Preservation, Repair, and Rehabilitation of Concrete Pavements

Kurt Smith, P.E., ksmith@appliedpavement.com

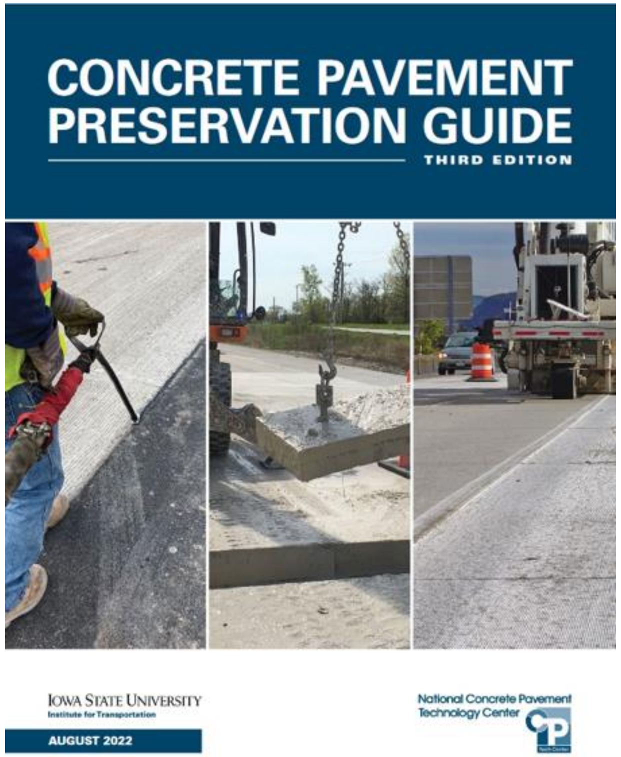
Larry Scofield, P.E., lscofield@acpa.org

IOWA STATE UNIVERSITY
Institute for Transportation

National Concrete Pavement Technology Center
Tech Center

Outline

- Introduction: What is Pavement Preservation?
- Major Preservation Treatments
  - Partial-Depth Repair
  - Full-Depth Repair
  - Dowel Bar Retrofit
  - Diamond Grinding
  - Joint Resealing
- Preservation and Rehabilitation Using Concrete Overlays
- Summary



Introduction: What is Pavement Preservation?

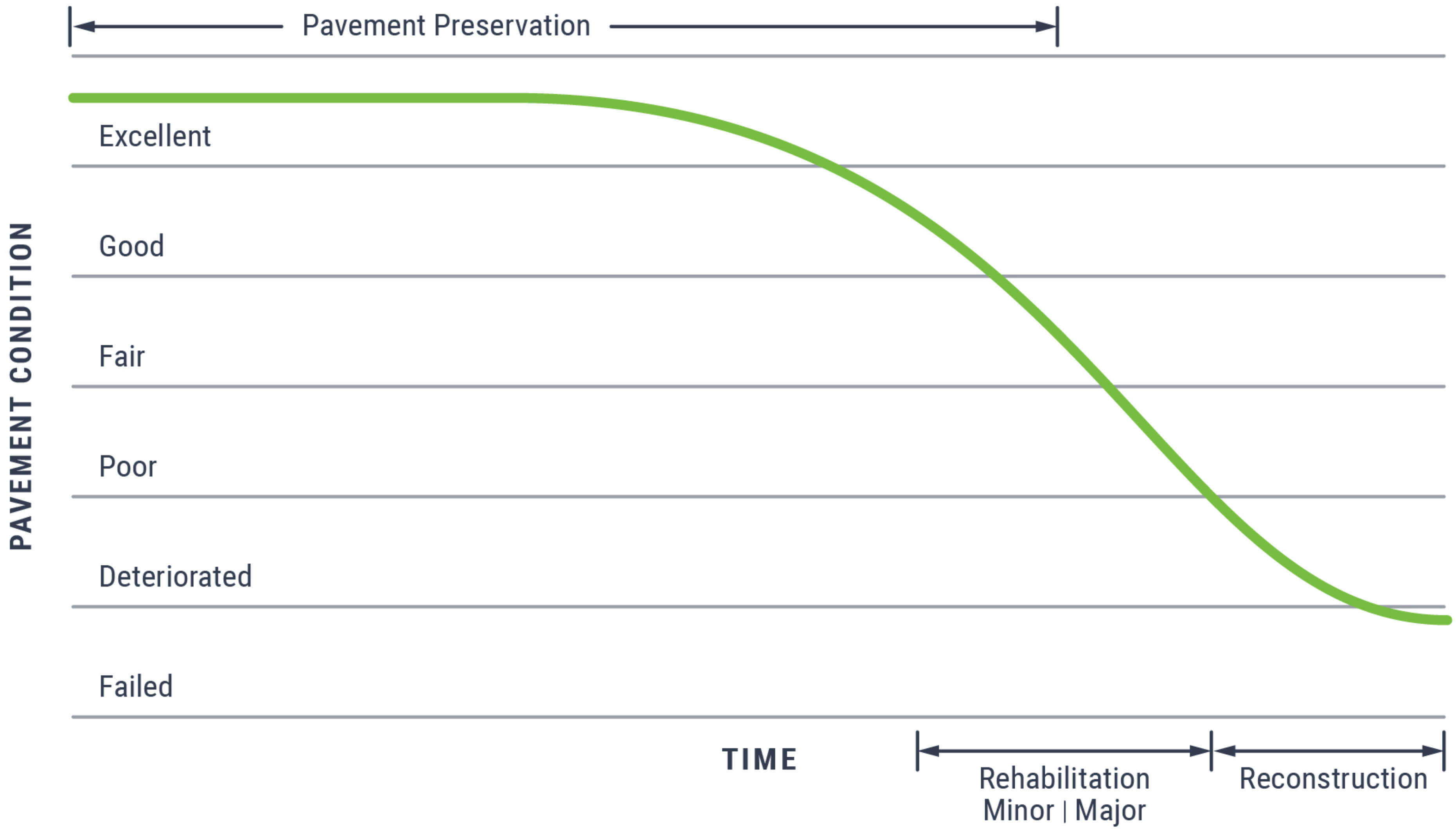
What is Pavement Preservation?

- Proactive approach to managing pavement assets
- Focus:
  - Extending pavement life
  - Maintaining or restoring functional condition
- Accomplished using a collection of preservation and rehabilitation treatments

A more recent definition:

Concrete pavement preservation is a strategy of extending concrete pavement service life for as long as possible by arresting, greatly diminishing, or avoiding pavement deterioration processes.

