Life Extension of Airport Asphalt Pavement

Preventive Maintenance & P-608

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Life Extension of Airport Asphalt Pavement
INSTRUCTOR

Joe Larusso, Regional Manager, Technical / Sales Marketing

Joe has 25 years' experience with asphalt Pavement Management and Maintenance products, processes, practices, and programs. Joe is Technical and has been intimately involved in all aspects of asphalt chemicals, emulsions, polymers, equipment, Contracting, materials manufacturing, Tech Dev, Q/A, R&D. He's been on many industry/Agency committees and has been active on levels from national to local. Joe was the founder and first Executive Director of the Illinois Pavement Maintenance & Preservation Association; he now resides in Tucson AZ and sits on the AZ AGC Pavement Preservation Committee, and oversees ASI activities in the southwest and Midwest.
Asphalt Systems, Inc.
Salt Lake City, UT (also production in NC & IN)

- 40+ years of asphalt preservation
- Specialty emulsion manufacturer
- Service:
  - Aviation
  - Dept of Defense
  - Federal, state, and local governments, DOTs
  - Private industry
  - Commercial
  - Residential
ASI Airport Application Video: P-608 Seal with GSB-88

https://www.youtube.com/watch?v=EFRTMJR0_ZU

http://www.asphaltsystemsinc.com/industries/aviation
Life Extension Requires Preventive Maintenance

- Life extension to delay rehabilitation
- Lower treatment costs compared with rehabilitation and reconstruction
- Reduced user costs
- Improved safety to users
- Improved overall network health
- Protect the environment by using less natural resources and recycling

![Life Extension Diagram](image)

![Remaining Service Life Diagram](image)

Figure 1. Pavement preservation scheme based on preventive maintenance.

**Remaining Service Life**

- RSL = 12 years
- RSL = 9 years
- RSL = 2 years
- RSL = 4 years

Terminal Threshold

15 yrs

Road A

Time (Years)

Treatment A: 5 year life extension

Treatment B: 10 year life extension

Distress Index (DI)
Preventive Maintenance is part of Pavement Preservation

A program employing a network level, long-term strategy that enhances pavement performance by using an integrated, cost-effective set of practices that extend pavement life, improve safety and meet motorist expectations.

Source: FHWA Office of Asset Management & FHWA Pavement Preservation ETG
Life Extension & Cost Savings

- It is more cost effective to apply preservation between rehabs than not.
- Savings are 15-50% over the life cycle.
- Additional savings (up to 15%) can result if the treatment is applied earlier.
- Total savings could be 30 to 65% over the life cycle.

**Figure 2. The asphalt deterioration curve.**

- **Excellent**
- **Good**
- **Fair**
- **Poor**
- **Very Poor**
- **Failed**

- 1. Fog seal rejuvenation
- 2. Slurry seal, chip seal or microsurfacing (single)
- 3. Chip seal or microsurfacing (double)
- 4. Cape seal
- 5. HMA overlay
- 6. Mill & HMA overlay
- 7. In-place recycling & overlay
- 8. Full-depth reconstruction
- 9. Crack filling (as needed)

**Figure 3. Patenaude’s progressive pavement management.**

**Preservation vs. Rehabilitation**

- **Preservation Strategy**
  - Years 3 & 38: Rejuvenation
  - Years 8 & 43: Microsurfacing (single)
  - Years 15 & 50: Microsurfacing (double)
  - Year 25: Cape seal
  - Year 35: 1%-in. hot-mix overlay
  - Total cost/SY over 50 years = $28.65

- **Rehabilitation Strategy**
  - Year 15: CPR with 2-in. HMA overlay
  - Year 30: CPR with 2-in. HMA overlay
  - Year 45: CPR with 2-in. HMA overlay
  - Total cost/SY over 50 years = $48.00

**Table 4.2. Examples of Cost Effectiveness of Various PM Treatments (27)**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Life of Treatment</th>
<th>Equivalent Annual Cost</th>
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</thead>
<tbody>
<tr>
<td>Fog Seal</td>
<td>3.5</td>
<td>$0.13</td>
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<td>Slurry Seal</td>
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<td>Microsurfacing</td>
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<td>Chip Seals</td>
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<td>Thin Hot-Mix Overlay</td>
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<td>$0.25</td>
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*Typical life of maintenance treatment for this example.
ACRP Syn 22, great reference source
Asphalt PP Treatments

Flexible Pavement Treatments
- Asphalt Rejuvenators
- Crack Sealing
- Chip Seals
- Slurry Seals
- Micro-surfacing
- Ultra-thin Overlays
- Profile Milling
- Hot In-place Recycling
- Cold In-place Recycling
- Asphalt Sealers
- Crack Filling
- Cape Seals
- Sand Seals
- Scrub Seals
- Bonded Wearing Course
- Ultra-Thin Overlays
- Thin Overlays
- Mill & Resurface

...and many others!

