Evaluation of Recycled Tire Rubber Modified Binder to Polymer Modified Binders for Performance Specifications

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Performance Specifications

- Current Binder Specifications Evaluated
  - AASHTO M 320
  - AASHTO MP 19
- Highway agencies are implementing existing binder specs for RTR modified binders.
- Do these specifications provide equivalent results for RTR binders

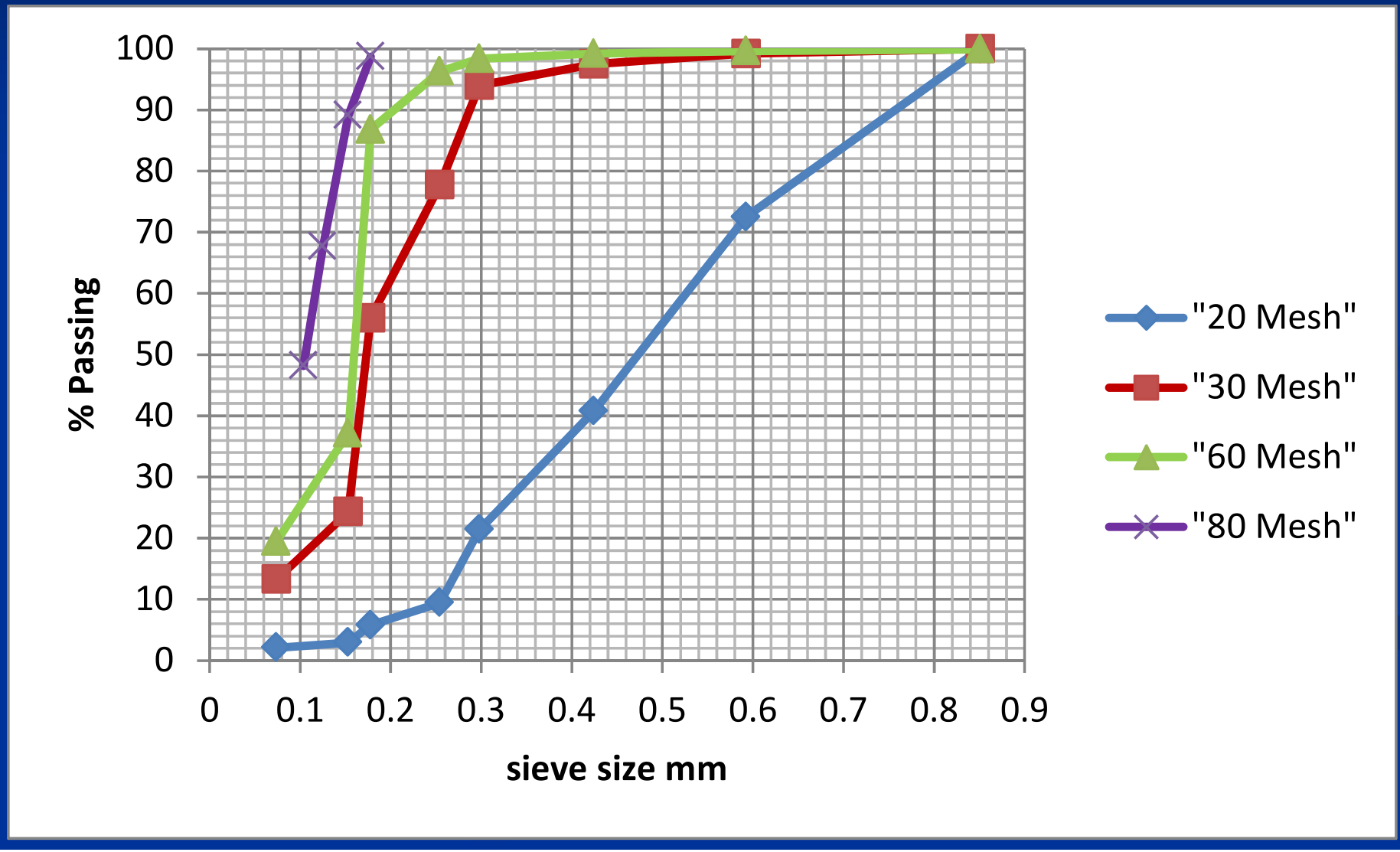
Experimental Design

- Compare SBS modified binder properties to RTR modified binder properties
  - SBS typical PG 76-22 grade
  - RTR one base binder PG 64-22
  - RTR 4 mesh sizes 20, 30, 60, 80
  - RTR 5, 10, 15, 20 % concentrations

