Rejuvenation Testing, Inspection and Performance on NC Airports

Presented by:
Paul Rogers, PE, Trimat Materials Testing, Inc.
Phil Lanier, NCDOT-Division of Aviation
Christopher Bacchi, PE, Trimat Materials Testing, Inc.

Learning Objectives
- What are rejuvenators?
- Do they work?
- Benefits and drawbacks
- Experience on NC airports
- Project Selection
- Product Selections
- Project Execution

Rejuvenators
- Encompassing term that covers all products designed to restore asphalt binder flexibility.
- Excellent product to seal the surface, stop the loss of fines, combat the effects of oxidation.
- Replaces maltenes lost due to oxidation to restore the maltenes/asphaltenes balance.
- Must have verifiable influence on the asphalt pavement.
- No changes to P-632 in new FAA AC 150/5370 – 10G

Do They Work?
NCDOT and Trimat have tested and evaluated 8 commercially available products over the past decade.
All of the products tested met FAA Item P-632.
Some of the products evaluated performed much better than expected and others much worse.

Surface Treatment Cost - Based on 100,000 Sq. Yds.

- PCMO: $7.96
- Thermo seal w/o aggregate: $2.07
- Thermo Slurry: $3.72
- Slurry Seal: $2.40
- Chip Seal: $1.08
- Rejuvenator: $1.65
- FOG Seal: $5.00
- Ekrete®: $9.00
- Surtreat®: $5.00
- Magnesium Phosphate: $18.00
- AddaGrip UK: $6.50
- MG-Krete®: $16.00
- HPCO: $8.20

Rejuvenators have been tested and evaluated by NCDOT and Trimat.

Presentation Team
Paul Rogers – Geotechnical engineer works primarily in airfield preservation, maintenance, and construction. Extensive background in inspection and quality assurance.
Phil Lanier: Currently NCDOT Division of Aviation Airport Project Manager. Developed NCDOT Airport Maintenance Program. Extensive background in construction program management.
Chris Bacchi: Former DOT pavement engineer. Currently working on FHWA, private, and university research on asphalt pavements. Extensive background in pavement and mix design.
Do They Work?

Henderson – Oxford Airport
NCDOT Division of Aviation Test Airport

Tested 5 commercially available rejuvenation products.

Products were graded on a variety of characteristics.

### Product Grading Matrix

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Product A</th>
<th>Product B</th>
<th>Product C</th>
<th>Product D</th>
<th>Product E</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short Term Performance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LT Perf - Untreated</td>
<td>2</td>
<td>10</td>
<td>5</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>LT Perf - treated</td>
<td>0</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>LT Perf - average initial</td>
<td>2</td>
<td>10</td>
<td>2</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td><strong>Surface Fodability</strong></td>
<td>1</td>
<td>4</td>
<td>10</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Raveling Fodability</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td><strong>Short Term Color/Conspicuity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Color/Conspicuity</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td><strong>Long Term Color/Conspicuity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Color/Conspicuity</td>
<td>7</td>
<td>9</td>
<td>0</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td><strong>Surface Distress</strong></td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td><strong>Friction</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friction</td>
<td>7</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td><strong>Crack Sealing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crack Sealing</td>
<td>5</td>
<td>6</td>
<td>1</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>51</td>
<td>83</td>
<td>52</td>
<td>80</td>
<td>56</td>
</tr>
</tbody>
</table>

### Asphalt Binder Testing

Henderson-Oxford Airport

Meeting the FAA P-632 can be accomplished in a variety of ways, not all are beneficial to the pavement.
Do They Work?
Asheville Regional Airport – Part 139
• Summer 2011 Runway Rejuvenation
• Summer 2013 Taxiway Rejuvenation
• Completed runway work between 12PM & 5AM
• Extensive test strip and application mock up program.
• Successful preliminary project testing
• Onsite QA

Do They Work?
Rocky Mount - Wilson – Part 139
• Summer 2012 Design and pre project testing including binder testing, M.I.S.T. testing, macro texture, and friction testing.
• Testing conducted on a previously treated section (PDC) and untreated runway extension.
• Summer 2013 Complete Runway and Taxiway Rejuvenation 160,000 Sq. Yds.

