FLEXIBLE PAVEMENT COMMITTEE MEETING
APRIL 17, 2019
GAINESVILLE, FLORIDA
Overview

PG Binder Specification
Certificate of Analysis
FDOT Specification
Binder Tests
  ◦ What are they
  ◦ What does they mean
  ◦ What do I need to know
Superpave Performance Grades

Grading System Based on Climate

PG 64-22

Performance Grade
Average 7-day max pavement design temp
Min pavement design temp
### SUPERPAVE™ Performance Graded Binders

Measure of the rheological properties of the binders over a wide range of temperatures, loading, and aging conditions.

#### Performance Grades

<table>
<thead>
<tr>
<th>Max. Design Temp.</th>
<th>PG 46</th>
<th>PG 52</th>
<th>PG 58</th>
<th>PG 64</th>
<th>PG 70</th>
<th>PG 76</th>
<th>PG 82</th>
</tr>
</thead>
</table>

### Original

- **Flash Point**
- **Rotational Viscosity**

#### (Rolling Thin Film Oven) RTFO, Mass Change ≤ 1.00%

- **DSR G*/sin δ (Dynamic Shear Rheometer)**

#### (Pressure Aging Vessel) PAV

- **DSR G*sin δ (Dynamic Shear Rheometer)**

#### BBR S (creep stiffness) & m-value (Bending Beam Rheometer)

- If BBR m-value ≥ 0.300 and creep stiffness is between 300 and 600, the Direct Tension failure strain requirement can be used in lieu of the creep stiffness requirement.

<table>
<thead>
<tr>
<th>S ≤ 300 MPa</th>
<th>m ≥ 0.300</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBR S</td>
<td>m-value</td>
</tr>
</tbody>
</table>

#### DTT (Direct Tension Tester)

- **εf ≥ 1.00%**
SUPERPAVE™ Binder Equipment

Construction  Rutting  Fatigue Cracking  Low Temp Cracking

Pavement Age

No aging (Original)  PAV - aging  RTFO (Short-Term)
Certificate of Analysis

Definition:
Document issued by QA that confirms that a regulated product meets its product specification.

- Asphalt Binder Grade
- APL Number
- Batch / Lot Number
- Date Sampled & Tested
- Test Results

<table>
<thead>
<tr>
<th>Test</th>
<th>Test Method</th>
<th>Specification</th>
<th>Original Binder</th>
<th>Test Results</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic Shear, kPa</td>
<td>T315</td>
<td>1.0 Min @ 76C</td>
<td></td>
<td>1.20</td>
<td>kPa</td>
</tr>
<tr>
<td>Density @ 15.6 C</td>
<td>T228</td>
<td>Report</td>
<td></td>
<td>1.0361</td>
<td>kg/l</td>
</tr>
<tr>
<td>Specific Gravity @ 15.6 C</td>
<td>T228</td>
<td>Report</td>
<td></td>
<td>1.0370</td>
<td>------</td>
</tr>
<tr>
<td>Density, lbs/gal</td>
<td>T228</td>
<td>Report</td>
<td></td>
<td>8.646</td>
<td>lbs/gal</td>
</tr>
<tr>
<td>API</td>
<td>T228</td>
<td>Report</td>
<td></td>
<td>4.950</td>
<td>API</td>
</tr>
<tr>
<td>Rotational Viscosity, Pa.s.</td>
<td>T316</td>
<td>3.0 Max</td>
<td></td>
<td>1.438</td>
<td>Pa.s.</td>
</tr>
<tr>
<td>@ 135°C, 20rpm spindle</td>
<td>T316</td>
<td>3.0 Max</td>
<td></td>
<td>0.400</td>
<td>Pa.s.</td>
</tr>
<tr>
<td>@ 165°C, 20rpm spindle</td>
<td>T316</td>
<td>3.0 Max</td>
<td></td>
<td>363</td>
<td>C</td>
</tr>
<tr>
<td>Flash Point CDC, C</td>
<td>T48</td>
<td>230°C Minimum</td>
<td></td>
<td>99.94</td>
<td>%</td>
</tr>
<tr>
<td>Solubility, % Soluble</td>
<td>T44</td>
<td>99.0% Minimum</td>
<td></td>
<td>56</td>
<td>dmm</td>
</tr>
<tr>
<td>Penetration @ 77°F, dmm</td>
<td>T49</td>
<td>Report</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sample Meets current FDOT requirements for PG 76-22 (PMA)
# FDOT Original Binder Testing