Table 3: Pavement Preservation Treatments for Asphalt Concrete Pavements

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<thead>
<tr>
<th>Treatment Type</th>
<th>Survey Result, %</th>
<th>Usage</th>
<th>Performance</th>
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<td>Routine</td>
<td>Have Tried</td>
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<td>Crack sealing with</td>
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<td>Hot-poured sealant</td>
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<td>Cold-applied sealant</td>
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<td>Small area (pothole) patching</td>
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<td>Hot mix</td>
<td>52</td>
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<td>Cold mix</td>
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<tr>
<td>Proprietary mix</td>
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<td>Spray patching (includes manual chip seal)</td>
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<tr>
<td>Machine patching with AC</td>
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<td>Milling and machine patching</td>
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<td>with AC</td>
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<td>Controlled shot blasting</td>
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<td>Rejuvenators, fog seals, etc.</td>
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<td>Surface treatment</td>
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<td>Hot-mix overlay</td>
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<td>Milling and hot-mix overlay</td>
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<td>Cold in-place recycling</td>
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<td>Whitetopping (PCC overlay)</td>
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Notes: Treatments traditionally considered preventive maintenance treatments are in italics.
## Typical Life Extensions (Years)

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<th>Treatment</th>
<th>Good Condition (PCI=80)</th>
<th>Fair Condition (PCI=60)</th>
<th>Poor Condition (PCI=40)</th>
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<td>Crack Fill</td>
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<td>Crack Seal</td>
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<td>Fog Seal</td>
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<td>Chip Seal</td>
<td>4 - 10</td>
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<td>0 - 3</td>
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<td>Micro-Surfacing</td>
<td>4 – 8</td>
<td>3 - 5</td>
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<td>Thin HMA</td>
<td>4 - 10</td>
<td>3 - 7</td>
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### Table 2.2: Typical Unit Costs and Expected Life of Typical Pavement Maintenance Treatments

<table>
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<tr>
<th>Treatment</th>
<th>Cost/m²</th>
<th>Cost/yd²</th>
<th>Min</th>
<th>Average</th>
<th>Max</th>
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<td>Crack Treatment¹</td>
<td>0.60</td>
<td>$0.50</td>
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<td>Fog Seals²</td>
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<td>Microsurfacing³</td>
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<td>Chip Seals³</td>
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<td>Thin Hot-Mix Overlay⁴</td>
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<td>Thin Cold-Mix Overlay⁵</td>
<td>1.50</td>
<td>$1.25</td>
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### Treatments

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<th>Treatments</th>
<th>PCI</th>
<th>Use on</th>
<th>Life Extension</th>
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<tr>
<td>Rejuvenating Fog Seal</td>
<td>70-100</td>
<td>Sound structural section</td>
<td>3-5 yrs</td>
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<td>Slurry Seals / Micro Surfacing</td>
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<td>Chip Seal / Scrub Seal</td>
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<td>Sound structural section</td>
<td>5-10 yrs</td>
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<td>Cape Seals</td>
<td>25-70</td>
<td>Fairly sound structural section</td>
<td>7-12 yrs</td>
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<td>Scrub Membrane Interlayer</td>
<td>20-50</td>
<td>Fairly sound structural section</td>
<td>10-15 yrs</td>
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<tr>
<td>Recycles (CIR / CCPR)</td>
<td>0-50</td>
<td>Fairly sound structural section</td>
<td>15-20+ yrs</td>
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<tr>
<td>Recycles (FDR)</td>
<td>0-40</td>
<td>Failed / Partially failed section</td>
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**ACC**

**LUNCH + LEARN**
The “4 R” system of Pavement Preservation

- the Right treatment
  - on the Right pavement
  - at the Right time
  » in the Right way

<table>
<thead>
<tr>
<th>Pavement Conditions</th>
<th>Severity Levels</th>
<th>Crack Filling</th>
<th>Crack Sealing</th>
<th>Fog Seal</th>
<th>Sand Seal</th>
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<th>HIR</th>
<th>Thin HMA Overlay</th>
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<td>NR</td>
<td>NR</td>
<td>R</td>
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<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>ADT</td>
<td>&lt; 2,500</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
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<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>2,500 – 10,000</td>
<td>R</td>
<td>R</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>&gt; 10,000</td>
<td>R</td>
<td>R</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
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<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Relative Cost (to $$$+)</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
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</tr>
</tbody>
</table>

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12
Optimal Timing?

Figure 3.8. Optimum Time to Fix Pavements (26)

NCHRP REPORT 523
Optimal Timing of Pavement Preventive Maintenance Treatment Applications

D.G. Peskin
T.E. Hoerner
And
K.A. Zinckman
Applied Pavement Technology, Inc.
Downers Grove, IL

Figure 33. Summary charts for Case Study 4—North Carolina.
Maximum Life Extension: Maybe… *Early & Often!*

**TH56 Findings**

- Sealing improves resistance to aging (cracking)
- Sooner is better when sealing
  - Waiting for 3 or more years to seal after construction produced same results as unsealed pavement
  - Sealing after 1 or 2 years showed improvement in resistance to aging (cracking)
Early Preventive Maintenance Extends Asphalt Pavement Life

What Was the Need?
As asphalt pavements age, the asphalt cement that binds the aggregate oxidizes, making the pavements more brittle and susceptible to cracking and other deterioration. To help mitigate this process, MnDOT periodically conducts preventive maintenance using surface treatments. These treatments, such as fog seals and chip seals, cover the existing pavement surface with an asphalt emulsion sometimes accompanied by an additional layer of gravel or crushed aggregate. When timed correctly, successive preservation treatments can extend the time needed before more expensive rehabilitation and reconstruction, resulting in a reduced life-cycle cost for the pavement.

