Effectiveness and Timing of Preventive Maintenance

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University of Nevada Reno (UNR)
WHAT IS OLD?

Evaluate *effectiveness* & *optimum time* for *single* application of slurry seal

Evaluate *effectiveness* & *optimum time* for *sequential* application of slurry seal
WHAT IS NEW?

- Evaluate the long-term performance of Cape Seals:
  - Slurry Seal
  - Micro-surfacing
Phase I: Slurry Seal *Performance Life* & *Extension in Pavement Service Life*

**Graph Description:**
- *New Construction* (green line)
- *Slurry Seal at year 3* (red dotted line)
- *Slurry Seal at year 7* (blue dashed line)

**Key Observations:**
- **Performance Life ~ 2 yrs**
- **Performance Life ~ 3 yrs**
- **Extension in Pavement Service Life ~ 2 yrs**

*PCI* vs. *Age in Years* chart
Phase I: SS Performance Life & Extension in Pavement Service Life

- In general, performance life ranged between 2 & 4 years.
  - Except when slurry seal was applied at year 0 and 1, performance life ranged from 0 to 1 year.

- Except few cases, the pavement service life was not extended by application of the single slurry seal.
Phase I: Slurry Seal Effectiveness

Overlay (Do Nothing)

Slurry Seal

Relative Benefit = \(100 \times \frac{B}{B_0}\)

Benefit Cost Ratio = \(\frac{B}{C}\)
Phase I: Effectiveness Analysis – New Construction
Phase I: Effectiveness Analysis – Overlay

Graphs showing:
- Benefit vs. Year of Slurry Seal Application for OL-Arterial (A), OL-Collector (B), and OL-Residential (C)
- Relative Benefit vs. Year of Slurry Seal Application for OL-Arterial (A), OL-Collector (B), and OL-Residential (C)
- Benefit-Cost Ratio vs. Year of Slurry Seal Application for OL-Arterial (A), OL-Collector (B), and OL-Residential (C)
Phase I: Conclusion

- Application of SS *immediately* or *one year after* construction of asphalt layer is not effective in terms of:
  - the benefit to the users and
  - the benefit-cost ratio for the agency.

**Optimum time** for application of a *Single Slurry Seal*:
- Newly constructed pavements: 3 years after construction.
- Pavements subjected to overlays: 3-5 years after construction.
Phase II: *Newly Constructed* Pavements: 
1st SS at year 3, 2nd SS at year 7
Phase II: Slurry Seal Effectiveness

Relative Benefit = 100 × B / B₀

Benefit-Cost Ratio = B / C

Pavement Condition Index (PCI)

Age in Years

University of Nevada Reno, www.wrsc.unr.edu
Phase II:

Effectiveness
PHASE II: Conclusions

- Application of first SS immediately or one year after construction is not effective in terms of both the benefit to users and benefit cost ratio for the agency.

- Regardless of construction activity, optimum time for a sequential slurry seal is when first SS is applied in year 3 & second SS is applied in year 7 (i.e. 4 years after the application of the first SS)
OVERALL RECOMMENDATION

For both new and overlay constructions, it is recommended that the agency applies

**First slurry seal 3 years after the construction of the asphalt layer and the second slurry seal 7 years after the construction.**
CAPE SEALS: Slurry or Micro

Chip Seal

- Asphalt Concrete
- Base
- Subgrade

Slurry or Micro

- Asphalt Concrete
- Base
- Subgrade
WHY CAPE SEALS

- Snow-Plow Damage
- Chip Loss
- Quieter
- Longer Life
Chip Seal
Chip Seal
Cape Seal: Slurry Seal
Cape Seal: Microsurfacing
## Evaluated Sections

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<thead>
<tr>
<th>Age (Service Life)</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
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<td>21</td>
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<th>3</th>
<th>4</th>
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<td>Incline Village</td>
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<td>21</td>
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<tr>
<td>Reno/Sparks</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>13</td>
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<tr>
<td>Gerlach</td>
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<td>2</td>
<td>6</td>
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<tr>
<th>Traffic</th>
<th>A - Arterial</th>
<th>B - Collector</th>
<th>C - Residential</th>
<th>D – Industrial</th>
<th>E – Rural Hwy</th>
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<td>3</td>
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<td>Gerlach</td>
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<tr>
<th>Surface Type</th>
<th>Micro-Surfacing</th>
<th>Slurry Seal</th>
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<tr>
<td>A - Arterial</td>
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<tr>
<td>B - Collector</td>
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<td>2</td>
</tr>
<tr>
<td>C - Residential</td>
<td>3</td>
<td>2</td>
</tr>
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<td>D – Industrial</td>
<td>10</td>
<td>5</td>
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<tr>
<td>E – Rural Hwy</td>
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Performance Data

