Performance Grading of Emulsions – Status Update

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Emulsion Task Force Meeting

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SPG Overview

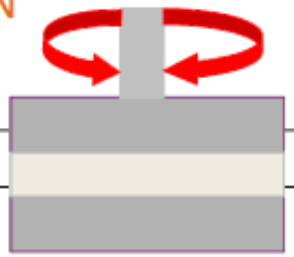
TXDOT/Texas A&M

- First research project started in 2001.
- **S**urface **P**erformance **G**rade (SPG)
  - Applies to both emulsion and hot-applied chip seals.
- Basic Testing Structure
  - Fresh emulsion properties stay the same.
  - High Temperature – DSR, Low Temperature – BBR
  - Modification – Phase Angle
- Validation
  - Field performance. Over 73 highway sections since 2011.
  - 79% Field and lab correlated well. Good/Good and Poor/Poor performance.

SPG

Specification Tests & Limits

Example: SPG 73 - XX

*MAX δ FOR EMULSION RESIDUE = 84 	Performance Grade			
	SPG 73			
	-13	-19	-25	-31
	<73			
	>-13	>-19	>-25	>-31
Original Binder				
G*/Sinδ ≥ 0.65 kPa by T 315 Test Temperature @ 10rad/s, °C	73			
Phase angle (δ), Max, @ temp. where G*/sin δ = 0.65 kPa	80*	80*	80*	80*

PAV Residue				
S ≤ 500 MPa by T 313 Test Temperature @ *8s*, °C	-13	-19	-25	-31

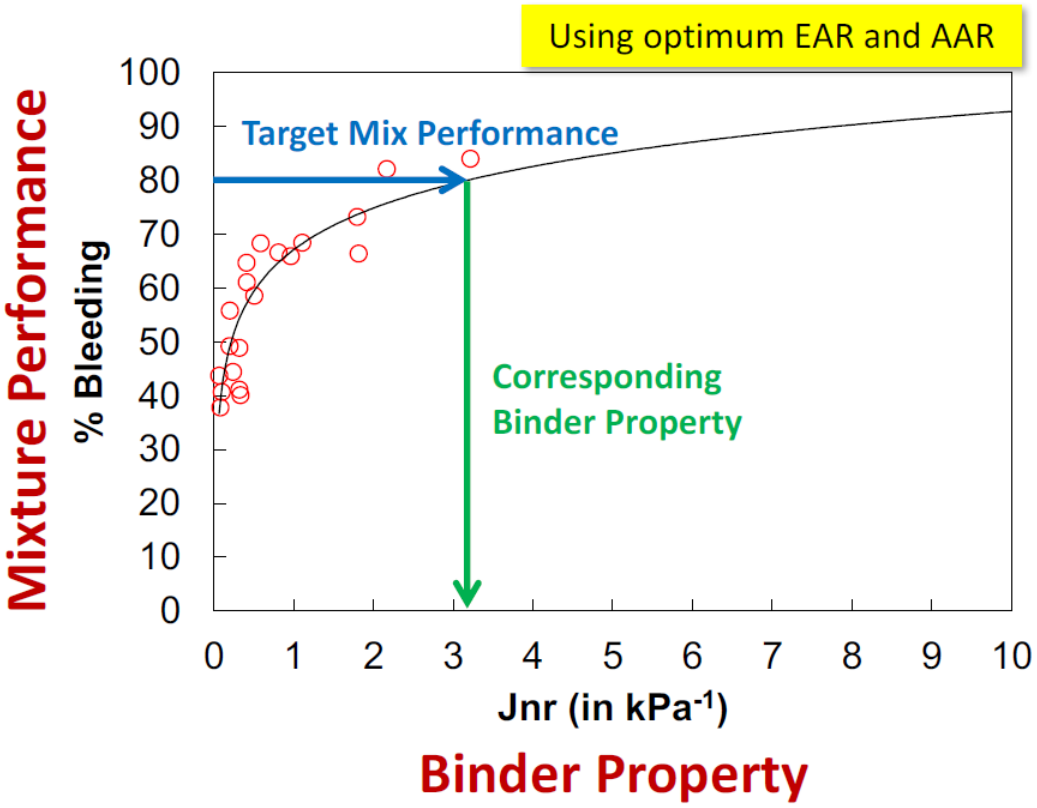
EPG Overview

NCHRP 9-50/NC State

- NCHRP 9-50 project started in 2011, final report is now available.
- **E**mulsion **P**erformance **G**rade (EPG)
  - Applies to emulsions only, no hot-applied binders.
    - Spray Grade: Fog Seal, Chip Seal, etc.
    - Mixing Grade: Micro-surfacing & Slurry Seal
- Basic Testing Structure
  - Fresh Emulsion: Brookfield RV methods proposed.
  - High and Low Temperature Properties measured by the DSR.
  - Modification – No direct measure for polymer identification.
  - Similar approach to MSCR. Three traffic levels, spec. threshold is varied.
- Validation
  - Specifications thresholds based on correlation with laboratory seal performance tests. Additional field validation pending.

