# Development of a CRM Binder Performance Spec.



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#### **CRM Sizes**

Rubber is delivered in different systems with supper sacks very prevalent.
 CRM comes in different sizes.





# CRM

- Historically testing has been done with pen and vis.
- Viscosity was mostly rotational or vane shear.



#### Photomicrographs of CMCRA Transmitted and Fluorescent Light





# Multi Stress Creep and Recovery Sample prep is exactly the same as the existing RTFOT DSR.



# **CRM DSR GAP Study**

- Several 10% blends with 30 and 60 mesh binders
- **T**wo binders 64-28 and 76-22
- Minimum 10% CRM actual formulation unknown
- Two gap openings tested, 1mm and 2mm.

# Gap study Several 10% blends with 30 and 60 mesh binders

base and CRM size Lion 64-22, 850 µm, 160°C Lion 64-22, 850 µm, 177°C Lion 64-22, 850 µm, 193°C Lion 64-22, 850 µm, 210°C Lion 64-22, 600 µm, 210°C Lion 64-22, 250 µm, 210°C Source A, 250 µm, 210°C Source B, 250 µm, 210°C Source C, 250 µm, 210°C Source D, 250 µm, 210°C Source E, 250 µm, 210°C Source F, 250 µm, 210°C

# Comparison of measurements at 1 and 2 mm gaps



# Terminal Blended CRM GAP study

	Con	Test Temp.,	l no re	0/ ****	% Change
Aspnait ID	Gap		Jnr	% rec	Jnr
PG 64-28	1mm	52	0.12	75.4	71.4
		58	0.36	64.4	125.0
		64	1.24	47.8	134.0
		70	3.14	29	204.9
		76	6.14	14	597.7
Paramount					
PG 64-28	2mm	52	0.07	83.7	40.0
		58	0.44	58.8	144.4
		64	0.82	56.5	46.4
		70	2.28	33.1	159.1
		76	6.39	11.9	257.0

# Jnr % Rec comparison

#### Gap testing Comparison 1mm 2mm 52, 58, 64, 70, 76C



# Terminal Blend CRM Gap Study

Asphalt ID	Gap	Test Temp., °C	Jnr	% rec	% Change Jnr
Paramount					
PG 76-22	1mm	52	0.024	89.2	26.3
		58	0.078	81	62.5
		64	0.222	70.6	103.7
		70	0.569	57.5	144.2
		76	2.067	28.9	164.3
Paramount					
PG 76-22	2mm	52	0.029	86.9	190.0
		58	0.085	78.5	57.4
		64	0.178	75.1	49.6
		70	0.502	61.8	128.2
		76*	1.53	35.7	267.8

# Terminal Blend CRM Gap Study

#### Gap testing Comparison 1mm 2mm 52, 58, 64, 70, 76C



# Terminal Blend CRM Gap Study

- DSR requirement that particles be less than <sup>1</sup>/<sub>4</sub> gap size works for CRM also.
- Binders tested would meet Jnr and % Recovery requirements, but both binders showed stress sensitivity.
- Stress sensitivity results marginal so minor adjustment of formulation could bring within requirements.

# How to handle larger CRM

- 60 mesh material is easily handled in 1 mm gap.
- 20 mesh material may require 4 mm gaps.
- What is the limit of gap size?
- Are other geometries available to test larger particles?

# Jnr of a PG 76-22 measured @ 3 gaps

		COMPLEX 3.2 kPa STRESS		3.2 kPa STRESS
GAP(mm)	TEMP (°C)	MODULUS (kPa)	J <sub>nr</sub> (1/kPa)	% Recovery
1	64	8.81	0.212	62.8
2	64	9.22	0.205	62.8
3	64	9.51	0.208	62.5

		COMPLEX	3.2 kPa STRESS	3.2 kPa STRESS
GAP(mm)	TEMP (°C)	MODULUS (kPa)	J <sub>nr</sub> (1/kPa)	% Recovery
1	76	2.93	1.579	27.2
2	76	2.97	1.558	27.1
3	76	3.03	1.640	25.8