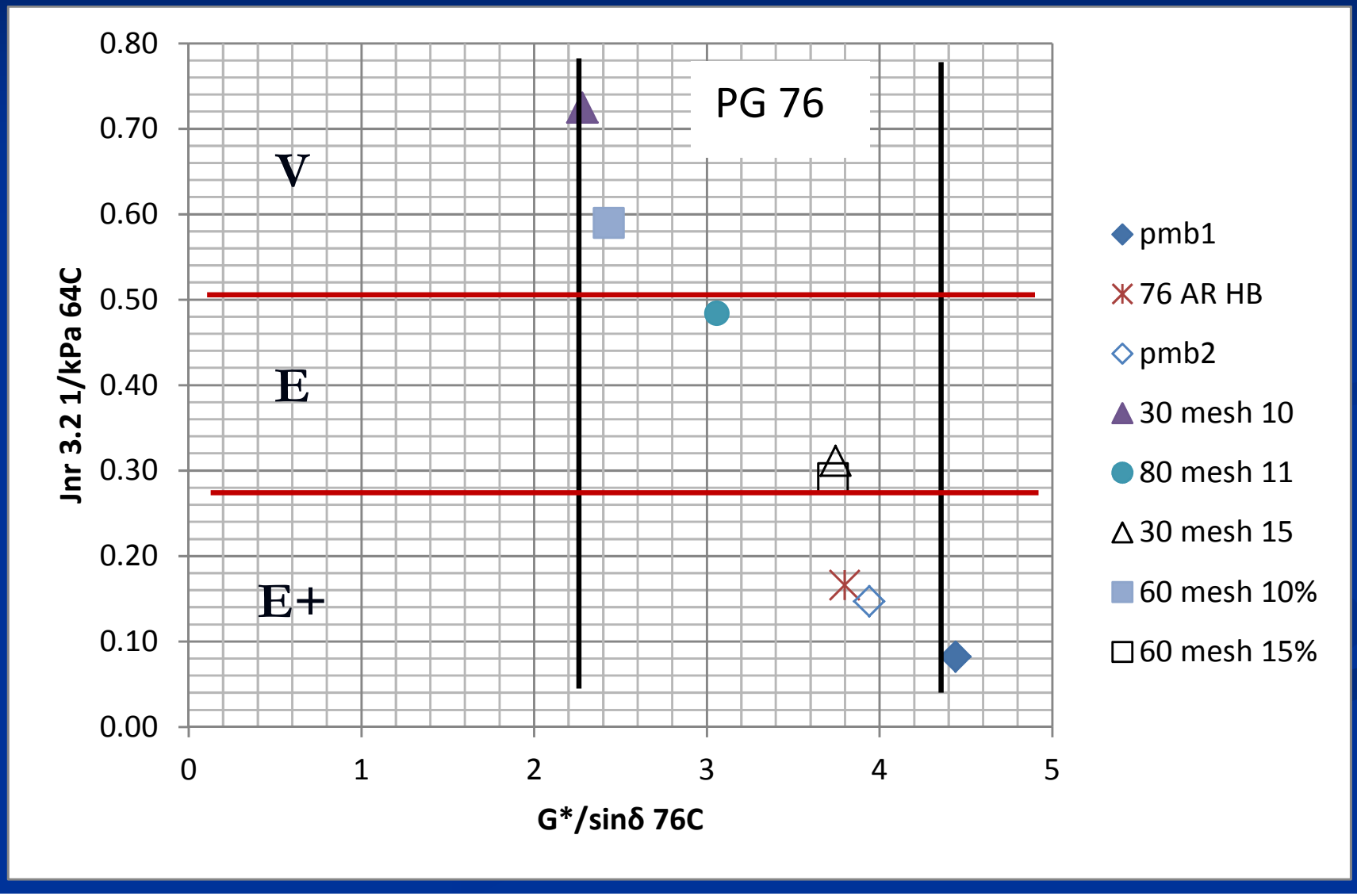
Experimental Design

- Full M 320 and MP 19 classification of binders
  - Compare M 320 to MP 19 properties
- Vary geometries for RTR modified binders
  - Parallel Plate and Cup and Bob
  - For this presentation C&B not complete

RTR Sizes Used in Study



High Temperature Binder Properties Comparing PG 76 Binders



High Temperature Binder Properties

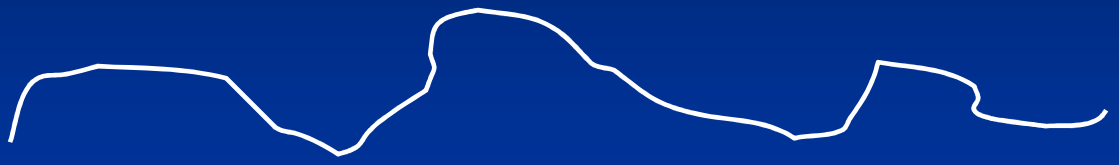
- M 320 indicates most of the binders are PG 76. Wide range in G*/sinδ from the low end of the grade to the top end.
- MSCR indicates that the binder vary over three grades from a 64V to a 64E+.
- M320 indicated equivalent properties while MP 19 indicates variations in properties.
- This may be why Louisiana requires PG 82 AR to be equivalent to PG 76 PMB

Modifier Structure in the Binder

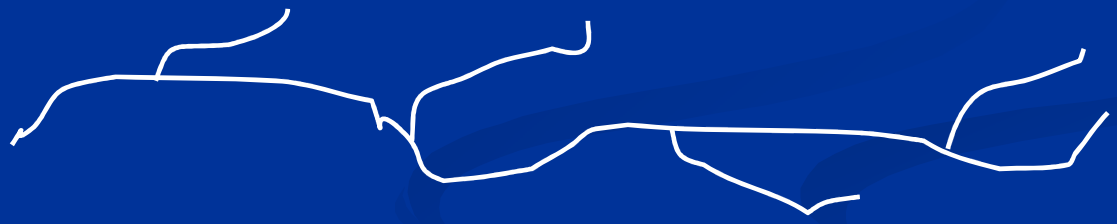
- Polymers like SBS set up networks in the binder to improve elasticity and toughness to reduce cracking
- RTR may provide some networking, but primarily provides an elastomeric filler which also improves elasticity and toughness to reduce cracking.
- Current recovery measurement systems may not identify RTR properties.

