

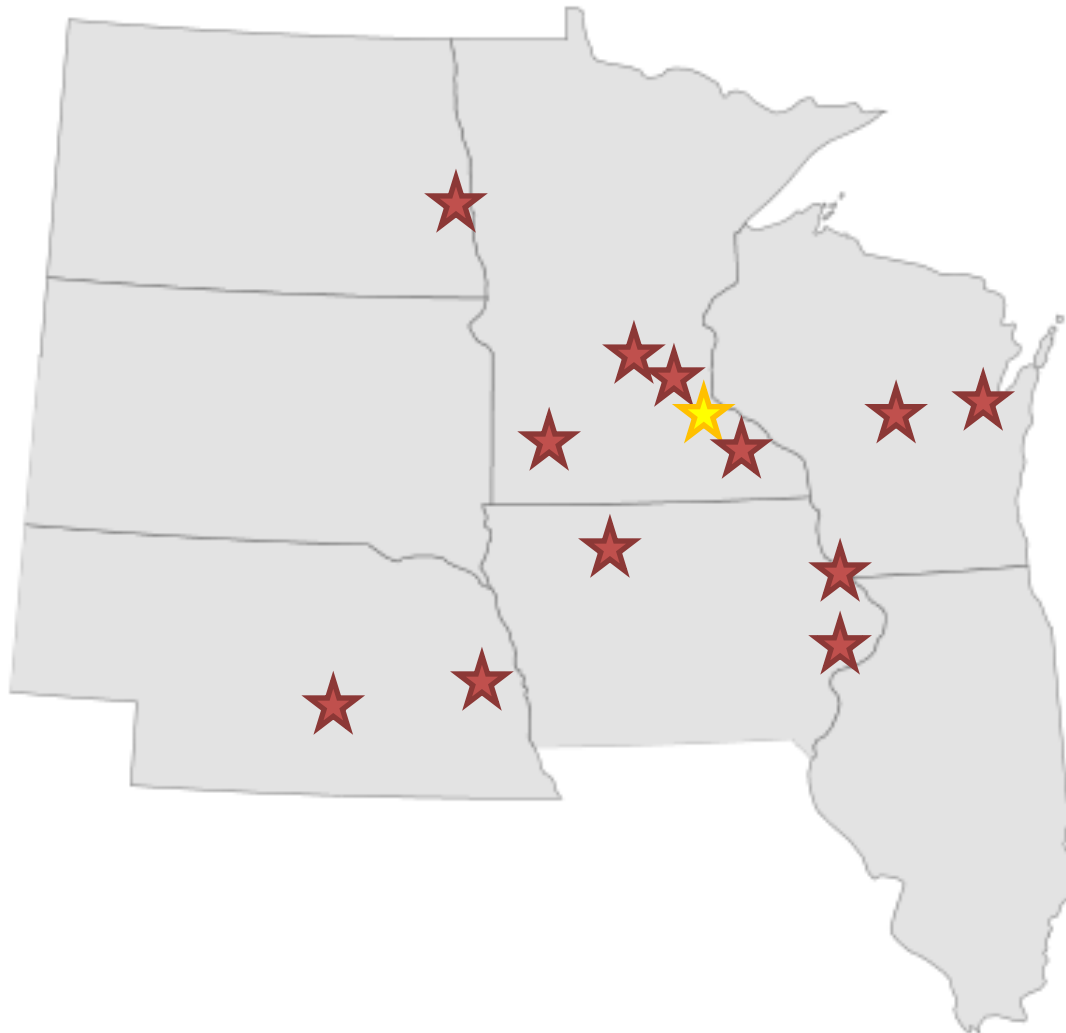


A Supplier's Experience with MSCR-JnrDiff

May 3, 2017 - ETG Binder Meeting

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Flint Hills Resources, LP

FHR Asphalt Locations



-  Terminal
-  Refinery

JnrDiff Parameter

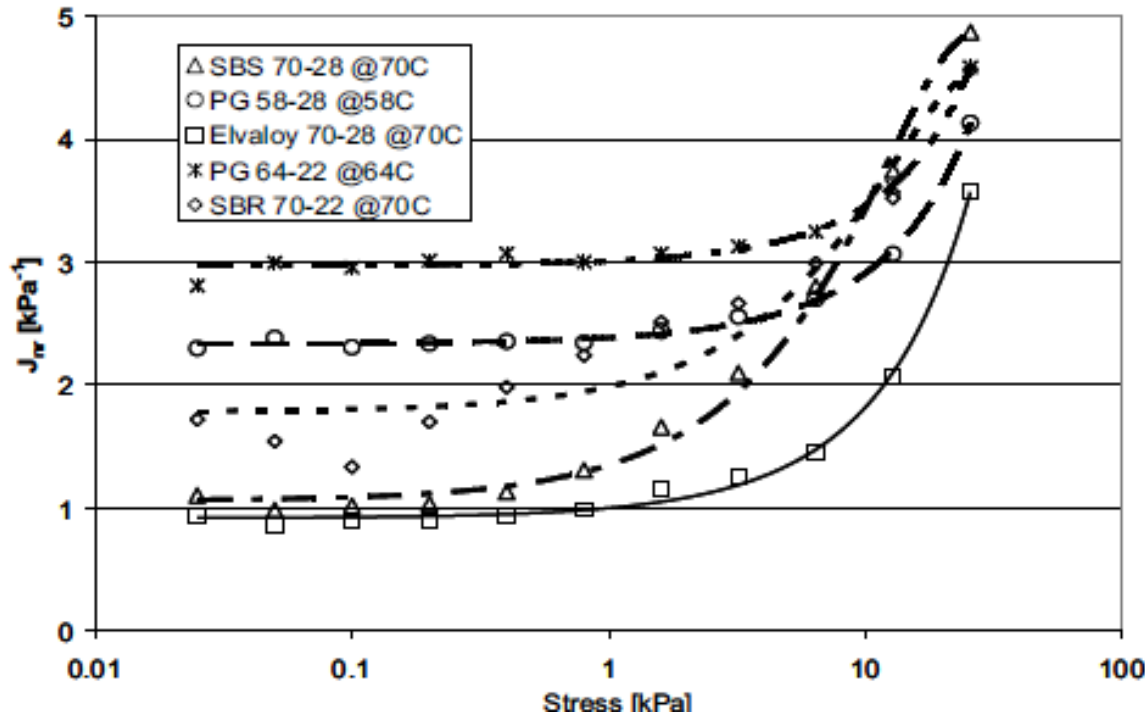


Figure 4 - D'Angelo, J. (2010), "New High-Temperature binder specification Using Multistress Creep and Recovery", Transportation Research Circular E-C147 Development of Asphalt Binder Specifications, Transportation Research Board of the National Academies, p 1 – 13.

