Concrete Pavement Preservation Manual Update

2014 Municipal Street Seminar
November 12, 2014 – Ames, Iowa
Update Concrete Pavement Preservation Manual - Winter 2014

- Contains 12 chapters on preservation techniques
- Added overlay chapter
- Working on 11 training modules and instructor guide
- Plan on 20 future workshops in next two years.
- Technical assistance to state DOTs
Concrete Pavement Preservation Manual

• To printer upon FHWA approval
• Complete modules in winter 2014

1. Introduction
2. Preservation concepts
3. Pavement evaluation techniques
4. Slab stabilization and slab jacking
5. Partial-depth repairs
6. Full-depth repairs
7. Retrofitted edge drains
8. Load transfer restoration
9. Diamond grinding and grooving
10. Joint /crack sealing
11. Overlays
12. Strategy Session
## Preservation Committee

<table>
<thead>
<tr>
<th>Name</th>
<th>Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gina Ahlstrom</td>
<td>FHWA</td>
</tr>
<tr>
<td>Thomas Van</td>
<td>FHWA</td>
</tr>
<tr>
<td>John Roberts</td>
<td>IGGA</td>
</tr>
<tr>
<td>Larry Scofield</td>
<td>IGGA/ACPA</td>
</tr>
<tr>
<td>Vince Perez</td>
<td>CTS Cement</td>
</tr>
<tr>
<td>Wouter Gulden</td>
<td>Retired GA DOT &amp; ACPA-S</td>
</tr>
<tr>
<td>Matt Ross</td>
<td>Penhall Company</td>
</tr>
<tr>
<td>Robert Hogan</td>
<td>Caltrans</td>
</tr>
<tr>
<td>Jim Tanner</td>
<td>Denton Concrete Services</td>
</tr>
<tr>
<td>John Donahue</td>
<td>MODOT</td>
</tr>
<tr>
<td>Larry Galehouse</td>
<td>National Preservation Center</td>
</tr>
<tr>
<td>Magdy Mikhail</td>
<td>TXDOT</td>
</tr>
<tr>
<td>Bret Andreasen</td>
<td>Contractor</td>
</tr>
<tr>
<td>Matt Zeller</td>
<td>CPAM</td>
</tr>
<tr>
<td>Gordon Smith</td>
<td>ICPA</td>
</tr>
<tr>
<td>Francis Todey</td>
<td>Iowa DOT</td>
</tr>
<tr>
<td>Kevin Merryman</td>
<td>Iowa DOT</td>
</tr>
<tr>
<td>Craig Hennings</td>
<td>Southwest Concrete Pmnt ssc</td>
</tr>
<tr>
<td>Paul Wiegand</td>
<td>SUDAS</td>
</tr>
</tbody>
</table>

---

[CP Tech Center Logo]
Chapter 1: Introduction

Changes:

• Purpose and objectives
• Describes updates and revisions
Chapter 2: Preventive Maintenance and Pavement Preservation Concepts

New additions:

• Pavement management importance
• Trigger values in identifying candidate pavements
• Incorporation of recent research (e.g., SHRP R26)
M&R Types vs. Condition/Time
## Typical Performance of Selected Preservation Treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Expected Performance (treatment life), years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete joint resealing</td>
<td>2 to 8</td>
</tr>
<tr>
<td>Concrete crack sealing</td>
<td>4 to 7</td>
</tr>
<tr>
<td>Diamond grinding</td>
<td>8 to 15</td>
</tr>
<tr>
<td>Diamond grooving</td>
<td>10 to 15</td>
</tr>
<tr>
<td>Partial-depth concrete patching</td>
<td>7 to 15</td>
</tr>
<tr>
<td>Full-depth concrete patching</td>
<td>10 to 15</td>
</tr>
<tr>
<td>Dowel bar retrofit</td>
<td>10 to 15</td>
</tr>
</tbody>
</table>

Table 2.5 on p. 2.9
Table 2.3. Michigan DOT Criteria for Preservation Strategies (Scofield et al. 2011)

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Minimum RSL</th>
<th>DI</th>
<th>RQI</th>
<th>IRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>FDR</td>
<td>7</td>
<td>&lt; 20</td>
<td>&lt; 54</td>
<td>&lt; 107</td>
</tr>
<tr>
<td>Joint Resealing</td>
<td>10</td>
<td>&lt; 15</td>
<td>&lt; 54</td>
<td>&lt; 107</td>
</tr>
<tr>
<td>Crack Sealing</td>
<td>10</td>
<td>&lt; 15</td>
<td>&lt; 54</td>
<td>&lt; 107</td>
</tr>
<tr>
<td>Diamond Grinding</td>
<td>12</td>
<td>&lt; 10</td>
<td>&lt; 54</td>
<td>&lt; 107</td>
</tr>
<tr>
<td>Dowel Bar Retrofit</td>
<td>10</td>
<td>&lt; 15</td>
<td>&lt; 54</td>
<td>&lt; 107</td>
</tr>
<tr>
<td>Concrete Pavement Restoration*</td>
<td>3</td>
<td>&lt; 40</td>
<td>&lt; 80</td>
<td>&lt; 212</td>
</tr>
</tbody>
</table>

*Consists of full-depth concrete repairs, diamond grinding, and other.