Polymer Structures

Linear



Branched

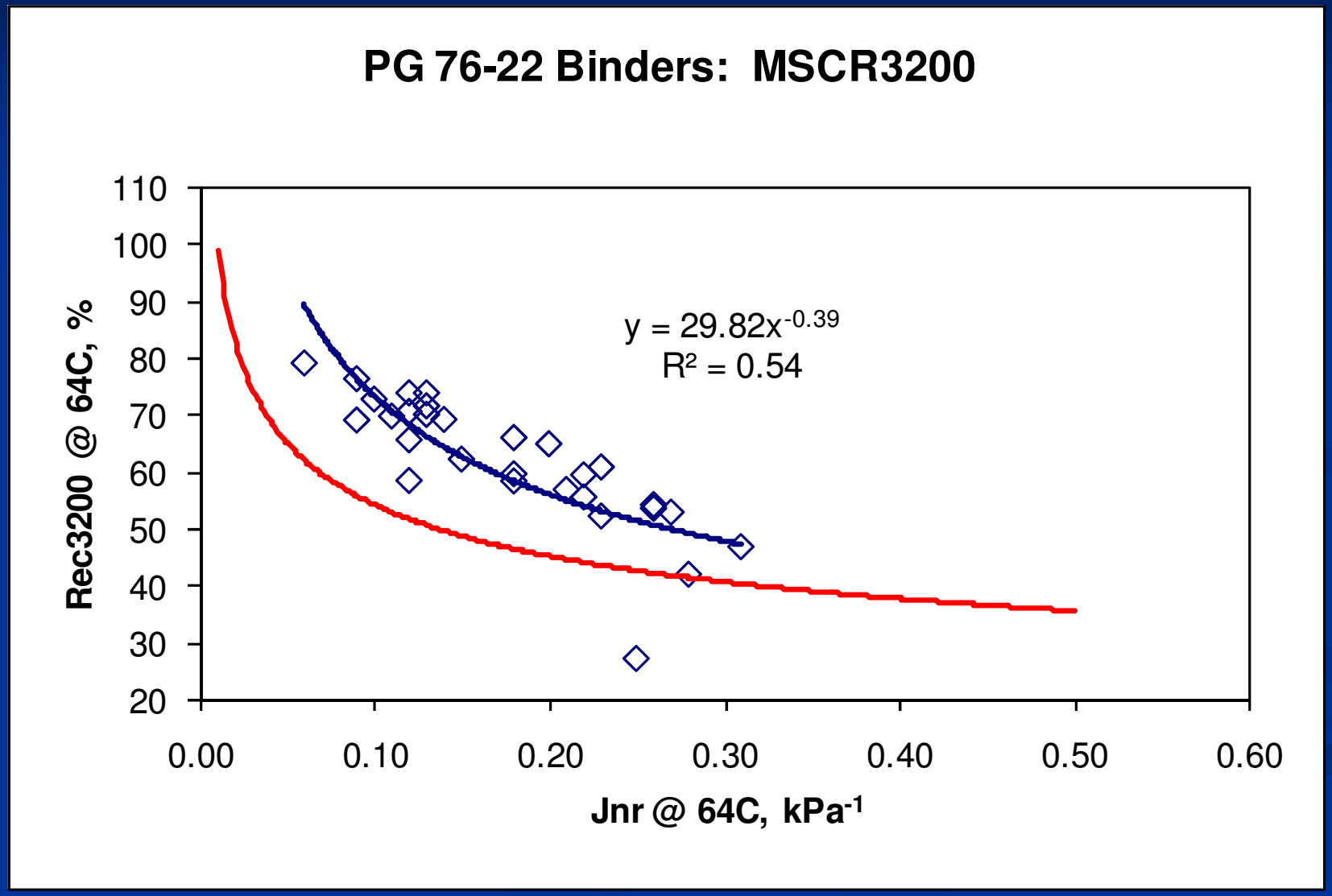


Cross-linked

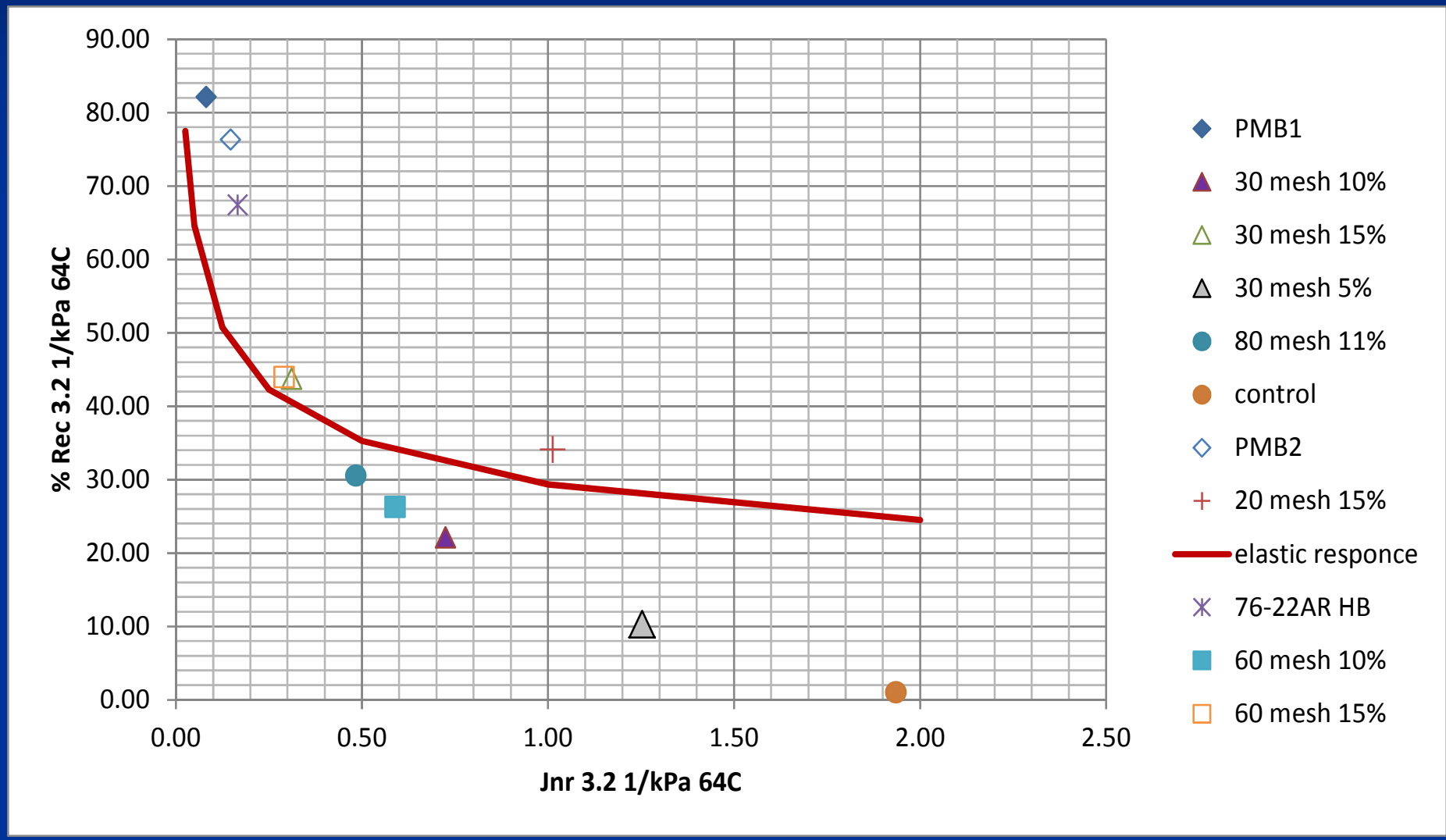
Modified Structure in the Binder

- Rubber has shown good performance in cracking but may not provide % recovery responses in current testing procedures.

