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.

New CRM spec to match MSCR Binder Spec

Original					
DSR G*/sinδ Min 1.0	64				
RTFOT					
64 Standard MSCR3.2 <4.0	[(MSCR3.2 – MSCR 0.1)/ MSCR 0.1] < .75	64			
64 Heavy MSCR 3.2<2.0		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

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?

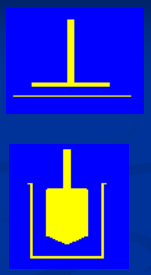
4 mm Gap Trial

Objective

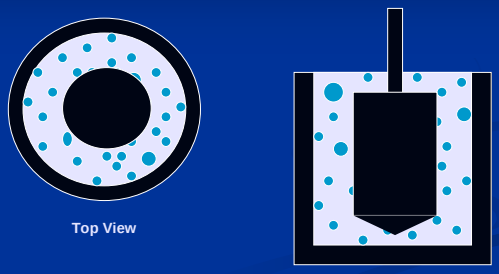
- Identify suitable testing methods for GTR under the Superpave procedures
  - Using smooth parallel plates for testing
- Concerns
  - Large gap requirements due to large particle size
  - Trimming of parallel plates
  - Sedimentation of particulates
  - Deformation of Asphalt at geometry surface, rather than entire volume of GTR sample

Geometries Used

- Parallel Plate
  - Plate Diameter: 12.5 mm
  - Gap: 1 mm
- Searle Set (Cup and Bob)
  - Cup Diameter: 27.5 mm
  - Bob Diameter: 14 mm
  - Effective Gap: 6.75 mm



Cup & Bob



Stress Strain Measurements for the Cup and Bob

Shear Stress = $\tau = \frac{T}{2\pi h R_b^2}$

Shear Strain = $\gamma = \frac{\theta R_b}{(R_c - R_b)}$

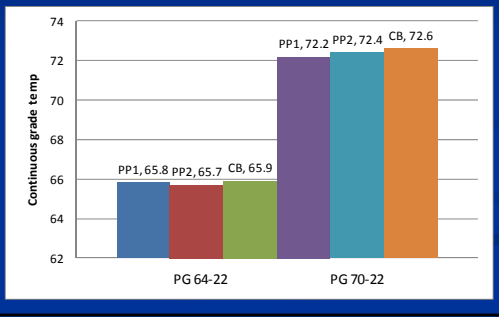
Rubber Grading Experiment for Cup and Bob

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

Gradations of various Rubber Sizes

	Liberty 20 Mesh	PolyVulc 30 Mesh	PolyVulc 40-80	PolyVulc 0080
	PLB2B5044	PLB5E5250	PLB4D4861	PLB4D2023
Percent Passing				
10 (2000 micron)	100	100	100	
20 (850 Micron)	58.89	99.84	97.91	
30 (600 Micron)	7.05	97.51	94.78	
40 (425 Micron)	0.72	54.9	62.97	
50 (300 Micron)	0.64	27.21	31.97	99.83
80 (180 Micron)	0.4	8.27	7.3	67.07
100 (150 Micron)				41.63
200 (7.5 Micron)				7.4

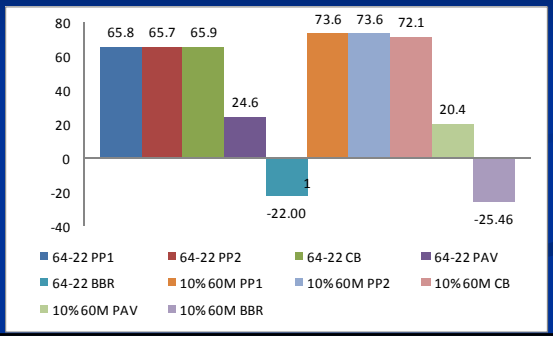
Comparison of Geometries DSR 64-22 Neat 70-22 (64-22+PPA)



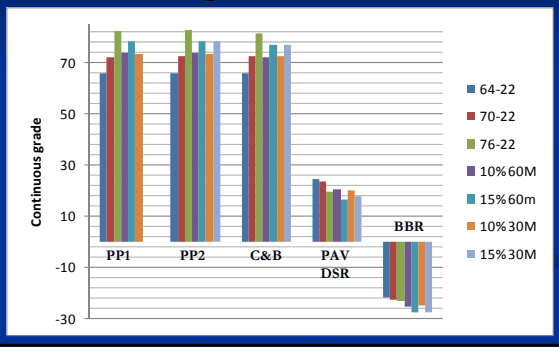
Comparison of Geometries DSR 64-22 Neat 70-22 (64-22+PPA)

- For Neat binder and or non particulate modifier the three geometries provide equivalent results using current G*/sin δ criteria.