RSL: Remaining service life
DI: Distress index
RQI: Ride quality index
IRI: International roughness index
Chapter 3: Concrete Pavement Evaluation

New additions:

• Information on joint distress study
• Update on evaluation tools-GPR, MIT Scan, MIRA, etc.
• Noise considerations
• Inclusion of FHWA - ASR initiatives
Purposes of a Pavement Evaluation

• Provides qualitative information to:
  – Determine causes of deterioration
  – Determine if pavement is not a candidate for preservation
  – Develop appropriate alternatives

• Provides quantitative information for:
  – Quantity estimates
  – Assessment of deterioration rates
  – Performing life-cycle cost analyses
Project Evaluation Approach

1. Historical data collection/records review
2. Initial site visit and assessment
3. Field testing activities
4. Laboratory materials characterization
5. Data analysis
6. Final field evaluation report
Transverse Cracking
Transverse Cracking
(Consecutive Slabs)
Joint Faulting
Saturated Concrete Pavement (Swallowing)
Pumping
Corner Break
Joint Spalling
Dowel Bar Misalignment or Corrosion
Joint Seal Damage
Blowup
Plastic Shrinkage

Cracking
Alkali-Silica Reactivity
Longitudinal Cracking
D Cracking
Scaling
Patch Deterioration
## Treatment–Distress Matrix

<table>
<thead>
<tr>
<th>Distress</th>
<th>Slab Stabilization</th>
<th>Slab Jacking</th>
<th>Partial-Depth Repair</th>
<th>Full-Depth Repair</th>
<th>Retrofitted Edge Drains</th>
<th>Dowel Bar Retrofit</th>
<th>Cross Stitching/Slot Stitching</th>
<th>Diamond Grinding</th>
<th>Diamond Grooving</th>
<th>Joint Resealing</th>
<th>Crack Sealing</th>
<th>Thin Concrete Overlay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corner breaks</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓ a</td>
</tr>
<tr>
<td>Linear cracking</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>✓ b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓ a</td>
</tr>
<tr>
<td>Punchouts</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓ c</td>
</tr>
<tr>
<td>D-cracking</td>
<td>✓ c</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓ c</td>
</tr>
<tr>
<td>Alkali-aggregate reaction</td>
<td>✓ c</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓ c</td>
</tr>
<tr>
<td>Map cracking, crazing, scaling</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Joint seal damage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Joint spalling</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Blowup</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Pumping</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Faulting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Bumps, settlements, heaves</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Polishing/Low Friction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
Chapter 4: Slab Stabilization and Slab Jacking
Slab Stabilization vs. Slab Jacking

• Slab stabilization:
  – Pressure insertion of grout/polyurethane to **fill** void beneath slab

• Slab jacking:
  – Pressure insertion of grout/polyurethane to **raise** slab
Slab Stabilization and Slab Jacking

New additions:

• Updated information on GPR
• Additional information on polyurethane materials
• Additional information of deflection systems
Chapter 5: Partial-Depth Repairs

New additions:

• Incorporate new PDR techniques
  – (2012 CP Center Guide)
• Update on PDR materials (resins)
Partial-Depth Repair Types

TYPE 2 - Crack "V" Milled

TYPE 2 - Transverse Joint "V" Milled

TYPE 2 - Longitudinal Joint "V" Milled

Type 1 - Joint "V" Milled

Type 1 - Spot Repair Saw and Chip

TYPE 3 Bottom Half
## Concrete Removal

### Cold Milling Heads

<table>
<thead>
<tr>
<th>“V” Shape Milling Head and Pattern</th>
<th>Rock Saw and Rounded Pattern</th>
<th>Vertical Edge Mill Head and Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="V Shape Milling Head" /></td>
<td><img src="image2.png" alt="Rock Saw and Rounded Pattern" /></td>
<td><img src="image3.png" alt="Vertical Edge Mill Head" /></td>
</tr>
</tbody>
</table>

- **“V” Shape Milling Head** and Pattern
- **Rock Saw and Rounded Pattern**
- **Vertical Edge Mill Head** and Pattern

*30 to 60 degrees*
Chapter 6: Full-Depth Repairs
Full-Depth Repairs

New additions:

• Precast repairs
• Utility cuts
• CRCP guidelines
## Opening Strength Matrix

<table>
<thead>
<tr>
<th>Slab Thick, in</th>
<th>Strength for Opening to Traffic, psi</th>
<th>Slab Replace</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Length &lt; 10 ft</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$f_c$</td>
<td>MR (3&lt;sup&gt;rd&lt;/sup&gt;)</td>
</tr>
<tr>
<td>6.0</td>
<td>3000</td>
<td>490</td>
</tr>
<tr>
<td>7.0</td>
<td>2400</td>
<td>370</td>
</tr>
<tr>
<td>8.0</td>
<td>2150</td>
<td>340</td>
</tr>
<tr>
<td>9.0</td>
<td>2000</td>
<td>275</td>
</tr>
<tr>
<td>10.0+</td>
<td>2000</td>
<td>250</td>
</tr>
</tbody>
</table>
Example Repair System
Dowel Bars Fabricated in Precast Panel
CRCP Pavements

