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Performance Graded (PG) Asphalt Binder Modification - Lessons Learned With the Hamburg and MSCR

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State Materials Laboratory
Just the Facts

- Connecting Washington Transportation Package
- 16 Year, $16 Billion Package
  - $9.7 Billion, state and local road projects
  - $1.4 Billion, highway maintenance, operations, preservation
- 11.9¢ Gas Tax, phased in over next two years
Washington State Department of Transportation

- Just the Facts
  - WSDOT manages 18,500 lane miles
  - Smooth, safe and economical pavements
  - 2016 forecast
    - 1,043,000 tons HMA
    - 586,555 tons HMA - modified asphalt
• Background

➤ How we got to where we are

• SHRP efforts - 1995
• Implemented PG Binders - 2000
• Superpave Volumetric Mix Design - 2004
Hamburg & MSCR

What have we learned?

- Asphalt and Anti-Strip Compatibility
- Asphalt Modification – Products and Processes
- Benefits of Polymer Modification
  - Note: Dual testing AASHTO M 320 & M 332 since 2008
Shown with optional Crane Lift
• Hamburg Testing
• Hamburg Testing
• Hamburg Testing
• Hamburg Testing

➢ Asphalt & Anti-Strip Compatibility

Hamburg Samples with PG64-28 “Original Formulation”
• Hamburg Testing

➢ Asphalt & Anti-Strip Compatibility

• Results of data analysis
  • AASHTO M 320 – binder meet specification

• Mix design
  • 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”
Hamburg Mix Design Verification Test Data

Hamburg Samples with PG64-28 “Original Formulation”

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

 ➢ Data Analysis

Original Formulation

• Met Conventional PG Specs (AASHTO - M 320)

• Met MSCR Specs * (AASHTO - M 332)

• Elastic Recovery = 25% (AASHTO - T 301)

*Excluding Appendix X1

Polymer Modified

• Met Conventional PG Specs (AASHTO - M 320)

• Met MSCR Specs ** (AASHTO - M 332)

• Elastic Recovery = 74% (AASHTO - T 301)

**Including Appendix X1
• Asphalt Binder Testing

➤ Data Analysis

• Typical Modified PG Binders
  • Met all specifications requirements (AASHTO - M 320)
  • Passed MSCR (AASHTO - M 332) *
    *Excluding Appendix X1 (% recovery)
  • Tested elastic recovery (AASHTO - T 301)
• Hamburg & MSCR

➢ Where are we today?

• Elastic Recovery Specification - 2012
• Hamburg and IDT Specification - 2014
• Multiple Stress Creep Recovery - 2018
### Elastic Recovery Specification

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Additional Requirements by Performance Grade (PG) Asphalt Binders</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>PG 58-22          PG 64-22          PG 64-28          PG 70-22          PG 70-28          PG 76-28</td>
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<tr>
<td>RTFO Residue:</td>
<td></td>
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<tr>
<td>Elastic Recovery¹</td>
<td>AASHTO T 301²</td>
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<tr>
<td>Notes:</td>
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1. Elastic Recovery @ 25°C ± 0.5°C
2. Specimen conditioned in accordance with AASHTO T 240 – RTFO
# Hamburg and IDT Specification

<table>
<thead>
<tr>
<th>Mix Criteria</th>
<th>HMA Class</th>
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<tbody>
<tr>
<td></td>
<td>⅜ inch</td>
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<tr>
<td>Hamburg Wheel-Track Testing, WSDOT FOP for AASHTO T 324</td>
<td>10</td>
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<tr>
<td>Rut Depth (mm) @ 15,000 Passes</td>
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<tr>
<td>Hamburg Wheel-Track Testing, WSDOT FOP for AASHTO T 324 Minimum Number of</td>
<td>15,000</td>
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<td>Passes With no Stripping Inflection Point</td>
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<tr>
<td>Indirect Tensile (IDT) Strength (psi) of Bituminous Materials WSDOT FOP for</td>
<td>175</td>
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<tr>
<td>ASTM D 6931</td>
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</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

Rut Depth in Millimeters

Number of Wheel Passes

-16
-14
-12
-10
-8
-6
-4
-2
0
• **Multiple Stress Creep Recovery**

  ➢ Where we’re headed next!

  • Multiple Stress Creep Recovery - 2018

    * Working with PCCAS, Regional Task Group & WAPA

  • Would Replace Elastic Recovery

  • New PG Grading Terminology
• **Asphalt Binder Grading - 101**

  • **Current Grading System**
    – Base grade (Environment)
    – Grade bump (Traffic/Load)
    – Bump = same stiffness at higher temperature
    – Allows for products & processes that may affect performance

  • **MSCR Grading System**
    – Base grade (Environment)
    – Grade bump (Traffic/Load)
    – Bump = increase stiffness at service temperature
    – Requires products & processes that ensure performance
• **Asphalt Binder Grading - 101**

- **Current 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
PG64-28 (PG64-28H) MSCR vs Jnr 2013

Passing % recovery

PG64-28H would require a Jnr of \( \leq 2.0 \) and an MSCR % recovery of \( \geq 30\% \)

Failing % recovery

% MSCR

J\(_{nr}\), kPa

Extremely heavy 0.5
Very heavy 1.0
Heavy 2.0
Standard 4.0

Jnr, Kpa
PG64-28
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Questions?

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State Construction Office - Information

http://www.wsdot.wa.gov/business/construction