FHWA Research and Equipment Update
### ALF Test Site
#### Final Test Matrix

<table>
<thead>
<tr>
<th>AZ</th>
<th>CRM</th>
<th>PG 70-22</th>
<th>Air Blown</th>
<th>SBS</th>
<th>TX TBCR</th>
<th>T-P</th>
<th>PG 70-22</th>
<th>Air Blown</th>
<th>SBS</th>
<th>Air Blown</th>
<th>SBS</th>
<th>T-P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>
*Initial Strain Measurements: 100% Complete
*Rutting Tests: Shakedown Tests Complete (5, 9)
*Rutting Tests: 5 of 12 Lanes Complete
*Fatigue Tests: Shakedown Test Complete (1)
Superpave Gyratory Compactor Calibration

The Angle Evolution
Standard Method of Test for

Preparing and Determining the Density of Hot-Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

AASHTO Designation: T 312-03
REFERENCED DOCUMENTS

• TP, Evaluation of the Superpave Gyratory Compactor (SCG) Internal Angle of Gyration

Separate standard for DAV operations
Average Dynamic Internal Angle (DIA)

DAV on Top to measure $\alpha_T$

DAV on Bottom to measure $\alpha_B$
Studies indicate internal angle 1.16°±0.02° reduces data bias among compactors.

Calibrated to 1.25 degrees External

Calibrated to 1.16 degrees Internal

Key
- Pine G1
- Pine 125X
- Troxler 4140
- Troxler 4141
Issue

• DIA is a function of mix stiffness
  – We need a standard mix

• DAV is time consuming
  – Up to 8 hours for SGC calibration
Evolution

- Pine RAM
  (Rapid Angle Measurement)

- Brovold HMS
  (Hot Mix Simulator)
  For use with the DAV
Evaluating the Evolution

- FHWA Study
  - Asphalt Institute
  - University of Arkansas

- “Evaluation of the Effectiveness of Mechanical Mixture Simulation Devices for Determination and Calibration of the Dynamic Internal Angle of Gyration”
Study Objectives

6 Month Project

- Determine the relationship between mix stiffness and eccentricity.
- Establish and average mix eccentricity – “Standard Mix Stiffness” for calibration
- Compare the RAM and the HMS
- Evaluate Mix-less procedures to DAV
New Equipment Evaluation
Compactor Comparison

Servopac

Brovold
Superpave Performance Tester
Performance Sample Preparation
Specimen Preparation

- Specimen fixed in place
- Sawing & coring took approximately 10 minutes
### Specimen Tolerances

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Recommended Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter (mm)</td>
<td>100 to 104</td>
</tr>
<tr>
<td>Height (mm)</td>
<td>147.5 to 152.5</td>
</tr>
<tr>
<td>Diameter Std Deviation</td>
<td>SD &lt; 1</td>
</tr>
<tr>
<td>End Parallelism (deg)</td>
<td>± 1°</td>
</tr>
<tr>
<td></td>
<td>1.3 mm</td>
</tr>
<tr>
<td>End Flatness (mm)</td>
<td>± 0.3</td>
</tr>
</tbody>
</table>
Dynamic Modulus Test

- **Rutting**
  - Min $|E^*|$ at High Temp
- **Fatigue Cracking**
  - Max $|E^*|$ at Intermediate Temp

\[ |E^*| = \frac{\sigma_0}{\varepsilon_0} \]
Mix Performance at $T_{eff}$ for Rutting

![Graph showing dynamic modulus $E^*$ versus load frequency (Hz) for different Va values at various conditions.](image)

- **Mix Design Average**
- **Plant Produced Average**
- **Plant Samples 1 on Day 1**
- **Plant Samples 2 on Day 1**
- **Plant Samples 3 on Day 2**
- **Plant Samples 4 on Day 2**
- **Plant Samples 5 on Day 3**
- **Plant Samples 6 on Day 3**

**Performance Values:**
- Va 6.8
- Va 4.0
- Va 4.8
- Va 4.2
- Va 3.2
Repeated Load Permanent Deformation Test

- Rutting
  - Min FN at High Temp
Flow Number

![Graph showing accumulated microstrains vs. number of cycles for different AC mix designs](image-url)
Aggregate Imaging
Aggregate Imaging

- Coarse aggregates
  
  **Stockpiles**
  
  #1 Stone
  
  1/2” chip
  
  3/8” chip

  **Source**
  
  WLS west quarry

- Fine aggregates
  
  **Types**
  
  Natural Sand
  
  Manufactured Sand
  
  JMF Blend

  **Sources**
  
  WLS west quarry
  
  Honey Creek pit
AIMS Image Device capture Fine Agg

Fine aggregate
No. 8 aggregates

FAA N Sand = 39.8
FAA M Sand = 48
FAA blend = 45.6
No. 16 aggregs

No. 30 aggregs
Coarse Aggregate Analysis
Coarse Aggregate

#1 Stone exhibits highest angularity
Small agg mostly sub-rounded
Coarse Aggregate

Texture

Compare 3 aggregate sizes:
• 3/4-inch
• 1/2-inch
• 3/8-inch

#1 Stone stockpile has highest texture, but no real difference among aggreg stockpiles
#1 Stone exhibits higher texture, but all aggs rated as Smooth in video analysis
Coarse Aggregate

Shape Index - Sphericity

Shape Index = 1
- Aggregate is perfect sphere

Superpave F:E
- 1:5 Ratio  6%
- 1:3 Ratio  22%

Aggregate from #1 Stone appears more flat & elongated
3/8-inch (9.5mm) aggregates
3/4-inch (19.5mm) aggregates

1/2-inch (12.5mm) aggregates
So what?

- Time savings – rapid return on test results
- Comparable with Superpave F:E test results
- Potential ties to performance test data
- Production monitoring of aggregates
Summary

How can data from SPT be used?

Pavement distress predictions in AASHTO design software are based on actual measured asphalt mix properties.

Mechanistic-Empirical !!!
Other testing
Questions