Implementing An effective Airport Pavement Management System

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Content

- What is Pavement Engineering
- Why Airports Pavement Management System
- Building Airports Pavement Management System
- Conclusion
Our Airports

TODAY...

Traffic Growth
Funding
Environment
Aging

Airports Expansion
New Aircrafts
<table>
<thead>
<tr>
<th>Pavement Engineering</th>
<th>Pavement Materials</th>
<th>Classification, quality assurance testing (specifications), material design</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pavement Design</td>
<td>Design of Structural layers for New Pavements and Pavement Rehabilitation Assess in-situ pavement material properties and layer thickness</td>
</tr>
<tr>
<td></td>
<td>Pavement Construction</td>
<td>Construction practices of New Pavements and Pavement Rehabilitation including specification development and quality assurance</td>
</tr>
<tr>
<td></td>
<td>Pavement Management</td>
<td>Monitoring Post-construction condition, timing preventive preservation and rehabilitation treatments, and economic analysis of alternatives</td>
</tr>
<tr>
<td></td>
<td>Pavement Research</td>
<td>Research to improve all of the above</td>
</tr>
</tbody>
</table>
Why do we need to “Manage” our Pavements?

- To preserve our infrastructure value
  - Key component of the asset Management

- To develop “optimum” pavement preservation and renewal programs
  - Better Use of Available Resources

- To provide a level of service that the user considers appropriate
  - State of Good Repair

Okay, Maybe We Can’t Let it Go for a Few More Years
Pavement Maintenance Management Basic Questions

- Where ?
Where to maintain my pavement network

- When ?
When should be maintained

- How ?
How it should be maintained
A Pavement Management System (PMS) is designed to provide objective information and useful data for analysis so that Airports Pavement managers can make more consistent, cost-effective, and defensible decisions related to the preservation of Airport pavement.
An airport’s Pavement Management System (APMS) not only evaluates the current condition of the airfield pavements, but also predicts its future condition.

By projecting the rate of deterioration, a life cycle cost analysis can be made for various maintenance alternatives.

Determine the optimal time for applying the best alternative.
Airports Pavement Management - Subsystems

- **Goals & Policies**
  - Performance measures
  - Budget
  - Guide analytical process
  - City specific

- **Inventory / Data Collection**
  - Network Definition
  - NDT and inspection
  - Storage / retrieval
  - Analysis (GIS, GPS)

- **Condition Assessment**
  - Deterioration modeling
  - Performance modeling

- **Alternative Evaluation**
  - Trade-off analysis
  - Cost/benefit analysis
  - Life Cycle Cost
  - Risk Analysis

- **Selection and implementation**

- **Monitoring / Feedback**
Pavement Management System – Business Process

INFORMATION MANAGEMENT

DATABASE

CONDITION

USAGE

MAINTENANCE STRATEGIES

INVENTORY

FEEDBACK

PERFORMANCE MONITORING

WORK PROGRAM EXECUTION

STRATEGIC ANALYSIS

Goals & Policies
Performance /Economic / Social & Environmental

Budget Allocations

NETWORK-LEVEL ANALYSIS TOOLS

CONDITION ASSESSMENT

PERFORMANCE PREDICTION

NEEDS ANALYSIS

PRIORITIZATION / OPTIMIZATION

PROGRAMMING (PROJECT SELECTION)

PROJECT LEVEL ANALYSIS (Design)

NETWORK-LEVEL REPORTS
Performance Assessment Network Needs Facility Life-cycle Cost Optimized M&R Program Performance-based Budget

GRAPHICAL DISPLAYS

CONSTRUCTION DOCUMENTS
Pavement Definition and Inventory

- Create a database of all airfield pavement:
  - Runway
  - Taxiway,
  - Apron
  - other aircraft movement areas

- Provides a basis for budget development, and maintenance program.
- Airport Name
- Feature (Runway, Taxiway, Apron)
- Feature Identification Number
- Length and Width
- Pavement Type, Structure
- Shoulder Type and Width
- Marking
- Number of daily operations and type of aircrafts using the pavement.

- Necessary when analyzing probable causes of the deterioration and when to consider alternatives M&R procedures.
- Mapping the airfield pavement structural composition (material and thickness), subsequent overlays, rehabilitation, etc.

- “As-built” records should provide this information; or coring of the pavement section
History of maintenance performed and its associated cost "provide valuable information on the effectiveness of various maintenance procedure on the different airport pavements".