Pavement Preservation Timing



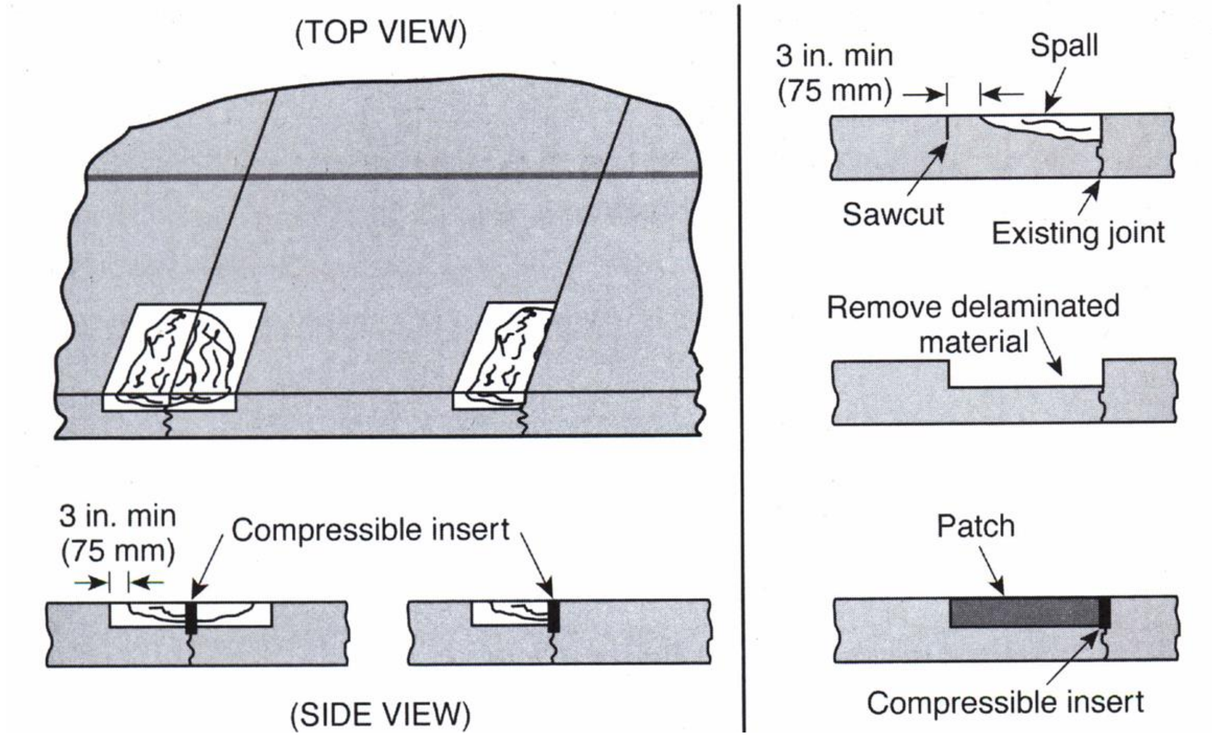
Pavement Preservation Keys and Benefits

- Keys to successful projects:
  - **Right pavement:** few/limited structural problems or MRD
  - **Right time:** before significant structural issues
  - **Right treatment:** treatments target conditions
  - **Right installation:** effective installation for performance
- Benefits:
  - User satisfaction (smoothness, safety, fewer disruptions)
  - Reduced lane closure duration
  - Improved network conditions
  - Long-term cost savings
  - Enhanced sustainability

Major Preservation Treatments

Partial-Depth Repairs

- Removal & replacement of shallow areas of deteriorated concrete
  - Depth up to 1/2 of slab thickness
- Frequently used to address joint spalling and deterioration



Partial-Depth Repairs

- Good candidates
  - Spalling caused by incompressibles
  - Joint deterioration caused by de-icing chemicals
  - Surface deterioration tied to poor curing or finishing

- Poor candidates
  - Deterioration > 1/2 slab thick
  - Spalling due to working cracks or dowel misalignment.
  - Materials-related distress spalling

Partial-Depth Repairs

- Range of repair materials
  - Conventional or high early strength concrete
  - Other types of rapid-setting cements
  - Polymer-based materials
  - Bituminous materials
- Selection based on curing time, placement conditions, performance

Partial-Depth Repairs

- Construction steps:
  1. Marking of repair boundaries
  2. Concrete removal
  3. Repair area preparation
  4. Joint preparation
  5. Bonding agent (if required)
  6. Repair material placement
  7. Curing



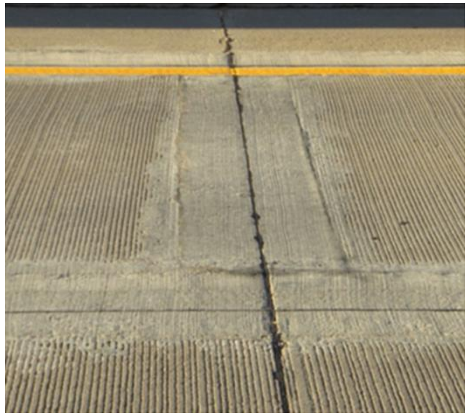






PDR: Ensuring Success

- Suitable candidate projects
- Repair properly sized (all deterioration removed)
- Use of durable materials
- Properly installed
  - Achieving bond
  - Proper placement and curing
- Performance: variable depending on project & installation (up to 15+ years)



Full-Depth Repairs

- Proven method of concrete pavement preservation
- Extends to the full depth of the existing slab
  - Cast-in-place
  - Precast
- Applicable for:
  - Jointed concrete pavements
  - Continuously reinforced concrete pavements
  - Utility cuts

Full-Depth Repairs

- Best for addressing intermittent structural deterioration
- Used to maintain serviceability or prepare pavement for overlay

Candidate JCP Distresses
Transverse Cracking (M, H)
Longitudinal Cracking (M, H)
Corner Breaks (L, M, H)
Spalling (M, H)
Blowups (L, M, H)
D-Cracking / ASR Deterioration*

* Stopgap

Candidate CRCP Distresses
Punchouts (L, M, H)
Deteriorated Trans. Cracks (M, H)
Longitudinal Cracking (M, H)
Blowups (L, M, H)
Construction Joint Distress (M, H)
D-Cracking / ASR Deterioration*