# 4 mm Gap Trial



# Objective

 Identify suitable testing methods for GTR under the Superpave procedures
 Using smooth parallel plates for testing

#### Concerns

Large gap requirements due to large particle size
Trimming of parallel plates
Sedimentation of particulates
Deformation of Asphalt at geometry surface, rather than entire volume of GTR sample

#### **Geometries Used**

#### Parallel Plate Plate Diameter: 12.5 mm ■ Gap: 1 mm Couette Set (Cup and Bob) ■ Cup Diameter: 27.5 mm Bob Diameter: 14 mm Effective Gap: 6.75 mm Vane 14mm Set (Cup and Vane) ■ Cup Diameter: 27.5 mm ■ Vane Diameter: 14 mm

#### **Parallel Plate**



# Cup & Bob



Top View



Malvern Instruments
 Kinexus Pro Rheometer
 Active Heated Chamber
 Used with 25mm parallel plates





Peltier Cylinder Cartridge
 Used with Cup & Bob and Cup & Vane





# Validation Experiment for Cup and Bob and Vane

#### Binders

- 64-22, 76-22 SBS, 70-22PPA
- Master curves with PG 64-22
- Full PG binder grading and MSCR for all three binders.

# G\* Master Curves for 64-22 with different geometries



# δ Master Curves for 64-22 with different geometries



#### **Comparison of Geometries DSR**



#### Control 0.1 kPa @ 70 C Cycle 1 with All 3 Geometries



#### **New Geometry Evaluation**

Preliminary testing indicates that new geometry may give similar results.
More extensive evaluation is needed to fully

- validate geometries.
  - Multiple grade binders
  - Full PG grading and MSCR

#### **Evaluation of New Geometries**

- Plate Pate provides similar results to cub and bob.
- Cup and vane will require unique calibration for individual binders and may not be ideal for specification testing.

# Rubber Grading Experiment for Cup and Bob

Binders 64-22, 76-22, 70-22PPA Full PG grading and MSCR; PP1, PP2, CB 64-22, 30 mesh rubber 10%, 15% Full PG grading and MSCR; PP2, CB 64-22, 20 mesh rubber 15%, 20% Full PG grading and MSCR, CB 64-22 60 mesh rubber 10%, 15% Full PG grading and MSCR, PP1, PP2, CB ALF AC rubber Full PG grading and MSCR, CB ALF Terminal blend Full PG grading and MSCR, PP1, CB

# New CRM spec to match MSCR Binder Spec

Original						
DSR G*/sinδ Min 1.0	64					
		RTI	FOT			
64 Standard MSCR3.2 <4.0			64			
64 Heavy MSCR 3.2<2.0	[(MSCR3.2 – MSCR 0.1)/ MSCR 0.1] < .75 _		64			
64 Very heavy MSCR3.2 <1.0			64			
PAV						
S grade DSR G*sinδ Max 5000	28	25	22	19	16	
H & V grade DSR G*sinδ Max 6000	28	25	22	19	16	

Low temp BBR and DTT remain unchanged

#### **Other Issues**

- Solubility What values should be considered?
  - 99%
  - 93%
  - No solubility
- MSCR % Recovery Rubber and polymers are not the same. Do we have a separate spec?

# Summary

- Control for all plate plate and cup and bob geometries showed similar results for T-315 and TP-70 at 2 different temperatures
- Trimming of samples not required when using cup and bob geometries
- GTR at 64C exhibited differences between the Bob and Vane geometries
- Accurate measurements can be generated if sedimentation of particulates occur during the test when using Bob geometry

# Summary

- **CRM** binder is sensitive to crude source.
- Rubber size will effect test results. Particles should be <sup>1</sup>/<sub>4</sub> gap size or less.
- Careful formulation is needed to meet all Jnr specs, but it can be done successfully.
- CRM Binders can be produced to meet PMA specs.
- Large CRM particle sizes can be tested in DSR

# Summary

- There may be some differences for CRM binder spec and PMA Spec
  - Solubility for CRM binder may be different.
  - Stress sensitivity may be different.
  - Most other properties will be the same.

# Thank You