SUPERPAVE TRAINING

SUPERPAVE

- SUPERPAVE the Industry standard
  - Initial Projects were let statewide in 1996
  - 100% SUPERPAVE Implementation on projects let in 1999
SUPERPAVE Issues

- Specification encourages coarse mixes with low asphalt contents
  - Difficulty w/Compaction
  - Prone to Segregation

Superpave FAA

- P401- Marshall Specification
  - Served the FAA well
  - EB 59
  - Struggled with Nequivalent
SUPERPAVE

- “SYSTEM”
  - Mix Design
    - Aggregate Specs
    - PGB Binder Criteria
    - ESAL’s
      - Gyratory Compactor
    - Volumetric Analysis
  - Compaction Requirements

Features of P401 Superpave

- Superpave
Gyrations are a function of Mix ESAL's
- MORE ESAL's - More gyrations
  - LESS ASPHALT (Rutting)
- Simulate the effect of traffic after over the “life cycle”
**Gyratory Compactor**

- Sample size
  - 115 mm +/- 5 mm
  - Typically 4600 grams
- Number of Specimens
  - 3-5 Specimens
- Ndesign
  - 75 > 60,000 lbs
  - 50 < 60,000 lbs

**Stability and Flow**

- Requirements are removed for Superpave option
Refining Process

Intermediate Products

Further Processing

Final Products

- Propane, Butane and Lighter

- Light Straight Run Gasoline

- Naphtha

- Kerosene

- Atmospheric Gas Oil

- Vacuum Gas Oil

- Residual

- Refinery Fuel Gas

- Propane

- NGLs

- Gasoline

- Jet Fuel

- Kerosene

- Jet Fuel

- Diesel

- Fuel Oil

- Gasoline

- Diesel

- Fuel Oil

- Gasoline

- Diesel

- Heavy Fuel Oil

- Asphalt

Binder

100 g

Penetration in 0.1 mm

Initial

After 5 seconds
Specifications evolved to characterize asphalt binder’s viscosity in the 1960’s.

Viscosity is defined as resistance to flow
- Asphalt is “temperature viscous”
  - Temperature of the material affects its stiffness (or resistance to flow)

Need to further characterize asphalt binder due to widespread pavement failures (permanent deformation)
- Radial tires
- Increased truck traffic
  - Higher tire pressures
- Changes in refining process
Superpave Binder

- Rolling Thin Film Oven Test
- Pressure Aging Vessel
- Direct Tension Tester
- Dynamic Shear Rheometer
- Bending Beam Rheometer

Binder

Superpave Binder specification grading based on pavement climatic conditions from LTPP bind

PG 64-22

Performance Grade

Average max pavement design temp

Min pavement design temp
Binder

- PG System
- Grade bumping
  - < 12,500 Standard
  - <100,000 – 1 grade
  - > 100,000- 2 grade
- “Plus” specifications
  - Elastic recovery to ensure that material polymer modified (70%)
- Highly polymerized materials that are difficult to use at reasonable temperatures

MSCR Binder

- MSCR
  - Multiple Stress Creep Recovery
  - AASHTO TP 70
- DSR
  - High and intermediate temperature grading
- NEW Grading for asphalt
- PG Grading appropriate for grading, followed by “letter” designation
- Changes to AASHTO M320, Table 1
  - PG 64-22S
    - Standard traffic loading
  - PG 64-22H
    - Heavy traffic loading
  - PG 64-22V
    - Very heavy traffic loading
  - PG 64-22E
    - Extremely heavy traffic loading
**Binder**

- MSCR Implementation
  - Transition from AASHTO M 320 to AASHTO MP 19
- Regional User-Producer groups and agencies
- Expect some changes in binder

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**Voids in Mineral Aggregate (VMA)**

\[
V_{\text{Total}} = V_{a} + V_{be} + V_{sb}
\]

- \( V_{a} \): Air
- \( V_{be} \): Binder
- \( V_{sb} \): Aggregate (stone)
VMA Historical perspective

- 1901- Referenced in FJ Warren patent application
- Early Marshall looked at VFA only (65-85%)
- 1956- McLeod proposes minimum VMA of 15% (based on 5% air voids and also revised in 1959 to differentiate NMAS)
- 1962- Asphalt Institute proposes McLeod recommendations and also drops VFA in MS-2 (AI reinstates VFA in 1992)
- Post 1962- Line in the sand...
- VMA vs. Film Thickness

VMA

\[ VMA = 100 - \frac{G_{mb} P_s}{G_{sb}} \]

VMA is the volume of air voids and effective binder (binder not absorbed into the aggregate), and in design is a powerful parameter to indicate that sufficient volume of binder is in the mixture
VMA
- Excludes the portion of binder absorbed into the aggregate
- As nominal maximum size decreases VMA increases (more volume of binder required to coat higher amount of surface area in finer mixtures)

Voids Filled with Asphalt

\[ VFA = 100 \times \frac{VMA - V_a}{VMA} \]

VFA is the percent of VMA that is filled with asphalt cement (related to “saturation” from soil mechanics)
M 323 Requirements for VMA

Table 6—Superpave HMA Design Requirements

<table>
<thead>
<tr>
<th>Design EAALs</th>
<th>Nominal Maximum Aggregate Size, mm</th>
<th>Voids in the Mineral Aggregate (VMA), Percent Minimum</th>
<th>Voids Filled with Asphalt (VFA), Range</th>
<th>Dust-to-Binder Ratio, Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>37.5</td>
<td>11.0</td>
<td>11.0</td>
<td>0.6–1.2</td>
</tr>
<tr>
<td>0.3 to &lt;0.5</td>
<td>25.5</td>
<td>11.0</td>
<td>11.0</td>
<td>0.6–1.2</td>
</tr>
<tr>
<td>0.3 to &lt;0.5</td>
<td>19.0</td>
<td>11.0</td>
<td>11.0</td>
<td>0.6–1.2</td>
</tr>
<tr>
<td>0.3 to &lt;0.5</td>
<td>12.5</td>
<td>11.0</td>
<td>11.0</td>
<td>0.6–1.2</td>
</tr>
<tr>
<td>0.3 to &lt;0.5</td>
<td>9.5</td>
<td>11.0</td>
<td>11.0</td>
<td>0.6–1.2</td>
</tr>
<tr>
<td>0.3 to &lt;0.5</td>
<td>4.75</td>
<td>11.0</td>
<td>11.0</td>
<td>0.6–1.2</td>
</tr>
</tbody>
</table>

- For 0.0 minimum maximum size of 50% of the VFA range, the specified VFA range shall be 4% for all design traffic levels.
- For 0.0 minimum maximum size in the range, 4% for the specified VFA range shall be 4% for design traffic levels ≥ 0.3 million EAALs.
- For design traffic levels ≥ 0.3 million EAALs, the specified VFA range shall be 0.5% for design traffic levels ≥ 0.3 million EAALs.
- The specified VFA range shall be 0% to 0.2% for design traffic levels ≥ 0.3 million EAALs.

Recommend that design VMA +0.5% desired production VMA
Each 1% VMA = 0.4 liquid
Aggregate characteristics including gradation, surface, texture and shape impact VMA
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Thanks!!