* Stopgap

Full-Depth Repairs

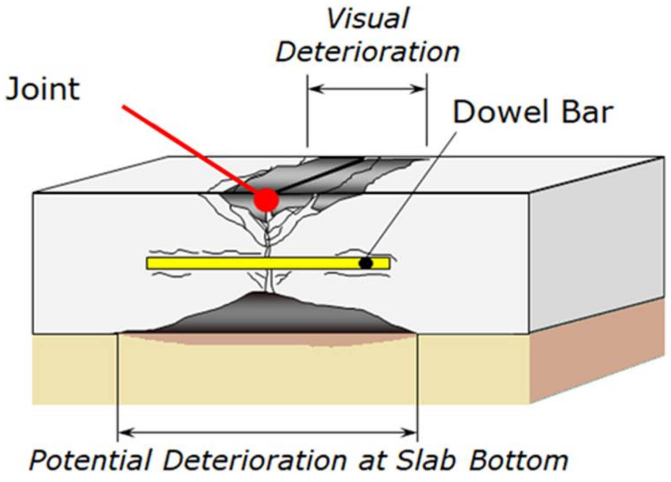
- Design and materials considerations
  - Repair location and boundaries
  - Opening time demands
  - Repair material selection
    - Standard PCC mix
    - High-early strength PCC mix
    - Mixes with other rapid-setting cements
  - Opening strength requirements

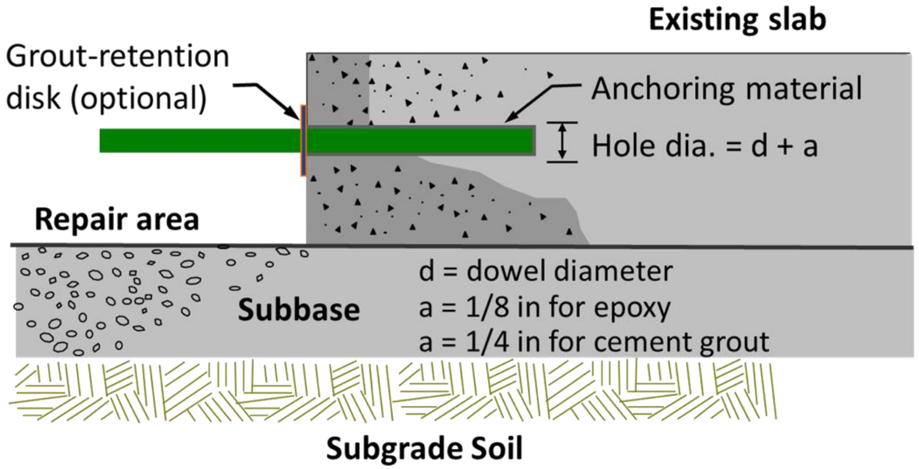
Full-Depth Repairs

- Construction steps:
  1. Marking and sawing of repair boundaries
  2. Concrete removal
  3. Repair area preparation
  4. Restoration of load transfer
  5. Treatment of longitudinal joint
  6. Concrete placement and finishing
  7. Curing

FDR: Ensuring Success

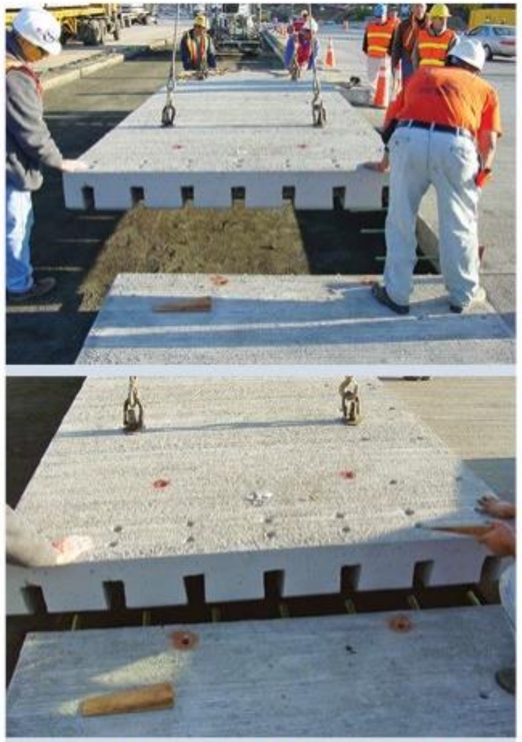
- Suitable candidate project
- Proper sizing of repair
- Restore load transfer system
- Use durable repair materials
- Ensure proper placement, finishing, and curing
- Performance: Full-depth repairs are capable of an extended treatment life of 20+ years





Full-Depth Repairs

- Precast panels may also be used for full-depth repairs
- Several systems are available with similar installation steps:



Dowel bars drilled in existing slab

Dowel bars fabricated in precast panel

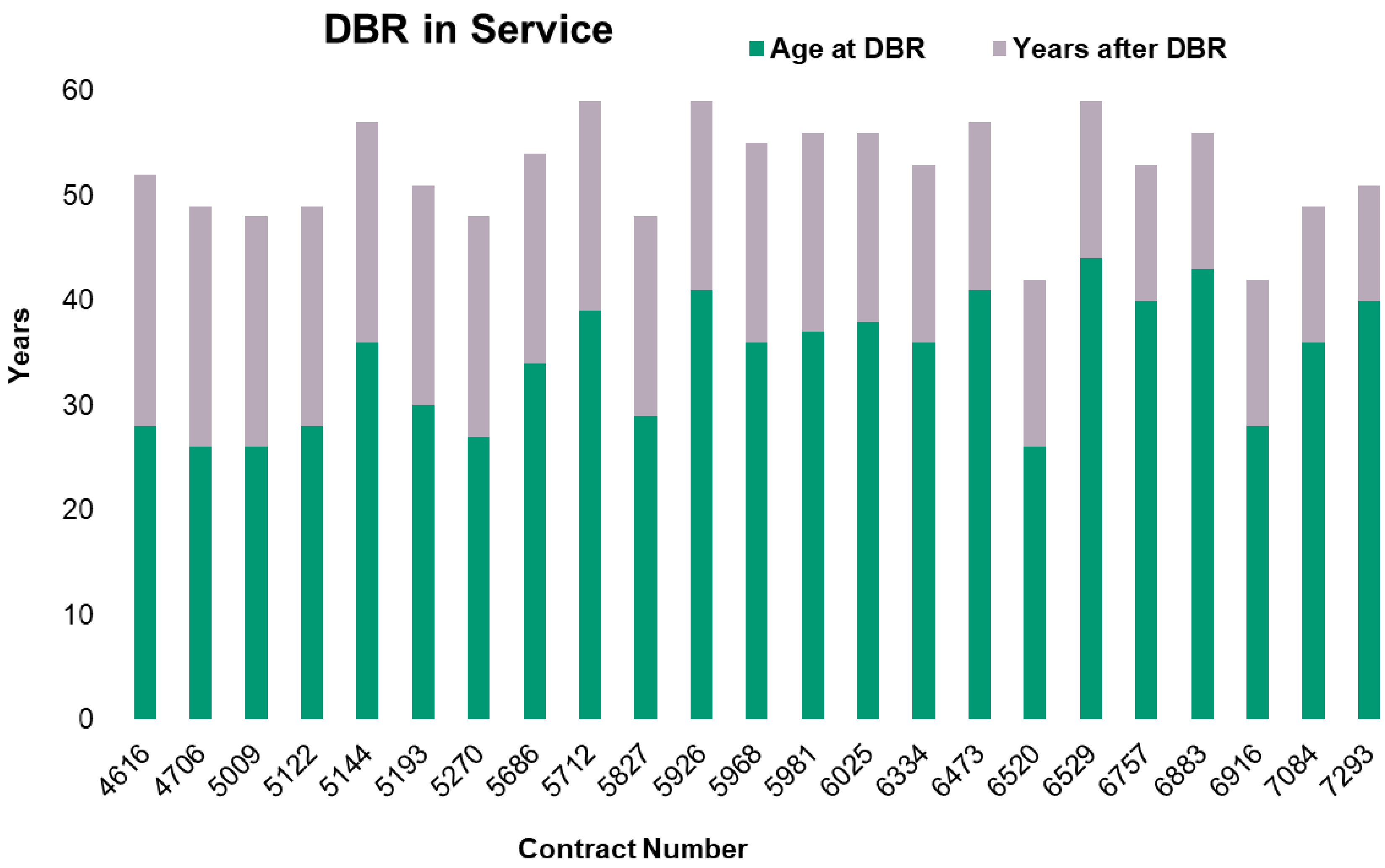
Precast panel using full dowel bar retrofit installation

