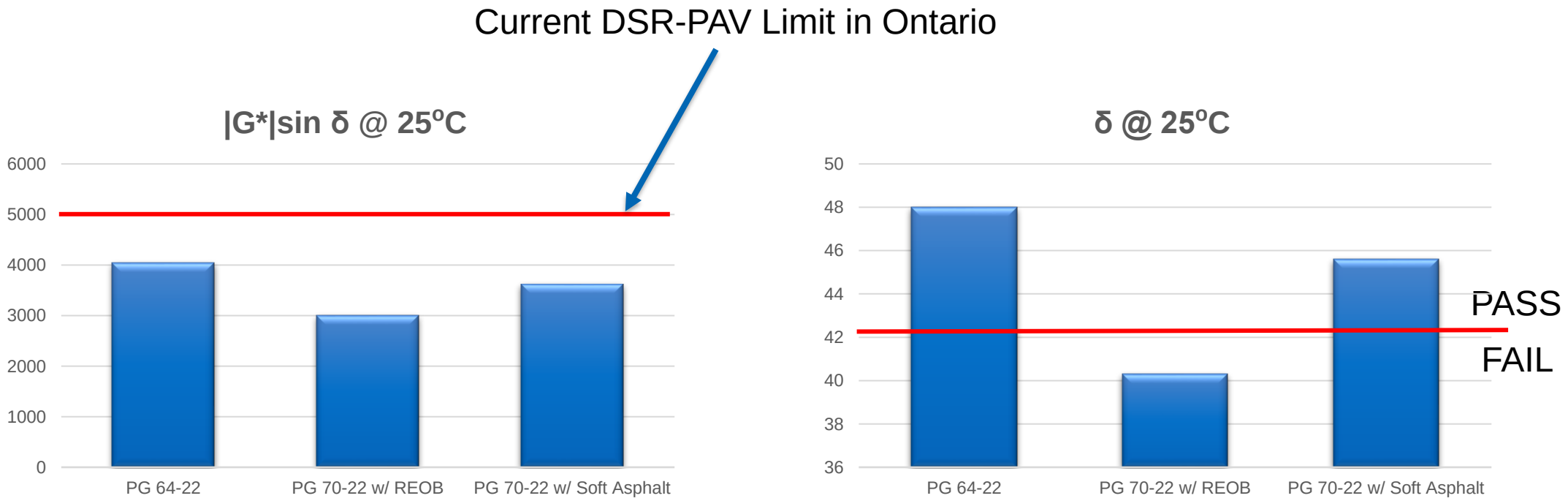
Phase Angle Supports Differentiation



PG 64-22: 100% Cold Lake straight distilled asphalt
PG 70-22 w/ REOB: 100% Cold Lake straight distilled asphalt softened to PG 64-22 with REOB
PG 70-22 w/ Asphalt Flux: 100% Cold Lake straight distilled asphalt softened to PG 64-22 with soft asphalt