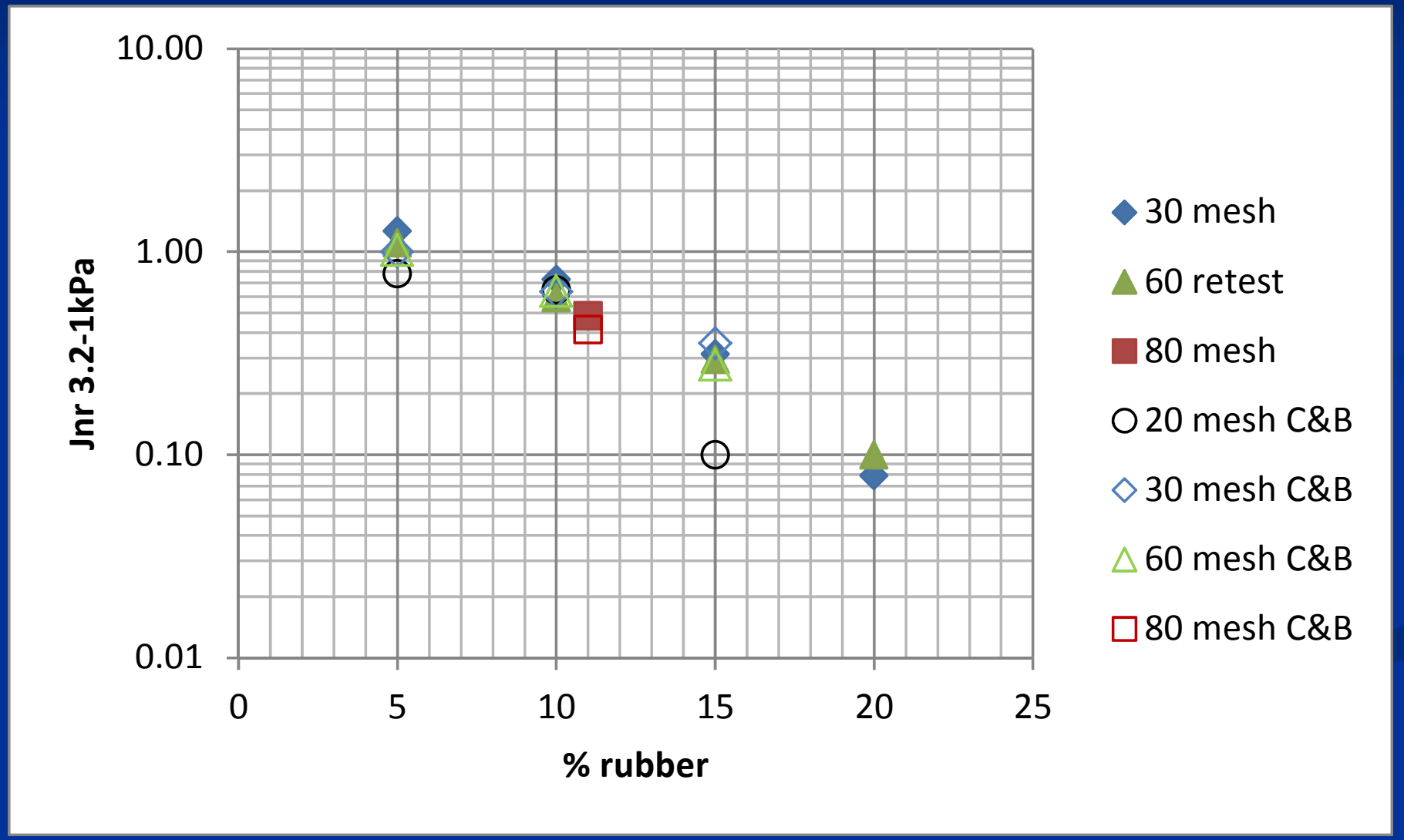
Validate Polymer Modification AI Study



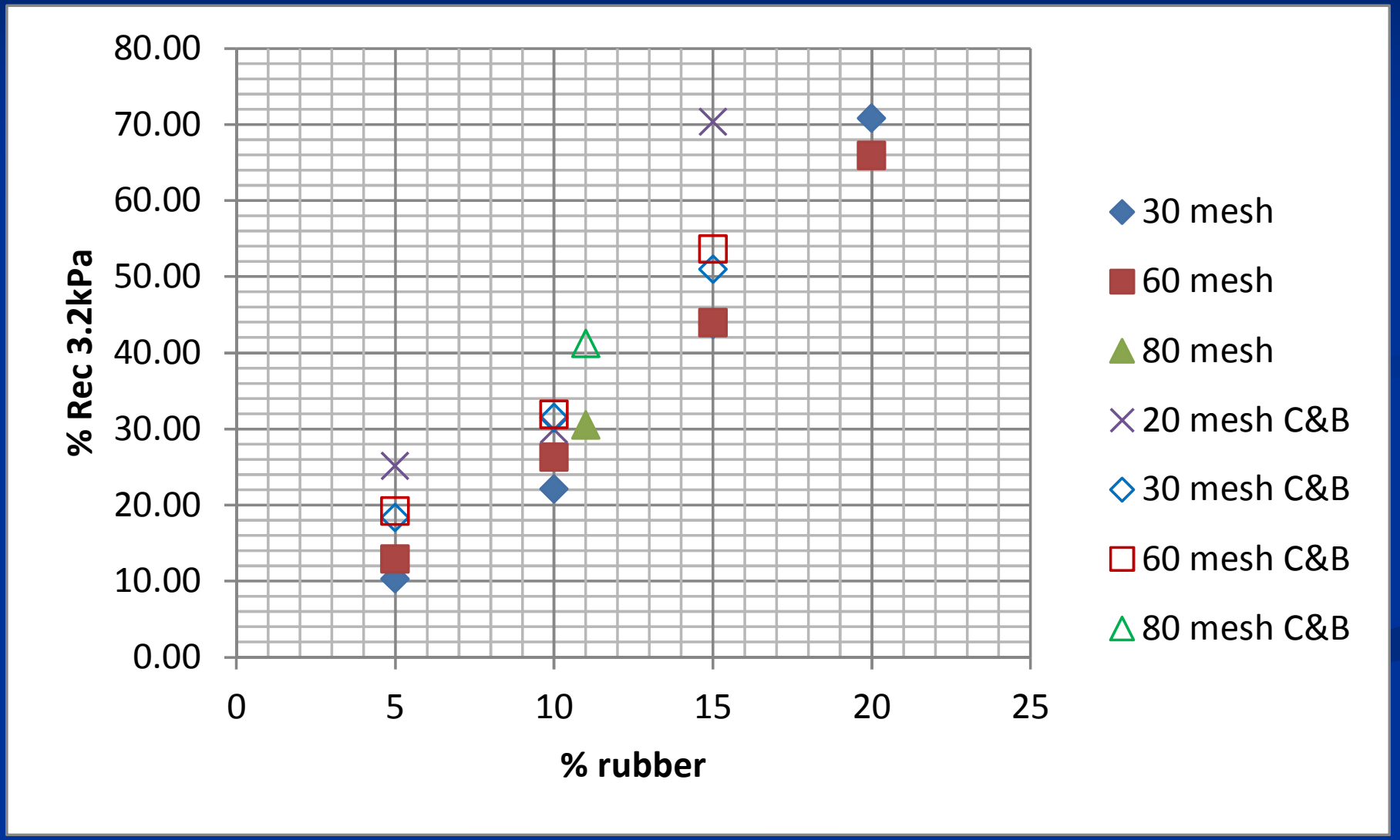
Jnr vs % Recovery for PMB and rubber blends