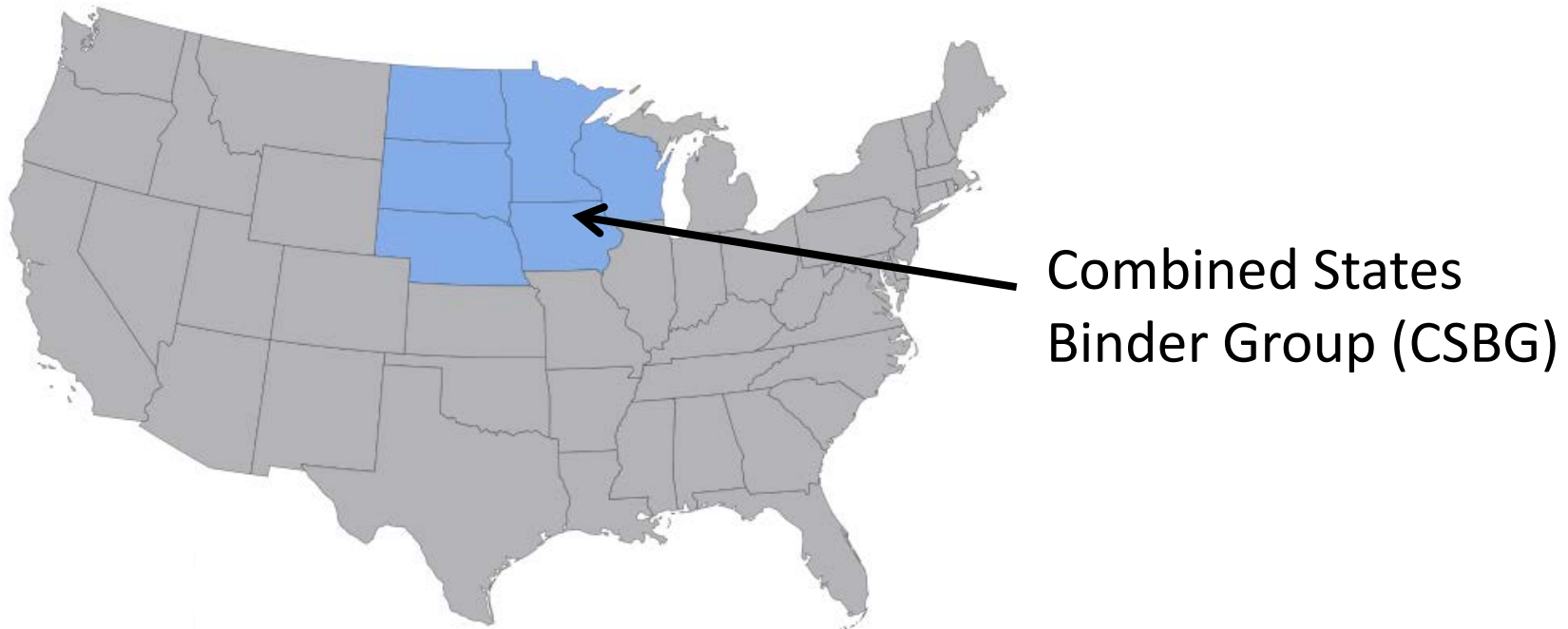
- JnrDiff limits the upward trend of the stress vs compliance curve

$$\frac{(J_{nr3.2} - J_{nr0.1})}{J_{nr0.1}} < 75\%$$

- Additional Safety Factor for rutting
- Indication of polymer network quality

JnrDiff Challenges in Northern Climates

- Binders with wide temperature ranges or soft base binders are susceptible to high JnrDiff values
- CSBG Agencies regularly purchase -34 binders



