Implementing Pavement Preservation Strategies

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Sealed Road in New Zealand
Agenda

1. Pavement Preservation Programs
   – US and Canada
   – Australia, New Zealand, United Kingdom, and South Africa

2. Surface Treatment Project Selection

3. Performance Measurement
Pavement Preservation

The Justification – Keep good roads GOOD!

![Graph showing the decline in pavement condition index (PCI) over time. The graph illustrates the benefits of early intervention in maintaining pavement quality. The costs and benefits of spending on pavement preservation are highlighted.]
Background

• The Pavement Preservation mantra:
  – “Place the right treatment, on the right road, at the right time” (Galehouse, Moulthrop, & Hicks, 2003)

• Project Selection = Right road & time
  – From agency pavement asset management plan

• Right Treatment: Based on substrate condition
  – Bituminous surface treatments have no structural capacity
  – Portland cement treatments have little.
  – Cannot repair failed pavement Will fail early is placed on the wrong substrate.
Reasons for Applying Chip Seal

NCHRP Synthesis 342: Chip Seal Best Practices, 2005
Chip Seal Service Life

NCHRP Synthesis 342: Chip Seal Best Practices, 2005

Typical Chip Seal Service Life (Years)

USA: 5.76
CANADA: 5.33
AU, NZ, UK, SA: 9.60

Bottom-line: Routine pavement preservation program = Increased service life
Pavement Preservation
Project Selection Factors

• Criteria from agency pavement asset management program:
  – Evaluate pavement distresses in substrate
  – Evaluate surface texture;
  – Evaluate traffic conditions: volume, speed, percentage of trucks, need for traffic control etc.;
  – Evaluate climatic and seasonal characteristics;
  – Evaluate options available aggregate selection;
Surface Distress: Rutting

• Rut cause
  – Mix instability/structural failure: not a PPT candidate
  – Layer densification/Abrasion: Chip seal if –
    • Rut depth < Average Least Dimension (M) of Chip
  – Depth > M: Micro to fill ruts prior to PPT

Schematic of McLeod’s Failure Criteria
(after Lee and Kim 2009).
Portland Cement Slurry Seal

“Polycon E-Krete” on asphalt substrate
Raveling/Shelling
Surface Distress: Raveling

• With severe map cracking – no PPT
• Severe raveling – Chip seal
  – General – double treatment
  – Localized – single treatment with chip large enough to fill voids left by raveling
• Minor cracking - Microsurfacing
Flushing/Bleeding
Surface Distress: Bleeding

- Amount of bleeding/flushing determines appropriate treatment
  - Minor/localized: Chip seal
  - Minor/localized to the wheel paths: Micro
  - Major/localized to the wheel paths: Retexture prior to PPT to remove excess bitumen
    - Shotblasting
    - Micromilling
    - Ultra High Pressure Watercutting
Shotblasting

Before

After

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www.intrans.iastate.edu
Micromilling
Watercutter Retexturizing in New Zealand

BEFORE

AFTER

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Surface Distress: Friction Loss

• Reason for friction loss drives PPT selection
• Bleeding in wheel paths – retexture to regain skid numbers…no need for surface treatment
• Polishing – Micro or chip seal
  – Strip seal
  – If minor rutting, Micro in the wheel paths only or full width
  – Major rutting, micro rut fill + full width
Surface Texture/Hardness

- Important not to add bitumen where there is already too much.
- Use data to select aggregate size/gradation
- Soft surface = early failure from flushing/loss of skid resistance.
- Measure using TNZ T/3 Sand Circle Test or ASTM Sand Patch.
Macrotexture Testing

TNZ T3 Sand Circle

Hydrotimer Outflow Meter
Change in Texture Over Time

Change in Average Wheelpath Texture versus Time

Average Wheelpath Texture
Traffic Conditions

• Traffic-related PPT selection issues
  – Time to open to traffic
  – Cost of traffic control
  – Congestion in work zones
  – Night work
  – Aggregate “whip-off” – windshield breakage
  – Binder “whip-off” – Claims for removal from paint
  – Local “sensitivity” to construction issues
  – Upper management “sensitivity” to complaints
Traffic Conditions

• Post construction issues
  – Road noise
  – Need for drainage
  – Maintenance of skid numbers

• Chip seal
  ✓ Traffic control during cure
  ✓ Temperature sensitivity during night work
  ✓ “Big” chips
  ✓ High road noise
  ✓ Great drainage

