Advances in Testing of Asphalt Pavements & Materials

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NCAT Director
Some Tests I’ll Talk About

- Bond Strength
- Three-Wheel Polishing Device
- Load-Related Cracking Tests
  - Bending Beam Fatigue
  - Texas Overlay Tester
  - IDT Fracture Energy
  - IDT Energy Ratio
  - Simplified Viscoelastic Continuum Damage
  - Semi-Circular Bend Test
Interlayer Bond Strength Test

- Simple shear method to evaluate strength of bond between pavement layers
- Optimize tack coat materials and application rates for different pavement surfaces
- Forensic evaluations
- General criteria of 100 psi min. bond strength
3-Wheel Polishing Machine

• Simulated trafficking of pavement surfaces to evaluate changes in texture and friction
• Used with Dynamic Friction Tester and Circular Texture Meter
• Assess ultimate friction results in a few days
3-Wheel Polishing Machine

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# Tests for Fatigue Cracking

<table>
<thead>
<tr>
<th>Test</th>
<th>Method</th>
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<tbody>
<tr>
<td>Bending Beam Fatigue</td>
<td>AASHTO T 321</td>
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<tr>
<td>Simplified Viscoelastic Continuum Damage</td>
<td>AASHTO PP 60-10</td>
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<tr>
<td>Texas Overlay Tester</td>
<td>TEX-248-F</td>
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<tr>
<td>Semi-Circular Bend</td>
<td>LTRC</td>
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<tr>
<td>IDT Energy Ratio</td>
<td>UF</td>
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<tr>
<td>Disc-Shaped Compact Tension Test</td>
<td>ASTM</td>
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Why we need a reliable cracking test?

- Economics drive us to use lower asphalt contents and more recycled binders which tend to reduce strain tolerance.
- Traditional mix criteria have weak relationships to performance and restrict innovation.
Bending Beam Fatigue Testing

- AASHTO T 321
- Temperature: 20°C
- Frequency: 10 Hz
- 3 beams at 3 strain magnitudes
  - 200 to 800 με
- Beam size – 2.5”x 2”x 15”
  - Usually @ 7% air voids
- 50% stiffness reduction
Bending Beam Fatigue Results

![Graph showing microstrain at 68F vs. cycles to failure for Control, HMA-RAP, and WMA-RAP materials.](image)
Fatigue Endurance Limit

70 micro strain = 1,220,832,905 cycles to failure (no shift factor)

Number of Cycles to 50% Stiffness

- Actual Data
- Predicted Data
- Extrapolated Test Result
- Predicted Test Result
IDT Fracture Energy

- Simple sample preparation
- Quick test, monotonic loading, 4 strain measurements
- 10°C test temperature
- Analysis is straightforward
- Specimens long-term aged prior to testing
IDT Fracture Energy

- Correlation with fatigue cracking at WesTrack
- R. Kim and H. Wen, AAPT 2002
Texas Overlay Tester

- (Tex-248-F)
- Test for fatigue or reflective cracking
- Developed to simulate overlay on horizontal joint movements of PCC
- Specimen cut from field core or SGC specimen
- Repeated direct tension, triangular 10 sec. waveform (5 sec loading and 5 sec unloading)
Texas Overlay Tester

93% Load Reduction
Energy Ratio

- Developed at U of FL to determine top-down cracking potential
- Three IDT tests required:
  - Resilient modulus
  - Creep compliance
  - Fracture energy
  - 10°C
- Criterion: ER > 1.95 for trafficking less than 1,000,000 ESALs

\[ ER = \frac{DCSE_f \times 7.294 \times 10^{-5} \times \sigma^{-3.1} (6.36 - St) + 2.46 \times 10^{-8}}{m^{2.98} \times D_1} \]
S-VECD (AMPT Fatigue) Testing

- AASHTO PP 60-10
- Draft procedure by NCSU
- Cyclic load: 10 Hz
- 19°C (or based on MAAT)
- $E^*$ needed first to estimate strain levels
- 4+ replicates of AMPT sample
- Failure defined as a sharp reduction in phase angle
- Two failure targets: 1,000 and 10,000 cycles
SVECD (AMPT Fatigue) Test

- Pseudostiffness versus damage curve (C vs. S)
- NCSU program allows user to characterize fatigue life for any strain level, temperature, and frequency
Summary of S-VECD Fatigue Prediction

45% RAP PG 52-28

Virgin

45% RAP PG 76-22
Consumer Reports’ Style

- Much better than average
- Better than average
- Average
- Less than average
- Probably a liability
# Tests for Fatigue Cracking

<table>
<thead>
<tr>
<th>Test</th>
<th>Std. Method</th>
<th>Field Verified</th>
<th>Eqmt. Cost</th>
<th>Time to Result</th>
<th>Best Buy</th>
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<tr>
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Thank You