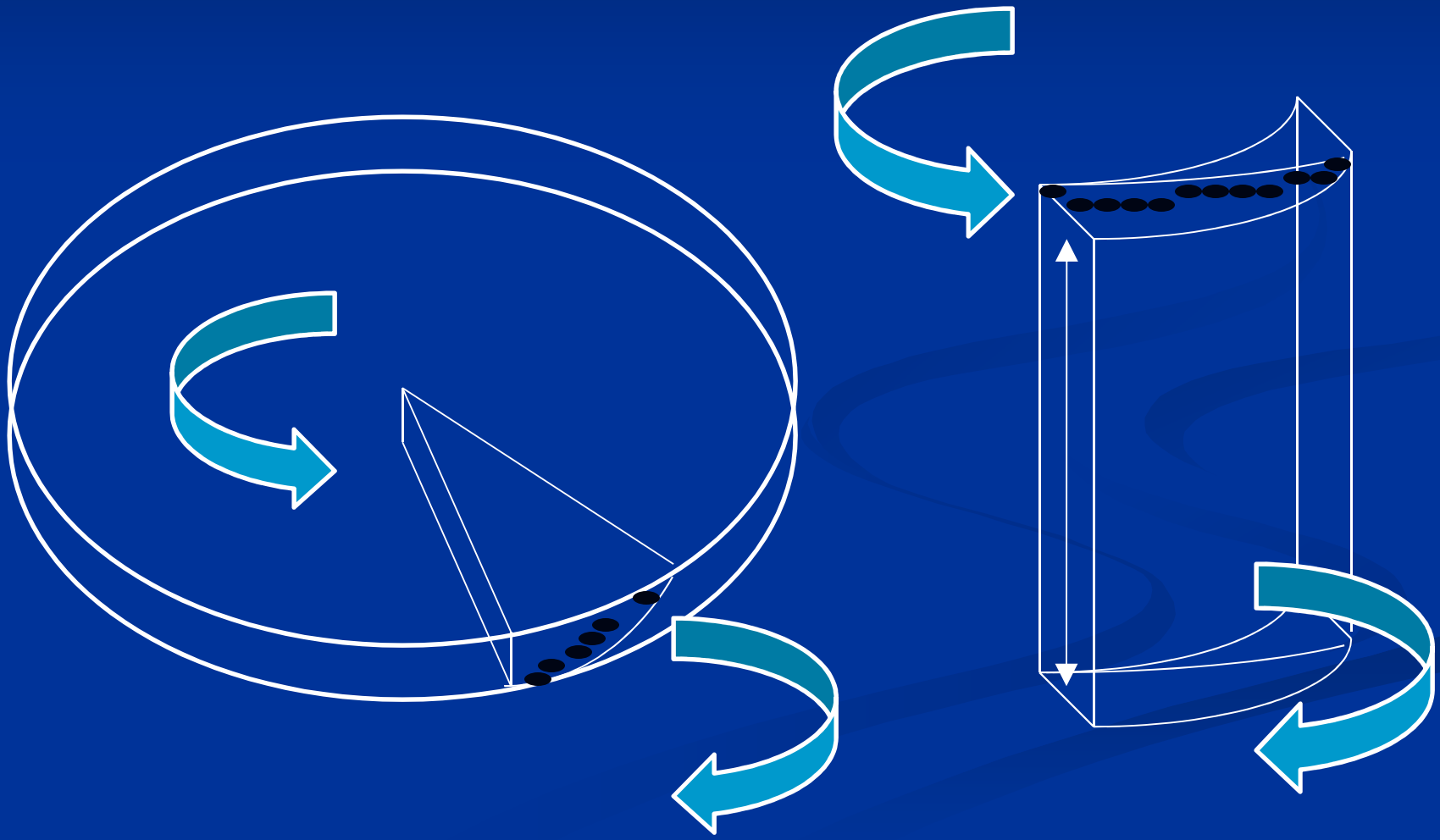
Jnr Changes with %RTR and Geometry @ 64C



Change in % Recovery with %RTR and Geometry



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

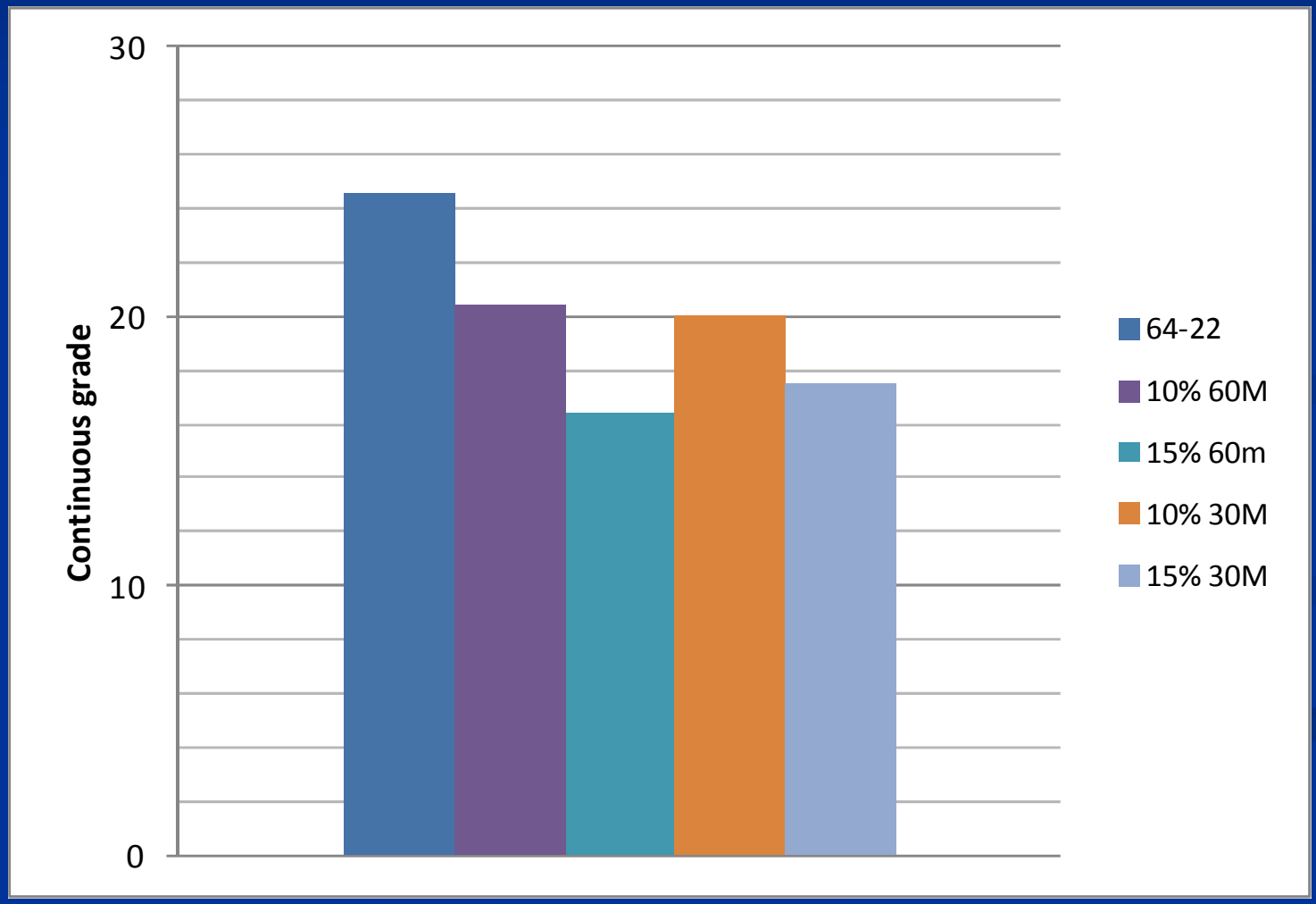


Recovery Properties of RTR

- RTR does not provide equal % recovery to PMB. This is not necessarily a performance characteristic.
- Cup & Bob indicates more recovery than Parallel Plate.
- RTR does not set up a network in the binder, however it has been shown to provide crack pinning and improve durability.
- We may need to reevaluate how to determine how much recovery is required for RTR

