Simple Performance Test

Northeast Asphalt User/Producer Group
Ramon Bonaquist, P.E.
Advanced Asphalt Technologies, LLC
What is it?

- Test conducted on the mixture that indicates how it will perform
- Identify inferior mixes
  - Rutting
  - Cracking
- Design
- QC/QA Operations
Lots of Possibilities

- Gyratory Compactor
  - NCHRP 9-7 Field Procedures and Equipment to Implement SHRP Asphalt Specifications
  - NCHRP 9-16 Relationship Between Superpave Gyratory Compaction Properties and Permanent Deformation of Pavements In-Service
Lots of Possibilities

• Loaded Wheel Testers
  – Transportation Research Circular E-C016
  – NCHRP 9-17 Accelerated Laboratory Rutting Tests: Asphalt Pavement Analyzer

• SHRP Shear Test
  – NCHRP 9-7 Field Procedures and Equipment to Implement SHRP Asphalt Specifications
  – NCHRP 9-18 Field Shear Test of Hot Mix Asphalt
Lots of Possibilities

• Fundamental Tests
  – NCHRP 9-19 Superpave Support and Performance Models Management
    • Stiffness
    • Permanent Deformation
    • Creep
    • Strength
  – PennDOT Evaluation of Triaxial Strength
    • Indirect Tensile Strength
General Conclusion

• Many show promising correlation with pavement performance

• How do you select the best?
  – Fundamental versus Empirical
  – Mixture Design versus Quality Control
  – Specimen Preparation
    • Size
    • Lab compacted versus field sample
  – Equipment and Training Costs
Specific Projects

• NCHRP 9-19 Task C
  – Simple Performance Test Recommendations
    • Dynamic Modulus
    • Repeated Load Permanent Deformation
    • Creep

• NCHRP 9-18 Field Shear Test
  – QC Application

• PennDOT Triaxial Study
  – Indirect Tensile Strength
NCHRP 9-19 Task C

- University of Maryland and Arizona State University
  - Matt Witczak PI
  - Subcontractors
    - Fugro BRE
    - AAT
    - Heritage Research

- Fundamental Test
Candidate Simple Performance Tests

- **(12) Stiffness and Deformation/Strength Related Tests**
  - **Rutting Stiffness**
    - Dynamic (Complex) Modulus  - ASU
    - Dynamic (Wave Propogation) Modulus  - ASU
    - Predicted Stiffness from Material Properties  - ASU
    - SST-G* Complex Modulus  - AAT
    - G*-Field Shear Tester  - UMD
  - **Rutting Deformability**
    - Triaxial Shear Strength  - ASU
    - Repeated Load Permanent Deformation (Triaxial)  - ASU
    - Repeated Shear Permanent Deformation  - Hertiage
    - Static Creep / Flow Time  - ASU
  - **Cracking**
    - Indirect Tensile (Strength, Creep, Fatigue)  - ASU
    - Dynamic (Complex) Modulus  - ASU

- **Over 80 Test Response Parameters**
Experimental Sites

MnRoad

WesTrack

FHWA-ALF

27-28 July 2000
Panel Meeting
## FHWA-ALF

<table>
<thead>
<tr>
<th>ALF Lane</th>
<th>Binder Type</th>
<th>Nominal Size, mm</th>
<th>Asphalt Content, %</th>
<th>Air Void Content, %</th>
<th>Rut Depth, (10,000 Passes) mm</th>
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<tbody>
<tr>
<td>5</td>
<td>AC-10</td>
<td>19.0</td>
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## MnRoad

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<thead>
<tr>
<th>MNROAD CELL</th>
<th>BINDER TYPE</th>
<th>NOMINAL SIZE, MM</th>
<th>ASPHALT CONTENT, %</th>
<th>AIR VOID CONTENT, %</th>
<th>RUT DEPTH, (NOV 98)</th>
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<td>WesTrack Section</td>
<td>Binder Type</td>
<td>Nominal Size, mm</td>
<td>Asphalt Content, %</td>
<td>Air Void Content, %</td>
<td>Rut Depth, (1.5M ESAL) mm</td>
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<td>12.5 Coarse</td>
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Compare Actual Performance to Measured Laboratory Response

