Alternate Interpretation of Stress Sensitivity in AASHTO T 350 (MSCR Test)

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Jeff Stempihar[1], Akshay Gundla[2], and B. Shane Underwood[3]

[1]Assistant Research Professor, [2]Graduate Research Associate, and [3]Assistant Professor, Arizona State University, USA.

Email : jstempih@asu.edu

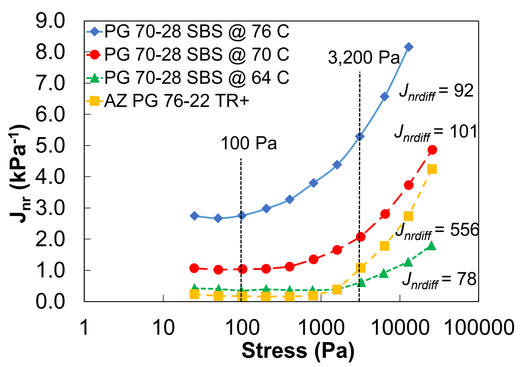
Objective: Present $J_{nr\ slope}$ as an alternative parameter to $J_{nr\ diff}$ and one that accurately describes stress sensitivity of asphalt binders.

Perspective on $J_{nr\ diff}$

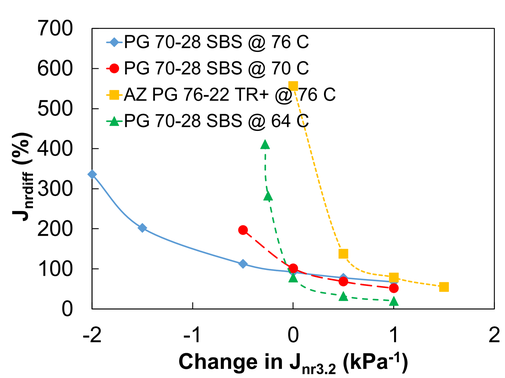
- The J_{nrdiff} parameter is intended to limit the stress sensitivity of binders

$$J_{nrdiff} = \frac{[J_{nr3.2} - J_{nr0.1}]}{J_{nr0.1}} \times 100$$

- AASHTO M 332 imposes an upper limit of 75% on J_{nrdiff}.
- Suppliers and agencies reported challenges with meeting this limit especially for low J_{nr} polymer modified asphalts.
- J_{nrdiff} is an extremely variable parameter and does not accurately describe stress sensitivity.



- Graphical representation of stress sensitivity and the J_{nrdiff} value do not correlate.
- J_{nrdiff} unfairly penalizes binders with low $J_{nr3.2}$ due to $J_{nr0.1}$ in the denominator.
- The following plot emphasizes the sensitivity of J_{nrdiff} to vertical changes in the relationship between J_{nrdiff} and applied stress.

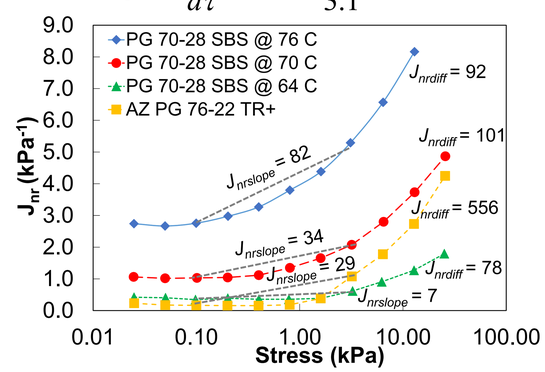


- The sensitivity of J_{nrdiff} to changes in $J_{nr3.2}$ is not equivalent for binders with similar J_{nrdiff} values at the measured $J_{nr3.2}$.
- J_{nrdiff} exhibits high sensitivity for binders with low $J_{nr3.2}$.
- The inability of J_{nrdiff} to accurately represent stress sensitivity in binders assessed using AASHTO T 350 is demonstrated.
- An alternative parameter, $J_{nrslope}$, is proposed to represent stress sensitivity in AASHTO M 332.

$J_{nr\ slope}$ as an Alternative Parameter

- Alternate parameter, $J_{nrslope}$ is defined as the change in J_{nr} for an incremental change in applied stress.

