Multiple Stress Creep Recovery (MSCR): New Binder Grade Testing and Terminology

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Mick Syslo, P.E.
Materials & Research Engineer
Nebraska Department of Roads
Current Superpave Specification

- Grading System Based on Climate

PG 58 - 28

- Performance Grade
- Average 7-day max pavement design temp
- Minimum pavement design temperature
MSCR Superpave Specification

- Grading System Based on Climate and Traffic

PG 58H - 28

- Performance Grade
- Average 7-day max pavement design temp
- Minimum pavement design temperature

Traffic Level
## MSCR Superpave 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

- **Current Superpave Specification**
  - The greater the temperature spread, the greater the modification level

- **MSCR Superpave Specification**
  - The greater the traffic level “letter”, the greater the modification level
  - No Temperature Bumping
How will you know which spec to use?

- **AASHTO M 320** – Current PG Specification
- **AASHTO M 332** – MSCR PG Specification
  - Nebraska DOR implementation October 2016
Benefits of changing to the MSCR Specification
Dynamic Shear Rheometer (DSR)

- Measures G*/Sin(δ)
- Current Rutting Parameter
- Tested at in-service temperatures
  - 58°C, 64°C, 70°C, etc.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unaged</td>
<td>≥ 1.0 kPa</td>
</tr>
<tr>
<td>RTFO Aged</td>
<td>≥ 2.2 kPa</td>
</tr>
</tbody>
</table>
Asphalt Binder Sample

25 mm (1 inch) Diameter
Oscillation rate of 10hz ≈ 55 mph traffic speed

But what if traffic slows down or increases?
Current Superpave Specification

- Slower speeds or heavier loads require stiffer asphalt binders

- Temperature Bumping

- Example grades for PG 58 climate
  - Fast moving traffic (PG 58-28)
  - Slow or heavy traffic (PG 64-28)
  - Stationary or high volume traffic (PG 70-28)
Response to Temperature Bumping

- Suppliers began utilizing a variety of modification technologies to meet the specification including:
  - Styrene-butadiene-styrene (SBS)
  - Ethyl vinyl acetate (EVA)
  - Polyphosphoric Acid
  - Ground Tire Rubber
  - Oxidation
  - Plastomers

- \( G^*/\sin \delta \) was found to be inadequate for characterizing different types of modifications
Response to Temperature Bumping

- Agencies adopted various PG+ test methods
  - e.g., Elastic Recovery, Ductility

- PG+ test methods do not relate well to performance
Response to PG+ Specifications

- Development of the MSCR Test
  - Uses the DSR for faster results
  - For both unmodified and modified binders
  - Identifies the presence of an elastomeric modifier
  - Excellent correlation with rutting
  - High stress level engages polymer network
New Parameters from MSCR Test

- **Rutting parameter**
  - \( J_{nr, 3.2kPa} = \) compliance value

- **Stress sensitivity**
  - \( J_{nr, \text{differential}} \)
    - (% difference between low and high stress levels)

- **Elastic recovery replacement**
  - % Recovery
## MSCR Grading System

<table>
<thead>
<tr>
<th>Letter</th>
<th>Traffic Level</th>
<th>Jnr Value</th>
<th>% Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard “S”</td>
<td>&lt; 3 million ESAL’s</td>
<td>&lt; 4.5 kPa$^{-1}$</td>
<td></td>
</tr>
<tr>
<td>Heavy “H”</td>
<td>&gt; 3 million ESAL’s</td>
<td>&lt; 2.0 kPa$^{-1}$</td>
<td>≥ 30%</td>
</tr>
<tr>
<td>Very Heavy “V”</td>
<td>&lt; 10 million ESAL’s</td>
<td>&lt; 1.0 kPa$^{-1}$</td>
<td>≥ 55%</td>
</tr>
<tr>
<td>Extreme “E”</td>
<td>&gt; 10 million ESAL’s</td>
<td>&lt; 0.5 kPa$^{-1}$</td>
<td>≥ 75%</td>
</tr>
</tbody>
</table>
Are H, V, E Grades Modified?

- Yes. They have an elastomeric modifier to meet the minimum % recovery.

- Example
  - PG 58V – 34
Can “S” Grade Binders be Modified?

- Yes. Rule of 90 still applies.

- PG 58S – 34  ⇒  58 - - 34 = 92 > 90
  - Probably modified

- PG 58S – 28  ⇒  58 - - 28 = 86 < 90
  - Doesn’t require a modifier
### Binder Grade Comparisons

<table>
<thead>
<tr>
<th>This MSCR Grade… (AASHTO M 332)</th>
<th>Is close to a… (AASHTO M 320)</th>
</tr>
</thead>
<tbody>
<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 – 34 / 64 – 34</td>
</tr>
<tr>
<td>PG 58E – 34</td>
<td>PG 64 – 34 / 70 – 34</td>
</tr>
<tr>
<td>PG 64S – 34</td>
<td>PG 58 – 34</td>
</tr>
<tr>
<td>PG 64H – 34</td>
<td>PG 64 – 34</td>
</tr>
<tr>
<td>PG 64V – 34</td>
<td>PG 64 – 34 / 70 – 34</td>
</tr>
<tr>
<td>PG 64E – 34</td>
<td>PG 70 – 34</td>
</tr>
</tbody>
</table>
Summary

- MSCR eliminates temperature bumping and PG+ tests
- New parameters relate better to pavement rutting
- Better Uniformity across states
- 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 ?