Dowel Bar Retrofit

- Installation of dowel bars across transverse joints or cracks
- Improves load transfer, reduces deflections, and corrects and prevents faulting
- Typically 3 to 4 bars in each wheel path

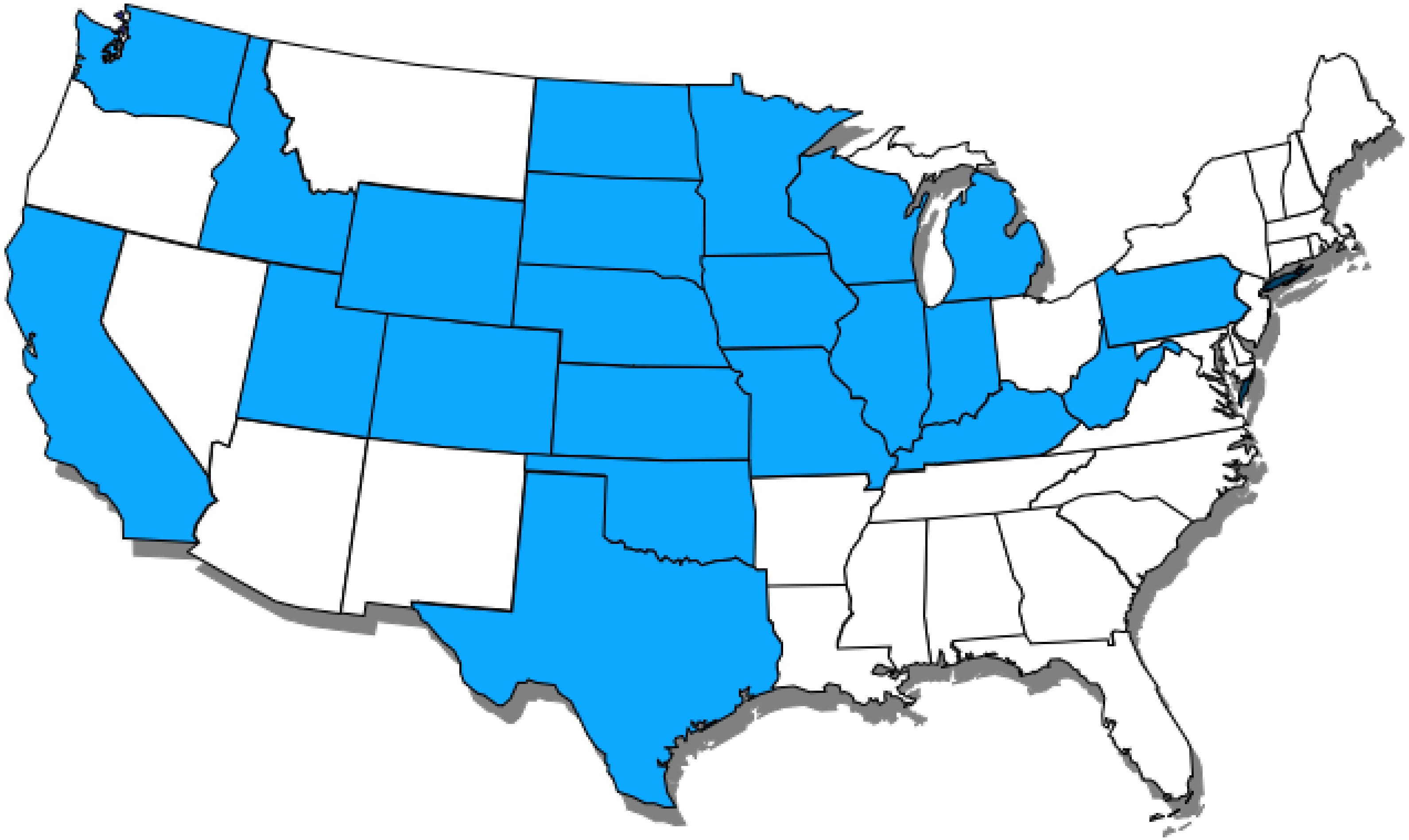
Dowel Bar Retrofit

WSDOT DBR Performance

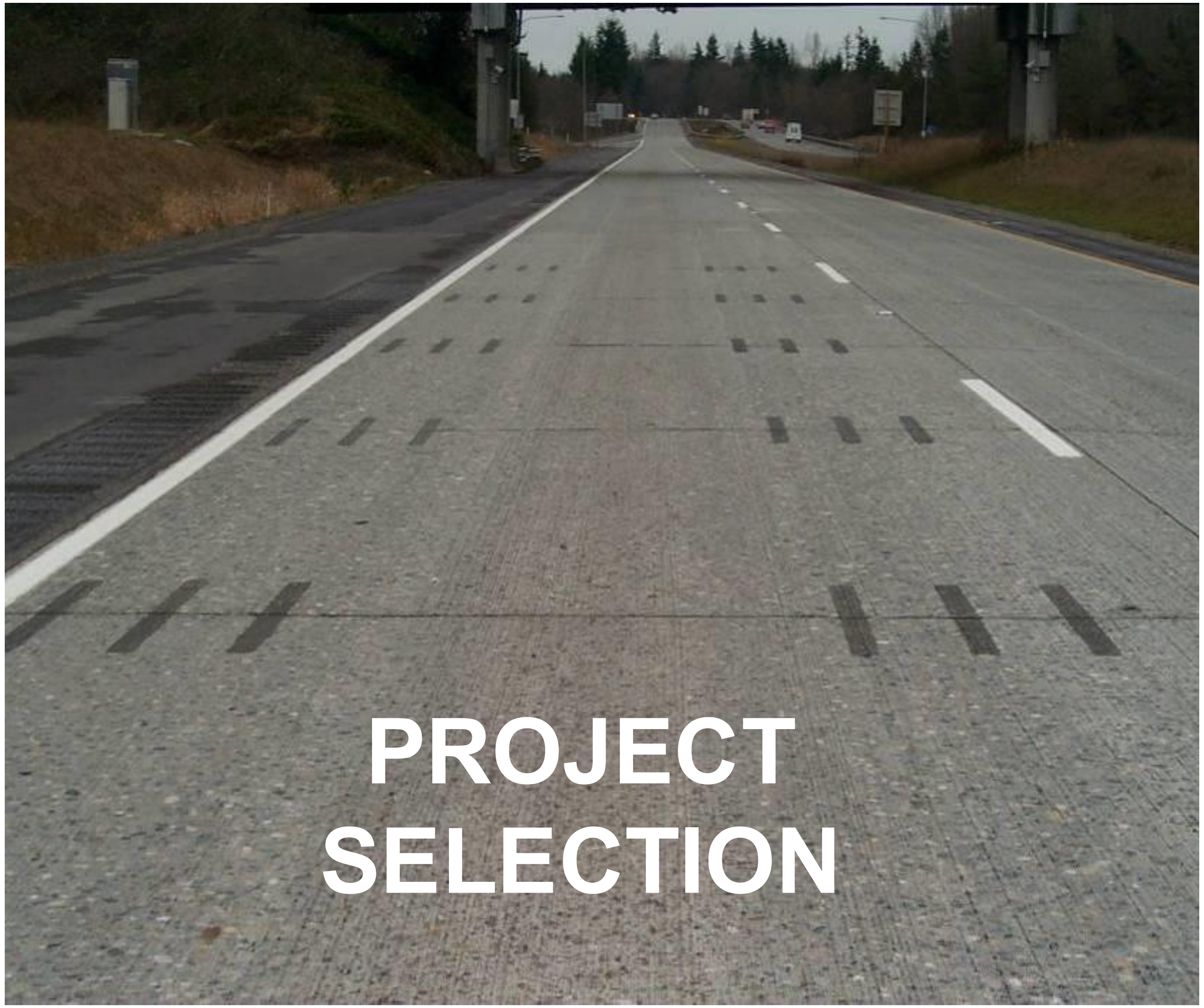


Dowel Bar Retrofit

Nationwide Use of DBR



Dowel Bar Retrofit



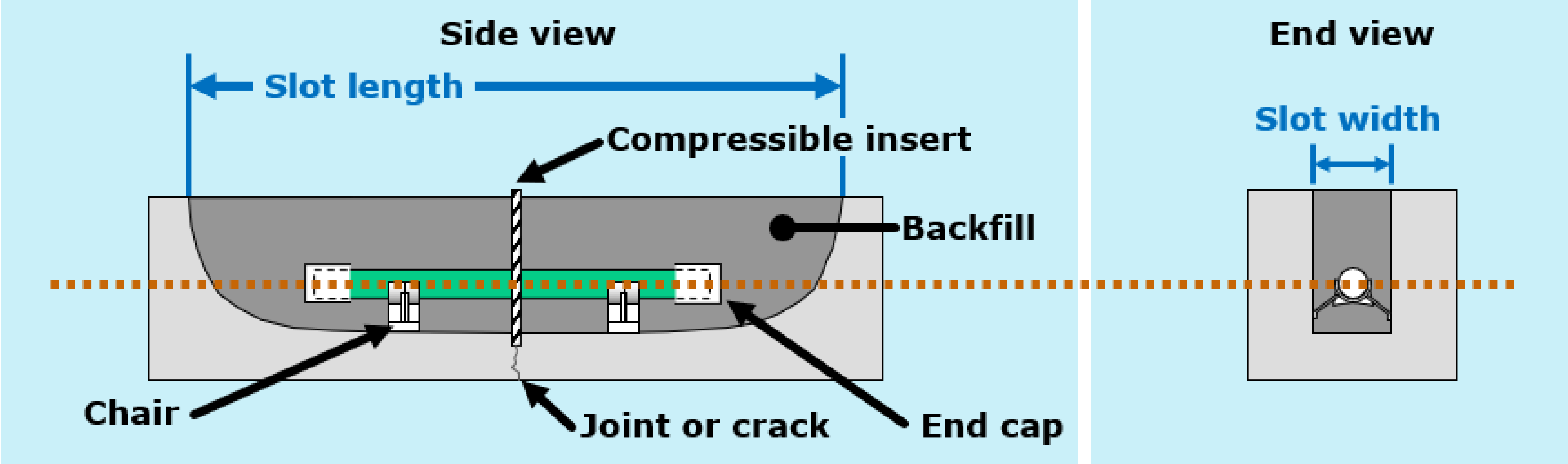
- No ASR, ACR, or D-cracking
- Structural Integrity
