An Introduction to Modified Asphalt Binders

Presented by:

3 Hour Short Course 2019
Handling Modified Binders
Contractor’s View

Presented By:
Ron Corun

Prepared for the Association of Modified Asphalt Producers Training Program
Handling Modified Asphalts
Handling Modified Asphalts

- Between 5-20% of all asphalts are currently modified
- Most modified binders are in the PG 64-28 to 76-22 range
- Be safe and follow manufacturer’s recommendations
Handling Modified Asphalts

• Mixing PMA with other asphalts can cause the asphalt to fail to meet the PG grade requirements
• Reduce contamination at the terminal
  ▪ Tanker truck empty before loading at terminal
  ▪ Load from correct loading arm at terminal
Residue as % of Load

Percentage of Total Load

Inches of Residue

<table>
<thead>
<tr>
<th>Inches of Residue</th>
<th>Percentage of Total Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00%</td>
</tr>
<tr>
<td>2</td>
<td>2.00%</td>
</tr>
<tr>
<td>3</td>
<td>4.00%</td>
</tr>
<tr>
<td>4</td>
<td>6.00%</td>
</tr>
<tr>
<td>5</td>
<td>8.00%</td>
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<tr>
<td>6</td>
<td>10.00%</td>
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</table>
Handling PMA at the Plant

• Reduce contamination at the HMA plant
  ▪ Pump into correct tank at HMA plant
  ▪ Use dedicated tanks, if possible
  ▪ If dedicated tank is not available
    • Empty tank as much as possible if previous material was different
    • Add 2 or 3 full loads of PMA before testing and/or using the material in the tank

• Diluted PMA may fail PG grade!!!
Handling PMA at the Plant

- Vertical tanks
  - Vertical tanks provide more efficient agitation
  - Very few PMAs require agitation to prevent separation
  - Agitation is recommended for GTR modified asphalt
  - Check with supplier
- Check and maintain proper temperatures
Handling PMA at the Plant

• Horizontal Tanks
  ▪ Horizontal tanks work fine for most PMAs
  ▪ Circulate to achieve uniform temperatures above and below heating coils
Proper Circulation in Horizontal Tanks

- Suction and return lines at opposite ends of tank to completely circulate material
- Return line near bottom of tank to prevent oxidation
Handling PMA at the Plant

- BEWARE OF MIXING MODIFIED ASPHALTS FROM DIFFERENT SUPPLIERS!!
  - Different suppliers may use different polymer technologies
  - Differing technologies may not be compatible
  - Polymer separation may occur
Handling PMA at the Plant

- BEWARE OF USING DIRECT-FIRE HEATERS WITH MODIFIED ASPHALTS!!!
  - Direct-fire heat tubes may develop hot spots
  - Hot spots will immediately destroy the polymer network in the asphalt
Effect of Mixing Time and Temperature

Fluorescence micrographs showing the effect of time and temperature on the compatibility of a 10% SBS/10% Aromatic Oil/80% asphalt binder:
(D) 430 °F 1 hour
(E) 430 °F 4 hours
(F) 430 °F 7 hours

Ref: B Brule, Y Brion and A. Tanguy, Asphalt Paving Technology 60, 43 (1991)
EC-101 Recommendations

<table>
<thead>
<tr>
<th>Grade</th>
<th>Min EC101</th>
<th>Max EC101</th>
<th>Midpoint EC101</th>
<th>Pol. (Midpoint EC101)</th>
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</thead>
<tbody>
<tr>
<td>46</td>
<td>200</td>
<td>220</td>
<td>210</td>
<td>210</td>
</tr>
<tr>
<td>52</td>
<td>260</td>
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<td>64</td>
<td>380</td>
<td>400</td>
<td>390</td>
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<td>70</td>
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<td>460</td>
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<td>76</td>
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<td>520</td>
<td>510</td>
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<td>82</td>
<td>560</td>
<td>580</td>
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</table>
# General Guidelines for Storage and Mixing Temperatures

<table>
<thead>
<tr>
<th>PG Binder</th>
<th>Storage Temperature (°F)</th>
<th>Mixing Temperature (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>64-22</td>
<td>285-315</td>
<td>265-320</td>
</tr>
<tr>
<td>70-22</td>
<td>300-325</td>
<td>280-330</td>
</tr>
<tr>
<td>76-22</td>
<td>315-340</td>
<td>285-335</td>
</tr>
<tr>
<td>Extended Storage</td>
<td>&lt;275 °F</td>
<td></td>
</tr>
</tbody>
</table>

Source: EC-101
Effect of Time and Temperature on Asphalt Properties


Stored at 250°F
Stored at 355°F
Long Term Storage of Modified Binders

- If storing PMA for longer than 60 days, turn heat down or off
- Lower temperatures minimize danger of damaging the PMA
Long Term Storage of Modified Binders

• Re-heating PMA binders
  ▪ Bring temperature up slowly
  ▪ If material has been held over the winter, heat incrementally 20 degrees increase at a time
  ▪ Allow 3 or 4 days to get material up to circulation temperature

• As a precaution, you may want to test before using after winter shutdown
Mixing and Compaction Temperature Guidance

- Asphalt Institute developed procedure in 1970’s for determining laboratory mixing and compaction temperatures (MS-2)
- Equiviscous laboratory mixing and compaction temperatures
  - Viscosity at 135°C and 165°C
  - Lab mixing range of 150-190 centistokes
  - Lab compaction range of 250-310 centistokes

