Economic Evaluation of Pavement Management Decisions

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Outline

• Long Term and Operational LCCA
• Cost Effectiveness
• Comparing Alternatives: Replacement Analysis and Breakeven Analysis
• Performance Measures and Their Application
• Conclusions
MAP-21 Policy

Established in Title 23, U.S.C.

Sec. 150. National goals and performance measures

(a) Declaration of Policy – Performance management will transform the Federal-aid highway and provide a means to the most efficient investment of Federal transportation funds by refocusing on national transportation goals, increasing the accountability and transparency of the Federal-aid highway program, and improving project decision making through performance-based planning and programming.
Comparing LCCA

• Long Term
  – Evaluating Pavement Design Strategies over many performance periods
  – Assumed performance
  – FHWA RealCost

• Operational (Year-to-Year)
  – Historical performance is known
  – Evaluation of single performance period
  – Decisions involve maintenance/preservation and rehabilitation/reconstruction
Example Performance Periods for LCCA

Long Term

Operational
Pavement Performance Variability

ACP Pavement Life
Western Regions (Olympic, Northwest, Southwest)

Average Life: 16.9 years
Standard Deviation: 7.3 years

ACP Pavement Life
Eastern Regions (North Central, South Central, Eastern)

Average Life: 11.0 years
Standard Deviation: 3.9 years

Washington State Department of Transportation
Percent Change in Annual Cost per 1 Year Extension in Life

Typical chip seal savings 14% - 20% per year of life extension

Typical asphalt savings 4% - 8% per year of life extension
Operational LCCA is Critical

1) Numerous opportunities for application
2) Variability in pavement life
3) Substantial opportunity for cost savings
Cost-Effectiveness

• Evaluates the cost of managing pavement performance at or above a standard

• Simpler than Benefit/Cost analysis, since difficult to express benefit, in dollars, of pavement performance differences in fair or better conditions
Equivalent Uniform Annual Cost (EUAC)

\[ \text{EUAC} = P \frac{i(1 + i)^n}{(1 + i)^n - 1} \]

where

\( P \) = Present Value of all costs
\( i \) = Discount Rate
\( n \) = number of years
Advantages of EUAC

1) A simple number that can be directly compared with a different project or statewide average

2) Easier to calculate (no need to add multiple performance periods)

3) Salvage Value does no need to be considered
## Cost Effectiveness Examples

<table>
<thead>
<tr>
<th>Project Type</th>
<th>Const. Cost ($/LM)</th>
<th>LMY gained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reconst (ACP)</td>
<td>$900,000</td>
<td>20</td>
</tr>
<tr>
<td>Rehab (ACP)</td>
<td>$250,000</td>
<td>14</td>
</tr>
<tr>
<td>Chip Seal</td>
<td>$45,000</td>
<td>7</td>
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<tr>
<td>Crack Seal</td>
<td>$5,000</td>
<td>3</td>
</tr>
<tr>
<td>Reconst (PCCP)</td>
<td>$2,500,000</td>
<td>50</td>
</tr>
<tr>
<td>Grinding (PCCP)</td>
<td>$150,000</td>
<td>15</td>
</tr>
</tbody>
</table>

* includes 4% Discount Rate
Replacement Analysis

- Decision Analysis to consider:
  - Do Nothing (no replacement)
  - Maintenance / Preservation
  - Rehabilitation / Reconstruction

- If proposed alternative results in lower annual cost, then make decision for replacement
Replacement Analysis

Lowest Total Annual Cost is time for replacement.
Calculation of EUAC for an asphalt pavement resurfacing ($250k for 12 year period).

Spending additional $5k on maintenance in year 10 and $15k in year 15 results in EUAC that is $3.1k less (12% reduction in annual cost). (Assumed Discount Rate 4%)
Spending $5k on maintenance in year 10 and $71.2k in year 13 to achieve a 15 year life is equivalent to EUAC of $26,638/yr. (Assumed Discount Rate 4%)
Economic Performance Measures

• Asset Measurement
  – EUAC divided by lane-miles
  – Dollars per lane mile per year ($/LMY)

• ESAL (Service) Measurement
  – EUAC divided by ESALs divided by miles
  – Dollars per ESAL Mile Traveled ($/ESAL)

• Historical Perspective
  – Actual cost and actual life

• Future Cost Efficiency
  – Expected cost and expected life
Uses for Economic Performance Measures

• Evaluation of Pavement Management
  – How efficiently are pavements performing?
  – Are the most cost-effective decisions being implemented?

• Evaluation of Pavement Design
  – Is pavement structure over designed or under designed?

• Setting Targets for Managing Pavement Assets
  – Establish targets for cost-effectiveness
South Central Region ACP $ / LMY by Contract

Region wide weighted average: $17,396 $/LMY
Conclusions

• Potential for Substantial Savings by Leveraging Operational LCCA

• Judicious use of the EUAC is a key to operational LCCA allows for comparison across time frames, projects and region averages

• The EUAC can be normalized and leveraged for several decision analyses
Questions?