• Microsurfacing
  ✓ Open to traffic fast
  ✓ Not as sensitive to cool temperatures
  ✓ “Little” chips – no whip-off
  ✓ Low road noise
  ✓ Low drainage
Climatic and Seasonal Conditions

• Length of season
  – Let as early as possible to give maximum time to install without temperature constraints

• Potential for sudden rain showers

• Chip seal – more temperature/weather sensitive than microsurfacing
Available Aggregate

• Aggregate quality
  – Aggregate degradation during construction – changing the gradation on the road’s surface
  – Aggregate degradation after construction – polishing, fracturing

• Micro requires high quality aggregate
  – time since crushing: “hot” rock – surface free energy

• Chip seal
  – Minimize number of times it is handled
## Rock Polish Stone Value Data

<table>
<thead>
<tr>
<th>Good Aggregates</th>
<th>Marginal Aggregates</th>
<th>Variable Aggregates</th>
<th>Unacceptable Aggregates</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSV AVG &gt; 55 MIN &gt; 45</td>
<td>PSV AVG &lt; 55 MIN &gt; 45</td>
<td>PSV AVG &lt; 55 MIN &lt; 45 MAX Varies</td>
<td>Sedimentary, Igneous, and Metamorphic Rocks that are unusable for use as wear course aggregates Ex: Shale, Noralite, Siltstone, Marl, Lamproite, etc.</td>
</tr>
<tr>
<td>Greywacke</td>
<td>Eclogite</td>
<td>Limestone</td>
<td>Greywacke, Sandstone, Arkose, Ampholite, Banded Gneiss, Granitic Gneiss, Gneiss, Mylonite, Quartzite, Hornfels, Larvikite, Hyperite, Monzonite, Trondhjemite, Diorite, Granite, Mangerite, Gabbro, Rhyolite, Greenstone, Romb Porphyry</td>
</tr>
</tbody>
</table>

### Sources:
Good Aggregates
Marginal Aggregates
Variable Aggregates
Unacceptable Aggregates

Sources:
Kansas Geologic Polish Stone Value Map

Good Aggregates
Marginal Aggregates
Variable Aggregates
Unacceptable Aggregates

Sources:
Concrete Densification

• Definition: *a chemical process where a reaction between a hardening agent and the concrete creates a surface texture that is denser, and hence harder, than plain concrete.*

• Lithium silicate has proved to be reliable as a concrete floor hardener in industrial settings.
  – Shotblasting prior to application permits deeper surface penetration
  – Thicker hardened layer = Longer abrasion resistance
  – Abrasion resistance = PCCP rut resistance
Concrete Densification

• Major concern with applying a compound to concrete surface is loss of skid resistance
  – Bridge deck curing compounds and sealants
  – Require shotblasting after curing to restore microtexture

• Therefore to be viable as a PCCP preservation treatment, densifier must:
  – Increase rut resistance
  – Maintain safe skid numbers
Microsurfacing Framework - Asphalt

1 Helali et al 1996; 2 Hicks et al 1997; 3 Caltrans 2009; 4 West et al 1996

Asphalt Pavement Distress

- Oxidation\(^1,2,3,4\)
  - Severe Map Cracking
    - No
    - Yes
  - Severe Raveling
    - No
    - Yes

Rutting\(^2,3\)

- Mix Instability
  - No
  - Yes

Friction Loss\(^2,4\)

- Bleeding
  - No
  - Yes

Asphalt Pave- ment Distress

- Raveling\(^1,2,3,4\)
  - More than Moderate
    - No
    - Yes
  - Severe Map Cracking
    - No
    - Yes

Bleeding\(^1,3,4\)

- Severe Map Cracking
  - No
  - Yes

- Severe Raveling
  - No
  - Yes

- Not Suitable for Microsurfacing\(^1,2,3,4\)
  - Yes
  - No

Not Suitable for Microsurfacing\(^2,3,4\)

- Layer Densification
  - No
  - Yes

Studded Tire Wear

Microsurfacing Recommended\(^1,2,3,4\)

- Polishing
  - Yes
  - No

Other Pavement Preservation Treatment Recommended\(^1,3,4\)

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Summary

• PPTs are shown to be cost effective IF:
  – Applied to good substrate
  – Applied with a bias to long-term performance versus a bias to short-term complaints

• MUST characterize the surface before selecting PPT

• Need to DESIGN these treatments rather than treat like a commodity.

• Local knowledge trumps research