However, it is unclear how to best time such treatments to maximize pavement life while minimizing life-cycle costs. Research was needed to investigate the fundamental mechanisms of pavement aging by relating it to the material properties of asphalt pavements. To conduct this research, MnDOT led pooled fund study TP-5(155) in cooperation with the Federal Highway Administration, Minnesota Local Road Research Board and four other states.

What Was Our Goal?
The goal of this project was to help determine the proper timing of preventive maintenance by identifying how environmental aging affects asphalt material properties in the pavement and how the application of pavement preservation treatments influences the aging process.

What Did We Do?
Researchers conducted field tests on two roadway test sections. The first section was located on the Low Volume Road of the MnROAD pavement research facility. This 2.5-mile loop consists of 500-foot pavement test sections constructed with various materials and designs, and subjected to repeated truck loading. Researchers evaluated test cell 24, an asphalt pavement built in 2004 and divided into five 100-foot subsections. The subsection received a log seal, in which an asphalt emulsion is applied to the surface of the pavement immediately after construction. Three other subsections were sealed one and two years later, with the final seal in 2012, and one subsection was left unsealed.

In 2010, researchers took core samples from each of these subsections as well as several other test cells and used various laboratory tests to evaluate them for stiffness, low-temperature durability, creep and susceptibility to cracking. They also evaluated pavement aging by testing samples for asphalt binder properties. Researchers conducted similar tests on core samples from a 10-year-old pavement on Trunk Highway 56 in southern Minnesota. Seals were similarly applied to consecutive subsections over a four-year period, with one subsection left unsealed as a control.

By optimizing the timing of preventive maintenance, MnDOT can extend the service life of its asphalt pavements and delay the need for more costly rehabilitation, reducing pavement life-cycle costs.

—Tom Wood, Research Project Engineer, MnDOT Office of Materials and Road Research

“The key to preventive maintenance is timing it to occur before there is pavement distress.”

—Mike Anderson, Research and Laboratory Services Director, Asphalt Institute

What Did We Learn?
Results showed that for core samples from both test sections, the aging and stiffness of the asphalt pavement were significantly greater near the surface than farther down in the pavement structure.

Researchers had hypothesized that the time between the initial construction and treatment application would be an important factor in the measured properties related to aging, with sections sealed sooner having less aging, but with sealing becoming less effective at preventing aging when applied later in the life of the pavement. The TH-56 test section confirmed the hypothesis, with testing indicating that the subsections with chip seals applied more than two years after construction had essentially the same susceptibility to cracking as the unsealed control subsection. The findings from TH-56 imply that to mitigate damage from environmental aging, sealing should occur within the first two years of the pavement’s life. After that, while some benefits may still be obtained from treatment, it appears that the damage from environmental aging may have already substantially occurred.

However, results from the MnROAD test section did not confirm this hypothesis aging was similar for all subsections. This may be because the TH-56 test section was 12 years old at the time core samples were taken and had experienced measurable distress, while the MnROAD section was only five years old and had experienced no distress, making it difficult to see the effect of sealing.

What’s Next?
MnDOT is reviewing its asphalt preventive maintenance guidelines and considering whether to reduce the timing for preventive maintenance to one at two years after initial paving. It is also considering replicating this study on a newly constructed pavement. Researchers recommend keeping MnROAD subsections in place and continuing testing every two to three years to see if initial findings change after 10 years in service instead of five. Researchers also recommend applying a new round of treatments to these subsections beginning after they have been in service for seven years to determine if that practice has added benefits.

Surface Binder Degradation

A major product of asphalt aging, the carbonyl functional group, is found as carboxylic acid, ketone, and aldehyde containing species in the asphalt. Unless asphalt is very severely aged, ketones are the principle carbonyl products of asphalt aging. The concentration of the carbonyl functional group in asphalt is routinely measured in solution with a laboratory Fourier-transform infrared (FTIR) spectrometer. This concentration is used to determine the extent of the oxidation reaction.

Asphalts from different sources oxidatively age at different rates and show differing rheological sensitivities to oxidative aging products depending on their chemical compositions. This has been shown by Glover’s research group at Texas A&M [Lau et al. 1992] and by West Research Institute [Petersen et al. 1993; Thomas 2002]. In addition, Thomas has shown how the presence of moisture during aging in a pressure aging vessel (PAV) influences the rate of oxidation.

The carbonyl content of the asphalt has a linear relationship with the logarithm of the complex modulus (stiffness) of an asphalt (usually denoted $G^*$). Regardless of aging temperature, time, or the presence of water vapor, each asphalt is characterized by one relationship. The complex modulus of the asphalt is relatively simply estimated from its carbonyl content. The time dependence of carbonyl formation varies widely and is strongly influenced by the chemical composition (or source). However, the plots of carbonyl content versus age have similar shapes, and the time dependence for an asphalt can be determined using a few laboratory calibration points.

