A Supplier’s Experience with MSCR-JnrDiff

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FHR Asphalt Locations

- Terminal
- Refinery
JnrDiff Parameter

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

\[
\frac{(\text{Jnr}_{3.2} - \text{Jnr}_{0.1})}{\text{Jnr}_{0.1}} < 75\%
\]

- 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

Combined States Binder Group (CSBG)
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 paper authored by Jeff Stempihar at ASU demonstrates JnrDiff may not adequately represent binder stress sensitivity
- E-Grade waiver


75% JnrDiff

H grades  V grades  E grades

Percent JnrDiff

75% JnrDiff
Asphalt produced at five terminals to show global variation of parameters.
The H binder failed JnrDiff, but it may be less stress sensitive than the V binder which passed JnrDiff.
## Difference in Software Versions

<table>
<thead>
<tr>
<th>PG 58H-34 Production Samples</th>
<th>AASHTO post-2014 (10 warm-up cycles) JnrDiff</th>
<th>AASHTO pre-2014 (No warm-up cycles) JnrDiff</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-16-16</td>
<td>77.9</td>
<td>43.4</td>
</tr>
<tr>
<td>6-9-16</td>
<td>80.2</td>
<td>39.0</td>
</tr>
<tr>
<td>6-23-16</td>
<td>76.9</td>
<td>41.4</td>
</tr>
<tr>
<td>8-1-16</td>
<td>84.9</td>
<td>41.2</td>
</tr>
<tr>
<td>8-16-16</td>
<td>91.2</td>
<td>35.3</td>
</tr>
<tr>
<td>9-16-16</td>
<td>90.8</td>
<td>48.0</td>
</tr>
</tbody>
</table>
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
<table>
<thead>
<tr>
<th>PG 58-28</th>
<th>% R</th>
<th>Jnr3.2 kPa$^{-1}$</th>
<th>JnrDiff (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Reaction</td>
<td>21.0</td>
<td>0.68</td>
<td>36.0</td>
</tr>
<tr>
<td>Partially Reacted</td>
<td>46.4</td>
<td>0.39</td>
<td>76.0</td>
</tr>
<tr>
<td>Partially Reacted</td>
<td>52.1</td>
<td>0.36</td>
<td>58.8</td>
</tr>
<tr>
<td>Partially Reacted</td>
<td>58.3</td>
<td>0.31</td>
<td>63.5</td>
</tr>
<tr>
<td>Fully Reacted</td>
<td>76.2</td>
<td>0.17</td>
<td>65.2</td>
</tr>
</tbody>
</table>
CSBG PG 64-28 Round Robin (2016)

58°C Test Temp

JnrDiff
Ave = 25.3%
COV = 25.7%
CSBG PG 58-34 Round Robin (2015)

JnrDiff
Ave = 47.5%
COV = 32.4%

58°C Test Temp
CSBG PG 64-34 Round Robin (2016)

JnrDiff
Ave = 50.8%
COV = 73.8%

58°C Test Temp
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 cannot be replicated at the terminal level?
  - Asphalt Suppliers are unable to control the parameter?
Thank you
Questions ?