The cost of each maintenance project is necessary when performing lifecycle analysis.
Pavement Definition and Inventory - pavement definition

- Network (individual airport)
- Branches (Runway, Taxiway, Apron)
- Sections (Location, Construction type, Maintenance History, Traffic, condition)
- Sample Units (Inspection unit)

<table>
<thead>
<tr>
<th>Pavement Designation</th>
<th>Section Number</th>
<th>Sample Unit Number</th>
<th>Subdivision</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1634</td>
<td>02</td>
<td>03</td>
<td>C</td>
</tr>
<tr>
<td>Runway 16-34</td>
<td>Section 02</td>
<td>Sample 3</td>
<td>Central</td>
</tr>
</tbody>
</table>

Branch ID:

- Section ID
Pavement Definition and Inventory
Airport Pavement Condition Survey

- Assessing the current pavement condition of the Analysis Sections
- Basis for the performance and economic analysis.
- Maintenance Programs
- Assess the state of being, or readiness for use.

Determining the “health” of the network.
Pavement Condition “Quality measures and Performance Indicators “

- **Physical Condition**
- **Service and User Perception**
- **Structural Integrity / Load-Carrying Capacity**
- **Safety and Sufficiency**
- **Pavement Layer Structure**

Distress (PCI)
Roughness (PSI, IRI)
Deflection (FWD)
Friction (FN)/Macro texture
Pavement Subsurface
Surface of the pavement is evaluated manually, or automated equipment to identify:

- Type of distress
- Severity.
- Quantity or extent of distress present on the pavement surface.
Standards:

- Federal Aviation Administration's (FAA's) Advisory Circular (AC) 150/5320 -6E, Airport Pavement Design and Evaluation

- ASTM D5340 - 12: Standard Test Method for Airport Pavement Condition Index Surveys

<table>
<thead>
<tr>
<th>Distress Type</th>
<th>PCI Range</th>
<th>PCI Ratings and Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOOD</td>
<td>06-100</td>
<td>GOOD: Pavement has minor or no distresses and should require only routine maintenance</td>
</tr>
<tr>
<td></td>
<td>71-85</td>
<td>SATISFACTORY: Pavement has scattered low-severity distresses that should require only routine maintenance</td>
</tr>
<tr>
<td>FAIR</td>
<td>55-70</td>
<td>FAIR: Pavement has a combination of generally low- and medium-severity distresses. Near-term maintenance and repair needs may range from routine to major</td>
</tr>
<tr>
<td>POOR</td>
<td>41-55</td>
<td>POOR: Pavement has low-, medium-, and high-severity distresses that probably cause some operational problems. Near-term M&amp;R needs range from routine to major</td>
</tr>
<tr>
<td></td>
<td>26-40</td>
<td>VERY POOR: Pavement has predominantly medium- and high-severity distresses that cause considerable maintenance &amp; operational problems. Near-term M&amp;R needs will be major</td>
</tr>
<tr>
<td></td>
<td>11-25</td>
<td>SERIOUS: Pavement has mainly high-severity distresses that cause operational restrictions. Immediate repairs are needed</td>
</tr>
<tr>
<td></td>
<td>0-10</td>
<td>FAILED: Pavement deterioration has progressed to the point that safe aircraft operations are no longer possible; complete reconstruction is required</td>
</tr>
</tbody>
</table>
Pavement Condition Survey – Pavement condition index

Pavement Condition Index (PCI) Runway: 16L/34R

<table>
<thead>
<tr>
<th>Section No.</th>
<th>PCI Index</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>83</td>
<td>Very Good</td>
</tr>
<tr>
<td>1B</td>
<td>51</td>
<td>Fair</td>
</tr>
<tr>
<td>1C</td>
<td>68</td>
<td>Good</td>
</tr>
<tr>
<td>2A</td>
<td>75</td>
<td>Very Good</td>
</tr>
<tr>
<td>2B</td>
<td>62</td>
<td>Good</td>
</tr>
<tr>
<td>2C</td>
<td>72</td>
<td>Very Good</td>
</tr>
<tr>
<td>3A</td>
<td>61</td>
<td>Good</td>
</tr>
<tr>
<td>3B</td>
<td>50</td>
<td>Fair</td>
</tr>
<tr>
<td>3C</td>
<td>64</td>
<td>Good</td>
</tr>
</tbody>
</table>
Runway roughness evaluation to be carried out in accordance to the guideline by the FAA Advisory AC no. 150/5380 – 9
  - International Roughness Index (IRI)
  - Boeing Bump Index (BBI)
Pavement Condition Survey - Skid Resistance

- Assessment of the Coefficient of Friction of the wet Pavement Surface.
- Evaluations to be carried out in accordance with the FAA AC 150/5320-12
Pavement Condition Survey – Structural Capacity

- Falling Weight Deflectometer (FWD), to measure the vertical deflection response of a surface to an impulse load.