**TASK 2 SUMMARY**

Four techniques were applied to determine the aging severity distribution in the Arizona cores. Extraction procedures, of course, produced the most reliable data and provide the most spectral detail. These data indicate a dramatic difference in the aging at the pavement surface and the aging just below the surface. This supports part of the concept for doing this work—that surface embrittlement would precede substantial aging below the surface. Neither of the non-contact...
Surface Binder Embrittlement, 1960s Study

Fig. 6. Relationship between Relative Viscosity and Age.

Fig. 1. Average Viscosity of Samples 1-14 versus Depth.

Fig. 7. Relationship between Relative Viscosity and Original Viscosity.
Has Asphalt Cement Changed vs the Good Old Days?

Refining methods have changed

Crude oil slates have changed

Why GSB-88? Gilsonite makes a big difference = better.

- Asphalt is "bottom of the barrel" of the refining process.
- Modern refining techniques = some qualities of asphalt decrease as vital oils refined out (goodbye to the good matheine middles).
  - Highly-refined asphalt binder = Hot-mix pavement with shorter life and increased surface distress.
  - Higher prices for AC, hot-mix, increased maintenance.
- GSB-88 sealer uses natural occurring Gilsonite asphalt that has never been refined & has unique chemistry.
- High quality Gilsonite components effectively "Turbo-Charge" the GSB engineered sealer, add life to pavement.
- GSB proven to perform much better than: standard asphalt emulsions; standard rejuvenator emulsions.
Airfield Asphalt Pavement Technology FAA

• “Exposure to Oxygen: Asphalt binder hardening progresses from the top of the pavement down, with the greatest effect in the top ½”.

• “Implementation of an effective pavement management system is required to insure a long life airfield pavement”.

• “The best approach to reducing non-load related distresses in HMA is to create and fund a strong pavement preservation program based upon traditional, and newly developed material applications”.

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Conclusions of this study: “It is clear from this data and the options available for pavement preservation that some of the new technologies and techniques may be able to reduce costs and result in higher quality pavements while preserving airfield pavements”.
New, Revised, Updated FAA Guidance & P-specifications: Includes Pavement Surface Treatments

unsealed  sealed

SEALS
PENETRATES
REJUVENATES
RESTORES
“Maintaining and preserving a pavement in good condition versus rehabilitating a pavement in fair to poor condition is four to five times less expensive and increases pavement useful life. The number of years a pavement stays in “good” condition before reaching the point of rapid deterioration depends on several factors, including construction type and quality, pavement use, climate, and maintenance.”
Recent FAA Info
Guidance & Policy Updates

Advisory Circular 150/5380-7B
Airport Pavement Management Program (PMP)

Advisory Circular 150/5370-10G
Standards for Specifying Construction of Airports

Advisory Circular 150/5380-6C
Guidelines and Procedures for Maintenance of Airport Pavements
Advisory Circular 150/5380-7B
Airport Pavement Management Program (PMP)
Discusses the Airport Pavement Management Program (PMP)

• Concept
• Basic essential components
• How it is used to make cost-effective decisions about pavement maintenance and rehabilitation (M&R).
• Includes Pavement Preservation & Preventive Maintenance
Some 7B Highlights…

- Airport/Owner needs an effective pavement maintenance management system in place.
- Inspection for PMP minimum requirements, include PCI survey, annual → 3 years.
- Using Paver™ Distress ID manuals.
- Incorporate Pavement Preservation concept.

Distinction between rehabilitation and **routine maintenance** activities.
- required to preserve the pavement to achieve the design life of the pavement.
- consists of work planned and performed on a routine basis to maintain and preserve the condition of the airport pavements and is an integral part of the overall pavement preservation concept.
- This includes items such as yearly crack sealing and daily inspections of the airport pavement system.
Benefits of a PMP

- Increased pavement useful life.
- An objective and consistent evaluation of the condition of a network of pavements.
- A systematic and documentable engineering basis for determining M&R needs.
- Identifying budget requirements necessary to maintain pavement functionality.
- Documentation on the present and future condition of the pavements.
- Identifying the impact on the pavement if no major repairs are performed.
Figure 1. Typical Planning and Budgeting Process.

