Concrete Pavement Preservation and Rehabilitation to Meet Sustainability Demands

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Introduction

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Introduction

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The Challenge in Hand- Sustainability
Sustainability

- The capacity to maintain a process or state of being into perpetuity.

- In the context of human activity, sustainability has been described as activity or development “that meets the needs of the present without compromising the ability of future generations to meet their own needs”.

- In the context of pavement systems, sustainable pavements are those that, from design through rehabilitation, use environmentally friendly materials and practices and enhance the public’s economic well-being and general quality of life.
Priorities Have Shifted

- Minimal system expansion
- Maintain the present system
- Minimize traffic disruptions
- Increase safety
- Address operator comfort
  - Reduce Roughness
  - Reduce Noise
- Save money
- **Protect the Environment**
The Need

- Cost effective, engineered strategies to preserve and rehabilitate the aging roadway system.
  - Interstate system still serves public utilizing 30 -50 year old PCCP sections.
  - Highway maintenance budgets are shrinking.
  - Traffic volumes and vehicle loads are increasing.
Tomorrow’s roadway preservation and rehabilitation strategies must be designed and constructed in a way that provides maximum benefit to the country’s economic and social well-being with minimal negative impact on the environment.
Question
What if?
What if you could......

- Rehabilitate pavements for a fraction of the cost of reconstruction?
- Preserve the remaining equity in existing pavements for another 30 to 40 years?
- Enhance pavements’ structural load-carrying capacity to meet changing traffic needs?
- Reduce “first use” of natural or manufactured materials by replacing some cements and aggregates in concrete mixtures with recycled, waste, or other lower-cost materials?
- Reduce frequency and duration of work zones, ultimately reducing vehicle emissions due to work-zone related traffic delays?
What if you could……

- Restore or enhance pavement surface characteristics like smoothness, quiet ride, skid resistance; and reflectivity?
- Reduce wear and tear on vehicles from poor pavement surfaces?
- Help mitigate storm-water runoff and other environmental impacts of pavement systems?
- Free up financial resources from pavement maintenance activities to address other highway sustainability challenges like urban congestion?
Tomorrow’s Technologies Here Today

Transportation agencies already have access to a variety of sustainable, concrete-based pavement maintenance and repair solutions. What is needed is not necessarily new technologies or solutions, but a new, proactive mindset toward using them. By focusing more time and effort on upfront evaluation and planning activities, agencies can optimize existing technologies and solutions, preserving the equity in their pavements and enhancing their functional and structural capacity, all for less than the cost of reconstruction.
Research confirms that concrete has many characteristics that make it a sustainable material for pavement.

- **Concrete Pavement Preservation Manual** - Describes the correct implementation of preservation strategies, and a systematic approach to evaluating pavement conditions and selecting optimum strategies.

- **Guide to Concrete Overlays-Sustainable Solutions for Resurfacing and Rehabilitating Existing Pavements** - Includes details about evaluating the conditions of an existing pavement to determine if it is a good candidate for a concrete overlay, and a flowchart for selecting an appropriate overlay solution.

- **Integrated Materials and Construction Practices for Concrete Pavement** - Utilized to enhance concrete pavement sustainability by implementing state-of-the-art pavement design, materials selection and mixture proportioning, and construction quality-control practices.
What Does Sustainable Pavement Look Like?

- Concrete Pavement is durable and long lived.
- Concrete Pavement requires less fuel consumption during materials production, transportation, placement and rehabilitation than alternative paving materials.
- Concrete mixes incorporate industrial byproducts such as fly ash, slag and tires.
- Concrete pavement requires less base aggregate materials for structural support than alternative paving materials.
What Does Sustainable Pavement Look Like?

- Concrete pavements’ lighter color and increased reflectivity improve nighttime visibility, reduce the amount of power needed to illuminate roads at night, and can help mitigate urban heat islands and smog generation.
- Concrete pavement itself is renewable and 100 percent recyclable.
- Optimized concrete pavement surface textures produce quieter pavements over longer periods of time, reducing noise pollution.
- Properly constructed and textured concrete pavements have reduced pavement deflection, which results in less vehicle drag and thus reduced vehicle fuel consumption.
California I-10
Diamond Grinding Was Invented in California

- Diamond grinding was first used in California in 1965 on a 19-year old section of I-10 to eliminate significant faulting (Neal and Woodstrom 1976).
- In 1983, CPR was conducted on this same pavement section, including the use of additional grinding to restore the rideability and skid resistance of the surface. In 1997, the process was repeated.
- Since its first use in 1965, the use of diamond grinding has grown to become a major element of PCC pavement preservation.
CALTRANS has determined that the average life of a diamond ground pavement surface is 17 years and that a pavement can be ground at least three times without affecting pavement structurally. See IGGA.net for full report.
Preservation and Restoration

- First level of response for deteriorating concrete pavements should always be Preservation/Restoration
  - Least cost – Cheaper than reconstruction
  - Least service disruption
  - Increases safety
  - Environmentally sound
  - Addresses operator comfort
Rehabilitation Timing

- Preservation
- Restoration
- Resurfacing
- Reconstruction

Min. Acceptable Rating vs. Age or Traffic

Structural / Functional Condition
Purpose of CPP

- Used early when pavement has little deterioration.
  - Repairs isolated areas of distress.
  - Repairs some construction defects.
  - Manages the rate of deterioration.
PCCP Preservation Techniques