Intermediate DSR results for CRM binder - Preliminary Study

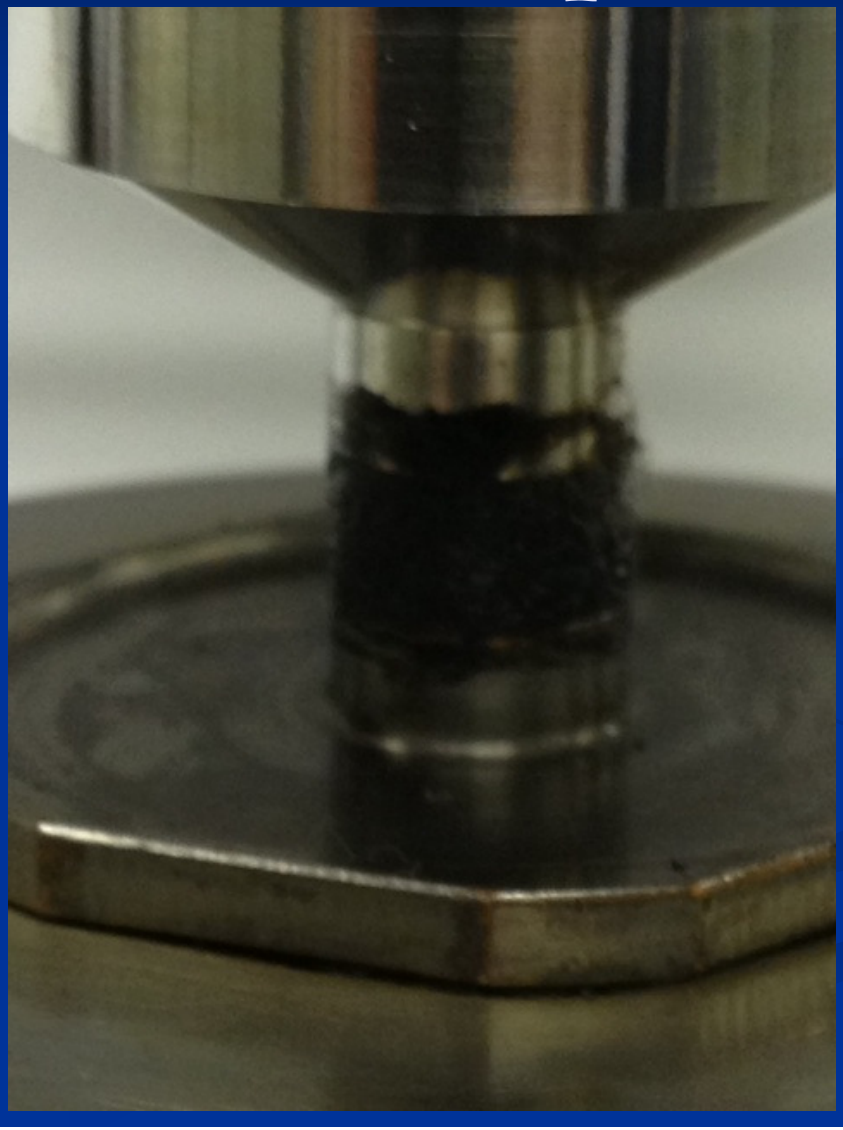
RTR improves Intermediate DSR



Intermediate DSR testing of RTR Binders

- Previous studies indicated that the cup & bob geometry had compliance issues with intermediate DSR testing.
- Large gap sizes needed for larger mesh size rubber.
- Large gap sizes at high temps resulted in sagging of sample, but at intermediate temps it may work.

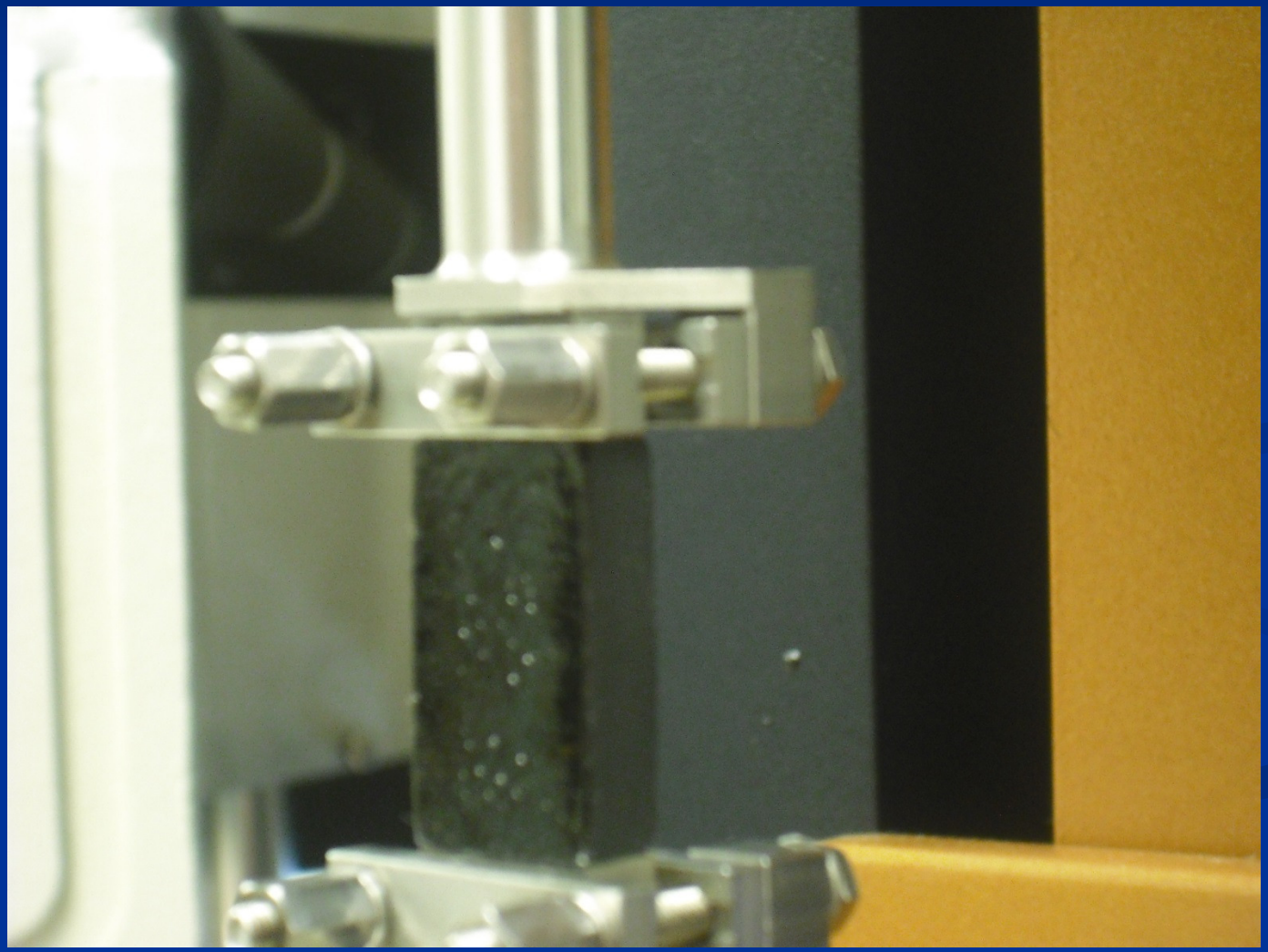
8 mm plates with 4 mm gap at intermediate temperatures