The following diagram shows that with the two preventive maintenance treatments, the rehabilitation treatment will be postponed to year 2026. The corresponding present value of this strategy, considering a 6% discount rate, is $28,700.
AUS DoD PMP Maintenance Flow Chart
### AUS DoD PCI & Treatments

<table>
<thead>
<tr>
<th>PCI Rating</th>
<th>Visible Distress</th>
<th>Maintenance Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>7 – Very Good</strong></td>
<td>Few visible defects, only minor maintenance required</td>
<td>Very high PCI risk, no major maintenance or treatments needed</td>
</tr>
<tr>
<td><strong>6 – Good</strong></td>
<td>No major distress, minor cracking and spalling</td>
<td>Very low PCI risk, no major maintenance or treatments needed</td>
</tr>
<tr>
<td><strong>5 – Fair to Good</strong></td>
<td>Early signs of surface deformation, minor cracking and spalling</td>
<td>Low PCI risk, localized repairs needed</td>
</tr>
<tr>
<td><strong>4 – Fair</strong></td>
<td>Surface deformation evident, minor cracking and spalling</td>
<td>Low PCI risk, localized repairs needed</td>
</tr>
<tr>
<td><strong>3 – Poor to Fair</strong></td>
<td>Moderate to high PCI risk, some distress evident</td>
<td>Moderate to High PCI risk, some distress evident</td>
</tr>
<tr>
<td><strong>2 – Poor</strong></td>
<td>Severe distress evident, major repairs needed</td>
<td>Severe distress evident, major repairs needed</td>
</tr>
</tbody>
</table>

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[ASD DoD PCI & Treatments](#)

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[Asphalt Systems Inc.](#)

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29
DISTRESS IDENTIFICATION

CONDITION RATING

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Preventive Maintenance | Corrective Maintenance | Capital Preventive Maintenance (CAPM) | Major Rehabilitation/Replacement

State 1 | State 2 | State 3 | State 3 | State 3

No Distress | Minor Surface Distress | Poor Ride Only | Minor Structural Distress | Major Structural Distress

**State 1**: Good/excellent condition with few potholes or cracks ⇒ Preventive maintenance project

**State 2**: Fair condition with minor cracking or slab cracking ⇒ Corrective maintenance project

**State 3**: Poor condition with significant to extensive cracks or poor ride only ⇒ CAPM, rehabilitation or reconstruction project

*Figure 1. Pavement Condition States*
This interactive data exchange application (IDEA) tool presents the results of the latest update of the Arizona Airports Pavement Management System. During this project the runway, taxiway, apron, T-hangar, and helipad pavements at selected airports in Arizona were evaluated. This program is organized into the following modules accessible from the tabs above:

- **Inventory Area Summary**—View a summary of pavement inventory area information at the State and individual airport level.
- **Inventory Condition Summary**—View a summary of pavement condition information at the State and individual airport level.
- **Airport Details**—View detailed inventory and condition data for each airport.
- **Pavement Program**—View the Arizona Pavement Preservation Program (APPP) as well as recommendations for major rehabilitation and restriping projects.
- **Maintenance Guidelines**—View general recommendations and FAA guidelines for pavement maintenance.
- **PCI Procedure**—Review background information on the PCI survey method used to assess pavement condition.
- **Miscellaneous**—View definitions of acronyms used throughout the IDEA, and learn about this program as well as Applied Pavement Technology.

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[Brand Logos]
Summary of Area-Weighted PCI by Surface Type and Facility Type

Notes: AAC = asphalt over asphalt concrete, AC = asphalt concrete, APC = asphalt over portland cement concrete, and PCC = portland cement concrete. PHX = Phoenix Sky Harbor International Airport and TUS = Tucson International Airport.

Pavement Condition Index (PCI) Survey Procedure

The inspections were conducted using the PCI survey procedure documented in the following publications:

- The FAA Advisory Circular 150/5380-68, Guidelines and Procedures for Maintenance of Airport Pavements (recently updated and replaced by FAA AC 150/5380-6C)
- ASTM D5345-12, Standard Test Method for Airport Pavement Condition Index Surveys

The PCI procedure is the standard used by the aviation industry to visually assess pavement condition, providing engineers with a consistent, objective, and repeatable tool to represent the overall pavement condition. During a PCI inspection, inspectors record and assess pavement distress, as are distress type, severity, and quantity.

The results of a PCI evaluation provide an indication of the structural integrity and functional capabilities of the pavement. However, it should be recognized that during a PCI inspection only the top layer of the pavement is evaluated.

Visual Representation of PCIs

During a PCI inspection, inspectors identify signs of deterioration on the surface of the pavement. Pavement distresses are characterized in terms of type of distress, severity level of distress, and amount of distress. A PCI number that represents the overall condition of the pavement is determined in numerical terms, ranging from 0 (poor) to 100 (excellent). A visual representation of the PCI scale is illustrated in the figure below.

Pavements with PCIs above 85 will benefit from routine maintenance actions, such as periodic crack sealing, periodic joint resurfacing, or patching.

Pavements with a PCI of 65 (65 for PCC pavements) to 85 may require pavement preservation, such as a surface treatment, thin overlay, or PCC joint resurfacing.

Pavement allowed to deteriorate below a PCI of 55 (55 for PCC pavements) will require costly reconstruction to restore it to operational condition.
### Table 1. Summary of Maintenance Projects Identified Under the Constrained Budget Scenario.

