Airport Pavement Management and Pavement Preservation

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Presentation

• Setting the Stage: Pavement Management and Maintenance Programs
• Why Bother?
• Overview of Airport Pavement Management
• Overview of Preventive Maintenance
• Resources
What Is Pavement Management?

• Pavement management is a tool to
  – Maintain pavement inventory
  – Monitor pavement condition
  – Identify pavement-related needs
  – Prioritize pavement-related work
  – Select most cost-effective repair strategy
  – Communicate pavement-related needs
What Is A Maintenance Program

Coordinated, budgeted, and systematic approach to both preventive and remedial maintenance
Why Bother?

- Investment
- Escalating Costs
- Uncertain Funding
- Safety
- Compliance
Investment

- Hypothetical calculation:
  - Assume 4500 paved runways with square footage of approximately 2.5 billion
  - Double that amount to include taxiways and aprons and you have 5 billion sf
  - If it costs on average $25 per sf to replace just pavement …
  - The grand total would be $113 billion
Increasing Costs and Uncertain Funding

• Have your costs gone up in the past 5 years for pavement work?
• Has your funding stream been stable?
• How do future funding levels look?
Safety Issues

• Hydroplaning
• Loss of friction
• FOD
• Tire damage potential
• Loss of steering control
• Pavement drop-offs
Compliance Issues

- Safety (Grant Assurance 19)
- Pavement Maintenance Management (Grant Assurance 11)
Grant Assurance 19. 
Operations and Maintenance

“The airport and all facilities which are necessary to serve the aeronautical users of the airport...shall be operated at all times in a safe and serviceable condition and in accordance with the minimum standards ...”
Part 139.305 Paved Areas

- 3 inch pavement drop-off
- Holes exceeding 3 inches in depth
- Hole where the slope from any point in hole to nearest point at lip of hole is $\geq 45$ degrees
- Cracks or surface variations that could impair directional control of aircraft
- FOD
- Ponding that obscures markings or impairs safe aircraft operations
Grant Assurance 11.

Pavement Preventive Maintenance

“With respect to a project … for the replacement or reconstruction of pavement …, it assures or certifies that it has implemented an effective airport pavement maintenance-management program and it assures that it will use such a program for the useful life of any pavement constructed, reconstructed or repaired with Federal financial assistance at the airport.”
Grant Assurance 11
Requirements

• Pavement Inventory
• Pavement Inspections
  – Detailed
  – Drive-by
• Record Keeping
• Information Retrieval
• Program Funding
Pavement Inventory

- Location of all runways, taxiways, and aprons
- Dimensions
- Type of pavement
- Year of construction or of recent major rehabilitation
- Whether Federal financial assistance was used to construct, reconstruct, or repair the pavement
Pavement Inspections

• Detailed Inspections
  – Identify type of distress and estimate quantity of distress
  – If PCI as part of pavement management, every 3 years satisfactory
  – If not PCI, required annually

• Drive-By Inspections
  – Minimum once per month to detect unexpected changes in pavement condition
Record Keeping

• Detailed Inspection
  – Inspection date, location, distress types, maintenance scheduled or performed

• Drive-By Inspection
  – Inspection date and maintenance scheduled or performed

• Material and equipment used to perform maintenance

• Must keep on file minimum of 5 years
Information Retrieval

• You may use any form of record keeping you deem appropriate as long as you can retrieve the necessary information for the FAA.
Program Funding

• Identify funding resources available to provide remedial and preventative maintenance activities
Once upon a time …

- FAA funded major rehabilitation, reconstruction, and new construction without requiring an airport to preserve its existing pavement infrastructure.
- Those times are long gone.
- If you want to receive federal funding you must show that you have maintained your pavement in a fiscally responsible manner.
Overview of Airport Pavement Management
Pavement Management Philosophy

- Cost-Effective Time for Preventive Maintenance
- Cost-Effective Time for Rehabilitation
- Costly Time for Rehabilitation

Excellent vs. Failed vs. Age
Pavement Management System Components

- Inventory
- Condition
- Database
- Analysis
- System Outputs
- Feedback Loop
Systems Inventory

- Identify Pavement Areas to Include
- Determine Type of Data to be Collected
- Identify Sources of Information
- Gather and Compile Data
Network Definition

- Network
- Branches (facilities)
- Sections (features)
- Sample Units
Pavement Condition Assessment

AC 150/5380-6B2-1: “airport pavements are designed, constructed, and maintained to support the critical loads... and to produce a smooth, skid-resistant, and safe-riding surface”

These do not always co-exist!
Evaluation Techniques

- Visual
- Geotechnical
- Falling Weight Deflectometer
- Dynamic Cone Penetrometer
- Ground Penetrating Radar
- Roughness
- Friction
Visual Inspection Using Pavement Condition Index (PCI) Procedure

