Innovative Concrete Preservation Practices Used in California

Thursday October 13, 2016

Robert Hogan, P.E.
Senior Pavement Engineer
Division of Maintenance Pavement Program
Office of Pavement Programming
(916) 274-6063
robert.hogan@dot.ca.gov
California Pavement Inventory

Total state network: 353,743 ln-mi

- Counties: 132,775 ln-mi (38%)
- Caltrans: 50,450 ln-mi (14% concrete)
- Cities: 170,518 ln-mi (48%)

(30% concrete)
Financial Breakdown

Caltrans Pavement Projects:
Last 4 yrs: $4.0 billion / 16,500 ln-mi

Preventive Maint:
Avg = $104,000/ ln-mi

Major Rehab:
Avg = $1 mil/ ln-mi

10 yr Pavement Needs = $2.0 bil / yr
Traffic & Climate
Cracking

- 1st Stage: Single longitudinal or transverse
- 3rd Stage: Intersecting, 3 or more pieces
### Typical Concrete Repair Strategies

<table>
<thead>
<tr>
<th>Distress Level</th>
<th>Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preventive</strong></td>
<td>Seal joints</td>
</tr>
<tr>
<td>Failed joint seal</td>
<td></td>
</tr>
<tr>
<td>3rd stage &lt; 3%; spalling</td>
<td>Slab replacement</td>
</tr>
<tr>
<td></td>
<td>Spall repair</td>
</tr>
<tr>
<td><strong>Corrective</strong></td>
<td>Grind</td>
</tr>
<tr>
<td>IRI &gt;170</td>
<td>DBR</td>
</tr>
<tr>
<td>Faulting &gt; ¼”</td>
<td>Slab replacement</td>
</tr>
<tr>
<td>3rd stage: 3% - 10%</td>
<td></td>
</tr>
<tr>
<td><strong>Rehabilitation</strong></td>
<td>Lane replacement</td>
</tr>
<tr>
<td>3rd stage &gt; 10 or 20%</td>
<td>CSOL</td>
</tr>
</tbody>
</table>

- **Seal joints**
- **Slab replacement**
- **Spall repair**
- **Grind**
- **DBR**
- **Slab replacement**
- **Lane replacement**
- **CSOL**
Preventive Strategies: Spall Repair

GUIDANCE

Preventive Strategies

SPALL REPAIR

EXISTING JOINT OR CRACK
3" Min

FORM BOARD

2" Min

EXISTING CONCRETE PAVEMENT
1 1/2" Min
1" Min

EXISTING DOWEL OR TIE BAR

SPALLED SURFACE

ROUGH SURFACE

SAW CUT

UN SOUND CONCRETE LIMIT

EDGE OF CHIPPED SURFACE

REPAIR BOUNDARY

DRY 10° ± 10°

SPALLED SURFACE

JOINT FORM BOARD

10" Min

ROUGH SURFACE

0.6±1 OR FLATTER
(30° TO 60°)

LEGEND

SPALL REPAIR
Spall Repair
Spall Repair
Spall Repair
Spall Repair

Future Innovation

• Developing an Authorized Materials List to allow alternative spall repair materials on contract projects
### Spall Repair

#### Potential Authorized Materials Lists

<table>
<thead>
<tr>
<th>Polymeric</th>
<th>Cementitious</th>
<th>Hot-Applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyester</td>
<td>Portland cement</td>
<td>Polymer-modified resins</td>
</tr>
<tr>
<td>Polyurethane</td>
<td>Modified high-alumina</td>
<td>Use aggregate extenders</td>
</tr>
<tr>
<td>Epoxy</td>
<td>Magnesium phosphate?</td>
<td>Require specialized placement equipment</td>
</tr>
<tr>
<td></td>
<td>Pozzolanic</td>
<td></td>
</tr>
</tbody>
</table>
Corrective Strategies

Dowel Bar Retrofit
- Limited given age of freeway sys

Individual Slab Replacement
- Rapid Strength Concrete or Precast

Diamond Grinding
- Long CA history to 1965
- Up to 17-yr service life (78% IRI ↑)
Dowel Bar Retrofit
Dowel Bar Retrofit
Dowel Bar Retrofit
Slab Replacement
Slab Replacement

3rd Stage Cracking vs. Age

- Doweled
- Not Doweled

Age (yr)