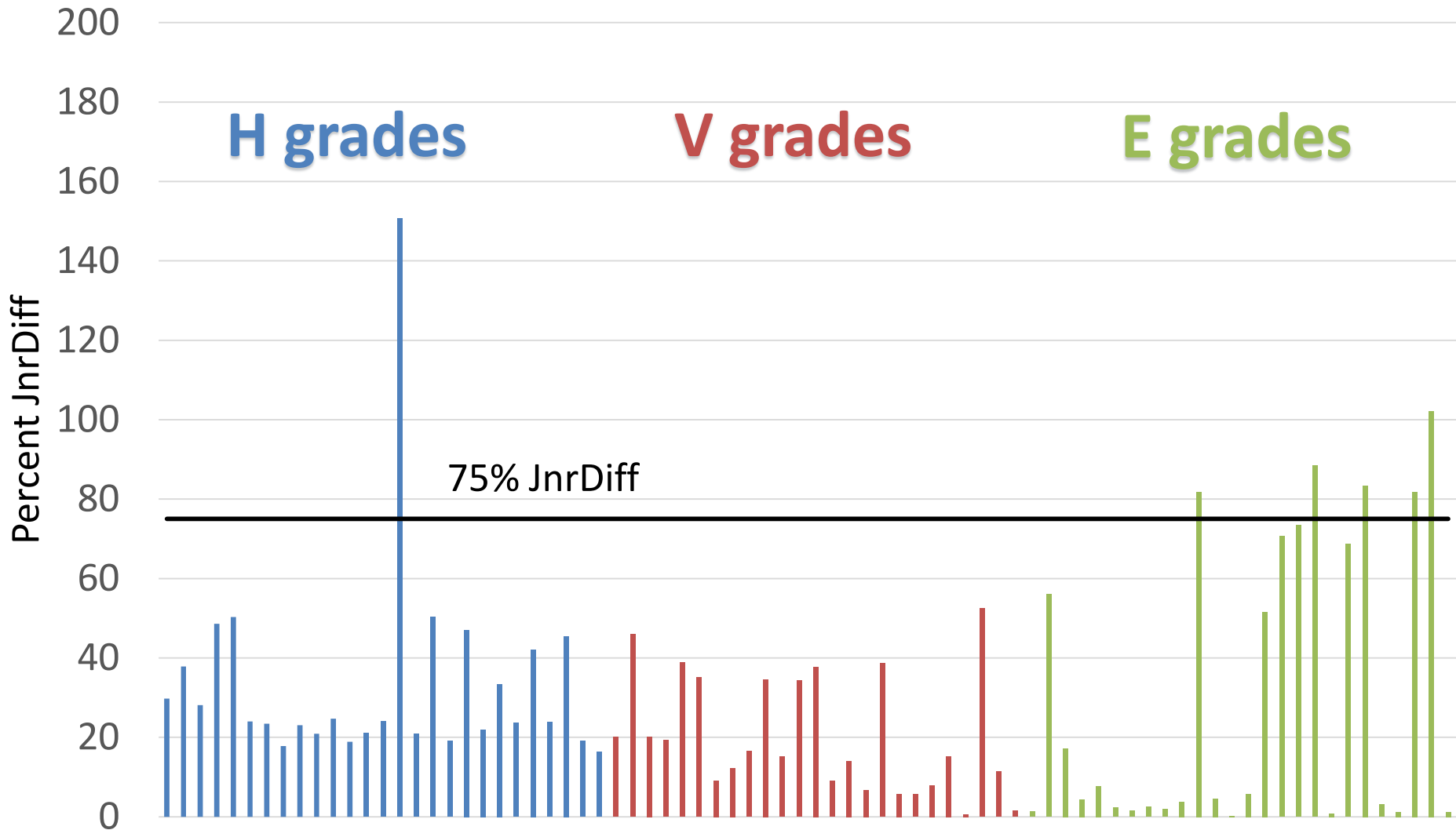


Current Status of JnrDiff

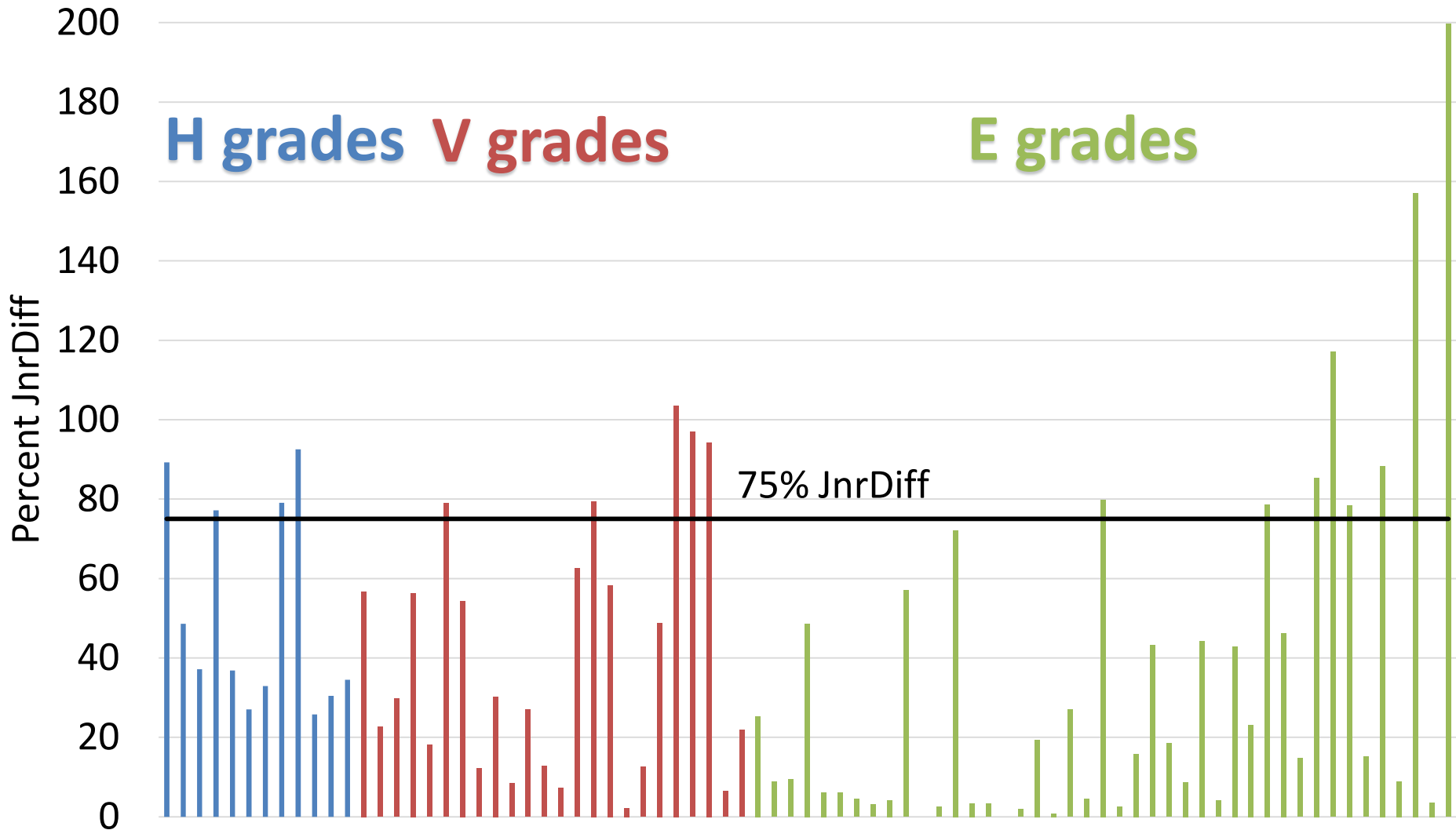
- Some US and Canadian Agencies list JnrDiff as report only
- AASHTO Resource doesn't certify labs based on JnrDiff
- 2017 TRB paper¹ authored by Jeff Stempihar at ASU demonstrates JnrDiff may not adequately represent binder stress sensitivity
- E-Grade waiver

¹Stempihar, J., Gundla, A., Underwood, B.S. (2017), "Alternate Interpretation of Stress Sensitivity in AASHTO T-350", Paper No. 17-06492, Transportation Research Board Annual Meeting 2017.