- Calculate pavement properties:
  - Bearing Capacity
  - Layer Thickness
  - E Moduli
  - Expected Surface Life

*ASTM D4694-03 Standard and FAA Advisory circular 150/5370-11A*
GPR in Airport Pavement Management System:

- Thickness of pavement layers
- Reinforcing steel
- Density variations
- Subsurface moisture
- Voids
APMS Performance and Economic Analysis

Prediction Model

- Distress Index
- Years
- Current Time
- Default Distress Model
- Triggers
- Do Nothing
- Pavement Preservation
- Rehabilitation
- Reconstruction

Age vs. PC Index

Eq: PCt = α(1-exp(-γ/Age))/t + β
Eq: PC3 = 1900(1+μ(1900-PC)/23)
Remaining Life Analysis

- Opportune Time to Invest
- Less Dollars to Fix
- More Dollars to Fix
- Condition Index
- Replacement Threshold

Years:
0 5 10 15 18 20 23 25

0 25 50 75 100
Multi Year Treatment Choices and Prioritization

- **APMS Performance and Economic Analysis**

- **Trigger Point for Treatment 1**
  - Age or Traffic Loads
  - Pavement Condition Index

- **Trigger Point for Treatment 2**
  - Preservation
  - Rehabilitation

- **Existing Performance**
- **Treatment 1 in Years X and Z at $ Cost**
- **Treatment 2 in Year Y at $S Cost**
- **Reconstruction**

- **Preservation**
- **Rehabilitation**

- **Age or Traffic Loads**
  - **Pavement Condition Index**
## Treatment Types and Costs

### Preservation Treatments

<table>
<thead>
<tr>
<th>Treatment Type</th>
<th>Cost Per L/ Km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slurry seals</td>
<td>$14,080</td>
</tr>
<tr>
<td>Micro surfacing</td>
<td>$17,600</td>
</tr>
<tr>
<td>High-performance thin overlays</td>
<td>$45,760</td>
</tr>
</tbody>
</table>

### Rehabilitation Treatments

<table>
<thead>
<tr>
<th>Treatment Type</th>
<th>Cost Per L/ km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor (functional): mill 2 in. and overlay 2 in.</td>
<td>$107,430</td>
</tr>
<tr>
<td>Major (structural rehab): mill 2 in. and overlay &gt;2 in.</td>
<td>$154,106</td>
</tr>
</tbody>
</table>

### Reconstruction

<table>
<thead>
<tr>
<th>Treatment Type</th>
<th>Cost Per L/ Km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partial</td>
<td>$422,400</td>
</tr>
<tr>
<td>Full</td>
<td>$689,920</td>
</tr>
</tbody>
</table>
APMS Performance and Economic Analysis

Asphalt Pavement

Pavement Preservation

Do-Nothing

PC Index >=85

PC Index >=60 and <85

PC Index < 60 or below

Load-Associated Structural Deterioration Present

Not Present

Functional Overlay

Minor Rehab

Structural Overlay

Major Rehab

PCI <=20

Reconstruction

Decision Trees/Treatment Rules
Decision Trees/Treatment Rules

Custom PCI Rating Scale

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate</td>
<td>70-100  Do Nothing To Routine Maintenance</td>
</tr>
<tr>
<td>Degraded</td>
<td>55-70   Routine Maintenance To Major Maintenance</td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td>0-55   Serious Major Maintenance To Reconstruction</td>
</tr>
</tbody>
</table>

Field Test Require

- Non Destructive Test
- Degraded and Unsatisfactory
  - FWD Test
  - Skid Resistance Test
  - Roughness Index Test

- Failed
- Pass

- Replace Asphalt Reconstruct
- Thick Overlay
- Thin Overlay
- Contaminants and Rubber Removal
- Mill and Repave
- Thin Overlay
**Policy Decisions** can be based on the **average projected condition** at given budget levels for a single asset or for the entire network.

**Network Performance Budget Scenarios**
- Do nothing
- Spend $1 million
- Spend $3 million

![Graph showing condition vs. age]
APMS Outcome

“The Most Effective Pavement Maintenance Program Through Pavement Life Cycle with the least possible cost “

Budget

<table>
<thead>
<tr>
<th>Section</th>
<th>Year</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>2016</td>
<td>$100,000</td>
</tr>
<tr>
<td>47</td>
<td>2019</td>
<td>$237,999</td>
</tr>
</tbody>
</table>

Current and predicted Airports Pavement Condition

Planning and Statistics

Most cost effective Maintenance Programs
Which Pavement Management System to Select?

Choosing What’s Right for YOU

PAVEMENT MANAGEMENT SYSTEMS

- Data Collection
- Analyses
- Equipment
- Maintenance

Sophistication

$
Conclusion

- There is a need to preserve our airfield pavement network assets.
- Asset Management System is a tool for better assets preservation.
- There is no system that can fit all, each organization should choose the system that meets its needs and challenges.
- It is important to realize that it is not a software but a complete integrated system.
- Feed back and continues improvement.
Thank you