- Visual signs of distress are identified and measured.
- Documented in AC 150/5380-6B and ASTM D5340.
PCI Scale

 PCI Scale

 Preventive Maintenance

 Major Rehabilitation

 Reconstruction

 PCI
 100
 85
 70
 55
 40
 25
 10
 0

 applied pavement technology
providing engineering solutions to improve pavement performance
PCI Limitations

- No direct data on underlying pavement structure.
- No direct measure of structural capacity.
Geotechnical Investigation

- Pavement layer thicknesses
- Bonding condition between layers
- Evaluation of underlying pavement condition
- Pavement layer strengths
- Subgrade characteristics
Petrographic Investigation

• Determine presence of deleterious reactions
  – Alkali-silica reactivity
  – Sulfate attack
  – Ettringite formation

• Determine void structure
Dynamic Cone Penetrometer Testing

- Measure in situ strength of paving materials and subgrade soils (can be correlated with CBR value)
- Determine layer boundaries
Ground Penetrating Radar Testing

- Pavement cross sections
- Delaminations
Falling Weight Deflectometer (FWD) Testing

FWD imparts dynamic force on pavement and measures resultant deflections.
FWD Testing (cont.)

- Assess pavement deflections
- Backcalculate material properties
- Determine structural integrity and load-carrying capacity
- Provide inputs for the structural analysis
- Identify localized areas of weakness
Friction Testing

Monitor pavement skid resistant characteristics by measuring the coefficient of friction between the pavement and the tires on the testing device.
Roughness Assessment

• Historically determined by pilot complaints
• Now specialized equipment and software designed to evaluate airport pavement roughness and the response of aircraft to pavement roughness is available
Database Development

- Inventory
- Condition
System Customization

- Database Fields
- Prioritization Rules
- Performance Models
- Repair Alternatives
- Unit Costs

providing engineering solutions to improve pavement performance
Development of a Pavement Program

- Assess current and project future pavement condition throughout the airport.
- Develop plan to address immediate “reactionary” needs, preservation needs, and long term rehabilitation needs.
Timing of Different Repair Strategies

- Preventive Maintenance
- Reactive Maintenance
- Rehabilitation

Pavement Condition vs. Time or Traffic
Factors Affecting Pavement Performance

- Traffic
- Design
- Construction Variability
- Materials
- Subgrade Soil
- Maintenance and Rehabilitation
- Environment
Load-Related Distresses

Load → Plastic Deformation → Rutting → Fatigue Cracking
Alligator (Fatigue) Cracking

Most commonly observed at commercial-service airports. However, it is not uncommon at general aviation airports in fueling areas or along edge of pavement where mowing equipment operates.
Rutting

A rut is a surface depression in the wheel path, usually caused by consolidation or lateral movement of the materials due to traffic loads.
What Can You Do To Address Load-Related Distresses?

- Pavement strength is inadequate for the loadings it is receiving and this must be corrected through major rehabilitation, such as overlays or reconstruction
- Preventive maintenance actions such as surface treatments and crack sealing are not appropriate or cost-effective
Environment/Aging-Related Distresses

Environment/Aging

Asphalt Hardening

Cracking

Raveling/Weathering
Longitudinal and Transverse (L & T) Cracking

L & T cracks may be caused by 1) poorly constructed paving lane joint, 2) shrinkage of the AC surface caused by oxidation and age hardening of the asphalt, 3) contraction caused by thermal fluctuations, 4) deflection of surface over an unstable foundation, or 5) a reflective crack caused by cracks beneath the surface course.
Block Cracking

Block cracking is very common at general aviation airports.
Weathering and Raveling
How to Address Environmental/Aging Related Distresses?

- Preventive maintenance techniques are very cost-effective if applied early in the deterioration cycle
  - Surface treatments
  - Crack sealing
Material/Mix-Related Distresses
What Can You Do To Address Materials/Mix Related Distresses?

• Preventive maintenance will not correct these types of distresses
• Removing the bad material and replacing it with good material is the only long-term solution
Water-Related Distresses

• Factors Influencing Drainage
  – Subsurface moisture
  – Infiltrated moisture
  – Surface removal
Water/Poor Drainage Related Distresses

Cracks
+ Moisture
Infiltration

Breakdown of Existing Cracks
Water/Poor Drainage Related Distresses

Cracks + Moisture Infiltration → Subgrade Softening

Potholes, loss of fines, swelling, and edge cracking are all related to moisture in the pavement system.
What can you do to address water-related distress?