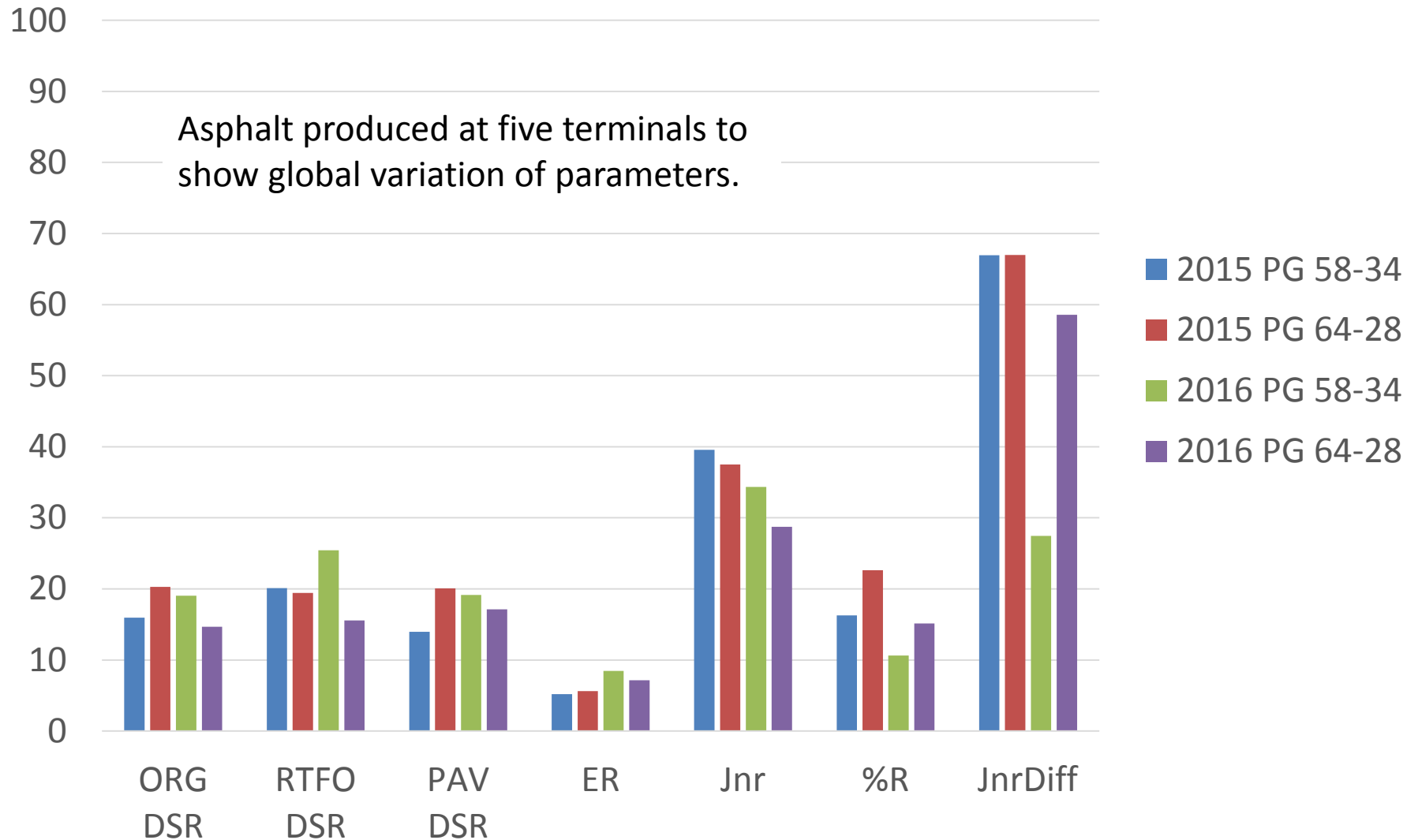
FHR PG 58-28 Binders (2015)



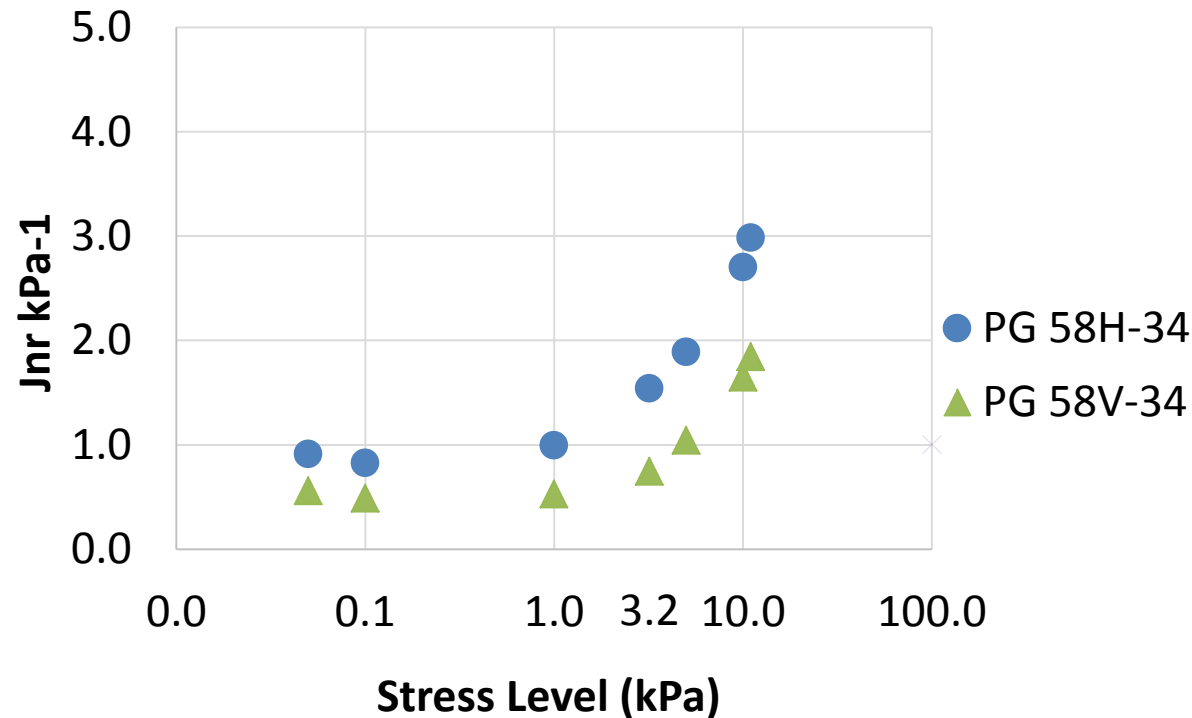
FHR PG 58-34 Binders (2015)



JnrDiff Variability



JnrDiff at Different Stress Levels



Stress Level kPa ⁻¹	58H-34 JnrDiff	58V-34 JnrDiff
0.1	0%	0%
1	20%	8%
3.2	87%	52%
5	129%	113%
10	227%	236%
11	261%	276%

The H binder failed JnrDiff, but it may be less stress sensitive than the V binder which passed JnrDiff.