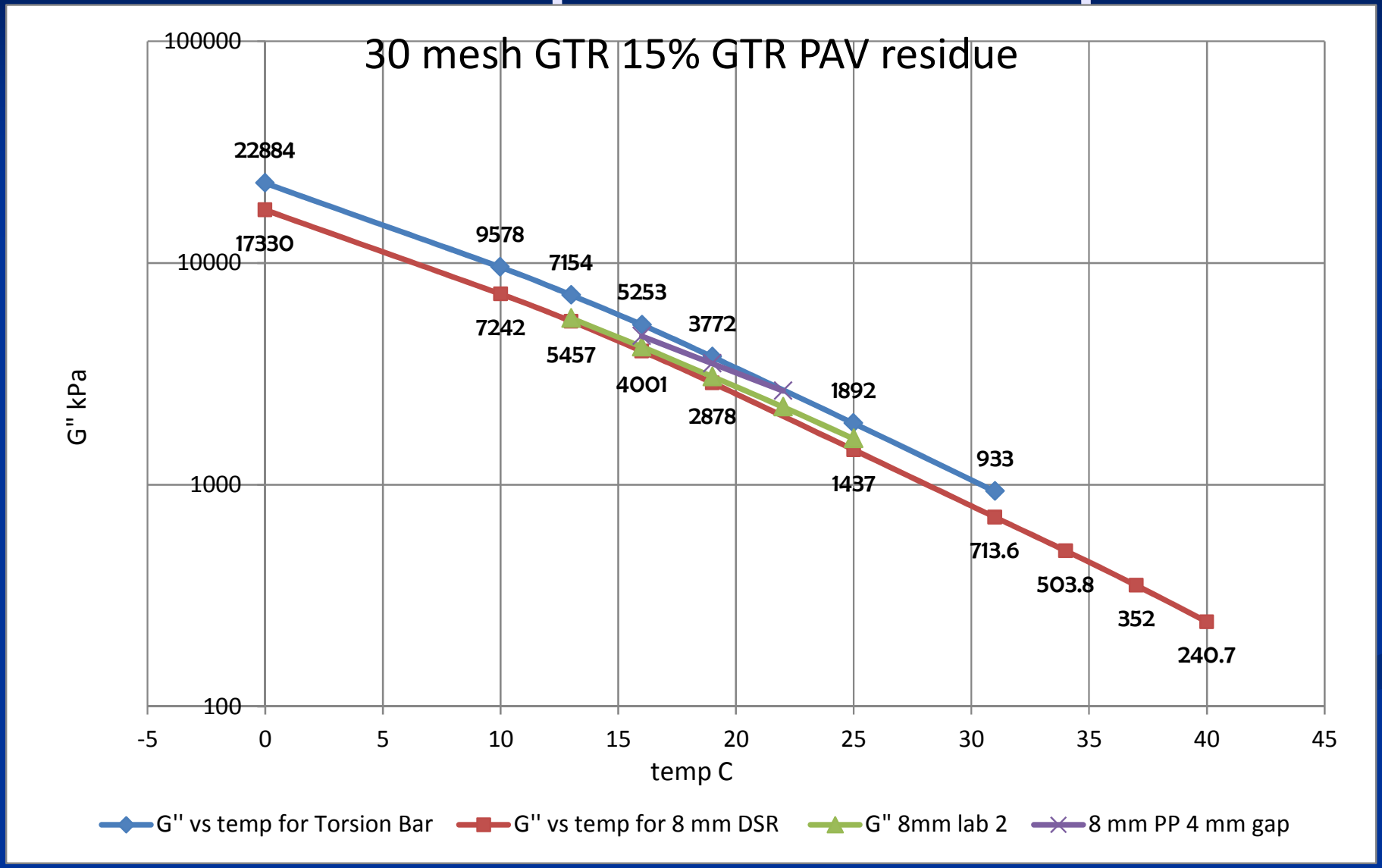
Intermediate DSR testing

- If particle size is an issue with test results how to develop control to validate gap size results.
  - Torsion bar testing at low and intermediate testing has been used historically.
  - Torsion bar geometry reduces or eliminates particle interaction issues. This can be used as a control to compare to parallel plate testing.

Picture of Asphalt torsion bar loaded in DSR



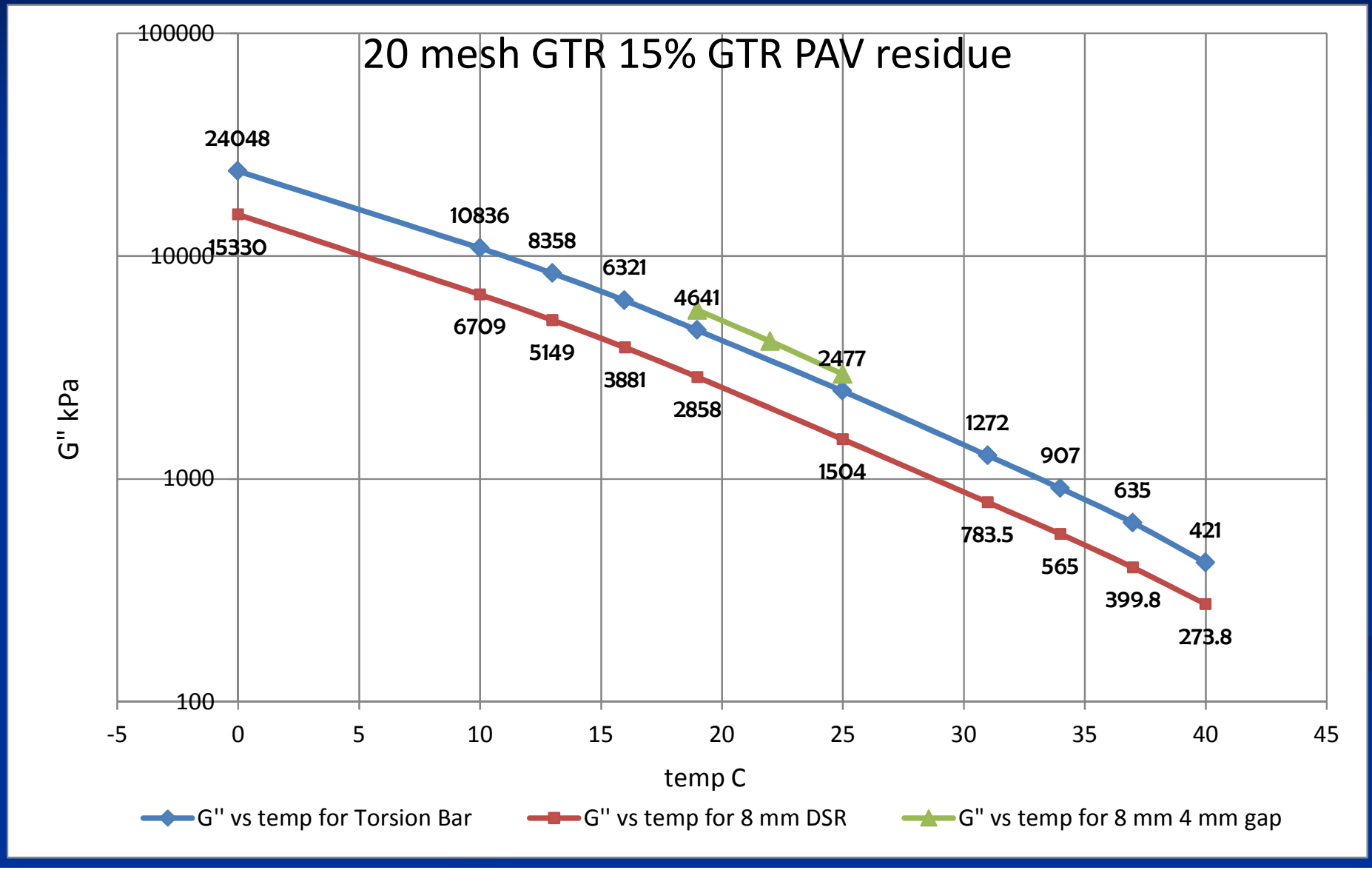
Torsion bar results compared to Parallel plate 2mm Gap