Rejuvenator Benefits
• Restore pavement flexibility
• Stop loss of fines
• Seal pavement surface and decrease permeability
• Increase marking conspicuity – Increase marking life
• Provide more attractive airport pavement.
• Requires limited mobilization and construction time

Rejuvenator Drawbacks
• Will not restore low friction
• Will not help stop the propagation of large cracks.
• Does not help alligator, fatigue cracked, raveling, or pavements with structural problems.
• Limited availability of qualified contractors.
• Much of the research available to potential beneficiaries of these products has not been conducted by independent parties.
• Not all products are created equal

Experience on NC Airports
Recent Projects  (Typically 8-10 Airports/Year)
• Mount Airy – 2009
• Asheville Regional Runway - 2011
• Person County Runway and Taxiway – 2011
• Henderson Oxford Airport Runway – 2012
• Pitt-Greenville Regional Runway – 2012
• Albert J. Ellis Taxiway – 2012
• Asheville Regional Taxiway – 2013
• Rocky Mount-Wilson Runway and Taxiway – 2013
• Duplin County Airport Runway – 2013
• Anson County Airport Runway and Taxiway - 2013
• Asheboro Airport - 2014
Mt Airy Runway PCI in 2008 ~ 68 = Fair

Why was Mt. Airy a good Candidate for Rej?
- Pavement @ 15 Years and has 10 yrs to Go ?!?!?
- PCI inspection noted weathering was a predominant distress. PCI was 68
- Markings @ end of life
- Need more Contrast Between Markings & Pavement
- Small fines becoming an issue (weathering)
- Funding not in place for Extension & Rehab...Yet

Testing Schedule for Mt. Airy RWY in 2009
- Pre & Post Coring
- Pre & Post Skid Testing
- Pre & Post Liquid Samples
- Applicator Rate (in this case 0.06 gal/sq.yd) & Atomization Check

Construction Phasing for Mt. Airy in 2009
- Pavement Markings are cleaned of mold & dirt
- Cracks are routed, blown, vacuumed
- RWY is rejuvenated, except for markings larger than 6"
- Cracks are sealed and squeegeed
- Half Rate paint (no beads). This is the scratch coat/primer coat
- Full Rate Paint With Beads then applied. Within 3-4 Weeks

Post Cleaning & Rejuvenating @ Mt. Airy, 2009

Final Product @ Mt. Airy, 2009

Mount Airy Surry County Airport - RWY 18 After
Mt Airy Runway PCI in 2010 ~ 80 = Good

Mt. Airy Rejuvenation Conclusions

- Rejuvenation was contributory in suppressing weathering distress
- RWY PCI increased from 68 to 80
- Enhanced Conspicuity of new Markings by providing contrast
- Per Airport Sponsor, small fines decreased - FOD
- 4300’ x 75’ RWY Rejuvenation costs ~35K
- Total Project Turn-Key cost ~ 75K

Before Photograph @ Asheville 2011 – Typical 139 in NC

Asheville Regional PCI

Legend

- Not Inspected
- 0-10 Poor
- 11-30 Fair
- 31-40 Very Poor
- 41-50 Fair
- 51-70 Poor
- 71-85 Substandard
- 86-100 Good

Why was Asheville a good Candidate for Rej?

- Pavement @ 15 Years and has 5-8 yrs to Go?!?!?
- PCI inspection noted weathering was a predominant distress. PCI was 50.
- Markings @ end of life ~ 7 yrs
- Need more Contrast Between Markings & Pavement
- Small fines becoming an issue (weathering)
- Funding not in place for New Runway Yet

Testing Schedule for Asheville RWY in 2011

- Pre & Post Coring
- Pre & Post Skid Testing
- Pre & Post Liquid Samples
- Pre & During Curing Time
- Applicator Rate (in this case 0.045 gal/sq.yd) & Atomization Check
- Full Time RPR and Testing Rep
Construction Phasing for Asheville RWY in 2011

- Rubber Removed (Chemically)
- Pavement Markings are cleaned of mold & dirt
- Cracks are routed, blown, vacuumed
- RWY is rejuvenated, except for markings larger than 6”
- Cracks are sealed and squeezed
- Half Rate paint (no beads). This is the scratch coat/primer coat
- Full Rate Paint With Beads then applied. Within 2 Weeks.

Asheville Rejuvenation Conclusions

- Rejuvenation was contributory in suppressing weathering distress
- RWY PCI increased from 50 in 2008, to 59 in 2013
- Enhanced Conspicuity of new Markings by providing contrast
- Per Airport Operations, small fines decreased
- 8000’ x 150’ Grooved RWY Rejuvenation costs ~100K
- Total Project Turn-Key cost ~ 200K

Constructability lessons Learned?