Difference in Software Versions

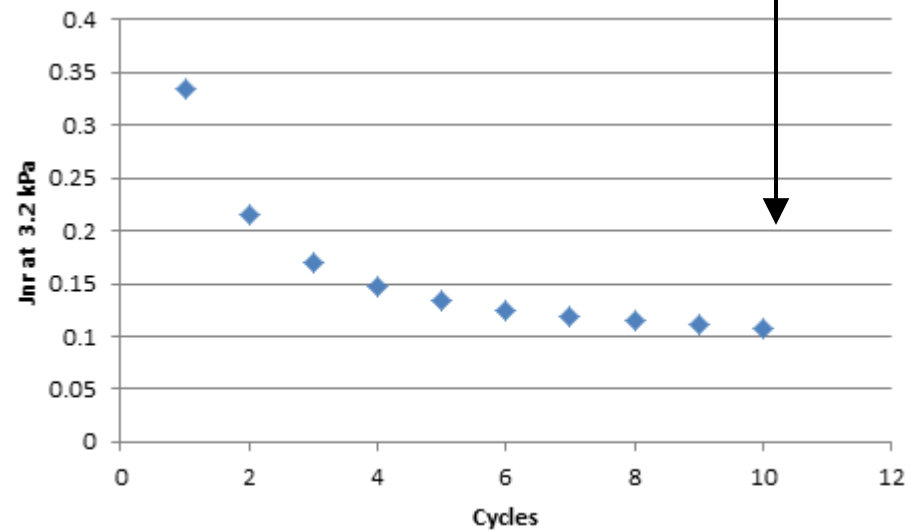
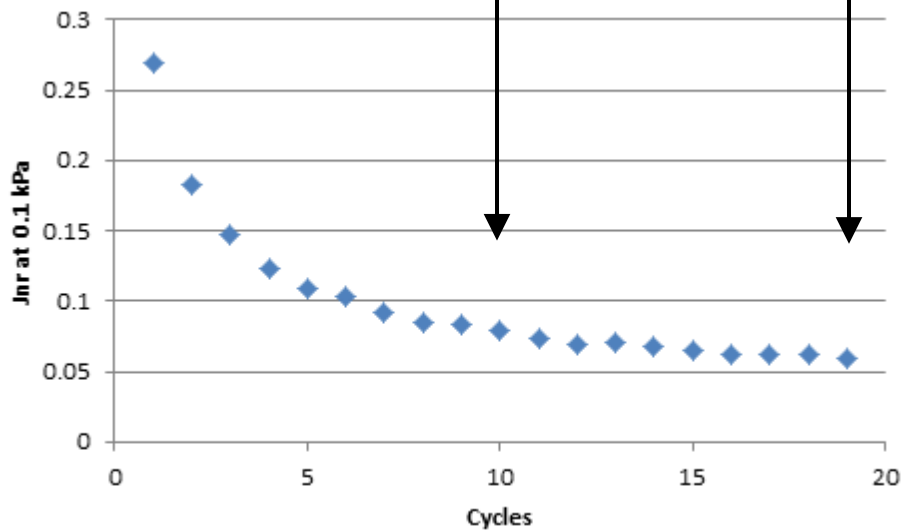
PG 58H-34 Production Samples	AASHTO post-2014 (10 warm-up cycles) JnrDiff	AASHTO pre-2014 (No warm-up cycles) JnrDiff
5-16-16	77.9	43.4
6-9-16	80.2	39.0
6-23-16	76.9	41.4
8-1-16	84.9	41.2
8-16-16	91.2	35.3
9-16-16	90.8	48.0