EPG

General Concept for Setting Thresholds



Kim, Performance Based Specifications for Emulsions Used in Pavement Preservation Surface Treatments, NCHRP 9-50, Presented at ETF Meeting, Tampa, FL, Dec. 2016.

EPG

High Temperature Specification

Surface Treatment Type	PG Test	Performance Parameter	Traffic Level	Test Temp. Range	EPG Limit
Chip Seal	DSR MSCR	Maximum *Jnr* @ 3.2 kPa	Low	High	< 8 kPa^{-1}
			Med		< 5.5 kPa^{-1}
			High		< 3.5 kPa^{-1}
Microsurfacing	DSR MSCR	Maximum *Jnr* @ 3.2 kPa	Low		< 5 kPa^{-1}
			Med & High		< 1.5 kPa^{-1}

Low (0-500 AADT), Medium (500 – 2500 AADT), High (>2500 AADT)

EPG

Low Temperature Specification

Surface Treatment Type	PG Test	Performance Parameter	Traffic Level	Test Temp. Range	EPG Limit
Chip Seal	DSR Frequency Sweep	Maximum |G*| @δc	Low	5°C and 15°C	< 30 MPa
			Med		< 20 MPa
			High		< 10 MPa
Microsurfacing	DSR Frequency Sweep	Maximum |G*| @δc	All Traffic Levels		< 16 MPa

- Parameters evaluated on as-recovered residue. No PAV aging.

EPG vs. SPG

Similarities

- Six degree grade increments and shift of +3°C to both high and low temperature grade for surface grading.
- AASHTO PP-72 Residue Recovery Procedure
- High temperature grading on as-recovered residue.

EPG

Differences

Issue	SPG	EPG
Application	Hot-Applied and Emulsion Chip Seals	Emulsion for spray and mixing application.
High Temperature Parameter	G*/sinδ (T315)	Jnr @ 3.2 kPa (T350)
Traffic Considerations	Grade Bumping for high temp.	Grade remains the same, spec. thresholds (HT and LT) change.
Polymer Identifier	Phase Angle	None
Low Temperature Parameter (Standardized?)	BBR (Yes)	G* at critical phase angle (No)
Long Term Aging	PAV	None
Basis for setting thresholds.	Field Performance (Validation over a ~15 yrs)	Lab Testing - Long term validation needed.

EPG and SPG

Comparison of Residue Grading

	SPG		EPG	
Emulsion	Grade	True Grade	Grade	True Grade
CRS-2	61-19	65.3-23.0	49/55-19 (H/L)	53.1/57.9 - H
CRS-2P	67-25	72.9-25.3	61/67-25 (H/L)	63.9/68.6 - H
CRS-2L	67-19	68.4-24.4	55/61-25 (H/L)	56.7/62.8 - H
CQS-1h	67-13	72.6-16.1	55/61-7 (H/L)	59.6/65.4-25L,-19M,-7, -13H
CSS-1h	73-19	73.8-24.5	61/67-25 (H/L)	62.7/68.3 - H
CRS-2P(1.0%)	67-19	69.1-20.7	55/61-25 (H/L)	57.6/63.4 - H

- HT Grade: SPG 5-10°C greater than EPG
- LT Grade: SPG equal to or one grade colder than EPG
- EPG Traffic Levels: Small spread between L and H grades, is a third traffic level needed?

Challenges

- Polymer Identification
  - Further conditioning of the residue is needed to capture elastic properties of some modifiers.
  - Solution: Evaluate %R on rec. residue + PAV.
- Include long term aging in spec?
  - No: Most chip seals perform if they last the first year. Equipment is too expensive.
  - Yes: Significant aging occurs in the first year. Allows for evaluating quality of the residue.
- Low Temperature Properties
  - BBR vs. Critical Phase Angle vs. Other concepts
  - Include new technologies (i.e. 4mm DSR)

Ideal Emulsion Residue Grading

Tests on Recovered Residue	
High Temperature Grade	$G^*/\sin\delta > 0.65$ kPa
Tests on Recovered Residue + PAV	
Polymer Identification	MSCR @ HT Grade Temp Jnr and %R at 3.2kPa
Low Temperature Grade & Durability	BBR, S(60) <300 MPa, m(60) > 0.300 $\Delta Tc > -3.0$

- Need to find balance between a performance and purchase specifications.
- Needs to be a relationship with PG binders.
- Can’t be more complicated than PG binder specs for HMA.

Next Steps

- Spring 2017
  - Finalize plans for multi-lab testing program. Including tests to be run, participating labs, and selection of materials.
  - Possible coordination by AI.
- Summer 2017
  - Data gathering and analysis.
- Winter 2017
  - Report final recommendations to ETF and Binder ETG.

Thank You!

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