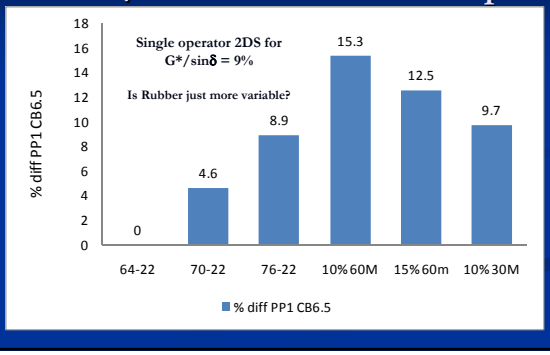
Continuous Grade for specific binders with different geometries



PG Continuous grading for blends using different Geometries

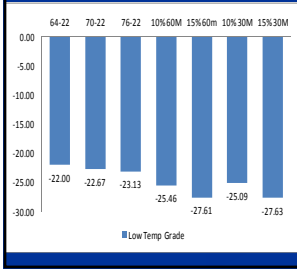


% Difference from PP1 to CB6.5 for G*/sinδ at the Grade Temp.

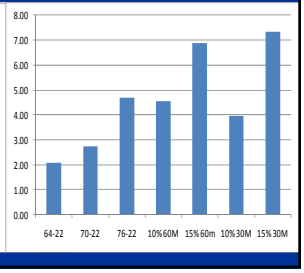


Effect of CRM on Low Temperature Grade

Low Temp Continuous Grade
All m controlled



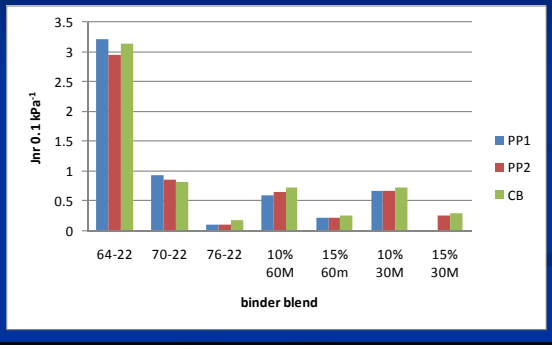
Difference between S and M grade temp
All m controlled



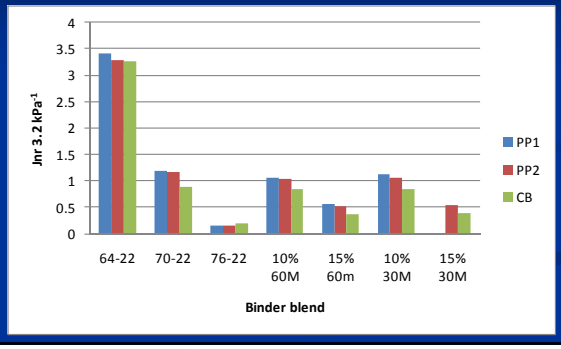
Effect of CRM on Low Temperature Grade

- Do oils from the Rubber soften the binder?
- Will the large improvement of S and m be long lived?
- Data indicates m changes more with age than S will this cause embrittlement?

