SELECTING A PREVENTIVE MAINTENANCE TREATMENT FOR FLEXIBLE PAVEMENTS

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for

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Presentation Outline

- Background and Objectives
- Establishing a Preventive Maintenance Program
- Framework for Treatment Selection and Timing
- Analysis to Determine the Most Effective Treatment
- Summary
Background

- Pavement Management Systems
  - Most Agencies have one
  - Usually contain maintenance component

- Limitations
  - Models to determine cost effective treatment
  - Most don’t contain proper treatment timing
Types of Pavement Maintenance

- **Preventive (Proactive)**
  - Arrest light deterioration
  - Retard progressive failures
  - Reduce need for corrective maintenance
  - “Right” treatment at the “right” time!

- **Corrective (Reactive)**
  - After deficiency occurs
  - More expensive

- **Emergency**
Typical Variation of Pavement Condition as a Function of Time

- **EXC**: 40% Drop in Quality
- **GOOD**: 75% of Life
- **FAIR**: 40% Drop in Quality
- **POOR**: 12% of Life
- **V. POOR**
- **FAILED**

PM Cost Here is a Fraction of $1.00

$1.00 for Rehab Here

Will Cost $4.00 to $5.00 Here

Typical Variation of Pavement of Pavement Condition as a Function of Time

- **EXC**: 
- **GOOD**: 
- **FAIR**: 
- **POOR**: 
- **V. POOR**: 
- **FAILED**: 

TIME
Study Objectives

- Review existing practices related to selection of appropriate PM strategies
- Develop a framework for selection of the most appropriate PM treatments
- Prepare Summary Report
Establishing a Preventive Maintenance Program

- Number of Technical Components BUT!
- Two most important are non-technical
  - Agency Top Management Commitment
  - Customer Education Program
Elements of a Preventive Maintenance Program

Program Guidelines

Feedback Mechanism

Determine Needs

Develop Analysis Procedures

Framework for Treatment Selection
Elements Flowchart

- Establish Program Guidelines
- Provide Framework for Treatment Selection
- Determine Needs
- Develop Analysis Procedures
- Provide a Feedback Loop to Determine Effectiveness
1. Establish Program Guidelines

- “Policy Manual”
- Contains overall strategies and goals
  - Safety issues
  - Environmental issues
- Program coordinator named
- Technical elements
- Feedback loop
2. Determine Maintenance Needs

- **Condition Survey**
  - Trained observers
  - Automated vehicles
  - Non-destructive testing (FWD, Friction)
  - Cores, slabs

- **Project data**
  - Location, ADT, % trucks, environment, etc.
3. Framework for Treatment Selection

- The “right” treatment at the “right” time on the “right” project

- Amen!
4. Develop Analysis Procedures for the Most Effective Treatment

- A number of procedures for determining cost effectiveness exist and should be used
- Cost should be part of the decision process but not the only consideration
- Use of decision trees is a viable method
5. Feedback Mechanism

- Generally a weakness in many management processes
  - “The boss doesn’t want to hear bad news” syndrome
- Need to know how the system is working
- A tool to adjust the program when needed
Preventive Maintenance Treatments

- Can be effective if used under proper conditions to address distress

- Types of Flexible Pavement distress include:
  - Rutting
  - Cracking (fatigue, block, thermal, etc.)
  - Bleeding
  - Raveling
Crack Sealing

- Used to prevent water and incompressibles from entering the pavement
- Cracks are often routed
- Sealants are only effective for a few years
Fog Seal

- Application of diluted emulsion to enrich the surface
- Primarily used to address raveling, oxidation, and seal minor surface cracks
- Expected life not greater than 3 to 4 years
Chip Seal

- Used to waterproof the surface, seal small cracks and improve surface friction
- Normally used on low-volume roadways, but have been used on high-volume facilities
Thin Cold-Mix Seal

- Treatments include slurry seals, micro-surfacing and cape seals
- Used to fill cracks, increase frictional resistance and improve ride quality
Thin Hot-Mix Overlay

- Treatments include dense-, open and gap-graded mixes
- Used to improve ride quality, increase frictional resistance and correct surface irregularities
## Unit Costs and Expected Life