![Graph showing the relationship between Test Parameter and Distress]
Subjective Classification

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<tr>
<th>Color</th>
<th>CRITERIA</th>
<th>$R^2$</th>
<th>Se/Sy</th>
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<td>&lt; 0.350</td>
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<tr>
<td>Good</td>
<td>0.70 - 0.89</td>
<td>0.36 - 0.55</td>
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<tr>
<td>Fair</td>
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<td>0.56 - 0.75</td>
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<tr>
<td>Poor</td>
<td>0.20 - 0.39</td>
<td>0.76 - 0.90</td>
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<tr>
<td>Very Poor</td>
<td>&lt; 0.19</td>
<td>&gt; 0.90</td>
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## Findings - Rutting

<table>
<thead>
<tr>
<th>Test</th>
<th>Mode</th>
<th>$R^2$</th>
<th>Se/Sy</th>
<th>Rating</th>
<th>Selected</th>
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<tr>
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<tr>
<td>Repeated Load</td>
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<td>0.36</td>
<td>Good</td>
<td>x</td>
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<tr>
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<td>Shear</td>
<td>0.88</td>
<td>0.39</td>
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<tr>
<td>Creep</td>
<td>Triaxial</td>
<td>0.91</td>
<td>0.32</td>
<td>Excellent</td>
<td>x</td>
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</table>
Clear Advantages

- Triaxial Modulus
  - Clear tie to 2002 Design Guide
    - Rational Limiting Stiffnesses
  - Indicator of Fatigue Cracking
    - Optimization

- Triaxial Creep
  - Simplicity of Testing Equipment

- Triaxial Repeated Load
  - Best represents actual loading
Disadvantage

- Specimen Size
  - 100 mm Diameter by 150 mm High
  - Parallel Ends
- Needed to Ensure Fundamental Properties
- Sawed and Cored From Oversized Gyratory Specimens
E* -- Triaxial Complex Modulus Testing

\[ |E*| = \frac{\sigma_0}{\varepsilon_0} \]

3 to 200 psi

0, 20, 30 psi

27-28 July 2000

Panel Meeting
ALF: Rut Depth vs. $E^{\text{max}}/\sin\phi$ @ 130 °F (54.4 °C)

Unconfined -- Linear Range

Rut Depth @ 10,000 Passes (mm)

$E^{\text{max}}/\sin\phi$ (10^6 psi)

Se/Sy = 0.35

$R^2 = 0.90$

Legend:
- 5 - AC-10
- 7 - Styrelf
- 8 - Novophalt
- 9 - AC-5
- 10 - AC-20
- 11 - Base AC-5
- 12 - Base AC-20
Creep - Flow Time Test

![Graph showing Creep - Flow Time Test]

- **D(t)**
- Time
- High
- Low
- Flow Time
MnR: Unconfined Static Creep Test - Flow Time @ 130 °F (54.4 °C)

Se/Sy = 0.155

R² = 0.98

Rut Depth Nov 98 (in)

Flow Time, sec

16 - AC-20
17 - AC-20
18 - AC-20
20 - 120/150 PEN
22 - 120/150 PEN
Repeated Load Permanent Deformation Test

Loading Cycles

Permanent Strain (in/in)

100 N 1000 N

FN (Flow Number)
ALF: Unconfined Repeated Load Test - Flow Number @ 130 °F (54.4 °C) (20 psi)

Se/Sy = 0.435
R²=0.84

Rut Depth @ 10,000 Passes (mm)

Flow Number of Repetitions

5 - AC-10
7 - Styrelf
8 - Novophalt
9 - AC-5
10 - AC-20
11 - Base AC-5
12 - Base AC-20
Further Work

• Field Verification
  – Underway as part of NCHRP 9-19
  – Establish and Validate Acceptance Limits
  – Introduce Equipment to Users

• First Article Equipment
  – New NCHRP Study NCHRP 9-29
  – Procure and Evaluate Two First Articles
NCHRP 9-18 Field Shear Test

• Penn State
  – Don Christensen PI
  – AAT
  – EnduraTec Systems