- Full-depth repair
- Partial-depth repair
- Slab stabilization
- Retrofitting dowels
- Cross-stitching longitudinal cracks/joints
- Diamond grinding
- Joint & crack resealing
Full-Depth Patching Operations
In Situ Full Depth Repair
Pre-cast Pavement Panels
Load Transfer Restoration – Dowel Bar Retrofit
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)
Performance of DBR Concrete Pavement Under HVS Loading by CALTRANS, UC Davis and UC Berkeley

- Tested two retrofitted PCCPs under a Heavy Vehicle Simulator (HVS) aka accelerated loading frame
- HVS results demonstrated large improvement in LTE and decrease in vertical deflections
- DBR sections not damaged by HVS loading, unlike control section
- DBR less sensitive to temp changes than control section
- Total of 11,000,000 ESALS applied to DBR sections without failure occurring
Ten-Year Performance of DBR Application - WASHDOT

- First production DBR project completed in Washington in 1992
- WASHDOT has retrofitted 225 miles since 1992
- Subject DBR sections still maintain average LTE of 70% to 90%
- Determined that carbide roto-milling is NOT a viable alternative for diamond grinding
- Based on 10 yr results, DBR is considered a successful alternative for rehabilitation of aging PCCPs in WS
Diamond Grinding
What is Diamond Grinding?

- Removal of thin surface layer of hardened PCC using closely spaced diamond saw blades;
- Results in smooth, level pavement surface;
- Longitudinal texture with desirable friction and low noise characteristics;
- Frequently performed in conjunction with other CPR techniques, such as full-depth repair, dowel bar retrofit, and joint resealing.
- Comprehensive part of any PCC Pavement Preservation program;
Diamond Grinding
Grinding Process
Diamond Grinding
Finished Product
Diamond Grinding
Advantages of Diamond Grinding

- Cost competitive;
- 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;
- Provides a low noise surface texture!
MODOT- Safer, Smoother, Sooner

- MODOT initiates Safer, Smoother, Sooner program in 2005 – 2007
- The initiative invests $400 million on 2,200 miles
- Improve customer satisfaction through
  - Safer pavements
  - Smoother ride quality
  - Quiet ride quality
- Approx 20,000,000 sq yds let since 1st Qtr 2005
- See IGGA.Net for MODOT’s BMP on diamond grinding new PCCP
Rehabilitation Timing

- **Preservation**
- **Restoration**
- **Resurfacing**
- **Reconstruction**

**Structural / Functional Condition**

**Min. Acceptable Rating**

**Age or Traffic**
Concrete Overlays
Why Concrete Overlays?

- Consistent performance with proven history
- Constructed quickly and conveniently
- Few pre-overlay repairs are necessary
- Placed using normal concrete pavement construction practices
- Can be opened to traffic within a short time
- Easy to repair
- Cost-effective
Family of Concrete Overlays

Concrete Overlays

Bonded Overlay Family
- Bonded Concrete Overlay of Concrete Pavements
- Bonded Concrete Overlay of Asphalt Pavements
- Bonded Concrete Overlay of Composite Pavements

Unbonded Overlay Family
- Unbonded Concrete Overlay of Concrete Pavements
- Unbonded Concrete Overlay of Asphalt Pavements
- Unbonded Concrete Overlay of Composite Pavements

Bond is integral to design

Old pavement is base
Why are we not using Concrete Resurfacing Technology more?

Perception:

- Pavement design theories for bonded and unbonded overlays (resurfacing) are difficult to understand
- There is lack of confidence in overlays because of lack of understanding on how they work
Concrete Overlay Guide

Contents

1. Overview of Overlay Families
2. Overlay types and uses
3. Evaluations & Selections
4. Six Overlay Summaries (11”x17 “sheets)
5. Design Section
6. Miscellaneous Design Details
7. Overlay Materials Section
8. Work Zones under Traffic
9. Key Points for Overlay Construction
10. Accelerated Construction
11. Specification Considerations
12. Repairs of Overlays

The overall objective of the program is to increase the awareness, knowledge and strengthen confidence in concrete overlay applications among state DOTs, cities, counties, contractors, and engineering consultants.
Concrete Overlay

Field Application States

Joined the Program
1. Delaware
2. Louisiana
3. Maryland
4. Nevada
5. New Mexico
6. North Dakota
7. Pennsylvania
8. South Dakota
9. Texas
10. Washington
11. West Virginia

Interested States
1. Arkansas
2. California
3. Georgia
4. Kentucky
5. Maine
6. Minnesota
7. Nebraska
8. North Carolina
9. Virginia

5 States – 6” Bonded Overlays over HMA (6’x6’ joints)
3 States – 6” Unbonded Overlays over Concrete (6’x6’ joints)
1 State – 7” Bonded CRCP over Plain Jointed Concrete

Iowa – 2009-2010
Field Application
Research Projects
Expert Team

Experts on concrete overlays will provide informational assistance to each participating state.

• Conduct initial field site review
• Walk through the evaluation process
• Walk through the design phase
• Attend pre-pour, pre-bid or pre-construction conference
• Attend during construction & may use mobile lab
Summary

- Many available rehabilitation treatments for PCC pavements
- Each has advantages and limitations
- Performance and cost vary with given conditions
- Applying the right treatment to the right pavement *at the right time*
- No universal method available
- Take advantage of local contractor experience
- IGGA & ACPA are ready to assist
We all need to start pulling together to help keep our environment cool & clean
Visit Us on the Web

International Grooving and Grinding Association
  • IGGA.net
American Concrete Pavement Association
  • ACPA.org