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Original Binder</th>
<th>Minimum Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solubility, AASHTO T44-14</td>
<td>in Trichloroethylene</td>
<td>Minimum 99.0% (Not applicable for PG 76-22 (ARB))</td>
</tr>
<tr>
<td>Flash Point, AASHTO T48-17</td>
<td>Cleveland Open Cup</td>
<td>Minimum 450°F</td>
</tr>
<tr>
<td>Rotational Viscosity, AASHTO T316-13 (2017)</td>
<td>275°F</td>
<td>Maximum 3 Pa·s&lt;sup&gt;(a)&lt;/sup&gt;</td>
</tr>
<tr>
<td>Dynamic Shear Rheometer&lt;sup&gt;(b)&lt;/sup&gt;</td>
<td>G&lt;sup&gt;*&lt;/sup&gt;/sin δ</td>
<td>Minimum 1.00 kPa</td>
</tr>
<tr>
<td>AASHTO T315-12 (2016)</td>
<td>Phase Angle, δ&lt;sup&gt;(c)&lt;/sup&gt; for PG 76-22 (PMA) and PG 76-22 (ARB)&lt;sup&gt;(d)&lt;/sup&gt;</td>
<td>Maximum 75 degrees</td>
</tr>
<tr>
<td>Separation Test, ASTM D7173-14 and Softening Point, AASHTO T53-09 (2013)</td>
<td>163±5°C, 48 hours</td>
<td>Maximum 15°F (PG 76-22 (ARB) only)</td>
</tr>
</tbody>
</table>

---

January 2019 FDOT Section 916-2.3 (AASHTO M 320 & M 332)
Solubility
(AASHTO T 44)

FDOT Specification:
Min. 99.0% in Trichloroethylene

Purpose:
Detect contamination of asphalt; ensuring that binder is substantially free of mineral matter

Effect of Filler Content to the Contractor:
- Accurate estimate of dust/asphalt ratio when the mix design is complete
- Impact on performance, particularly with respect to moisture damage
- Fillers are a cheap extender to increase PG grades
Flash Point (AASHTO T 48)

FDOT Specification:
Min. 450°F

Purpose:
Measure tendency of asphalt to produce flammable mixture when heated under controlled lab conditions

Contractor: SAFETY
Rotational Viscosity (AASHTO T 316)

**FDOT Specification:**
Max. 3 Pa·s @ 275°F

**Purpose:**
Measures the viscosity of an asphalt at a designated temperature

**Contractor:**
- Viscosity at pumping and handling temperatures
- Mixing and compaction temperatures
- Not designed for modified asphalts – consult your supplier
Dynamic Shear Rheometer (AAHTO T 315)

**FDOT Specification:**
G* / sin \(\delta\) = Min. 1.00 kPa at PG HT
Phase Angle (\(\delta\)) = Max. 75° at 76°C

**Purpose:**
Characterizing the viscous (G*) and elastic (\(\delta\)) behavior of binders at medium to high temperatures

**Contractor:**
- Predictors of rutting and fatigue cracking susceptibility
- G* should decrease with temperature
- Phase angle should increase with increase in temp.
- To stay in grade – 2.00 kPa
Separation Test (ASTM D7173)