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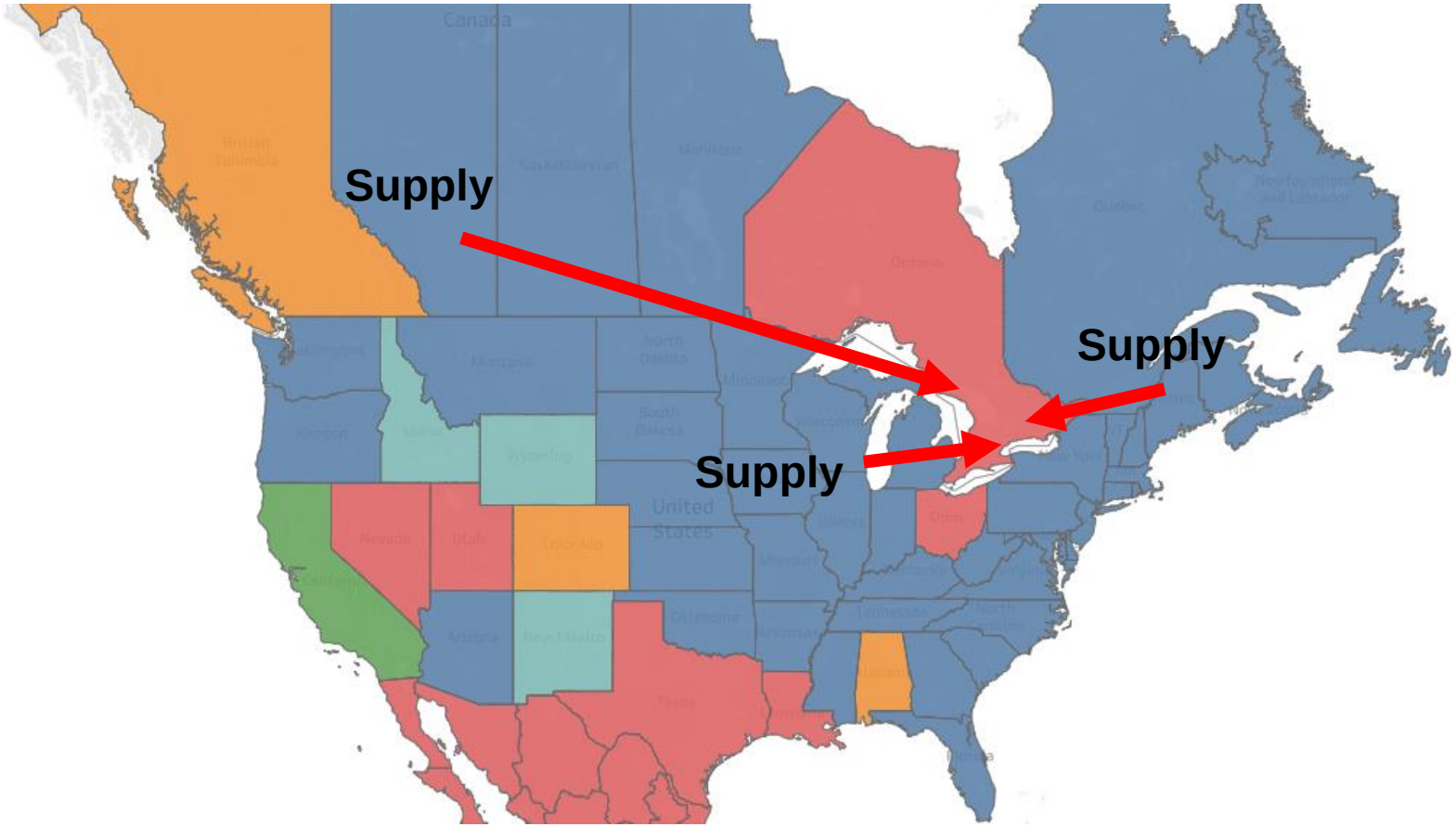
New Specification Adopted by AASHTO and ASTM

AASHTO Technical subcommittee 2b (liquid asphalt) approved revision to standard

- Reviewed by 34 committee members comprising 33 states and Ontario
- Revision received unanimous approval

AASHTO (M320/M332) & ASTM (D6373) now allow binders with DSR-PAV $|G^*|\sin\delta$ parameter between 5001 - 6000 kPa if the phase angle at the intermediate PG temperature is > 42^o

North American Adoption of New Limit



* Acceptance data representative of information provided at time of collection, status may vary
* Product movement based on publically available information and internal estimates

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Summary

- |G*|sin δ has high variability
  - High variability results in poor test performance
- Phase Angle better parameter for differentiating poor performing binders
  - Phase angle captures materials ability to relax or dissipate stresses with less variability in testing
  - Higher phase angle represents a more viscous material, better at dissipating stress
  - Material that can dissipate stresses sufficiently are less likely to cause cracking
- Asphalt entering market from other regions
  - Most provinces & states have adopted new |G*|sin δ limit of 6000 w/ phase angle >42^{o}
  - Local suppliers could be challenged to meet 5000 kPa limit based on material sourcing
  - Supply may require modification to meet Ontario requirements for DSR-PAV

Thank You