![Graph showing Performance Data over years for DST-SS and DST-MS sections.](image-url)
# Emulsions Grades

<table>
<thead>
<tr>
<th>Year</th>
<th>Chip Seal</th>
<th>Slurry Seal</th>
<th>Micro-surfacing</th>
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<tbody>
<tr>
<td>2000</td>
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<td>LMCQS</td>
<td>N/A</td>
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<tr>
<td>2001</td>
<td>PASS</td>
<td>LMCQS</td>
<td>N/A</td>
</tr>
<tr>
<td>2002</td>
<td>PASS</td>
<td>LMCQS</td>
<td>N/A</td>
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<tr>
<td>2006</td>
<td>LMCRS</td>
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<td>LMCQS</td>
</tr>
<tr>
<td>2007</td>
<td>LMCRS</td>
<td>N/A</td>
<td>RTE</td>
</tr>
<tr>
<td>2008</td>
<td>LMCRS</td>
<td>N/A</td>
<td>RTE</td>
</tr>
<tr>
<td>2009</td>
<td>LMCRS</td>
<td>N/A</td>
<td>RTE</td>
</tr>
<tr>
<td>2010</td>
<td>LMCRS</td>
<td>N/A</td>
<td>MSE</td>
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LMCRS: Latex-Modified Cationic Rapid Set  
LMCQS: Latex-Modified Cationic Quick Set  
PASS - "Proprietary" Polymer-Modified Emulsion  
MSE – Micro-surfacing Surfacing Emulsion  
RTE - Rapid Traffic Emulsion - Polymer-Modified
## Quality Control

<table>
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<tr>
<th>Year</th>
<th>Slurry Seal</th>
<th>Micro-Surfacing</th>
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<tr>
<td></td>
<td>Aggregate</td>
<td>Emulsion</td>
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<tr>
<td>2000</td>
<td>Pass</td>
<td>Pass</td>
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<tr>
<td>2001</td>
<td>No Results</td>
<td>No Results</td>
</tr>
<tr>
<td>2002</td>
<td>Pass</td>
<td>Pass</td>
</tr>
</tbody>
</table>
| 2006 | No Results  | No Results      | No Results | Failing Residue  
Failing Softening Pt.  
Failing Torsional Recovery |
| 2007 | No Results  | No Results      | No Results | Failing Penetration  
Failing Softening Pt.  
Failing Torsional Recovery |
| 2008 | No Results  | No Results      | Failing L.A. Abrasion | Failing Torsional Recovery |
Impact of Construction Practice: Micro
Impact of Traffic Level: Micro
Impact of Traffic Level: Slurry

![Graph showing the impact of traffic level on PCI over age, years. The graph includes lines for different traffic levels such as A ELD13, A ELD14, A WLP1, A WLP2, A WLP3, A ELD1, D RCR1, D RCR4, and A ELD2. The y-axis represents PCI ranging from 0 to 100, and the x-axis represents age in years from 0 to 7.]
Impact of Pre-PCI: Micro
Impact of Pre-PCI: Slurry
## Benefit Cost Ratio

<table>
<thead>
<tr>
<th>Location</th>
<th>Cape Seal</th>
<th>Effective Performance Life (yrs)</th>
<th>Unit Cost ($/yd²)</th>
<th>Benefit Cost Ratio (yr/$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truckee Meadows</td>
<td>Micro-surfacing</td>
<td>7.0</td>
<td>4.46</td>
<td>1.57</td>
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<tr>
<td></td>
<td>Slurry Seal</td>
<td>3.5</td>
<td>3.50</td>
<td>1.00</td>
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<tr>
<td>Incline Village</td>
<td>Micro-surfacing</td>
<td>5.0</td>
<td>4.46</td>
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<td>Slurry Seal</td>
<td>3.0</td>
<td>3.50</td>
<td>0.86</td>
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</tbody>
</table>
Micro-Cape Seal: 9yrs/Pre-PCI:34
Micro-Cape Seal: 6yrs/Pre-PCI: 56
Micro-Cape Seal: 1yr
FINDINGS

- The effective performance life of micro-surfacing cape seals is 7 years in the Truckee Meadows and 5 years in Incline Village.

- The effective performance life of slurry seal cape seals is 3.5 years in the Truckee Meadows and 3 years in Incline Village.

- The LCCA indicates that the micro-surfacing cape seal is more cost effective than the slurry seal cape seal at both locations of Truckee Meadows and Incline Village.
RECOMMENDATIONS

- Continue to use the micro-surfacing cape seal as a preventive maintenance treatment
- Conduct full mix designs and implement an effective QA testing program for the cape seal projects
- Implement an effective crack sealing program prior to the application of the cape seal treatment
- Investigate the various individual distresses on the existing pavement
THANK YOU FOR YOUR ATTENDANCE

Visit our websites at: www.wrsc.unr.edu

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