Session 5: Partial-Depth Repairs
Learning Outcomes

1. List benefits and appropriateness of partial-depth repairs
2. List the advantages and disadvantages of different repair materials
3. Describe recommended construction procedures
4. Identify typical construction problems and appropriate remedies
Introduction

• Definition: *Removal and replacement of small, shallow areas of deteriorated PCC at spalled or distressed joints.*

• Distress limited to upper 1/3 – 1/2 of slab
• Existing load transfer devices are functional
Partial-Depth Repair Process

Fig. 5.8 on p. 5.12
Benefits

• Restores slab integrity
• Improves ride quality
• Extends the service life
• Restores a well-defined uniform joint sealant reservoir
Good Candidate Projects

• Spalls caused by:
  – Incompressibles in joints
  – Localized areas of weak material
  – Joint inserts

• Surface deterioration caused by:
  – Reinforcing steel too close to surface
  – Poor curing or finishing practices

• Recommended evaluation procedures:
  – Distress surveys
  – Sounding
Poor Candidate Projects

- Spalls due to dowel bar misalignment
- Spalls at working cracks due to shrinkage, fatigue, or vertical movement
- Spalls due to D-cracking or reactive aggregate
Good candidate?
Good candidate?
Good candidate?
Good candidate?
Good candidate?
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

Fig. 5.1 on p. 5.2

5-13
Design Considerations

• Sizing of repair
• Material selection
• Bonding agent
Sizing of Repair

• Greater than 3 inches beyond spall
• Combine spalls if closer than 24 inches
• Cementitious:
  – 4 inch x 10 inch
  – 2 inch depth
• Proprietary:
  – Refer to manufacturer’s instructions
Material Selection Factors

• Allowable lane closure time
• Ambient temperature
• Material and placement cost
• Material properties (shrinkage, CTE, bond strength)
• Compatibility between repair material and existing pavement
• Size and depth of repair
• Performance capabilities
Material Selection – Repair Material

• Repair materials for partial-depth repairs are generally classified cementitious, polymeric, or bituminous.

• Concrete mixes along with a wide variety of rapid-setting and high-early-strength proprietary materials have been developed.

• *High-quality portland cement concrete is generally accepted as the most appropriate material for the repair of existing concrete pavements.*

• *Concrete mix requires use of small-sized, coarse aggregate, usually less than 1/2 in.*
Material Selection – Repair Material

• MnDOT Cementitious 3U18 Material Recommended for Use in Partial-Depth Repairs
  – 850 lbs Type I Cement
  – 295 lbs of water
  – 1,328 lbs of coarse aggregate
  – 1,328 lbs of sand
  – Target W/C of 0.35
  – Type E Water Reducing and Accelerator
  – 6.5% air

• ~2500 psi strength in 18 hours
• Used successfully for 30+ years
Material Selection – Repair Material

• Cementitious 3U18 Recommended for Use in Partial-Depth Repairs
  – Maximum 1 in. slump (measured after allowing to set 5 minutes after mixing)
  – Cure time of 18± hours
  – Aggregate gradation of
    o 100% passing the 3/8 in. sieve
    o 55% - 95% passing the #4 sieve
    o Not more than 5% shall pass the #50 sieve
Bonding Agent

• Intended to enhance bond between repair material and existing pavement
• Required for most cementitious repair materials
• Manufacturer’s instructions should be consulted for proprietary mixes
Bonding (Grout) Agent

- Sand-cement grouts have proven adequate when used as bonding agents with concrete repair materials.
  - 2 parts Type I cement
  - 1 part water (may be more or less to develop a creamy consistency)
  - 1 part sand
Bonding (Grout) Agent

• The Kansas DOT uses a different approach regarding bonding agents.

• Use a more watery mix which helps cool and pre-wets the existing concrete pavement before placement.
  – 1 part Type I cement
  – 3 parts water
Construction Steps

1. Repair dimension selection
2. Concrete removal
3. Repair area preparation
4. Joint preparation
5. Bonding agent application
6. Patch material placement
7. Curing
8. Diamond grinding (optional)
9. Joint resealing
1. Repair Dimension Selection

Sounding
1. Repair Dimension Selection

Marking
1. Repair Dimension Selection

Recommendations for Cementitious

Min. Patch Length 10 in
Min. Patch Width 4 in
2. Concrete Removal

• Methods
  – Saw and Patch
    ➢ Saw perimeter and light jackhammer breakout
  – Chip and Patch
    ➢ Light jackhammer breakout (no sawing)
  – Mill and Patch
    ➢ Removal of deteriorated concrete through cold milling
2. Concrete Removal

Sawing
2. Concrete Removal

Chipping
2. Concrete Removal

Cold Milling

Transverse Milling (small head, moves along joint)

Longitudinal Milling (wide head, pick up & move over)

Fig. 5.13 on p. 5.15
2. Concrete Removal

Cold Milling

Milling Along the Joint

Milling Across the Joint
2. 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="Image" /></td>
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<td><img src="image5.png" alt="Image" /></td>
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<tr>
<td>30 to 60 degrees</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. Repair Area Preparation

Sandblasting
3. Repair Area Preparation

Air Blasting

- Air blasting to remove dust and debris (90 psi minimum)
- Free of oil and moisture
- Direct away from patches
4. Joint Preparation

Fig. 5.18 on p. 5.19
Placement of Compression Relief

- Waxed cardboard fits with the irregular nature of random cracks.
- Has the ability to maintain its rigidity for the concrete placement.
- Place a foot on the cardboard during concrete vibration, so it does not float.
5. Bonding Agent Application

Cement Grout

Epoxy
6. Patch Material Placement

- Batch small quantities
- Temperature restrictions (PCC should not be placed below 40 °F)
- Some epoxy materials placed in lifts
- Overfill patch area by ~3 mm (1/8 in)
- Consolidate material with small spud vibrator
- Screed and hand trowel (center to edge)
6. Patch Material Placement
6. Patch Material Placement

Consolidation

Finish Towards Edges
6. Patch Material Placement
Sealing Edges and Runouts
7. Curing

- Prevent moisture loss
- White-pigmented curing compound commonly used
- Opening to traffic
  - Mix / temperature dependent
  - Common values: 1600 to 1800 psi
Re-establish Joint/Crack

- Type 1 and Type 2A joints have been successfully sawed.
- Tooling of the joint can be done to help create a weak plane during concrete placement.
- Joint reservoir shall be wider than the crack under the repair.
8. Diamond Grinding (optional)
9. Joint Resealing
Completed Repairs
Examples of Long-Lasting Partial-Depth Repairs

20 year old Type 2A longitudinal and transverse partial-depth repairs in Hopkins, MN

Close up of partial-depth patch in Hopkins, MN done in 1991 and picture taken 2011
Key Factors For Success

• Proper selection of candidate projects
• Proper material selection
• Identification of repair boundaries
• Use of joint/crack reformers
• Achieving good bond
  – Patch area clean and dry
  – Sandblasting sidewalls
  – Application of bonding agent
• Proper placement and curing
Troubleshooting

• Problem

*Deterioration found to extend beyond the original repair boundaries*

• Solutions?
Troubleshooting
What is wrong here?
Troubleshooting
What is wrong here?
Troubleshooting
What is wrong here?
Troubleshooting
Construction Quality Problems

• Problem

Patch material flows into joint

• Potential causes? Solutions?
Troubleshooting

What might have happened here?
Review: Learning Outcomes

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