Saw Cut Locations and Repair Details

Repair Length (1.8 m [6 ft] tied; 1.2 m [4 ft] welded/mechanical)

610 mm (24 in) for tied
200 mm (8 in) for welded/mechanical

Partial-depth saw cut

Full-depth saw cuts

Partial-depth saw cut

Slab Thick

End section

Center section

End section

Existing Base

Sawing Details

New reinforcement (same size/spacing as existing reinforcement)

2 in minimum clearance

Overlap Length

Existing Base

Slab Thick

Chairs

Repair Details

Existing reinforcement
Chapter 7: Retrofitted Edge Drains
Retrofitted Edge Drains

New additions:

- Streamlining of information
- Importance of maintenance
Chapter 8: Dowel Bar Retrofit, Cross Stitching, and Slot Stitching
Dowel Bar Retrofit

- Restores load transfer
- Reduces probability of pumping, faulting, and corner breaks
- Improves long-term rideability
- Increases service life
Load Transfer Restoration

New additions:

- Update long-term performance of DBR
- Update cross stitching and slot stitching
Slot Creation
Close-Up of Sawblades
Chapter 9: Diamond Grinding and Grooving
Diamond Grinding and Grooving

New additions:

- New diamond grinding heads
- New information on slurry management
- Update on equipment capabilities
- Introduce next generation concrete surface
New Surface Textures

• Optimized Texture for City Streets (OTCS)
  - Similar to diamond grinding but reduced land heights/widths

• Next Generation Concrete Surface (NGCS)
  - Manufactured, low-noise surface consisting of flush grinding and grooving
Chapter 10: Joint Resealing and Crack Sealing

New additions:

• General chapter update
• Improve troubleshooting
Chapter 11: Concrete Overlays

Intersections  Rural secondary roads  Urban freeway/interstate  Urban arterial  Rural primary/interstate
Concrete Overlays

New additions:

• New chapter
• Information from 2014 Overlay Guide update
• Lessons learned from projects (2008 to 2014)
# Types of Concrete Overlays

<table>
<thead>
<tr>
<th>Bonded Overlay Option</th>
<th>Unbonded Overlay Option</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(Preventative Maintenance/Minor Rehabilitation)</strong></td>
<td><strong>(Minor/Major Rehabilitation)</strong></td>
</tr>
<tr>
<td>In general, bonded resurfacing is used to eliminate surface distress when the existing pavement is in good structural condition. Bonding is essential, so thorough surface preparation is necessary before resurfacing.</td>
<td>In general, unbonded resurfacing is highly reliable, with longer design life than rehabilitation with asphalt. Minimal pre-resurfacing repairs are necessary for unbonded resurfacing.</td>
</tr>
</tbody>
</table>

## OVER ASPHALT

<table>
<thead>
<tr>
<th>Bonded Overlay Option</th>
<th>Unbonded Overlay Option</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Bonded Overasphalt" /></td>
<td><img src="image2" alt="Unbonded Overasphalt" /></td>
</tr>
</tbody>
</table>

## OVER COMPOSITE

<table>
<thead>
<tr>
<th>Bonded Overlay Option</th>
<th>Unbonded Overlay Option</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3" alt="Bonded OverComposite" /></td>
<td><img src="image4" alt="Unbonded OverComposite" /></td>
</tr>
</tbody>
</table>

## OVER CONCRETE

<table>
<thead>
<tr>
<th>Bonded Overlay Option</th>
<th>Unbonded Overlay Option</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5" alt="Bonded OverConcrete" /></td>
<td><img src="image6" alt="Unbonded OverConcrete" /></td>
</tr>
</tbody>
</table>
Evaluations of Existing Pavements

• Evaluation is used to determine:
  ▪ Required repairs where needed
  ▪ Establish the concrete overlay design thickness
  ▪ When combined with an overlay can the existing pavement help carry anticipated traffic as:
    – an integrated part of the pavement (bonded)
    – or serve as a base or subbase (unbonded)
    – coring is important
Overlay Selection for Existing Asphalt or Composite Pavements in “Good” to “Fair” Condition

Pavement is structurally sound but has minor surface distresses such as potholes, block cracking, or random thermal cracking.

Pre-Overlay Question
Can milling and minor spot repairs cost effectively solve deficiencies, bring the pavement to “Good Condition” and meet other constraints (i.e., vertical clearance, shoulders, safety rails, foreslopes, etc.) to allow for bonded overlay?

Yes

Bonded Concrete Overlay Over Asphalt Pavement

Note: Concrete overlay thickness must be appropriately designed considering estimated traffic, desired design life, and budget.
Chapter 12: Strategy Selection

New additions:

- Sustainability considerations
- How key concepts enter into selection
- Update selection process and treatment
Questions

www.cptechcenter.org