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Unit Cost ($/SY)</th>
<th>Expected Life (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crack Seals</td>
<td>1.00</td>
<td>1 – 3</td>
</tr>
<tr>
<td>Fog Seals</td>
<td>0.45</td>
<td>2 – 4</td>
</tr>
<tr>
<td>Slurry Seals</td>
<td>0.90</td>
<td>3 – 7</td>
</tr>
<tr>
<td>Microsurfacing</td>
<td>1.25</td>
<td>3 – 9</td>
</tr>
<tr>
<td>Chip Seals</td>
<td>0.85</td>
<td>3 – 7</td>
</tr>
<tr>
<td>Thin HM Overlay</td>
<td>1.75</td>
<td>2 – 10</td>
</tr>
</tbody>
</table>
Framework for Treatment Selection and Timing

- Data/criteria used for developing tools
- Decision tools for treatment selection
  - Decision Trees
  - Decision Matrices
- Benefits/limitations of decision tools
- Optimum timing of treatments
Data/Criteria Considered in Developing Tools

- Pavement type and construction history
- Functional classification or traffic level
- Pavement condition index
- Specific type of deterioration present
- Geometric issues
- Environmental conditions
- Unit costs ?
- Expected life ?
Other Potential Criteria

- Availability of qualified contractors
- Availability of materials
- Time (of year) of construction
- Pavement noise
- Facility downtime
- Surface friction
Typical Decision Tools

- Decision trees
- Decision matrices
### Example HMA Decision Matrix

<table>
<thead>
<tr>
<th>Distress</th>
<th>Severity</th>
<th>Treatment Number and Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Do Nothing</td>
</tr>
<tr>
<td>Flushing/ Bleeding</td>
<td>Moderate</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Severe</td>
<td></td>
</tr>
<tr>
<td>Non-Structural Cracking</td>
<td>Minor</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>3-5</td>
</tr>
<tr>
<td></td>
<td>Severe</td>
<td></td>
</tr>
<tr>
<td>Insufficient Structure</td>
<td>Minor</td>
<td>RL</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>2-6</td>
</tr>
<tr>
<td></td>
<td>Severe</td>
<td></td>
</tr>
<tr>
<td>Bad Ride</td>
<td>Minor</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Severe</td>
<td></td>
</tr>
<tr>
<td>Unstable Base &amp; Subgrade</td>
<td>Minor</td>
<td>RL</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>5-8</td>
</tr>
<tr>
<td></td>
<td>Severe</td>
<td></td>
</tr>
<tr>
<td>Unstable Mix</td>
<td>Minor</td>
<td>RL</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>2-6</td>
</tr>
<tr>
<td></td>
<td>Severe</td>
<td></td>
</tr>
<tr>
<td>Aged Pavement</td>
<td>Minor</td>
<td>08-Apr</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>5-10</td>
</tr>
<tr>
<td></td>
<td>Severe</td>
<td></td>
</tr>
<tr>
<td>Surface Raveling</td>
<td>Minor</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>3-6</td>
</tr>
<tr>
<td></td>
<td>Severe</td>
<td></td>
</tr>
</tbody>
</table>
Benefits and Limitations

- Makes use of experience
- Works well for local conditions
- Good project level tool

- Transferability
- Limits innovation
- Difficult to consider multiple factors
- Difficult to consider multiple distresses
- Avoids thorough LCC analysis
- Not good for network level evaluation
Analysis to Determine the Most Effective Treatment

- Determine cost and life expectancy data for YOUR agency to reflect local conditions
  - Previous projects
  - Pavement Management records

- Perform cost effectiveness evaluation
  - Number of different approaches exist
  - Use Equivalent Annual Cost-simple and effective
EQUIVALENT ANNUAL COST

Equivalent Annual Cost (EAC) = \( \frac{\text{unit cost of treatment}}{\text{expected life, years}} \)
Decision Matrix

- Useful to analyze several variables
- Can take several forms
- Preparation is easy
  - Select potential treatments
  - Compute equivalent annual cost
  - Identify project specific conditions
  - Develop rating factors for each condition
  - Rate the importance of each
  - Compute total score
Example Decision Matrix