- Successful & Cost Effective When:
  - LTE < 60 Percent
  - Faulting > 0.1 in. but < 0.25 in
  - < 10% Slabs with Multiple Cracks
  - What is The Remaining Service Life

Dowel Bar Retrofit

Key Factors for Success

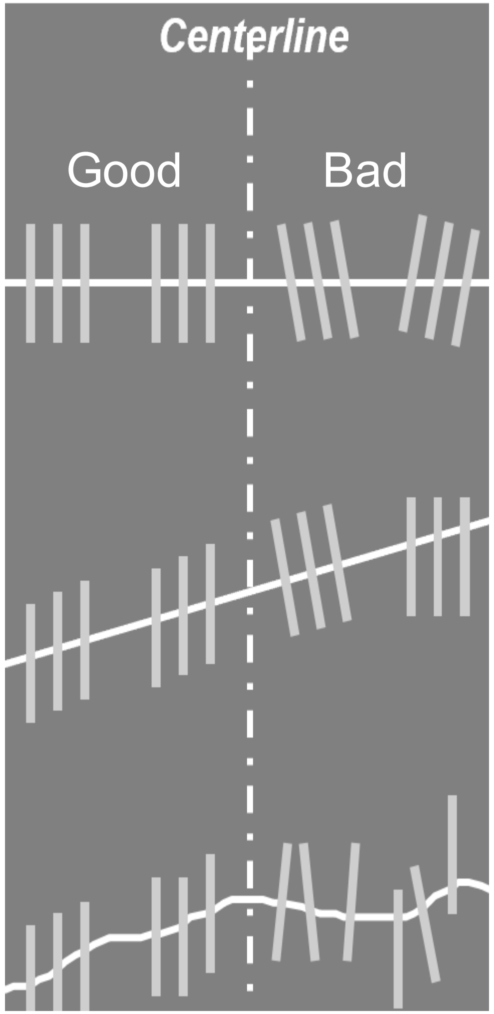
- Selection of Proper Candidates
- Proper Dowel Bar Design and Layout
- Cutting of Dowel Bar Slots
- Proper Preparation of Dowel Bar Slots
- Proper Placement of Dowel Bar Assembly
- Selection of Appropriate Material
- Careful Material Placement and Curing

