Extending Your Investment With Concrete Pavement Preservation

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Introduction

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Background

- The first Portland Cement Concrete Pavement (PCCP) constructed in US was located in Bellefontaine, Ohio, 1891
- Used two lift construction
  - Hard aggregate on surface so horseshoes wouldn’t wear pavement.
  - Surface Texture was grooved in 4” squares so horses would not slip
Background

- Concrete roadway construction in the US increased at a rapid rate at the turn of the century.
- By 1914, there were 2,348 miles of paved Portland Cement Concrete Pavement in US.
- A significant portion of the early Interstate Highway System was constructed using PCCP.
Background

- Early traffic predictions greatly underestimated future needs
- Traffic growth outpaces road construction
- Highway funding fails to keep pace with needs
- Many PCCP carry 10 to 20 times predicted traffic due to these factors
Priorities Have Shifted in Modern Times

- Minimal system expansion
- Maintain the present system
- Minimize traffic disruptions
- Increase safety
- Address operator comfort
  - Reduce roughness
  - Reduce noise
- Save money
- Protect the Environment
Pavement Preservation Philosophy

Keeping good roads in Good Condition!
Concrete Pavement Preservation Origins

- Diamond grinding was the first treatment used as part of an engineered system to preserve PCC Pavement in the 1960’s. Concrete Pavement Preservation (CPP) is born.
PCCP Preservation Techniques

- Subsurface rehabilitation
- Partial-depth repair
- Cross-stitching longitudinal cracks/joints
- Dowel bar retrofit
- Full-depth repair
- Diamond grinding
- Joint & crack resealing
Pavement Sub-Surface Rehabilitation

- Undersealing/Slab stabilization
- Deep - injection
- Medium - injection
- Slab jacking

*NOTE – Slab stabilization ≠ slab jacking
Material Types

- Cement grout mixtures
  - Cement
  - Lime
  - Flyash
- Asphaltic materials
- Structural polymers
  - (e.g., URETEK)
Pavement Sub-Surface Rehabilitation

- Used for sub-grade repair
- Soil collapse
- Poor compaction
- Reduces
  - Pumping
  - Joint faulting
  - Corner breaks
Cross Stitching

- Used for longitudinal cracks that are in good condition
- Used to maintain aggregate interlock and provide added reinforcement to crack
  - Strengthen longitudinal cracks
  - Prevent slab migration
  - Maintain aggregate interlock
  - Prevent lane separation
  - Prevent longitudinal joint faulting
**Top View**

- Transverse Joint
- See Note A
- 24 in. min.
- Cross-stitch Holes (Typ.)
  (Alternate sides of crack)

**Cross-sectional View**

- See Note B
- 35°-45°
- 0.75-in. dia. Rebar
  Epoxy into Place
- Slab
- Subbase
- T

**Note A:** Distance between holes is 24 in. for heavy traffic; 36 in. for light traffic.

**Note B:** Determine distance from longitudinal crack to hole based on slab thickness $T$ and drill angle. Slabs less than 12 inches thick require a 35° insertion angle.
Partial Depth Repair - PDR

- Partial-depth repairs are used on surface defects and joint spalls that are limited to the upper one-third of the PCC slab.
- Restores ride quality and pavement functionality with minimal traffic interruption.
- Costs less than a full depth repair.
MNDOT PDR Method

- Concrete removal by modified cold-milling.
- Must faster and less expensive than sawing and jack-hammering.
- Since PDR is a bonding operation, irregular shapes are permitted.
- Provides long term performance (20 years plus).
Cementitious vs Non-Cementitious

- New cementitious fast setting materials minimize traffic disruption and increase durability
- Non cement based materials while more expensive do not require reformation of the joint or crack due to greater material flexibility
  - Polymer Resins
  - Elastomeric Materials
Dowel Bar Retrofit - DBR

- Placement of load transfer devices across joints or cracks of existing pavements
- Reestablishes load-transfer across joints or cracks in PCCP
- Used in undoweled pavements to limit future faulting
- First production use of DBR in 1993 by WSDOT
WSDOT DBR Research

- Since 1992, WSDOT has retrofitted over 300 Lane-mi or 650,000 bars
- Average age of pavement prior to DBR was 32 yrs.
- Many 30 and 40 year PCCPs successfully retrofitted adding over 20 years additional pavement life at a fraction of the cost of reconstruction
Pavement Age vs. DBR Placement

**Contract Number**

**Age (years)**

- **PCC Age at DBR**
- **DBR In-service Age**
Distribution of PCCP Miles by Rehabilitation Method

- Untouched, Built Before 2000
- Doweled, Built After 2000
- DBR
- Grind
- Panel Replacement

<table>
<thead>
<tr>
<th>Mile Category</th>
<th>Untouched Built Before 2000</th>
<th>Doweled Built After 2000</th>
<th>DBR</th>
<th>Grind</th>
<th>Panel Replacement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>1,130 (55%)</td>
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- Total Doweled Built After 2000: 179 (9%)
- Total DBR: 352 (17%)
- Total Grind: 225 (11%)
- Total Panel Replacement: 156 (8%)
IGGA DBR Project Database