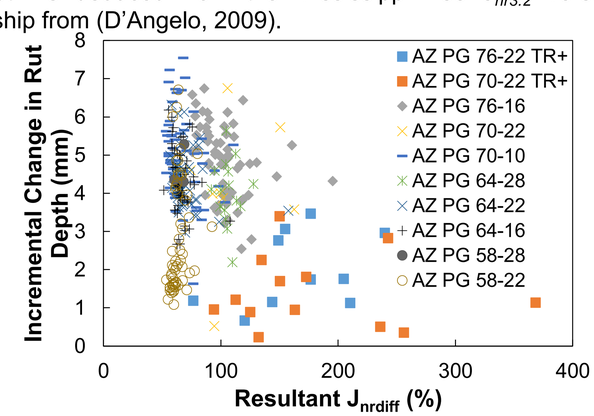
$$J_{nrslope} = \frac{dJ_{nr}}{d\tau} = \frac{[J_{nr3.2} - J_{nr0.1}]}{3.1} \times 100$$

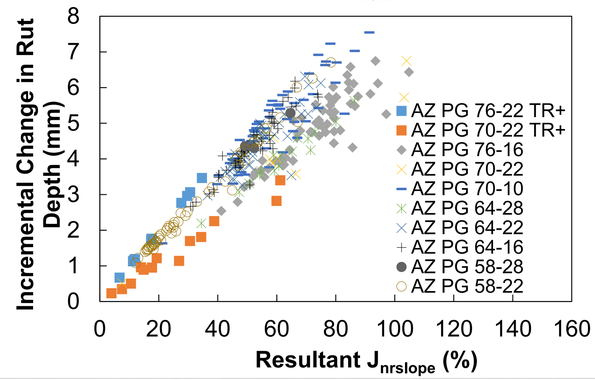


- Clear correlation between graphical representation of stress sensitivity and $J_{nrslope}$.
- $J_{nrslope}$ is insensitive to the magnitude of $J_{nr3.2}$ and does not unfairly penalize binders with low $J_{nr3.2}$

Relationship of $J_{nr\ slope}$ to Empirical Rutting Correlation

- Rut depth is deduced from the Mississippi I-55 $J_{nr3.2}$ versus rut depth relationship from (D'Angelo, 2009).



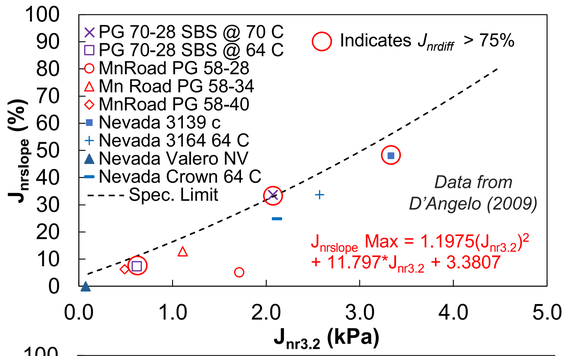


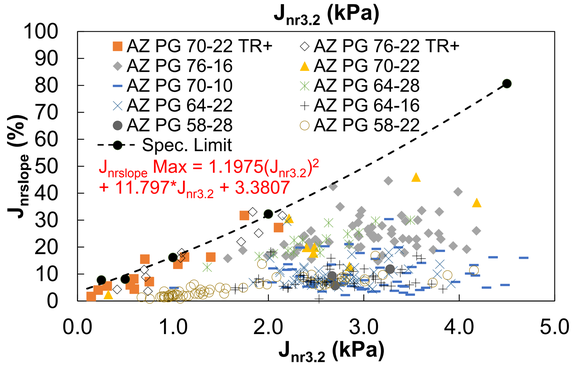
$J_{nr\ slope}$ as a Specification Parameter

- Original intent of J_{nrdiff} was to specify binders where : $J_{nr3.2}$ at T°C ≤ $J_{nr0.1}$ at T+ 6°C.
- The specification limit proposed for $J_{nrslope}$ follows the intent of J_{nrdiff}.

Temp. (°C)	$J_{nr0.1}$	$J_{nr3.2}$	$J_{nrslope}$
T+24	2	4.5	80.6
T+18	1	2	32.3
T+12	0.5	1	16.1
T+6	0.25	0.5	8.1
T	0.01	0.25	7.7

- The maximum $J_{nrslope}$ values were determined by setting the $J_{nr0.1}$ value for the next higher grade to the $J_{nr3.2}$ of the previous grade.





- Of the 340 AZ binders analyzed only 4 binders fail $J_{nrslope}$ specification.
- The specification limit is shown to be valid for other states' data also.
- Binders which fail J_{nrdiff} criteria typically pass the $J_{nrslope}$ specification limit.

Summary

- $J_{nrslope}$ is a more accurate assessment of stress sensitivity and is a definite improvement over J_{nrdiff}.
- $J_{nrslope}$ shows a better correlation with an incremental change (hypothetical) in rut depth than J_{nrdiff}.
- Almost all of AZ binders are within the developed $J_{nrslope}$ specification limit.
- More data from various states are required to further assess the $J_{nrslope}$ specification and also validation through examination of field data and comparison to binder test data is needed.

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