Rigid Pavement Repair

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PCCP Repair Techniques

- Full-depth repair
- Partial-depth repair
- Slab stabilization
- Retrofitting dowels
- Cross-stitching longitudinal cracks/joints
- Diamond grinding
- Joint & crack resealing
Partial Depth Repairs

- Repairs deterioration in the top 1/3 of the slab.
- Generally located at joints, but can be placed anywhere surface defects occur.
Size of Patches

- Minimum length 300 mm
- Minimum width 100 mm
- Go beyond problem by 75-100 mm
- Combine close patches (<0.6 m)
- Repair entire joint if more than 2 patches
Patch Layout

- 50-150 mm min.
- 50 mm (min.) - t/3 (max.)
- t
- Spall
- Patch
- 50-150 mm min.
Patch Materials

• Normal Set PCC
• High-Early Strength PCC
• Rapid Strength Proprietary Materials
• Epoxy Resin Mortar or Epoxy Concrete
Construction of Partial-Depth Patches
Finding Unsound Concrete

- Sounding the pavement:
  - Hammer
  - Steel rod
  - Steel chain

- DULL
  - Unsound-Delaminated

- SHARP
  - Solid
• Sounding the Pavement
Concrete Removal

• Sawing and chipping
• Carbide milling
  – Transverse
  – Longitudinal
Sawing

- Vertical cut at perimeters
- Diamond blade
- Depth to 50 mm
- Overcut slightly
Chipping

• Break to minimum depth of 35 mm (1/3 slab thickness maximum)
• 13.5 kg maximum hammer
• 7 kg hammer preferable for control
• Spade bits preferable to gouge bits
• Do not expose dowels
Removal of Concrete with Jackhammer
Milling Machine

• Requirements:
  – High kilowatt (horsepower) rating
  – 300-450 mm milling head width
  – Wheels preferable to tracks

• Transverse orientation

• Longitudinal orientation
Removal of Material

- Transverse Milling (small head, moves along joint)

- Longitudinal Milling (wide head, pick up & move over)
Transverse Orientation
Longitudinal Orientation
Cleaning

• Sound to check for weak spots before cleaning
  – Chip out with 7 kg hammer if necessary

• Sandblast bottom and sides

• Waterblast acceptable alternative:
  – 100 - 200 MPa pressure
  – Waiting period to dry
Chipping out weak spots
Sandblasting
Blowing Compressed Air to Remove Debris
Joint Insert

- Separates patch from adjacent concrete
- Reforms joint reservoir
- Provides uniform sealing reservoir
- MUST get below patch material
- Acceptable materials:
  - Styrofoam
  - Asphalt-impregnated fiberboard
  - Fiberboard
Compressible Joint Insert
Compressible Insert

- 75 mm min.
- Spall
- Patch
- Compressible insert
- 25 mm
If Insert Not Used...

- Point Bearing
- Joint Closure
- Debonding
- Popout & Breakage
- Expansion
• Checking patch cleanliness
Application of Grout Bonding Agent
Placing Patch Material

• Mix in small quantities
• Place from wheelbarrows or buggies soon after bonding grout
• Slightly overfill the patch area
• Use small spud vibrators (<25 mm)
  – Hold at 15-30 degrees
  – Do not drag!!
Placing Patch Material
Finishing & Texturing

• Match surrounding elevation
• Work tool from center toward edges
• Texture similar to surrounding pavement
• Seal saw-cut runouts with grout or liquid epoxy
Applying Curing Compound
Joint Sealing

• Resealing joints will help prevent further damage

• Saw & air blast all joint faces before sealing

• Seal according to agency specifications (silicone, hot pour, etc.)
Opening to Traffic

• 2 methods:
  – Specified minimum strength
  – Specified minimum time after completing placement

• Time method acceptable
Summary

- Limit use to top 1/3 of slab
- Avoid “point bearing”: Use a compressible insert in joints & cracks
- Cure properly
- Reseal Joints
Full Depth Patching
Full-Depth Repair

• Purpose
  – Restore structure
  – Restore ride

• Used for:
  – Joint deterioration
  – Transverse cracking
  – Longitudinal cracking
  – Broken slabs & corner breaks
Uses of Full-Depth Repair

• **Joint Deterioration**
  – Spalling (also below surface)
  – Cracking
Uses of Full-Depth Repair

- Multiple Cracks
- Corner Breaks
Sizing a Patch

• Go beyond deterioration
• Remember to check for below-surface spalling
• Minimum length 2 meters
• Adjust as necessary
• Combine closely spaced patches
Field Adjustments to Patch Size

• **If Patch Boundary:**
  • Falls within 2 m of transverse joint
    – Then extend to include joint
  • Falls on or very near a doweled joint
    – Then extend beyond joint 0.3 m to remove the dowels
  • Falls on a crack
    – Then extend beyond crack by 0.15 m
Combine Patches!!
Load Transfer

• **Jointed Pavements:**
  
  • 38mm dowels
  
  • At least 175mm of embedment on either side
  
  • Minimum of 4 dowels in each wheelpath
  
  • Corrosion resistance necessary if deicing chemicals will be used
Load Transfer

• Jointed Pavements:

• Top View
  - Optional
  - Dowels
  - Patch
  - 300 mm c-c typ. spacing
  - 300 mm typ.