• Subsurface Drainage
  – Best to consider subsurface drainage during design
  – Difficult to rectify after construction
  – Keep drains clean and functional

• Surface Infiltration
  – Crack sealing
What can you do to address water-related distress (continued)?

• Standing Water
  – Avoid “bathtub” effect by making sure ground around pavement edge not built up
Back to Preparing Pavement Program

- Is pavement structurally adequate?
- Is pavement functionally adequate?
- Is the rate of deterioration normal?
- Are the materials durable?
- Is drainage adequate?
- Has previous maintenance been normal?
- Do other features require upgrading?
Report Generation and Training

• Reporting
  – Traditional reports
  – Internet access

• Training
  – Pavement condition assessment
  – Pavement management
  – Pavement management software
  – M&R techniques and materials
Feedback Cycle and System Updates

• Feedback Cycle

• System Updates
  – Update inventory portion of database
  – Periodically reevaluate condition of pavements
  – Refine performance models
  – Update unit cost information, feasible repair strategies, and so on
  – Obtain refresher software training
Preventive Maintenance
Preventive Maintenance

• Planned strategy of treatments to:
  – Slow surface aging and environmental cracking
  – Keep moisture out of pavement system
    ➢ Reduce infiltration
    ➢ Maintain drainage
  – Reduce debris infiltration into cracks
Definitions Applied

- **Good**
  - Preventive Maintenance
- **Poor**
  - Routine/Corrective Maintenance

- Pavement Condition
- Time

- Pavement Preservation
- Reconstruction

- Providing engineering solutions to improve pavement performance
Preventive maintenance is not appropriate for pavements with structural deterioration.
Preventive maintenance is not appropriate for pavements with certain types of materials-related distress.
Preventive Maintenance Actions

• Crack and joint sealing
• Surface treatments
• Patching (not always preventive)
• Vegetation control
• Shoulder blading
• Restriction of heavy loads
• Cleaning up fuel and other spills
Crack Sealing
Purposes of Crack Sealing

- Reduce moisture infiltration
  - Stripping
  - Cupping
  - Delamination
- Reduce incompressibles filling cracks
- Provide support to adjacent pavement
- Prepare existing pavement for HMA overlay
Factors Affecting Crack Sealing Performance

- Candidate pavement
- Sealant material
- Crack configuration
- Preparation method
- Application method
- Quality control
Ideal Application Conditions

• Good base support
• Little or no secondary cracking
• Little or no raveling at crack face
• Moderate temperatures
• Proper preparation (clean and dry)
Would You Seal This?
Joint Sealing
Purpose of Joint Sealing

- Reduce moisture infiltration
- Prevent intrusion of incompressibles
- Reduce infiltration of deicing chemicals

And reduce the occurrence of distresses associated with these conditions.
Guidelines for Resealing Joints

• When existing sealant no longer functional

• Most effective when:
  – Pavement is not severely deteriorated
  – Performed with other restoration activities

• Moderate installation temperatures

• Proper joint preparation is essential
Surface Treatments
Introduction to Selected Surface Treatments

• Application of asphalt emulsion with or without aggregate

• Treatment differences
  – Emulsion type
  – Use of aggregate
  – Method of embedment
  – Fuel spill resistance

• Application rate, timing, and construction quality are critical
Performance Benefits

- Slow aging process
- Waterproof surface
- Prevent stone loss
- Increase surface friction
- Improve surface appearance
Surface Treatments

Good Candidate Projects

- No unstable rutting
- No fatigue cracking
- No severe bleeding
- Cracks with minimal movement
Preventive Maintenance Actions

Kill vegetation.
Preventive Maintenance Actions

- Maintain good drainage.

Buildup of soil and vegetation along the edge of pavement traps water. Grade shoulders to reestablish good drainage.
Preventive Maintenance Actions

- Control loadings
  - Construction equipment
  - Fuel trucks
  - Mowing equipment
  - Snow plow equipment
  - Air shows
Preventive Maintenance Actions

• Don’t ignore solvent spills.
  – Continuous fuel spillage on a bituminous surface will soften the asphalt. Unaddressed, it can cause serious damage to pavement.
Resources

• AIP Handbook (Order 5100.38C)
• AC 150/5380-6B: Guidelines and Procedures for Maintenance of Airport Pavements
• ASTM Standard D5340: Airfield PCI Procedure
• AC 150/5320-5: Airport Drainage
• AC 150/5320-6E: Airport Pavement Design and Evaluation
Resources (cont.)

• FAA AC 150/5370-10B Standards for Specifying Construction of Airports
• UFC 3-270-02 O&M: Asphalt Crack Repair
Resources (cont.)

- AEMA (www.slurry.org)
Resources (cont.)

Resources (cont.)


Questions

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