10 Warm-up Cycles Lowers Jnr0.1

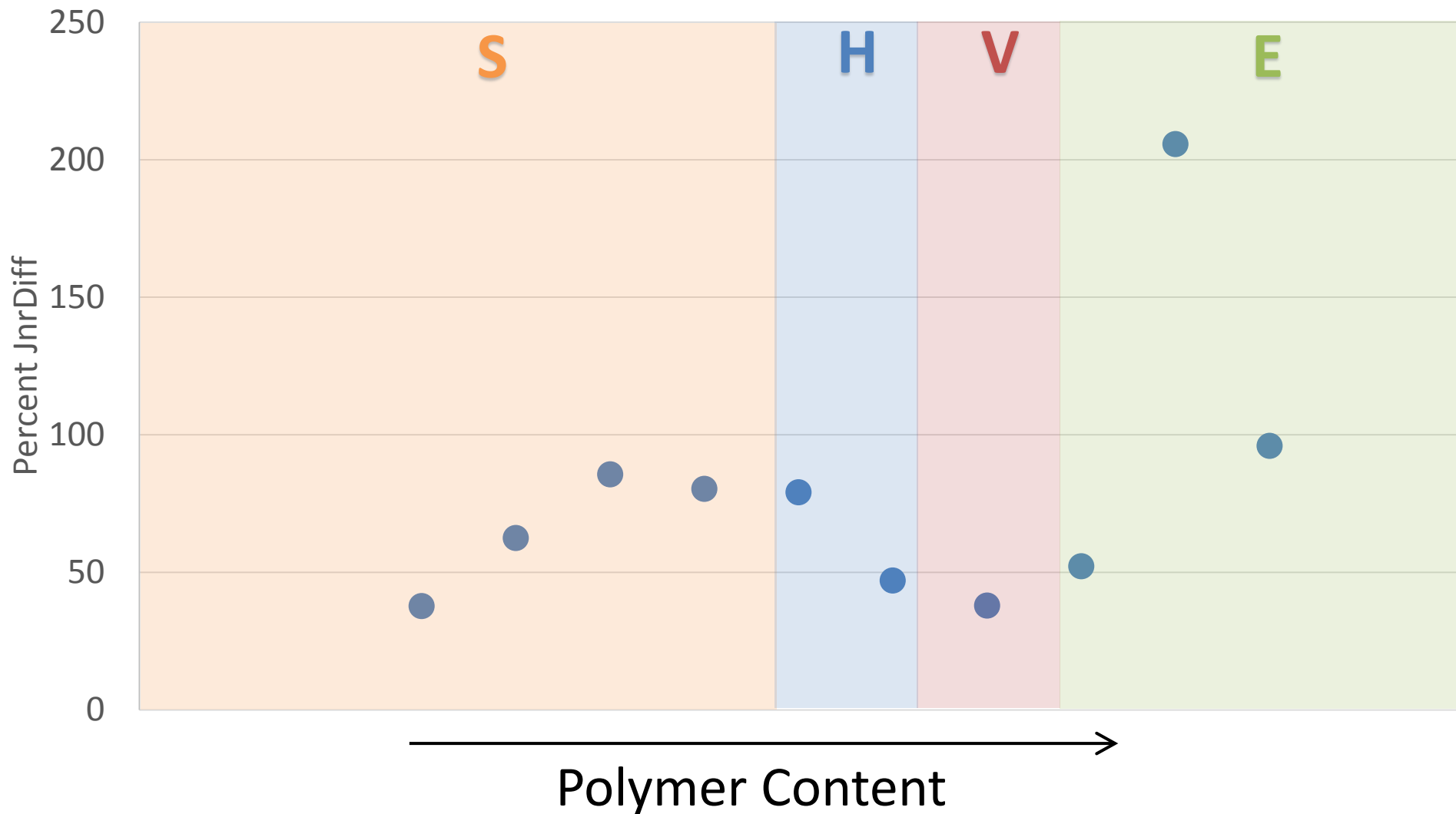
Original
Values for
Jnr 0.1

New
Values for
Jnr 0.1

MSCR Cycles for
Jnr 3.2



Unpredictability of JnrDiff

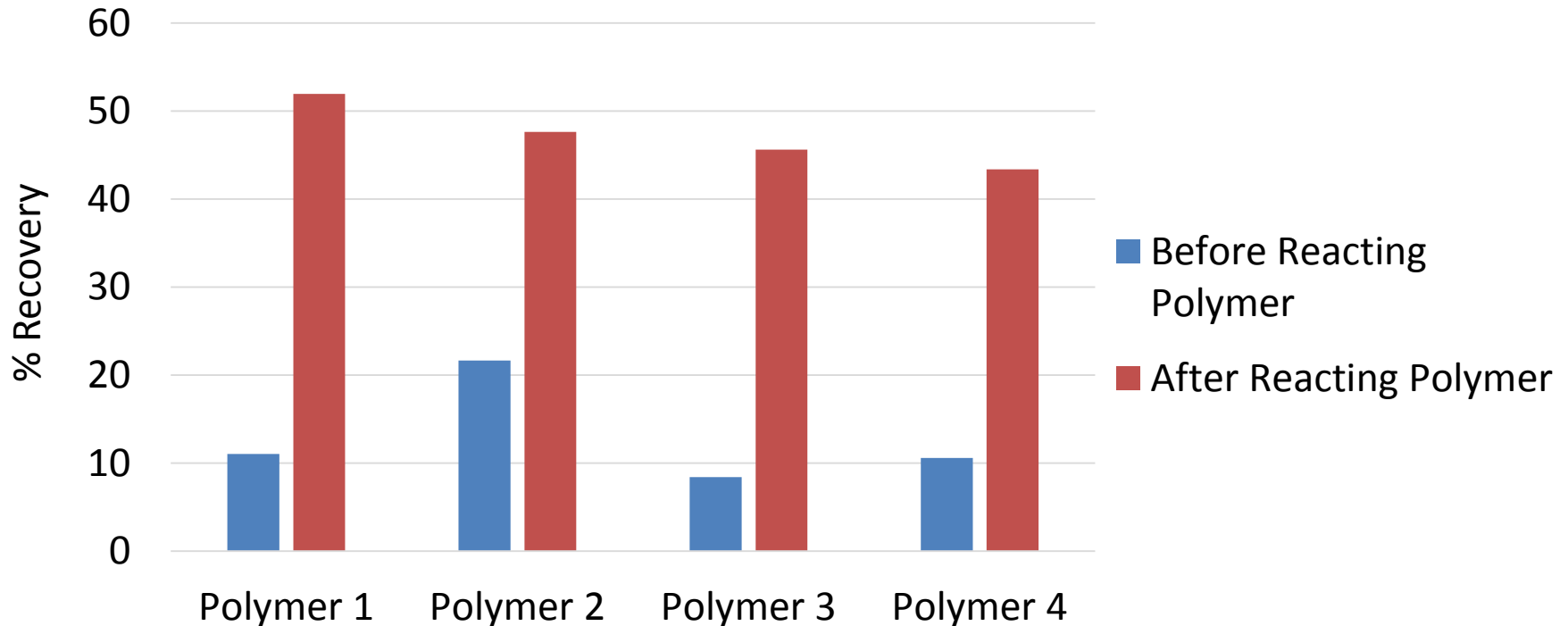




Reacting Polymer Experiment

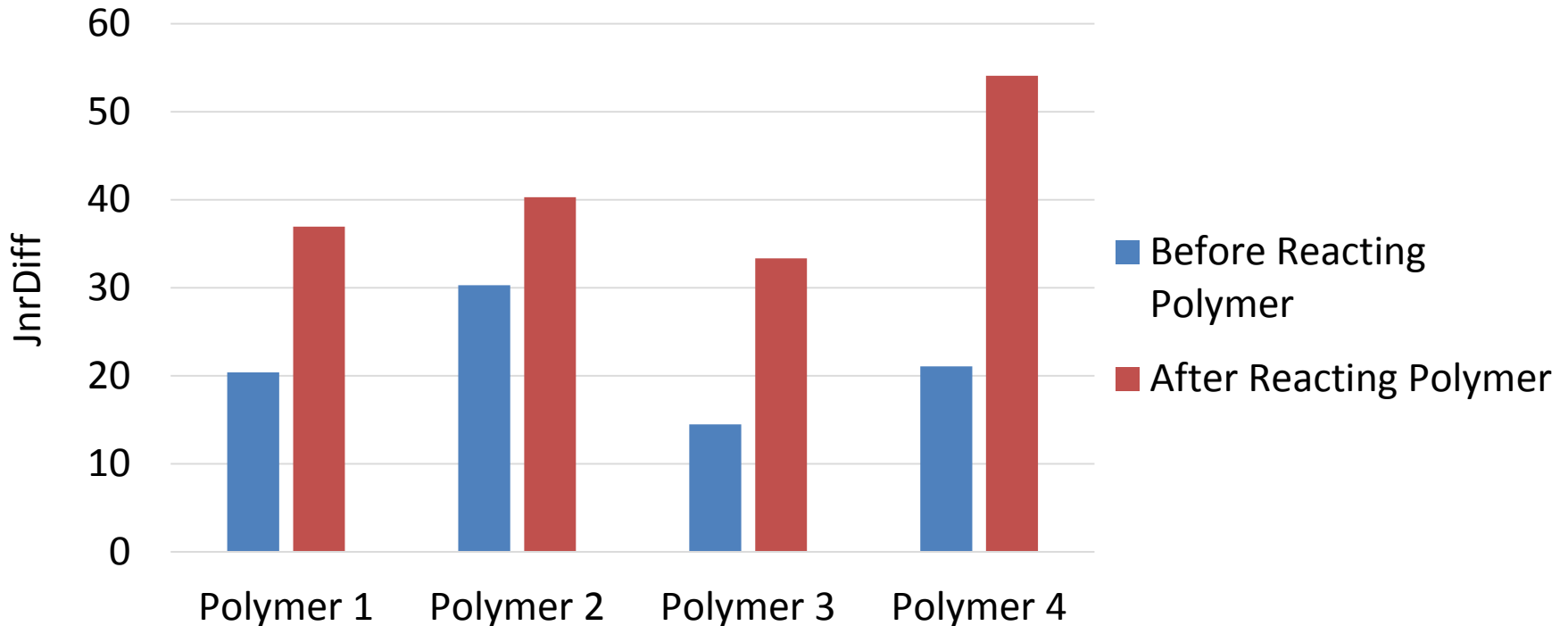
- Laboratory Procedure
 - Blend 4 different types of polymer in a highly compatible PG 58-28
 - Use 1 gallon container for each blend
 - Use IKA high shear mixer at 5k rpms for 2 hours at 375F
 - Test MSCR before and after reacting the polymer
 - MSCR Test Temperature 58C

Polymer Reaction Experiment

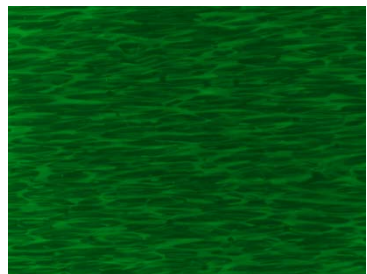
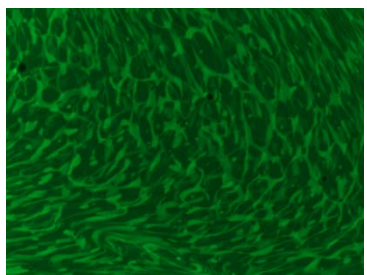
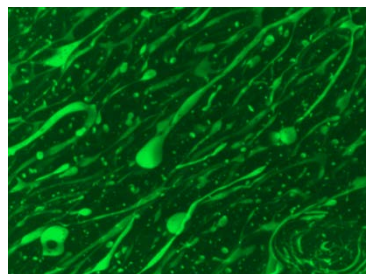
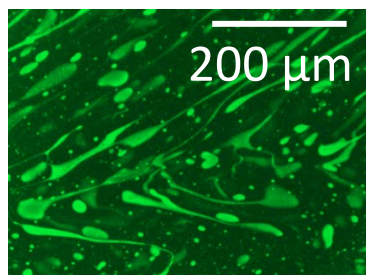