- Includes individual project data including:
  - Project Location
  - Project Date
  - Number of bars installed
- Over 7 million bars installed in the US since 1992
Full-Depth Repair

• Purpose
  - Restore structure
  - Restore ride

• Used for:
  - Joint deterioration
  - Transverse cracking
  - Longitudinal cracking
  - Broken slabs & corner breaks

Full-Depth Repair
Full-Depth Repair

- Removal and replacement of concrete through entire depth
- Restores ride quality
- Fast setting materials minimize traffic disruption
- Pin/lift-out speeds process
  - Full depth saw cuts done days prior to the lift out.
  - Minimizes traffic disruption.
  - Preserves base, minimizes base repair labor and materials
Combine Patches

- The cost of lay out, saw cutting, dowel bar placement and labor outweigh the savings in a minimal amount of concrete.
Key Factors For Success

- Selection of proper candidate projects
- Properly sized repairs
- Good material removal practices
- Well prepared subbase
- Effective restoration of load transfer
- Selection of appropriate repair material
- Proper material placement, finishing, and curing
Diamond Grinding

- Removal of thin surface layer of hardened PCC using closely spaced diamond saw blades
- Results in smooth, level pavement surface
- Provides a longitudinal texture with desirable friction and low noise characteristics
- Frequently performed in conjunction with other CPP techniques, such as full-depth repair, dowel bar retrofit, and joint resealing
Advantages of Diamond Grinding

- Can be used on both concrete and asphalt pavements
- Costs substantially less than overlays
- Enhances surface friction and safety
- Can be accomplished during off-peak hours with short lane closures and without encroaching into adjacent lanes
- Grinding of one lane does not require grinding of the adjacent lane
- Does not affect overhead clearances underneath bridges
- Blends patching and other surface irregularities into a consistent, identical surface
- Environmentally sustainable!
Pavement Problems Addressed

- Faulting at joints and cracks
- Built-in or construction roughness
- Polished surface
- Wheel-path rutting
- Permanent upward slab warping
- Inadequate transverse slope
- Unacceptable noise level
Diamond Grinding can provide a 60% to 70% improvement over the pre-grind profile on average!
IRI of Kentucky Interstate PCCP

- IRI of 112.1 in 2007
- Decrease to 74.5 in 2012

Time from 2007 to 2012
Impact of CPP Strategy in KY

- IRI Improved from 112.1 to 74.5 in 5 years
- Lowest recorded average IRI ever covering 536 lane miles
- $188,000 per lane mile
- Diamond grinding had an avg. cost of $2.75 per sq. yd. in KY over a 5-year period
- Reconstruction cost would have been $1.5 - $2.5 million/lane mile
- Preservation saved over $1 Billion
Safety, Surface Texture and Friction

- MoDOT Increased macro-texture of asphalt surface by diamond grinding to improve profile and drainage of water at tire-pavement interface

- In Wisconsin Marquette University found that, overall accident rates for ground surfaces were 40% less than for un-ground surfaces over a 6-year period, 57% in wet weather conditions

Commonly Used on Asphalt Pavement!
Blade Spacing Can Be Optimized

- Noise, Friction, or Smoothness can be optimized by blade spacing
- Research conducted by the National Concrete Pavement Technology Center shows diamond grinding as the most quiet PCCP surface texture commonly used
CA and AZ PCCP Noise Test Results
Effectiveness of Diamond Grinding

CALTRANS has determined that the average life of a diamond ground pavement surface is 16 to 17 years and that a pavement can be ground at least three times without affecting the pavement structurally. See IGGA.net for full report.
Joint and Crack Resealing
Joint and Crack Resealing

- Minimizes water & incompressibles into pavement system
- Reduces:
  - Subgrade softening
  - Pumping
  - Erosion of fines
  - Spalling

Sealant Nozzle
Reservoir
Backer Rod
Influence of Moisture Infiltration

- Loss of Fines (Pumping)
- Corner Breaks
- Transverse Joint Faulting
Sealing Affects Pavement Noise

Unsealed vs Sealed Joint is about 5 dBA
Guidelines for Resealing Joints

- Recommendation: continue to reseal joints if they were originally sealed!
- Reseal when sealant no longer functional
- Reseal when pavement not severely deteriorated
- Perform in conjunction with other preservation activities
- Proper material selection and joint preparation is essential
Summary

- This is a challenging time for the transportation industry.
- Innovative, cost-effective solutions are needed to meet these challenges.
- Many CPP techniques provide sustainable benefits such as increased friction (safety), reduced noise, improved smoothness and long life.
- Concrete Pavement Preservation can extend pavement life significantly at a competitive cost.
- When building roadways we must begin with the end in mind – consider sacrificial thickness for future grinding.
- IGGA is ready to assist!
Visit Us on the Web

International Grooving and Grinding Association

at

igga.net