<table>
<thead>
<tr>
<th>Year</th>
<th>Project Airport</th>
<th>Branch</th>
<th>Section</th>
<th>Work Type</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>Phoenix-Mesa Gateway</td>
<td>RW12R30LWG</td>
<td>70</td>
<td>Crack Seal/Rubberized Asphalt Emulsion Seal Coat</td>
<td>$17,327</td>
</tr>
<tr>
<td>2017</td>
<td>Rolle Airfield</td>
<td>TWARL</td>
<td>10</td>
<td>Crack Seal/Rubberized Asphalt Emulsion Seal Coat</td>
<td>$6,663</td>
</tr>
<tr>
<td>2018</td>
<td>Ernest A. Love Field</td>
<td>RW3R21LFR</td>
<td>10</td>
<td>Mill and Replace PFC</td>
<td>$2,724,271</td>
</tr>
<tr>
<td>2018</td>
<td>Ernest A. Love Field</td>
<td>TWKPR</td>
<td>10</td>
<td>Thin Asphalt Overlay/PFC</td>
<td>$43,935</td>
</tr>
<tr>
<td>2018</td>
<td>Page Municipal</td>
<td>TWAPM</td>
<td>20</td>
<td>Crack Seal/Rubberized Asphalt Emulsion Seal Coat</td>
<td>$12,006</td>
</tr>
<tr>
<td>2018</td>
<td>Springerville Municipal</td>
<td>TWBSP</td>
<td>20</td>
<td>Thin Asphalt Overlay/PFC</td>
<td>$9,931</td>
</tr>
<tr>
<td>2019</td>
<td>Benson Municipal</td>
<td>A01BN</td>
<td>30</td>
<td>Crack Seal/Rubberized Asphalt Emulsion Seal Coat</td>
<td>$3,214</td>
</tr>
<tr>
<td>2019</td>
<td>Grand Canyon National Park</td>
<td>TWPGC</td>
<td>10</td>
<td>Thin Asphalt Overlay/PFC</td>
<td>$1,568,237</td>
</tr>
<tr>
<td>2019</td>
<td>Phoenix Deer Valley</td>
<td>TWSRDV</td>
<td>10</td>
<td>Thin Asphalt Overlay/PFC</td>
<td>$16,686</td>
</tr>
<tr>
<td>2019</td>
<td>Phoenix Deer Valley</td>
<td>TWSRDV</td>
<td>30</td>
<td>Thin Asphalt Overlay/PFC</td>
<td>$17,538</td>
</tr>
<tr>
<td>2020</td>
<td>H.A. Clark Memorial Field</td>
<td>A02WI</td>
<td>30</td>
<td>Crack Seal/Rubberized Asphalt Emulsion Seal Coat</td>
<td>$1,904</td>
</tr>
<tr>
<td>2020</td>
<td>Show Low Regional</td>
<td>TWA4SL</td>
<td>10</td>
<td>Crack Seal/Rubberized Asphalt Emulsion Seal Coat</td>
<td>$20,841</td>
</tr>
<tr>
<td>2020</td>
<td>Show Low Regional</td>
<td>TWA4SL</td>
<td>20</td>
<td>Crack Seal/Rubberized Asphalt Emulsion Seal Coat</td>
<td>$14,172</td>
</tr>
</tbody>
</table>

**Total Estimated Cost for 2017:** $23,990

**Total Estimated Cost for 2018:** $2,790,142

**Total Estimated Cost for 2019:** $1,605,676

**Total Estimated Cost for 2020:** $36,917

**Total Estimated Cost:** $4,456,724

---

**Figure 3. Arizona airport PCI values versus APPP funding levels.**
- 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. Year

Before Photograph @ Mt. Airy 2008 – Typical GA in NC
Advisory Circular 150/5370-10G
Standards for Specifying Construction of Airports

‘P’ Items related to asphalt pavement surface treatments:

- **P-608 Emulsified Asphalt Seal Coats / Natural Asphalt Sealer Binders** (new, added)
- P-609 Seal Coats and Bituminous Surface Treatments (standard chip seal)
- P-626 Emulsified Asphalt Slurry Seal Surface Treatment
- P-629 Thermoplastic Coal-Tar Emulsion Surface Treatments
- P-630 Refined Coal Tar Emulsion Without Additives, Slurry Seal Surface Treatment
- P-631 Refined Coal Tar Emulsion With Additives, Slurry Seal Surface Treatment
- P-632 Bituminous Pavement Rejuvenation

Including Engineering Briefs:
- DRAFT EB7X Rejuvenation Product Qualification Procedure and Requirements - Draft
- DRAFT EB 68 Four Component Coal-Tar Sealer Rejuvenator
- EB 62 Polymer Composite Micro-Overlay for Fuel-Resistant Wearing Surfaces
- EB 60 Semi-Flexible Wearing Course for Apron Pavement
- EB 44 Coal-Tar Sealer/Rejuvenator
- EB44B Revised Coal-Tar Sealer/Rejuvenator Specification
- EB35A Thermoplastic Coal-Tar Emulsion Slurry Seal

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[Image of logos: ASI, ACC, LUNCH + LEARN]
Table 8. Maintenance Strategy Cost Table