- % Recovery increased after reacting the polymer
- A good polymer network was established in the asphalt

Polymer Reaction Experiment

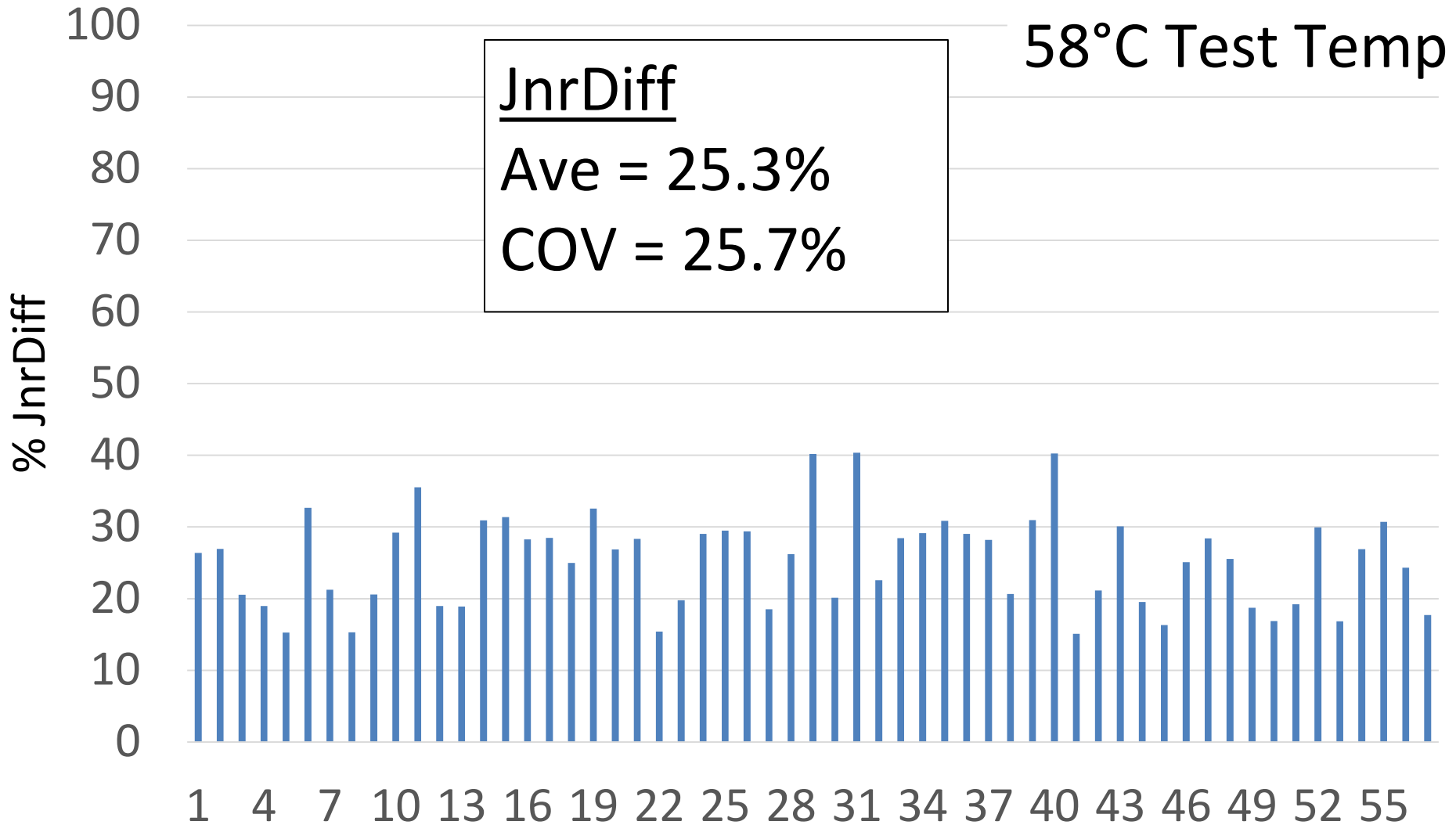


- Reacting the polymer caused the JnrDiff to increase, rather than decrease

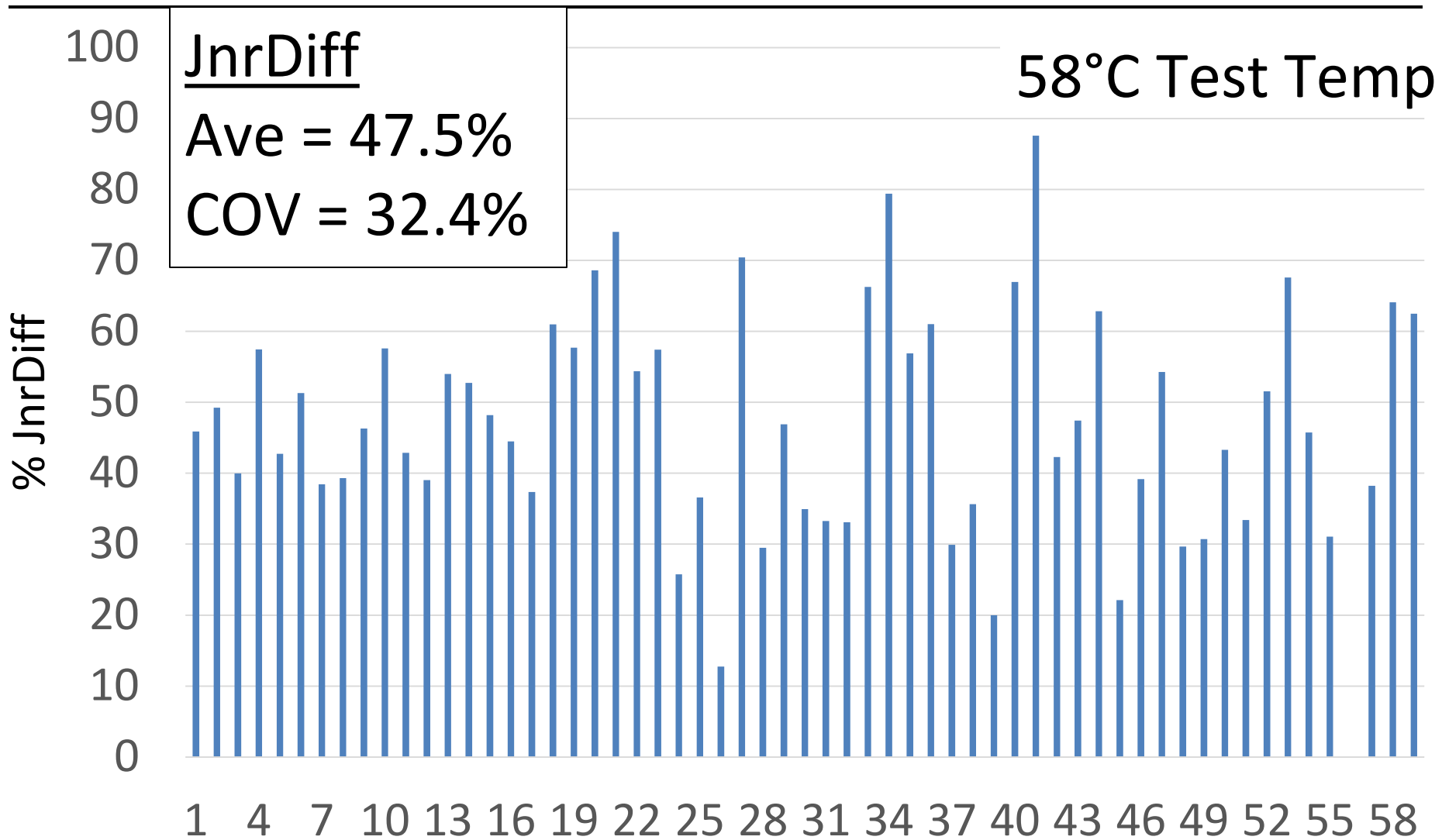


PG 58-28	% R	Jnr3.2 kPa⁻¹	JnrDiff (%)
No Reaction	21.0	0.68	36.0
Partially Reacted	46.4	0.39	76.0
Partially Reacted	52.1	0.36	58.8
Partially Reacted	58.3	0.31	63.5
Fully Reacted	76.2	0.17	65.2

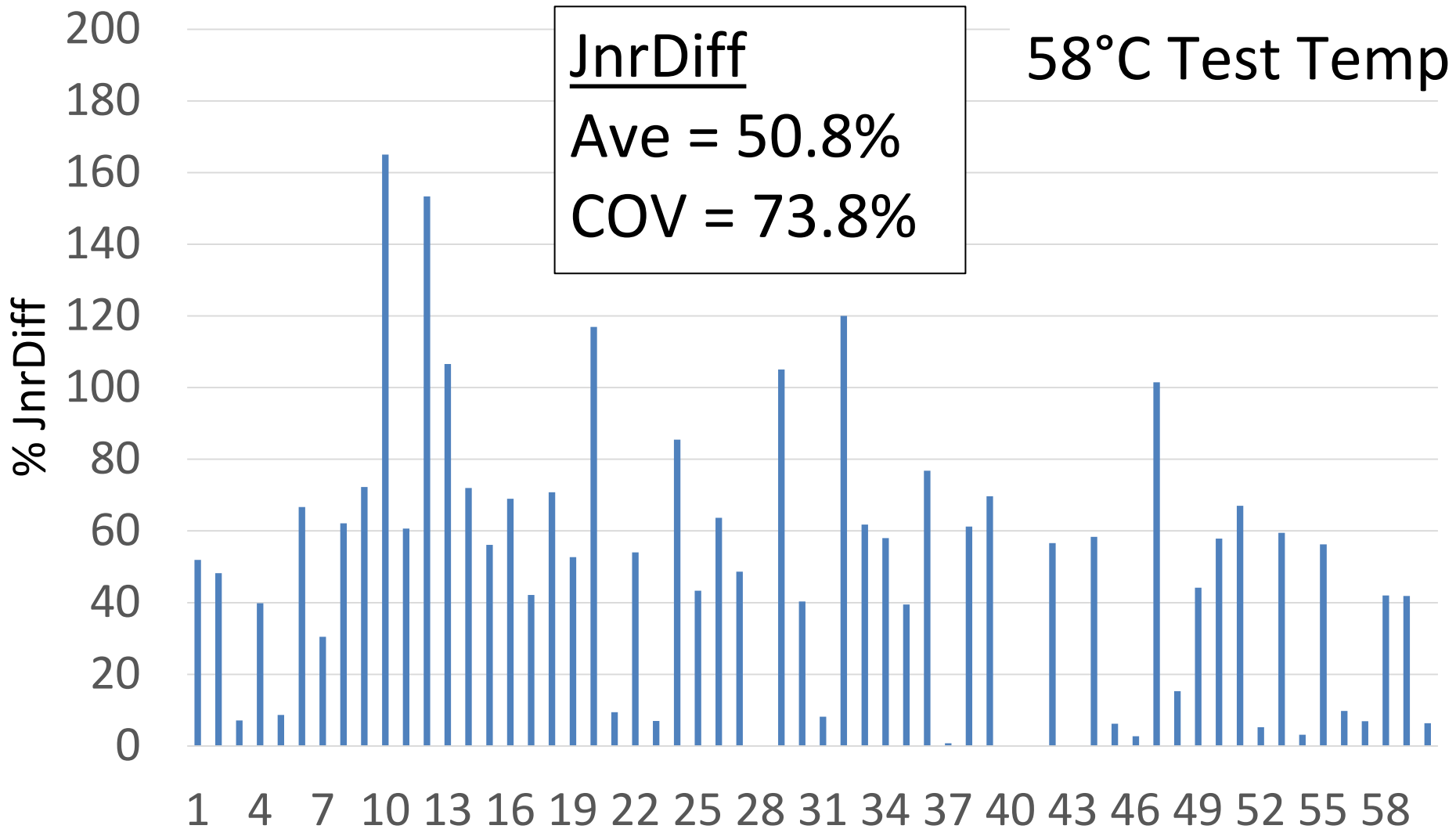
CSBG PG 64-28 Round Robin (2016)



CSBG PG 58-34 Round Robin (2015)



CSBG PG 64-34 Round Robin (2016)

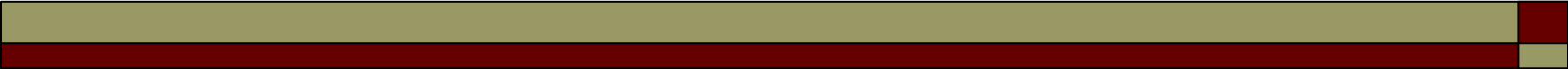




Considerations

- The stress sensitivity of polymer modified asphalt is an important consideration but more research is needed before a parameter is implemented.

- Should JnrDiff be reconsidered as a specification in AASHTO M332 if:
 - Round-robins (CSBG) and supplier data show high variability?
 - 10 warm-up cycles are causing binders to fail the JnrDiff?
 - Lab results can not be replicated at the terminal level?
 - Asphalt Suppliers are unable to control the parameter?



Thank you
Questions ?