Multiple Stress Creep Recovery (MSCR): Binder Selection and Lessons Learned

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Past Asphalt Binder Specification

- Grading System Based on Climate

PG 58 - 28

Performance Grade

Average 7-day max pavement design temp

Minimum pavement design temperature
MSCR Asphalt Binder Specification

- Grading System Based on Climate and Traffic

**PG 58H - 28**

- Performance Grade
- Average 7-day max pavement design temp
- Traffic Level
- Minimum pavement design temperature
# MSCR Asphalt Binder Specification

<table>
<thead>
<tr>
<th>Letter Designation</th>
<th>Traffic Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>Standard</td>
</tr>
<tr>
<td>H</td>
<td>Heavy</td>
</tr>
<tr>
<td>V</td>
<td>Very Heavy</td>
</tr>
<tr>
<td>E</td>
<td>Extreme</td>
</tr>
</tbody>
</table>
Specification Differences

☐ Past Asphalt Binder Specification
  - The greater the temperature spread, the greater the modification level

☐ MSCR Asphalt Binder Specification
  - Temperature spread doesn’t change
  - Rather, the greater the traffic level “letter”, the greater the modification level
Why Change to the MSCR Specification?
G*/Sinδ - Poor Rutting Correlation

Federal Highway Accelerated Loading Facility

\[ y = -7.4519x + 10.956 \]

\[ R^2 = 0.1261 \]

Jnr - Improved Rutting Correlation

\[ y = 4.7357x - 1.1666 \]

\[ R^2 = 0.8167 \]

Development of the MSCR Test

- Still use the DSR
- Test at actual pavement temperature
- No temperature bumping
- Change the specification value rather than the test temperature
58°C (98% Confidence)
Past Temperature Grade Bumps

58°C (136°F) - PG 58-28
64°C (147°F) - PG 64-28
70°C (158°F) - PG 70-28

- Standard traffic
- Slow or heavy traffic
- Stationary or high volume traffic
MSCR Traffic Bumping

58°C

PG 58S-28
1 Bump
Standard traffic

PG 58H-28
2 Bumps
Heavy traffic

PG 58V-28
3 Bumps
Very heavy traffic

PG 58E-28
Extreme traffic
-34°C (98% Confidence)
## Combined States MSCR Specifications

<table>
<thead>
<tr>
<th>Letter</th>
<th>Traffic Level</th>
<th>Jnr Value</th>
<th>% Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>58S – 28</td>
<td>&lt; 3 M ESAL’s</td>
<td>&lt; 4.5 kPa$^{-1}$</td>
<td></td>
</tr>
<tr>
<td>58H – 28</td>
<td>&gt; 3 M ESAL’s</td>
<td>&lt; 2.0 kPa$^{-1}$</td>
<td>≥ 30%</td>
</tr>
<tr>
<td>58V – 28</td>
<td>&gt; 10 M ESAL’s</td>
<td>&lt; 1.0 kPa$^{-1}$</td>
<td>≥ 55%</td>
</tr>
<tr>
<td>58E – 28</td>
<td>&gt; 30 M ESAL’s</td>
<td>&lt; 0.5 kPa$^{-1}$</td>
<td>≥ 75%</td>
</tr>
</tbody>
</table>
Benefit of % Recovery
PMAC under Fluorescence Microscope

<table>
<thead>
<tr>
<th></th>
<th>Unreacted</th>
<th>Partially Reacted</th>
<th>Fully Reacted</th>
</tr>
</thead>
<tbody>
<tr>
<td>% R</td>
<td>21.0</td>
<td>46.4</td>
<td>58.3</td>
</tr>
<tr>
<td>Jnr</td>
<td>0.68 Pa⁻¹</td>
<td>0.39 Pa⁻¹</td>
<td>0.31 Pa⁻¹</td>
</tr>
</tbody>
</table>
## Binder Grade Comparisons

<table>
<thead>
<tr>
<th>This MSCR Grade…</th>
<th>Is close (not equal) to a…</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG 58S – 28</td>
<td>PG 58 – 28</td>
</tr>
<tr>
<td>PG 58H – 28</td>
<td>PG 64 – 28</td>
</tr>
<tr>
<td>PG 58V – 28</td>
<td>PG 64/70 – 28</td>
</tr>
<tr>
<td>PG 58E – 28</td>
<td>PG 70/76 – 28</td>
</tr>
<tr>
<td>PG 58S – 34</td>
<td>PG 58 – 34</td>
</tr>
<tr>
<td>PG 58H – 34</td>
<td>PG 58 – 34</td>
</tr>
<tr>
<td>PG 58V – 34</td>
<td>PG 58/64 – 34</td>
</tr>
<tr>
<td>PG 58E – 34</td>
<td>PG 64/70 – 34</td>
</tr>
</tbody>
</table>
Lessons learned with MSCR

- Temperature bumping + traffic bumping
  - Results in over designing an asphalt binder

PG 64V-34 → PG 70 – 34
Lesson’s learned with MSCR

- Challenges with JnrDiff
  - The JnrDiff specification was designed to limit stress sensitivity
  - Parameter has high variability (no spec tolerance)
  - AMRL does not certify labs on this parameter
  - Never properly evaluated for -34 binders
  - In fall 2016, the Binder ETG created a task group to investigate
  - Other CSBG DOT’s have waived JnrDiff
Summary

- MSCR eliminates bumping the high temperature

- New parameters relate better to pavement rutting

- Selecting the right asphalt binder is only one part of producing long lasting roads
  - Aggregate selection, mix design, hot mix production, and application technique will remain as integral parts for project success
Thank You

Questions ?
Lessons learned with MSCR

- Accounting for RAP
  - Lower the low temperature PG since that’s where the failures are on RAP mixes
  - Some States lower the high temperature too
  - Iowa is trying 52°C for RAP mixes
  - All other CSGB States are sticking with 58°C
Minimum %R specification value based on Jnr result. %R must plot above curve.
CSGB specs use a step function to replace the AASHTO continuous curve.