% 3rd Stage

y = 0.7586x

y = 1.5213x

Linear (Doweled)
Linear (Not Doweled)
Slab Replacement

3rd Stage Cracking (%) vs. Age (yr)

Doweled

Not Doweled

Linear (Doweled)

Linear (Not Doweled)
Study Limitations

• Survivor bias
  ➢ Some failed slabs already replaced
• Repeat projects at same location
  ➢ Difficult to ID previously replaced slabs from newer replaced slabs
Innovations Being Considered

GOAL: Extend Service Life

• Dowels at all transverse joints
  - Ready to implement, some district interest, no projects to date

• Thicker monolithic pour with dowels
  - Some interest. Validity?
Innovations Being Considered

- Reinforcement
  - Macro/ microfibers: challenging for RSC
  - Jointed Reinforced
  - Wire mesh or #5 bar at 12” C-C
    (3 projects to date)
Abrasive Wear & Rutting

**GOALS:**

- Preserve existing concrete surface
- Maintain concrete thickness

Avoid Grinding!!!
Abrasive Wear & Rutting

Piloted Strategies

- HMA Overlay
- Bonded Wearing Course
- Grinding/ Grooving
- Lithium Silicate Surface Hardeners?
- Polyester Concrete Inlay?
Lithium Silicate Surface Hardeners

**Background**

- Lithium penetrates voids in concrete surface
- Silicate reacts with free lime in concrete paste
- Densifies & hardens by forming CSH
- Proprietary issues
Abrasive Wear & Rutting

Lithium Silicate Surface Hardeners

• Lab studies showed some hardening & abrasion resistance for existing concrete surfaces

➢ Correlation to field performance?
Abrasive Wear & Rutting
Lithium Silicate Surface Hardeners

• Cost Effectiveness
  ➢ Reapplication frequency?
  ➢ Contract vs. Maintenance work
  ➢ $18K/ln-mi (full-width) hardener material cost

  +

  Surface preparation, traffic control, OH, etc.
Lithium Silicate Surface Hardeners

- Limited penetration depth (≤ 5 mm)

  - Best surface prep method?
    - Grinding ($70K/ln-mi)
    - Abrasive blasting (sand or steel shot-$25K/ln-mi)
    - Sweep; flush with water or compressed air (low $)
Polyester Concrete Inlays: Background

• 2 full lane-width polyester concrete overlays were evaluated by CT on I-80 corridor in ‘80’s, along with other material alts
  ▪ Poly conc data, performance results unclear
• CA bridge decks use ¾” poly conc OL
  ▪ Working with material supplier to resin durability
A abrasive Wear & Rutting
Polyester Concrete Inlays: 2 Sections

FILL-IN

GROUND-IN
Abrasive Wear & Rutting

Polyester Concrete Inlay Prep

1. Diamond grind ¾” min (if req’d)
2. Abrasive blast (sand/ shot)
3. Apply HMWM
Abrasive Wear & Rutting
Polyester Concrete Inlay Construction

4. Place Polyester Concrete
A abrasive Wear & Rutting
Polyester Concrete Inlay Construction

5. Finish Grind Inlays
<table>
<thead>
<tr>
<th>ISSUE</th>
<th>INNOVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spall repair durability</td>
<td>CP Tech Center (2012)</td>
</tr>
<tr>
<td></td>
<td>Polyester concrete</td>
</tr>
<tr>
<td></td>
<td>Future: AML alternatives</td>
</tr>
<tr>
<td>Rapid slab replacement</td>
<td>Rapid strength concrete</td>
</tr>
<tr>
<td></td>
<td>Precast panels (nonstandard)</td>
</tr>
<tr>
<td>Abrasive wear &amp; rutting</td>
<td>Surface hardeners?</td>
</tr>
<tr>
<td></td>
<td>Polyester concrete inlays?</td>
</tr>
</tbody>
</table>
Concrete Pavement Guide

http://www.dot.ca.gov/hq/maint/Pavement/Offices/Pavement_Engineering/Concrete_Pavement_Guide.shtml
Concrete Pavement Preservation

GUIDANCE

Questions?

Robert Hogan, P.E.
Senior Pavement Engineer
(916) 274-6063
robert.hogan@dot.ca.gov
Caltrans Division of Maintenance
Pavement Program, MS-91
2389 Gateway Oaks Dr.
Sacramento, CA 95833
FAX: (916) 274-6213
http://www.dot.ca.gov/hq/maint/Pavement/Pavement_Program/index.html

Leave only footprints behind...