Implementation of AASHTO T 350 & M 332 by WSDOT
• **Background**

  ➢ *How we got to where we are*

  • SHRP efforts - 1995
  • PG Binders - 1999
  • Superpave Volumetric Mix Design - 2004
  • PG Plus AASHTO T 301 - 2012
  • Hamburg & IDT - 2014
  • MSCR - 2018
• **Background**

➢ What have we learned?

• Asphalt and Anti-Strip Compatibility

• Asphalt Modification – Products and Processes

• Benefits of Polymer Modification

  • Note: Dual testing AASHTO T 315 & T 350 since 2008
Shown with optional Crane Lift
• Hamburg Testing
• Hamburg Testing
• Hamburg Testing
• Hamburg Testing

➤ Asphalt & Anti-Strip Compatibility

Hamburg Mix Design Verification Test Data

Hamburg Samples with PG64-28 “Original Formulation”
• Hamburg Testing
  - Asphalt & Anti-Strip Compatibility
    • Asphalt Binder – PG64-28
      - AASHTO M 320 – binder met specification
    • Mixture – HMA Class ½"
      - Lottman – improved TSR with anti-strip
      - Hamburg – significant rutting with anti-strip
• Hamburg Testing

➤ Asphalt & Anti-Strip Compatibility

Hamburg Samples with PG64-28 “Polymer Modified”
• Asphalt Binder Testing

  ➢ Data Analysis

**Original Formulation**

• Met Conventional PG Specs (AASHTO - M 320)

• Met MSCR Specs *(Excluding Appendix X1)* (AASHTO - M 332)

• Elastic Recovery = 25% *(Excluding Appendix X1)* (AASHTO - T 301)

**Polymer Modified**

• Met Conventional PG Specs (AASHTO - M 320)

• Met MSCR Specs **(Including Appendix X1)** (AASHTO - M 332)

• Elastic Recovery = 74% **(Including Appendix X1)** (AASHTO - T 301)
Passing % Recovery

PG64-28 Polymer Modified
Jnr 1.0, % Rec 33.4

Failing % Recovery

PG64-28 Original Formulation
Jnr 2.3, % Rec 4.6
• Asphalt Binder Testing

  ➢ Data Analysis

• Typical Modified PG Binders

  • Met all requirements (AASHTO - M 320)

  • Passed MSCR (AASHTO - M 332) *

  *Excluding Appendix X1 (% recovery)

  • Tested elastic recovery (AASHTO - T 301)
• Asphalt Binder Grades - WA

  • Western WA
    – PG58-22
    – PG64-22
    – PG70-22

  • Eastern WA
    – PG64-28
    – PG70-28
    – PG76-28
• Resulting Changes

  ➢ Implementation

  • Elastic Recovery Specification - 2012
## Elastic Recovery Specification

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Additional Requirements by Performance Grade (PG) Asphalt Binders</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PG 58-22</td>
</tr>
<tr>
<td>RTFO Residue:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elastic Recovery¹</td>
<td>AASHTO T 301²</td>
<td>--</td>
</tr>
</tbody>
</table>

**Notes:**

1. Elastic Recovery @ 25°C ± 0.5°C
2. Specimen conditioned in accordance with AASHTO T 240 – RTFO
• Resulting Changes

➢ Implementation

- Elastic Recovery Specification - 2012
- Hamburg and IDT Specification - 2014
<table>
<thead>
<tr>
<th>Mix Criteria</th>
<th>⅜ inch</th>
<th>½ inch</th>
<th>¾ inch</th>
<th>1 inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rut Depth (mm) @ 15,000 Passes</td>
<td></td>
<td>10</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Hamburg Wheel-Track Testing, WSDOT FOP for AASHTO T 324</td>
<td>15,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Number of Passes With no Stripping Inflection Point</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indirect Tensile (IDT) Strength (psi) of Bituminous Materials</td>
<td>Min.</td>
<td>Max.</td>
<td>Min.</td>
<td>Max.</td>
</tr>
<tr>
<td>WSDOT FOP for ASTM D 6931</td>
<td>175</td>
<td></td>
<td>175</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>175</td>
</tr>
</tbody>
</table>
Hamburg Mix Design Test Data

No Inflection Point Allowed Prior to 15,000 Passes

Minimum Number of Passes 15,000

Maximum Rut Depth 10mm

0.50% Anti-strip

0.00% Anti-strip

Number of Wheel Passes

Rut Depth in Millimeters
• **Multiple Stress Creep Recovery**

  ➢ Where are we now?

  • Multiple Stress Creep Recovery - 2018
    * Worked with PCCAS, Regional Task Group & WAPA
  • Included percent recovery - M 332
  • ER (T 301) as referee - 1 year
9-02.1(4) Performance Graded (PG) Asphalt Binder

PG asphalt binder meeting the requirements of AASHTO M 332 Table 1 of the grades specified in the Contract shall be used in the production of HMA. For HMA with greater than 20 percent RAP by total weight of HMA or any amount of RAS the new asphalt binder, recycling agent and recovered asphalt (RAP and/or RAS) when blended in the proportions of the mix design shall meet the PG asphalt binder requirements of AASHTO M 332 Table 1 for the grade of asphalt binder specified by the Contract.

In addition to AASHTO M 332 Table 1 specification requirements, PG asphalt binders shall meet the following requirements:

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>PG58S-22</th>
<th>PG58H-22</th>
<th>PG58V-22</th>
<th>PG64S-28</th>
<th>PG64H-28</th>
<th>PG64V-28</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTFO Residue: Average Percent Recovery @ 3.2 kPa</td>
<td>AASHTO T 350&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td>30% Min.</td>
<td>20% Min.</td>
<td>25% Min.</td>
<td>30% Min.</td>
</tr>
</tbody>
</table>

<sup>1</sup>Specimen conditioned in accordance with AASHTO T 240 – RTFO.

The RTFO Jnrdiff and the PAV direct tension specifications of M 332 are not required.

* 2018 T 301 ER referee specification minimum of 65% if failing percent recovery.
## Asphalt Binder Grades - WA

### Previous Grading System
- PG58-22
- PG64-22
- PG70-22
- PG64-28
- PG70-28
- PG76-28

### MSCR Grading System
- PG58S-22 (Standard)
- PG58H-22 (Heavy)
- PG58V-22 (Very Heavy)
- PG64S-28
- PG64H-28
- PG64V-28
• Asphalt Binder Grading - 101

• Previous Grading System
  - PG58-22
  - PG64-22
  - PG70-22
  - PG64-28
  - PG70-28
  - PG76-28

• MSCR Grading System
  - PG58S-22 (Standard)
  - PG58H-22 (Heavy)
  - PG58V-22 (Very Heavy)
  - PG64S-28
  - PG64H-28
  - PG64V-28
PG58H-22 (PG64-22) 2016, 2017 Combined Test Data

- 6000 kPa Specification for PAV DSR
- ≤ 2.0 Jnr Specification

![Scatter plot showing PAV DSR vs. Jnr for 2016 and 2017 data.]
PG64V-28 (PG76-28) 2016, 2017 Combined Test Data

% Recovery vs. $J_{nr}$

≤ 1.0 $J_{nr}$ Specification

30% Minimum Recovery Spec.

2017 Data  2016 Data
FHWA Asphalt Binder ETG
Fall River, MA
May 10, 2018

Questions?

devolj@wsdot.wa.gov
(360)709-5421