<table>
<thead>
<tr>
<th>Maintenance Strategy</th>
<th>Cost per Year</th>
<th>Cost per SqYd</th>
<th>Avg Useful Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Seal - Fog Seal</td>
<td>$0.50</td>
<td>$0.50</td>
<td>1</td>
</tr>
<tr>
<td>Surface Seal - Rejuvenating</td>
<td>$0.75</td>
<td>$0.75</td>
<td>1</td>
</tr>
<tr>
<td>Surface Seal - Emulsified Asphalt Seal Coat</td>
<td>$0.38</td>
<td>$0.75</td>
<td>2</td>
</tr>
<tr>
<td>Surface Treatment - Modified Seal Coat</td>
<td>$0.33</td>
<td>$1.00</td>
<td>3</td>
</tr>
<tr>
<td>Surface Treatment - GSB-88 Sealer Binder</td>
<td>$0.25</td>
<td>$1.00</td>
<td>4</td>
</tr>
<tr>
<td>Surface Treatment - Slurry Seal</td>
<td>$0.50</td>
<td>$1.50</td>
<td>3</td>
</tr>
<tr>
<td>Surface Treatment - Single Chip Seal</td>
<td>$0.67</td>
<td>$2.00</td>
<td>3</td>
</tr>
<tr>
<td>Micro Surfacing</td>
<td>$0.56</td>
<td>$2.25</td>
<td>4</td>
</tr>
<tr>
<td>Overlay - AC Thin (Global)</td>
<td>$2.38</td>
<td>$19.00</td>
<td>8</td>
</tr>
<tr>
<td>Patching + Crack Sealing + or Surface Treatment</td>
<td>$1.35</td>
<td>$6.75</td>
<td>5</td>
</tr>
</tbody>
</table>

Note: OL is cost by condition from PAVER where condition being 5 PCI below min. i.e. RW is a 70 therefore cost from table is average of the cost at 70 and 60.
P-608 Emulsified Asphalt Seal Coat

This specification covers the requirements for emulsified asphalt surface treatments (not coal tars products) for taxiways and runways with the application of a suitable aggregate to maintain adequate surface friction; airfield secondary and tertiary pavements including low-speed taxiways, shoulders, overruns, roads, parking areas, and other general applications with or without aggregate applied.

The emulsified asphalt seal coat and sealer binder may be applied to new asphalt pavement and pavements in fair or better condition as defined in ASTM D5340 or advisory circular (AC) 150/5320-17, Airfield Pavement Surface Evaluation and Rating (PASER) Manuals.

Emulsified asphalt surface treatment composed of:

- An emulsion of natural* and refined asphalt materials,
- Additional dilution with Water, and if specified,
- A polymer additive.

For taxiways and runways, aggregate shall be:

- Dry, clean, dust and dirt free,
- Sound, durable, angular shaped manufactured specialty sand (such as that used as an abrasive),
- A Mohs hardness of 6 to 8,
- A specified percent retained gradation
- *The asphalt material base residue shall contain not less than 20% gilsonite, or uintaite and shall not contain any tall oil pitch or coal tar material.
FAA P-608 (Gilsonite Sealer)

- New AC 150/5370-10G effective in July 2014.
- Item P-608, Emulsified Asphalt Sealcoat (Gilsonite), specification met with GSB-88. **Only sealcoat approved for runways. Can also be used for taxiways, aprons, ramps, and all other asphalt pavements.**
- 150/5320-12C : Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces. **Requires test-strips to measure seal-coat skid resistance on runways.**
EXISTING PAVEMENT
OXIDIZED, RAVELED,
SURFACE CRACKING

PAVEMENT IS SEALED
BINDER IS PROTECTED
GSB-88, rejuvenate, seal, and protect the existing asphalt binder. Historical life cycle 4 – 6 years.
ONE–PASS Process
Lightly sanded - 0.25 to 0.50 lb sy
Clean, dry, angular silica sand
Black beauty or black slag
THIS METHOD INCORPORATES THE SAND INTO THE TREATMENT
Excellent Friction
Asphalt cracksealants are compatible
GSB-88 Product Description

- Complex asphalt emulsion
- Cationic emulsion
- Contains 20% Gilsonite
- Surface oxidation retardant
- Rebinding agent
- Sealant
- Surface rejuvenator, penetrates
- Cosmetically enhancing
- Applied as a fog seal
Gilsonite is a natural, resinous hydrocarbon

- TERMED – NATURAL ASPHALT
- Petrified crude
- Mined in Utah
- 99.85% free from impurities, safe, non-toxic
- High molecular weight
- High Nitrogen Content
- Balanced Asphaltenes & Maltenes
- Discovered in the 1860’s
- First mined in the 1880’s
- Easily crushed into a powder
- Gilsonite is added to base stock asphalt
- All the good stuff is still in it!
Modified Asphalt can be complex
Gilsonite & Asphalt  possible interactions
GSB-88 is Cationic

Contact of emulsion with aggregate.

Adsorption of 'free' emulsifier.

Electrophoresis of droplets to surface.
Cationic is best: adhesion, break, cure.