Dowel Bar Retrofit



Dowel Bar Retrofit

Things to Watch For



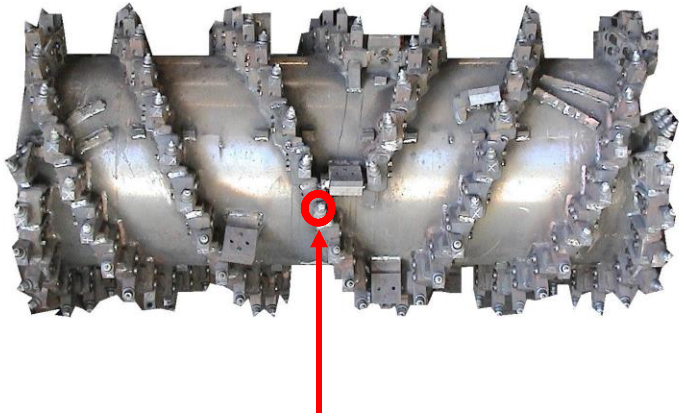
Dowel Bar Retrofit

Diamond Grinding (and Grooving)

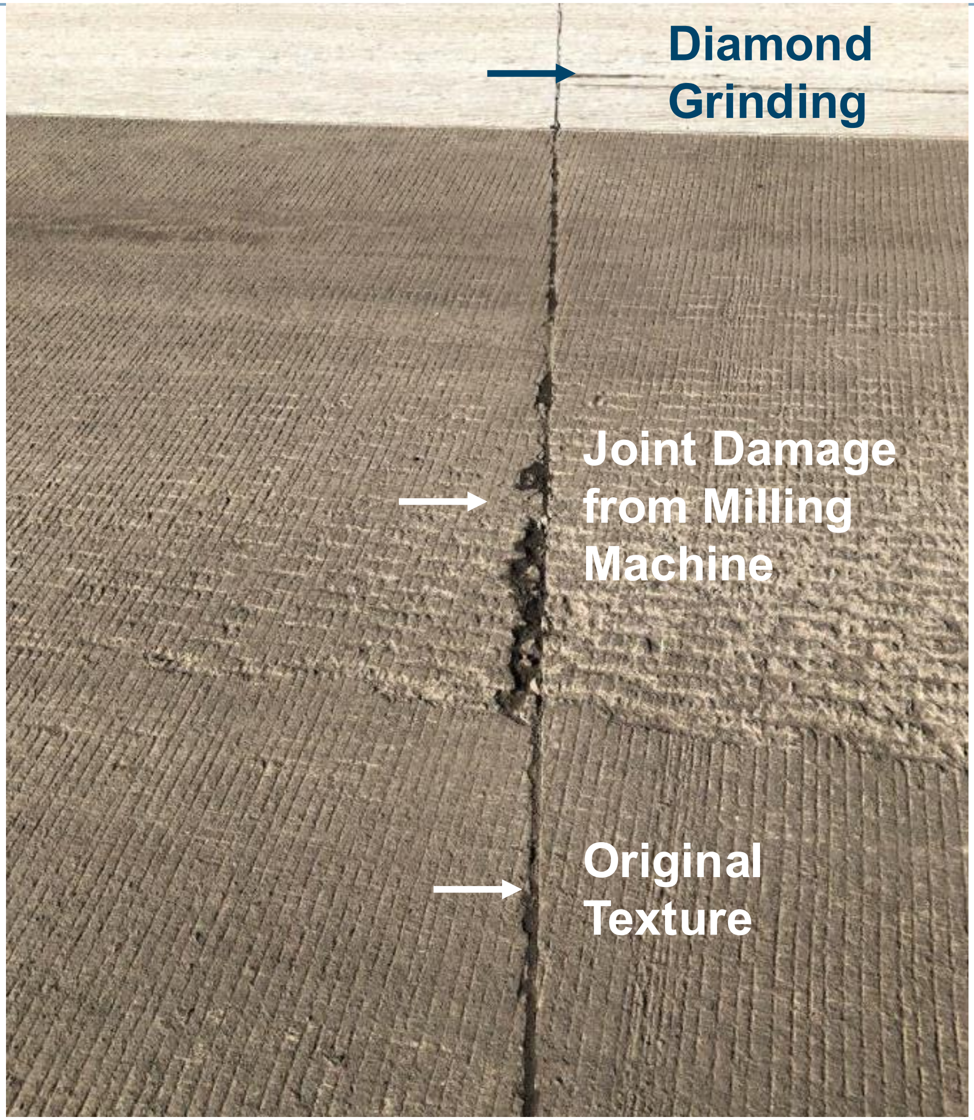
- Diamond grinding
  - Removal of a thin layer of the concrete surface
  - Improves pavement smoothness, surface texture, and noise
- Diamond grooving
  - Creation of channels to reduce potential for hydroplaning