- **NOT FOR FIELD TEMPERATURES!!!**
Laboratory Mixing and Compaction Temperatures

- **Viscosity, Pa**
  - 0.1
  - 0.2
  - 0.3
  - 0.5
  - 1.0
  - 5.0
  - 10.0

- **Temperature, C**
  - 100
  - 110
  - 120
  - 130
  - 140
  - 150
  - 160
  - 170
  - 180
  - 190
  - 200

**Compaction Range**

**Mixing Range**
Mixing and Compaction Temperature Guidance

- Superpave adopted AI procedure using rotational viscometer
- Equiviscous laboratory mixing and compaction temperatures
- Does not work for PMA
  - Yields extremely high temperatures
  - Use suppliers’ recommendations

- **Not For Field Temperatures for Unmodified or Modified Asphalts!!!**
### Field Mixing and Compaction Temperature Guidance

#### Typical Asphalt Binder Temperatures

<table>
<thead>
<tr>
<th>Binder Grade</th>
<th>HMA Plant Asphalt Tank</th>
<th>HMA Plant Mixing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Storage Temperature (°F)</td>
<td>Temperature (°F)</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>Midpoint</td>
</tr>
<tr>
<td>PG 46-28</td>
<td>260 – 290</td>
<td>275</td>
</tr>
<tr>
<td>PG 46-34</td>
<td>260 – 290</td>
<td>275</td>
</tr>
<tr>
<td>PG 46-40</td>
<td>260 – 290</td>
<td>275</td>
</tr>
<tr>
<td>PG 52-28</td>
<td>260 – 295</td>
<td>278</td>
</tr>
<tr>
<td>PG 52-34</td>
<td>260 – 295</td>
<td>278</td>
</tr>
<tr>
<td>PG 52-40</td>
<td>260 – 295</td>
<td>278</td>
</tr>
<tr>
<td>PG 52-46</td>
<td>260 – 295</td>
<td>278</td>
</tr>
<tr>
<td>PG 58-34</td>
<td>280 – 305</td>
<td>292</td>
</tr>
<tr>
<td>PG 64-22</td>
<td>285 – 315</td>
<td>300</td>
</tr>
<tr>
<td>PG 64-28</td>
<td>285 – 315</td>
<td>300</td>
</tr>
<tr>
<td>PG 64-34</td>
<td>285 – 315</td>
<td>300</td>
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<tr>
<td>PG 67-22</td>
<td>295 – 320</td>
<td>308</td>
</tr>
<tr>
<td>PG 70-22</td>
<td>300 – 325</td>
<td>312</td>
</tr>
<tr>
<td>PG 70-28</td>
<td>295 – 320</td>
<td>308</td>
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<tr>
<td>PG 76-22</td>
<td>315 – 330</td>
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<tr>
<td>PG 76-28</td>
<td>310 – 325</td>
<td>318</td>
</tr>
<tr>
<td>PG 82-22</td>
<td>315 – 335</td>
<td>325</td>
</tr>
</tbody>
</table>

Use mid-point temperature for test strip construction.
HMA Plant Asphalt Pump

- Adequately sized AC pump
  - PMA will cause higher amperage draw
- AC pump in good condition
- Calibrated
- Strainer
  - Larger than standard holes – \( \frac{1}{4} \)”
  - Clean
HMA Plant Asphalt Pump Operation

- Circulate unmodified asphalt first before start-up
- Switch to PMA and circulate before start-up
- Switch to unmodified asphalt and circulate through pump after shutdown at end of shift
- Unmodified asphalt in AC pump, meter and strainer until next shift
HMA Plant Slat Conveyor

- Properly sized
- Good condition
- PMA will increase amperage draw on conveyor
  - Start at reduced tonnage rate
  - Start on unmodified mix to heat conveyor
Modified HMA Storage

- **DO NOT STORE OVERNIGHT!!!**
Transporting Modified HMA to Paver

• Clean, smooth truck beds
• Release agent
  ▪ Type
  ▪ Amount
  ▪ Powdered Tide detergent
• Tarps
Placing Modified HMA

- No modifications to equipment
- Handwork is more difficult
- Attention to detail
- Weather Conditions – 50 °F minimum
Compacting Modified HMA

- Compaction Equipment
  - Number - 3 or 4
  - Type – high frequency
  - Size

- Mix temperature
  - Only high enough to allow proper compaction
  - Extra 10 °F doubles fumes
  - High temperatures can damage PMA

- Roller pattern
  - Front roller close to paver

- Field monitoring
  - Temp
  - Density
Compacting Modified HMA

- Compacting mixes with PMA may actually be easier than un-modified asphalt mixes
  - Compaction requires confinement
  - PMA may eliminate tender zone
Contractor QC Plan

• Contractors need to establish QC plan to prevent PG asphalt contamination and failing test results
  ▪ Identify all hardware – label or number
    • Tanks
    • Pumps
    • Piping
    • Valves
    • Sample points
    • Heat system
  ▪ Establish standard procedures and hardware settings for asphalt flow into storage and into HMA plant
Summary

- PMA improves the performance of HMA pavements
- Understand the product you are using and treat it with respect
  - Follow suppliers recommendations
  - Best Practices