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

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

- The original intent of $J_{\text{diff}}$ was to specify binders where $J_{nr,1}$ at $T \geq T_{\text{spec}}$. The specification limit proposed for $J_{nr \text{diff}}$ follows the intent of $J_{\text{diff}}$.
- The maximum $J_{nr \text{diff}}$ values were determined by setting the $J_{nr,1}$ value for the next higher grade to the $J_{nr,2}$ of the previous grade.
- Of the 340 AZ binders analyzed only 4 binders failed $J_{nr \text{slope}}$ specification.
- The specification limit is shown to be valid for other states’ data also.
- Binders which fail $J_{\text{diff}}$ criteria typically pass the $J_{nr \text{slope}}$ specification limit.

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

- The maximum $J_{nr \text{diff}}$ values were determined by setting the $J_{nr,1}$ value for the next higher grade to the $J_{nr,2}$ of the previous grade.
- The sensitivity of $J_{\text{diff}}$ to changes in $J_{\text{nr,2}}$ is not equivalent for binders with similar $J_{\text{nr,2}}$ values at the measured $J_{\text{nr,2}}$.
- $J_{\text{diff}}$ exhibits high sensitivity for binders with low $J_{\text{nr,2}}$.
- The inability of $J_{\text{diff}}$ to accurately represent stress sensitivity in binders assessed using AASHTO T 350 is demonstrated.
- An alternative parameter, $J_{nr \text{diff}}$, is proposed to represent stress sensitivity in AASHTO T 350.

$J_{nr \text{slope}}$ is a more accurate assessment of stress sensitivity and is a definite improvement over $J_{\text{diff}}$.

$J_{nr \text{slope}}$ shows a better correlation with an incremental change (hypothetical) in rut depth than $J_{\text{diff}}$.

Almost all of AZ binders are within the developed $J_{nr \text{slope}}$ specification limit.

More data from various states are required to further assess the $J_{nr \text{slope}}$ specification and also validation through examination of field data and comparison to binder test data is needed.

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**Graphical Representation**

- The $J_{\text{diff}}$ parameter is intended to limit the stress sensitivity of binders.
- AASHTO M 332 imposes an upper limit of 75% on $J_{\text{diff}}$.
- Suppliers and agencies reported challenges with meeting this limit especially for low $J_n$ polymer modified asphalts.
- $J_{\text{diff}}$ is an extremely variable parameter and does not accurately describe stress sensitivity.

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

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

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**Resultant $J_{\text{nr}}$**

- $J_{\text{nr}}$ is defined as the change in $J_n$ for an incremental change in applied stress.
- $J_{\text{nr}}$ correlation magnitude intent.
- $J_{\text{nr}}$ is extremely sensitive to the magnitude of $J_{\text{nr,2}}$ and does not unfairly penalize binders with low $J_{\text{nr,2}}$.

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

- The maximum $J_{\text{nr,2}}$ values were determined by setting the $J_{\text{nr,1}}$ value for the next higher grade to the $J_{\text{nr,2}}$ of the previous grade.

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

- Rut depth is deduced from the Mississippi i-55 $J_{\text{nr,2}}$ versus rut depth relationship from (D’Angelo, 2009).

- Of the 340 AZ binders analyzed only 4 binders failed $J_{nr \text{slope}}$ specification.
- The specification limit is shown to be valid for other states’ data also.
- Binders which fail $J_{\text{diff}}$ criteria typically pass the $J_{nr \text{slope}}$ specification limit.

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**Summary**

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