Diamond Grinding

Milling Head

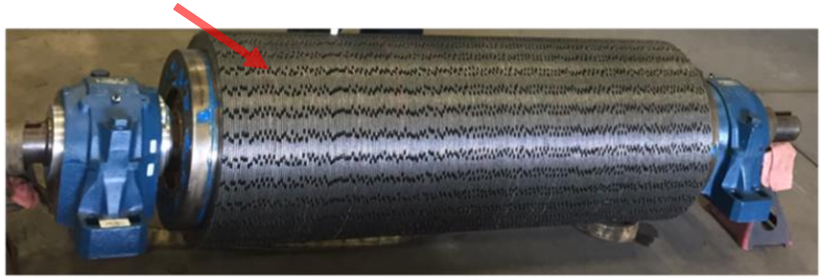


Uses Carbide Bits to
Impact Concrete



Grinding Head

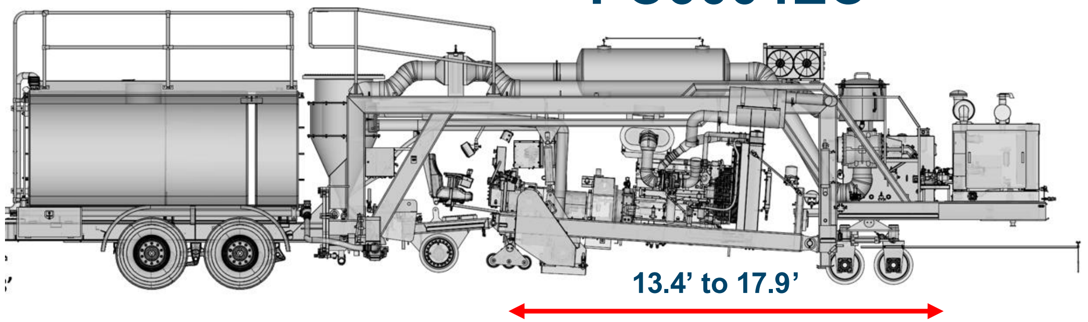
13,000 to 19,000 Carats of
Industrials Diamonds



Uses Diamond Impregnated
Blades to Grind Concrete

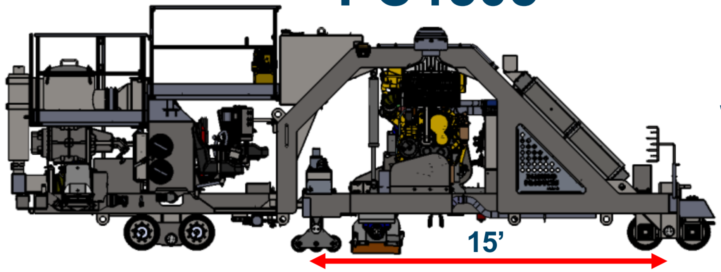
Diamond Grinding

PC6004EC



WT = 57,000 to 80,000 lbs.

PC4505



WT = 46,500 lbs.

PC1505XL

11.4’ to 13.4’

WT = 24,500 lbs.

Drawings Courtesy of Diamond Products

Diamond Grinding

Pavement Problems Addressed

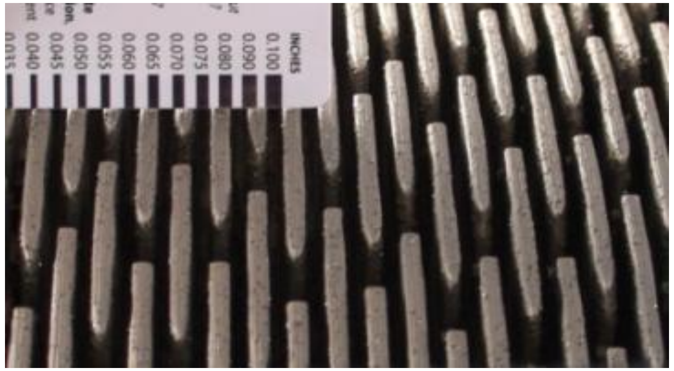
- Faulting Roughness at Joints and Cracks
- Built In Construction Roughness
- Increases Friction on Polished Surfaces
- Improves Unacceptable Noise Levels
- Blends Patching/surface Irregularities into a Consistent Surface
- Drainage Modifications

Smoothness:
US-45 West Bend WI – Pre Grind

Smoothness: US-45 West Bend WI - Post Grind

Diamond Grinding

NGCS Compared to CDG

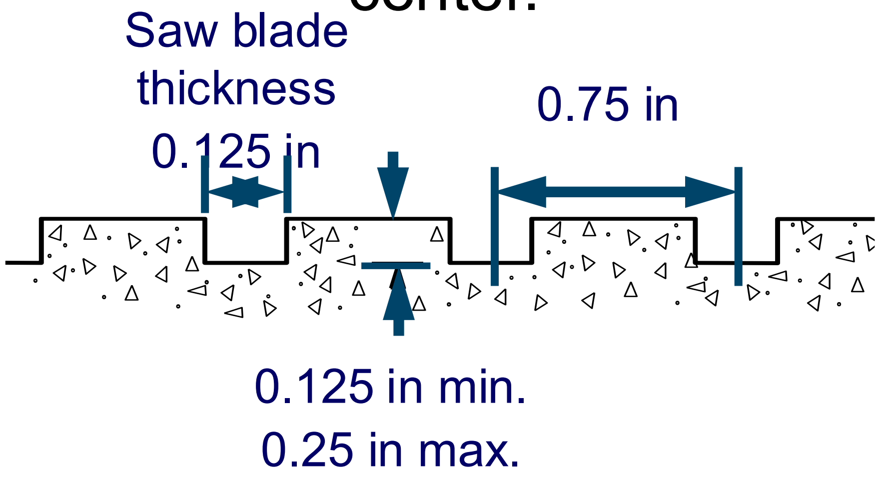


CDG

NGCS

Diamond Grooving

Longitudinal Grooving Cuts Narrow, Parallel Channels into Hardened Concrete Pavement in the Direction of Travel. Typical dimensions are 1/8 in wide, 1/8–1/4 in deep and spaced 3/4 in on center.



Diamond Grooving

- **Purpose of Grooving** is to Enhance Safety and Provide Better Lateral Stability
  - **Grooving Creates Water escape paths** at the tire–pavement contact patch, which reduces water-film thickness, hydrodynamic pressure, and hydroplaning risk
  - **Grooving Improves Macrotexture and Directional “Tracking”** so tires interlock with the surface improving wet friction and resisting lateral (sideways) sliding—especially useful on curves.
- Does Not Improve Smoothness
- Does Not Reduce Tire Pavement Noise