• Side View
  - d/2
  - Remove loose material and fill any depressions with concrete
Patch Materials

- ASTM C 150 Types I, II, or III portland cement (CAN/CSA A5-M88)
- Target slump: 50 - 100 mm
- Entrained air: 4.5 - 7.5%
- Accelerators common for early strength gain
  - CaCl$_2$ accelerator may cause early set time (within 30 minutes)
  - Workability decreases with accelerators
Defining Repair Limits
Sawing Boundaries

• Use diamond bladed saws
• Saw full-depth through the joints so base of blade reaches boundary (except where aggregate interlock needed)
• Isolate transverse, longitudinal and shoulder
• Provide pressure-relief cut within patch if saws bind
Sawing Boundaries
Removal

• Liftout
  – Lift pin and chain
  – Forklifts
  – Torque claws
  – Lateral-pressure lifts

• Breakup
  – Handheld pneumatic hammers (small projects)
  – Drop hammers or hydraulic rams (large projects)
Liftout

- Pin and Chain
- Torque Claw
- Lateral Pressure
Liftout Damage
Vibratory Plate Compactor
Drilling Dowel Holes

• Use gang-mounted drill rig
  – Consistent holes
  – Alignment jig
  – Improved productivity

• Slab reference preferable

• Hydraulic or pneumatic drills O.K.
Drilling Dowel Holes

• Adjust location of hole for:
  – Cracks
  – Embedded steel
  – Major spalling

• Size hole diameter for grout
  – Cement-based use \textit{Dowel Dia.} + 5 \textit{mm}
  – Epoxy use \textit{Dowel Dia.} + 2 \textit{mm}
Self-Propelled Subbase Reference
Self-Propelled Slab Reference
Boom-Mounted Slab Reference
• Installing Dowels

1. Inject Grout to Back of Hole

2. Twist one turn while pushing in dowel

3. Place grout retention disk to hold in grout
Injecting Grout
Grout Retention Disk
Troweling of Grout around Bar
Placement of Bond-Breaking Board
Placing Concrete

• Distribute evenly
• Avoid excessive shoveling
• Vibrate uniformly
  – Use vertical penetrations of vibrator
  – Do not drag!!
Concrete Placement
Finishing

- Vibratory screeds or 3m straight edges
- For short repairs (<3m), pull finishing tool along transverse boundary
- For longer repairs, finish the concrete longitudinally using vibratory screed
- Straight Edge
- Vibrating Screed

- <3 m

- >3 m

- Finishing
• Finishing
• Texturing
Curing
Joint Sealing

- Form or saw joint sealant reservoirs at all patch boundaries
- Sealed joints reduce spalling
Opening to Traffic

• 3 methods:
  – Specified minimum strength
  – Specified minimum time after completing placement (5 or 10 hour patches)
  – Maturity method (mix specific)

• Strength method preferred

• Variations in air temperature influence strength development
Slab Stabilization/Jacking
- Pressure insertion of flowable material beneath the PCC slab
Slab Stabilization vs. Slab Jacking

• Slab Stabilization:
  – Pressure insertion of a flowable material to restore support beneath PCC slabs
  – Fills existing voids but does not lift slab

• Slab Jacking:
  – The lifting or raising of a PCC slab by pressure inserting a grout beneath the slab
  – Levels depressed slabs and restores rideability (but not for correcting faulted joints)
Identifying Loss of Support

• Visual distress survey
• Deflection testing
  – Maximum deflections
  – Void detection procedures
• Other methods
Construction
Material Injection
Construction
Operation
Quality Control
Monitoring Slab Lift
Slab Jacking
Slab Jacking

• Address localized areas of settlement
  – Fill areas
  – Culverts
  – Bridge approaches

• Materials:
  – Cement grouts widely used at one time
  – More recent use of polyurethane materials
Stringline Method

- Beginning of sag
- String line
- Maximum depth of sag
- 10 ft
- Wooden separator blocks
- Nail to secure line

Fig. 4.6 on p. 4.11
Stringline Method
Grouting Hole and Plug
Completed Project
Dowel Bar Retrofit
Load Transfer Restoration

• Placement of load transfer devices across joints or cracks of existing pavements

• Candidate projects
  – Poor load transfer (< 70 %)
  – Pumping
  – Faulting
  – Corner breaks
Purpose of Load Transfer Restoration

• Reestablish load-transfer across joints or cracks
  – Load-transfer is a slab’s ability to transfer part of its load to its neighboring slab

• Used in JRC and JPC pavements to limit future faulting

\[ \Delta L = x \]
\[ \Delta U = 0 \]

Load Transfer = 0% (Poor)

\[ \Delta L = x \]
\[ \Delta U = x \]

Load Transfer = 100% (Good)
Diamond saw slot cutter
- Cuts multiple slots in a single pass
- Cuts form the edges of the slots
- Fins are removed later
- Can cut 3 or 6 slots in a single pass
Caution!

Modified milling machines are NOT recommended!

Diamond sawing is the most reliable and proven method. Modified milling has been used experimentally with very limited success.
• Milled slots may cause patches to fail and/or joints to lock up.

• Modified milling machines are demolition tools, not precision cutting instruments.
Questions