- Ensure QA/QC roles/responsibilities prior to construction. Each job is different.
- Application rates determined by friction testing, cores, and other project specific factors
- Too much rejuvenation = Asphalt too soft & Friction to low.
- Too little rejuvenation = Full Benefits not achieved
- Scarring/streaking should be avoided
- Communication is key: Engineer/Contractor/Testing & RPR/Owner/Tenants

PROJECT SELECTION

Good candidates include:
- PCI > 70
- Asphalt age 8-12 years, again at 16-20 years
- Severe oxidation
- Loss of fines
- Good macro-texture
- Poorly compacted new asphalt
- Hairline cracks
- Marking conspicuity problems

Bad candidates include:
- PCI < 60
- Major cracking
- Structural issues
- Raveling Pavements
- Previous surface treatments
- Poor macro-texture
- Low friction
Other Selection Factors include:

- Marking Conspicuity
- Beautification
- GA Airports – Weathering deterioration
- Pavements that need to be sealed

Current P-632 Testing Requirements

- Lab – Recovered Binder Testing:
  - Pre and post treatment
  - Absolute Viscosity
  - Complex Modulus (viscosity)
  - Phase Angle
  - Targeting 25% or 40% decrease in these values dependant on age of pavement (table)

Current P-632 Testing Requirements

<table>
<thead>
<tr>
<th>Item</th>
<th>Property of Recovered Binder</th>
<th>Requirement</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Absolute Viscosity, η, Pa</td>
<td>≥ 25% Decrease</td>
<td>ASTM D 2171</td>
</tr>
<tr>
<td>2a</td>
<td>Complex Modulus, G, kPa</td>
<td>≥ 50% Increase</td>
<td>AASHTO T 315</td>
</tr>
<tr>
<td>2b</td>
<td>Phase Angle, δ, °</td>
<td>Report</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Property of Recovered Binder</th>
<th>Requirement</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Absolute Viscosity, η, Pa</td>
<td>≥ 40% Decrease</td>
<td>ASTM D 2171</td>
</tr>
<tr>
<td>2a</td>
<td>Complex Modulus, G, kPa</td>
<td>≥ 50% Increase</td>
<td>AASHTO T 315</td>
</tr>
<tr>
<td>2b</td>
<td>Phase Angle, δ, °</td>
<td>Report</td>
<td></td>
</tr>
</tbody>
</table>

Current P-632 Testing Issues

- No specs for rejuvenators (other than EB44B)
- Core/recovered asphalt lab testing does not tell whole story
- No pre-treatment testing on asphalt mix after PCI evaluation (min 70)
- Confusing specs for rejuvenators
- Section P632-6.1 specifies:
  - "Testing, as necessary, will be accomplished by the Engineer to verify information provided by the MSDS information"
- MSDS only provides information regarding physical data, safety and transport, NOT product properties.
- Materials should conform and be tested using EB44B as guidelines.
- Materials conforming to ASTM D490, Standard Specification for Road Tar
Current P-632 Testing Issues

- MSDS Info
- Specific Gravity
- Items covered by D490 (EB44B Table 1):
  - % Water
  - Specific Gravity
  - Distillation
  - Softening Point

Reasons to Test Rejuvenators

- Percent Change in Recovered Binder Properties (ABS)

Friction Testing Changes – 40 mph

Friction Testing Performance – 60 mph

Friction Testing Performance vs. Lab Results

Only relationship noted was between Absolute Visc and Skid #
Relationship Between Absolute Viscosity and Friction Number

\[ y = -0.7418x + 0.933 \]

\[ R^2 = 0.9526 \]

\[ y = -0.6526x + 0.9478 \]

\[ R^2 = 0.8241 \]

Proposed P-632 Testing

- Porosity/permeability testing for pavement prior to application
- MiST testing
- Long Term Performance
- Testing for individual rejuvenators
- Test Strips for Skid Testing
- Other Factors to Consider
  - Tracking – concrete aprons?
  - Color – some are clear
  - FOD – does it flake?

New Trimat Protocol for Rejuvenators

- Friction testing – test sections?
- Random core sampling of existing pavement:
  - Perform density testing, MiST testing, and viscosity/comp Mod, Phase Angle on recovered binder.
  - Rejuvenator Product Sampling and testing as per EB44B (per shipment)
  - Post application cores and lab testing
  - Onsite QC-QA Inspection

Summary...