Cat-ion

is pozzitively charged
Standard sealers sit on top of the pavement. May crack, peel, allowing water infiltration, compromising any sealing.
GSB-88 seal won’t crack
608-3.6 Sanded Applications

- ASI recommends ramps, taxiways, and runways be sanded. Sanded applications provide adequate friction to ensure proper measure of safety.
608-3.6 SANDING – SANDING UNITS

608-3.6 The sanding shall be done during the application of the sealant material. In the areas where hand work is done, if required by the engineer, sanding material shall be applied before the sealant begins to break. Sand will be applied at a rate of 0.25 to 0.50 pounds per square yard as determined by the engineer or the sealant Manufacturer Representative.
PURPOSE.

This advisory circular (AC) contains guidelines and procedures for the design and construction of skid-resistant pavement, pavement evaluation with friction measuring equipment, and maintenance of high skid-resistant pavements.
# Friction Level Classification for Runway Pavement Surfaces

<table>
<thead>
<tr>
<th></th>
<th>40 mph</th>
<th>60 mph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mu Meters</td>
<td>.42</td>
<td>.52</td>
</tr>
<tr>
<td>Dynatest Consulting, Inc. Runway Friction Tester</td>
<td>.50</td>
<td>.60</td>
</tr>
<tr>
<td>Airport Equipment Co. Skiddometer</td>
<td>.50</td>
<td>.60</td>
</tr>
<tr>
<td>Airport Surface Friction Tester</td>
<td>.50</td>
<td>.60</td>
</tr>
<tr>
<td>Airport Technology USASafegate Friction Tester</td>
<td>.50</td>
<td>.60</td>
</tr>
</tbody>
</table>
“The application of surface treatments on airfield pavement carries the potential reduction in pavement friction and subsequent maintenance for skid-resistant airport pavement surfaces.”

“Friction data from Skid Resistance testing performed at NAS Fallon, for example, indicated the friction coefficient was reduced from ~ 0.77 Mu to ~ 0.56 Mu after 24 hours, which was better than anticipated and above 0.50 Mu, the required minimum for asphalt pavement.”
“After 4 days the average was ~ 0.7 Mu, and after 3 months, back to ~ 0.77 Mu. Additional friction testing produced similar satisfactory results. Graph below depicts actual friction testing for GSB-88 runway and taxiway applications. As can be seen, an initial drop in friction is followed by an immediate recovery to near previous numbers and a continued progressive increase in friction.”
Friction / Skid Resistance
Airport Markings
Airport Markings

• Recommend painting specifications match painting over a new overlay, temporary markings, full paint application to follow after xx number of days.
Early Stage Preservation
Appropriate Applications
Preserve Previous Surface Treatments

Micro’s and Slurry Seals
Oxidized & Raveled Pavements

Rejuvenate
Seal
Protect
Grooved Pavements
PROJECT PROFILE: FALLON NAVAL AIRSTATION
THE PROBLEM

“Runway 31L/13R was prematurely deteriorating due to binder failure, the runway was taken out of service”
GSB-88 was applied to the runway at a rate of 0.22 gal square yard of 2:1 dilute along with approximately 0.45 lbs square sy
THE RESULT
ONE YEAR AFTER

Advanced Pavement Preservation

asphalt-systems-inc.
ENVIRONMENTALLY RESPONSIBLE

• Environmental Product Declaration (EPD) No other asphalt preservation product has ever been subjected to this intense and comprehensive process.
• GreenCircle Certification - GreenCircle’s rigorous evaluation process provides independent, third party verification that claims of sustainable aspects of products and operations are valid.
Instead of casually calling GSB-88 a "Green" product, GSB-88 was submitted for a rigorous year long Life Cycle Assessment (LCA) to determine whether a product is truly green.

- Tested under the strict International Organization for Standardization (ISO) guidelines
- Examined manufacturing activities
- Procurement of raw materials
- Performance of the product
- Excess waste disposal
- Recyclability
GreenCircle
Certification System

GreenCircle Certified, LLC certifies that an independent, third-party evaluation has been conducted for:

Asphalt Systems, Inc.
GSB-88®
Salt Lake City, UT

One application of GSB-88® every five years can extend the lifetime of a road and have the following environmental impact reductions on a road:

- Global Warming - 49.15%
- Acidification - 48.44%
- Eutrophication - 49.31%
- Ecotoxicity - 35.64%
- Smog - 49.38%

These impact results are based on a published EcoInvent LCA study on an average road in Switzerland that has been adapted to United States road conditions. US road conditions last half as long as in Europe; therefore, a 20 year lifetime for the sub-base was assumed. The impacts from the sub-grade was excluded from this analysis. Each application is assumed to extend the life of a road by 5 years.

Certification Period: June 1, 2012 – May 31, 2013
Certificate Number: 12-0131

Tad Radzinski, PE, LEED AP
Certification Officer
Questions
Future ACC Events

Reaching for the Stars

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Future ACC Institute Courses

• **Airfield Pavement Design, Evaluation & Analysis Workshop**
  December 14-17, 2015
  Salt Lake City, UT

• **Construction Administration & Observation Course**
  January 26-27, 2016
  Philadelphia, PA
Survey

www.surveymonkey.com/r/AsphaltPavements
For More Information

Contact:
John Hunter
john@asphaltsystemsinc.com

Thank You!
ACC ASI Webinar: Life Extension of Airport Asphalt Pavement, June 24, 2015

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