**FDOT Specification:**
Max. 15°F

**Purpose:**
Measure the tendency of the CRM to separate from binder

**Contractor:**
- Handling and Settlement Issue

Softening Point (AASHTO T 53)
## FDOT RTFO Binder Testing

<table>
<thead>
<tr>
<th>Rolling Thin Film Oven Test Residue (AASHTO T240-13 (2017))</th>
<th>Mass Change %</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Stress Creep Recovery, J\text{nr, 3.2} \text{ (d, e, f)} AASHTO T350-14</td>
<td>Grade Temperature (Unmodified binders only)</td>
<td>“S” = 4.50 kPa\textsuperscript{-1} max</td>
</tr>
<tr>
<td>Multiple Stress Creep Recovery, J\text{nr, 3.2} \text{ (d, e, f)} AASHTO T350-14</td>
<td>67°C (Modified binders only)</td>
<td>“V” = 1.00 kPa\textsuperscript{-1} max Maximum J\text{nr, diff} = 75%</td>
</tr>
<tr>
<td>Multiple Stress Creep Recovery, %Recovery \text{ (d, e)} AASHTO T350-14</td>
<td>76°C (High Polymer binder only)</td>
<td>0.10 kPa\textsuperscript{-1} max</td>
</tr>
<tr>
<td>Multiple Stress Creep Recovery, %Recovery \text{ (d, e)} AASHTO T350-14</td>
<td>67°C (Modified binders only)</td>
<td>%R\textsuperscript{3.2} \geq 29.37 (J\text{nr, 3.2})\textsuperscript{0.2633}</td>
</tr>
<tr>
<td>Multiple Stress Creep Recovery, %Recovery \text{ (d, e)} AASHTO T350-14</td>
<td>76°C (High Polymer binder only)</td>
<td>%R\textsuperscript{3.2} \geq 90.0</td>
</tr>
</tbody>
</table>
Rolling Thin Film Oven (AASHTO T 240)

**FDOT Specification:**
Mass Change = Max. 1.00%

**Purpose:**
Measures the changes in PG properties that occur in a batch plant operating at approx. 150°C

**Contractor:**
- Simulated STOA
- Should be under 1.00%
- Monitors the excessive aging through the plant and the presence of possible light ends
  - If does not show up in flash – typically a refinery
  - Fuming in plant
Multiple Stress Creep Recovery (MSCR) (AASHTO T 350)

**Purpose:**
Characterizes neat & polymer modified binders at their temperatures in which they are used

A measure of modification performance within the binder (% Recovery)

**Contractor:**
- Stiffness (Jnr) & Elasticity (%R)
- Neat Binders Jnr= 2.00 – 4.50 kPa\(^{-1}\)
- %Recovery no mix related
- Modified Binders typically around 0.50 and below
## FDOT PAV Binder Testing

### Pressure Aging Vessel Residue (AASHTO R28-12)

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Description</th>
<th>Limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic Shear Rheometer, AASHTO T315-12 (2016)</td>
<td>$G^* \sin \delta$, 10 rad/sec.</td>
<td>Maximum 5000 kPa ($\varepsilon-g$)</td>
</tr>
<tr>
<td>Creep Stiffness, AASHTO T313-12 (2016)</td>
<td>$S$ (Stiffness), @ 60 sec.</td>
<td>Maximum 300 MPa Minimum 0.300</td>
</tr>
<tr>
<td>$\Delta T_c$, ASTM D7643-16</td>
<td>20 hours PAV aging</td>
<td>$\Delta T_c \geq -5.0^\circ C$</td>
</tr>
<tr>
<td></td>
<td>$S$ (Stiffness), @ 60 sec.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$m$-value, @ 60 sec.</td>
<td></td>
</tr>
</tbody>
</table>

Long Term Aging = 5-7 years

January 2019 FDOT Section 916-2.3 (AASHTO M 320)
Intermediate Temperature (Fatigue / Durability)

**FDOT Specification:**
\[ G^* \sin \delta = \text{Max. 5,000 kPa} \]

**Purpose:**
Complex Shear Modulus should be at a minimum to resist fatigue cracking

**Contractor:**
- There is arguments of this property’s value

Intermediate Temperature = \(((\text{PG HT} + \text{PG LT}) / 2) + 4\)
Bending Beam Rheometer (AASHTO T 313)

FDOT Specification:
Stiffness = Max. 300 MPa / m-value = Min. 0.300
- Tested at PG LT +10°C
- $\Delta T_c = \text{Min. } -5.0°C$ (ASTM D7643)

Purpose:
Determine the binder’s stiffness and ability to relax at low temperatures.
Measure of ductility loss of an aged binder.

Contractor:
- Thermal Events – large temperature changes, quickly
- Looking for speed of recovery – Florida gets thermal shock with hot temp. and rain quenching.
- The more negative the Delta Tc the less relaxation capability the binder has as it ages.
QUESTIONS?