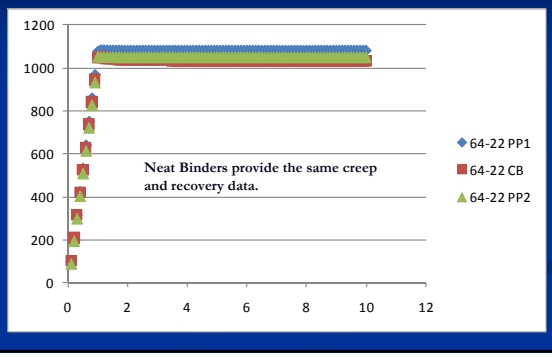
MSCR Jnr 0.1kPa Data for various blends



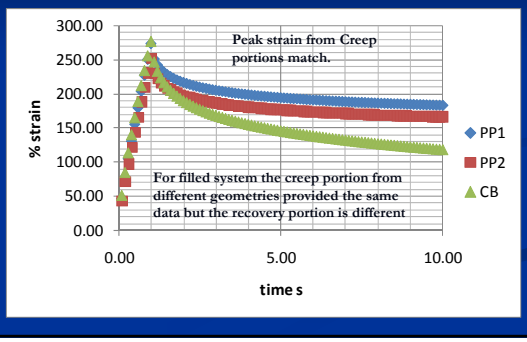
MSCR Jnr 3.2kPa Data for various blends



C&R for 64-22 3.2 kPa Neat Binder



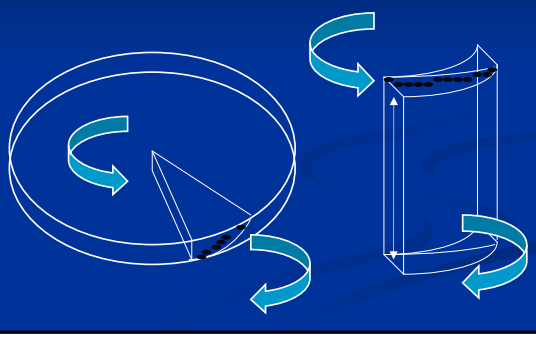
C&R for 64-22, 15% 60 mesh, 3.2kPa



Cup and Bob Issues

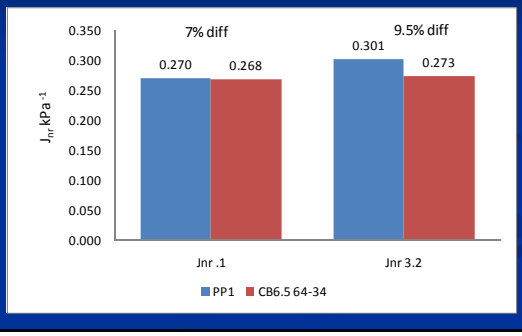
- The creep portion of the test should be different but isn't, the recovery should be similar but isn't.
  - Is it a particulate binder issue – test binders that have stress sensitivity but no particulates, waxes and extender oils to determine if there is different recoveries.
  - Try some creep testing at extended times and extended recoveries to evaluate differences.

Cup and Bob has significantly more particle interaction than Plate-Plate Geometry

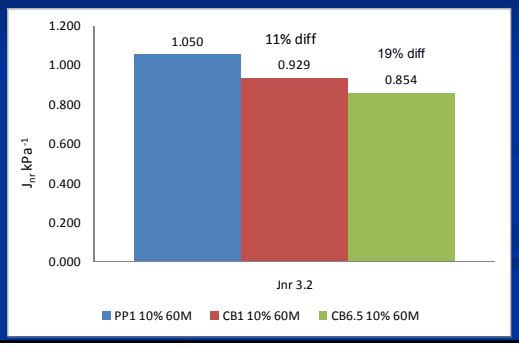


Diff in Results for PG 64-34 PMA

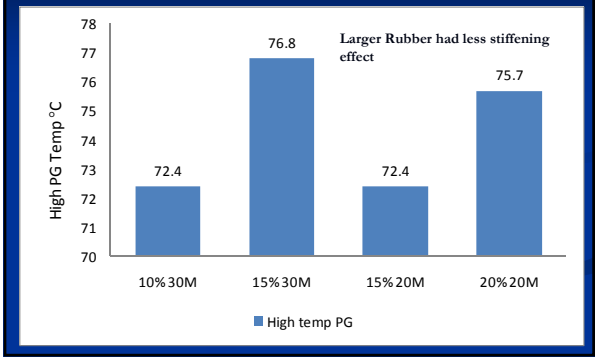
Well within standard 2Ds for testing



Comparison of PP1 to CB1 and CB6.5 gap sizes 1 mm CB reasonable repeatability of 1mm PP



Effect of size and % of CRM



Cup & Bob using new calibration procedure PAV testing

Meas. Pts.	Temp. [°C]	|G*|[kPa]	|G*|sinδ[kPa]	Delta [°]	Torque [mNm]
8 mm PP	25	5,490	4,100	48.4	5.534831
C&B old Css	25	1,800	918	30.7	66.7
C&B new Css	25	5,580	2,900	31.3	61.4

Alternative Approaches

- Cup and Bob works ok for High Temperature
- Test original binder for Intermediate PAV
- Preliminary testing indicates that Crumb Rubber improves the Intermediate DSR values.

Other Issues

- Solubility – What values should be considered?
  - 99%
  - 93%
  - No solubility
  - ETG has recommended two step plan. Run AASHTO T 44. If it fails run D5546, report what is in residue.
- 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
- Trimming of samples not required when using cup and bob geometries
- CB and PP can give the same results for MSCR, particulate systems will be different. Which is Correct?
- Mix testing to look at performance.

Summary

- Rubber size will effect test results. Particles should be ¼ 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

Thank You