- Assumptions
  - Project PCI is 70
  - Cracking low to moderate
  - Surface condition variable
  - Ride quality marginal
  - Projected traffic, 5 years, less than 5K ADT
  - Two lanes, suburban, feeder to strip shopping center
  - Desired life is 7 years
Example Decision Matrix (continued)

- Rating factors
  - Customer satisfaction
  - Performance
  - Constructability
# Treatment Analysis Worksheet

<table>
<thead>
<tr>
<th>RATING FACTOR</th>
<th>SCORING FACTOR</th>
<th>RATING FACTOR</th>
<th>TOTAL SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERFORMANCE EVALUATION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>____% Expected Life</td>
<td>_______ X</td>
<td>_________ =</td>
<td>_________</td>
</tr>
<tr>
<td>____% Seasonal Effects</td>
<td>_______ X</td>
<td>_________ =</td>
<td>_________</td>
</tr>
<tr>
<td>____% Pavement Structure Influence</td>
<td>_______ X</td>
<td>_________ =</td>
<td>_________</td>
</tr>
<tr>
<td>____% Influence of Existing Pavement Condition</td>
<td>_______ X</td>
<td>_________ =</td>
<td>_________</td>
</tr>
<tr>
<td>CONSTRUCTABILITY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>____% Cost Effectiveness (EAC)</td>
<td>_______ X</td>
<td>_________ =</td>
<td>_________</td>
</tr>
<tr>
<td>____% Availability of Quality Contractors</td>
<td>_______ X</td>
<td>_________ =</td>
<td>_________</td>
</tr>
<tr>
<td>____% Availability of Quality Materials</td>
<td>_______ X</td>
<td>_________ =</td>
<td>_________</td>
</tr>
<tr>
<td>CUSTOMER SATISFACTION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>____% Traffic Disruption</td>
<td>_______ X</td>
<td>_________ =</td>
<td>_________</td>
</tr>
<tr>
<td>____% Noise</td>
<td>_______ X</td>
<td>_________ =</td>
<td>_________</td>
</tr>
<tr>
<td>____% Surface Friction</td>
<td>_______ X</td>
<td>_________ =</td>
<td>_________</td>
</tr>
</tbody>
</table>

RATING FACTOR: PERCENT OF IMPACT ON TREATMENT DECISION (Total must equal 100%)

SCORING FACTOR:

- 5 = Exceptional
- 4 = Good
- 3 = Average
- 2 = Below Average
- 1 = Unsatisfactory
## Example Rating Factors

<table>
<thead>
<tr>
<th>Treatment/Factor</th>
<th>Thin HMA</th>
<th>Slurry Seal</th>
<th>Chip Seal</th>
<th>Micro-surfacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Conditions</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Quality Materials</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Pavement Structure</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Expected Life</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Qualified Contractor</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Weather Limitations</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
## Total Ranking for Project

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thin HMA Overlay</td>
<td>3.40</td>
</tr>
<tr>
<td>Slurry Seal</td>
<td>3.50</td>
</tr>
<tr>
<td>Chip Seal</td>
<td>3.35</td>
</tr>
<tr>
<td>Microsurfacing</td>
<td>3.75</td>
</tr>
</tbody>
</table>
Example Decision Matrix

- Rating factors
  - For any given project, the number and types of factors will vary
  - Should be developed for each agency, the same as the EAC factor
  - Factors can be weighted to account for differences between treatments for a the same characteristic
Computing Rankings

- Factors are computed and scores for each treatment are derived
- Treatment with highest score is considered the most effective treatment for the specific project
Summary

- Preventive maintenance is the only effective way to manage pavements.
- Simple, logical process for determining the most effective treatment for a specific pavement has been presented.
- Recognizing the type and cause of pavement distress is fundamental to the approach.
Summary (continued)

- Agencies must develop cost and life data for various maintenance treatments
- A number of factors must be accounted for in determining the most effective treatment
- Cost needs to be considered but must not be the only consideration
- Good engineering principles should guide the selection of the treatment