Torsion bar results compared to Parallel plate 2mm Gap

- Torsion bar test provides higher modulus results than the 2 mm gap parallel plate even for 30 mesh rubber at 15% concentration.
- At higher rubber concentration a larger gap may be needed for accurate results.

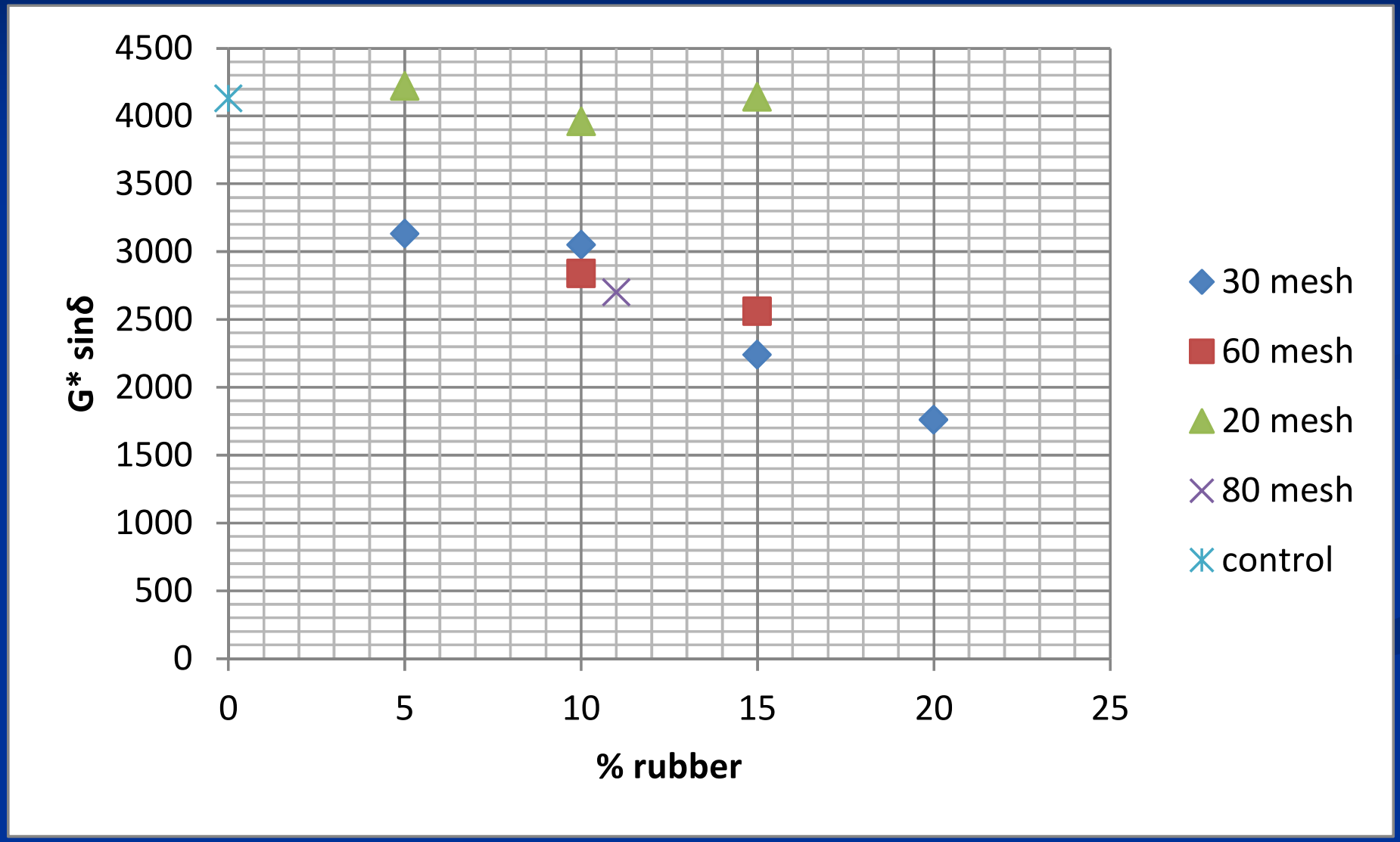
Comparison of Intermediate DSR for Torsion Bar and 2 and 4 mm gap



Torsion bar results compared to Parallel plate 2 and 4 mm Gap

- Torsion bar test provides higher modulus results than the 2 mm gap parallel plate even for 20 mesh rubber at 15% concentration.
- 4 mm gap Parallel plate provides equivalent results to the Torsion bar for 20 mesh RTR.

Change in Intermediate DSR with size and % RTR



Change in Intermediate DSR with size and % RTR

- Smaller mesh RTR reduced the intermediate Temp Modulus of binders.
- Increased RTR percentage increases reduction.
- Larger RTR did not show the same reduction.

Summation

- At high temperature M 320 and MSCR do not provide equivalent results for the rubber and PMB binders. MSCR has been verified to more closely relate to high temp performance of binders.

Summation

- MSCR % recovery different for PMB and RTR.
- % recovery relates to internal structure not directly to performance.
- May need to develop new relationship for RTR to determine internal structure.

Summation

- Torsion bar testing was used as a control to determine true Intermediate DSR results.
- 4 mm gap parallel plate testing related well to the torsion bar results for 20 mesh rubber.
- 2 mm gap parallel plate did not compare well to torsion bar results for the 30 mesh rubber. Three or 4 mm gap may be needed even for 30 mesh RTR. What about high temp?

Summation

- RTR binders can be produced to be equivalent to PMB binders.
- MSCR is more discriminatory than the M 320 spec.
- More work is needed to determine internal structure of RTR and relationship to improved performance.
- RTR improves intermediate DSR properties but affect is size dependent.

Thank You