Diamond Grooving

Diamond Grooving Equipment

Longitudinal Grooves

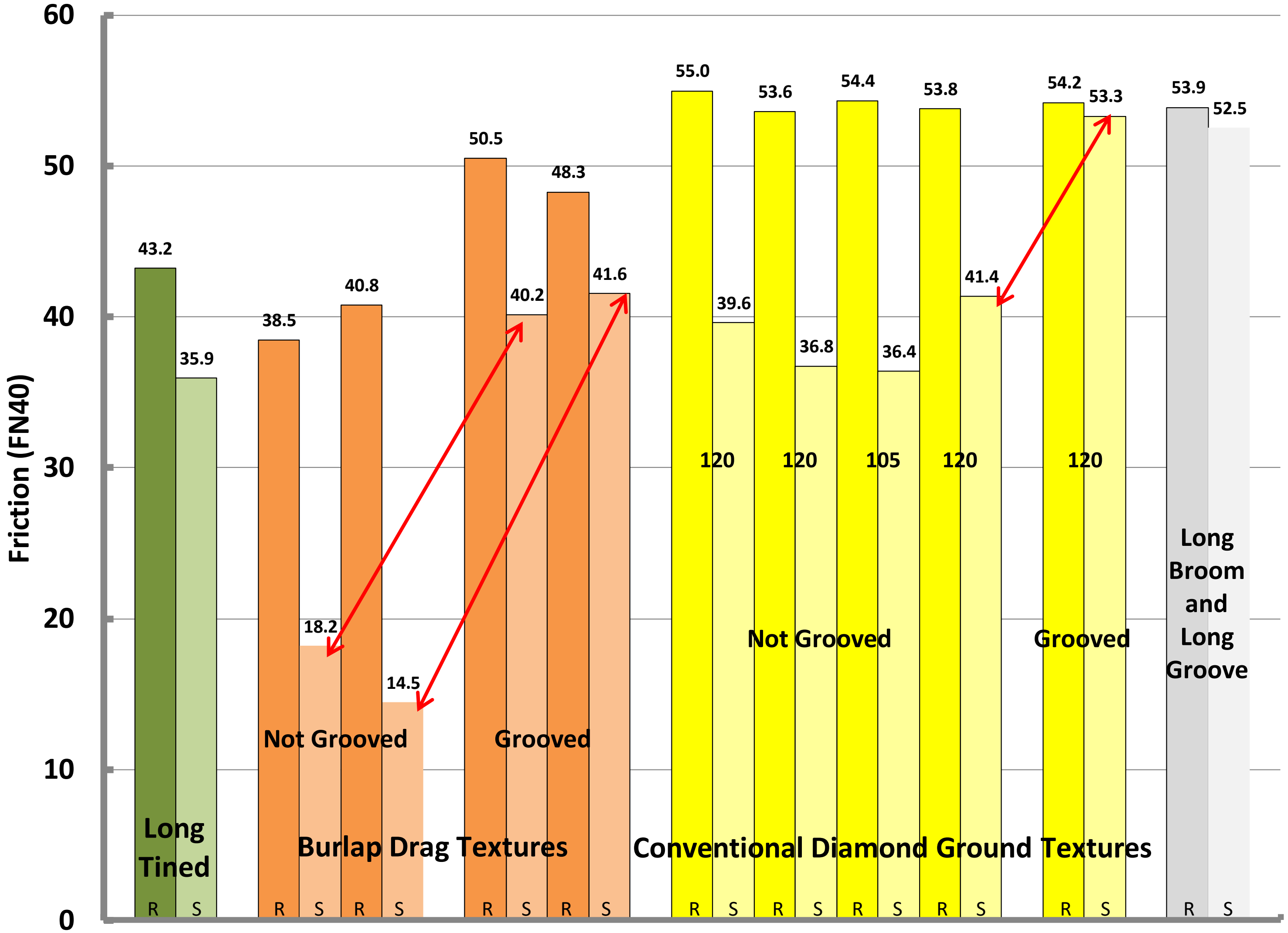
Diamond Grooving Head for Cutting Grooves

Diamond Grooving

California SR 58
-10 Years Old-

1972 California Highway Department Study

- 20 % Reduction in Total Accidents
- 50 % Percent Reduction in Fatal Accidents
- 70 % Reduction in Wet Pavement Accidents



Diamond Grooving

Highway Groover

Bridge Deck Groover

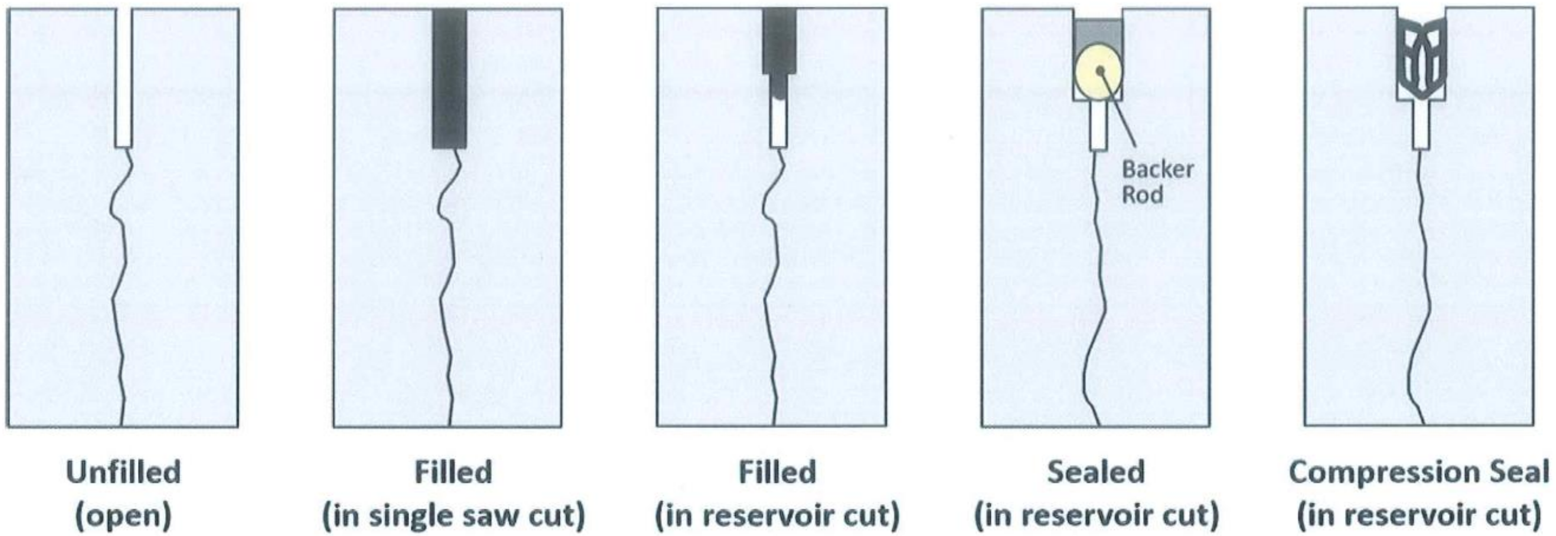
Runway Groover

Joint Resealing

- Goals
  - Reduce Infiltration of Moisture and Deicing Chemicals
  - Prevent Intrusion of Incompressible Materials
- Variety of Materials May be Used for Sealing
  - For Resealing, Usually Hot-poured Asphalt or Silicone Sealant
- “Sealing” vs “Filling”

Joint Resealing

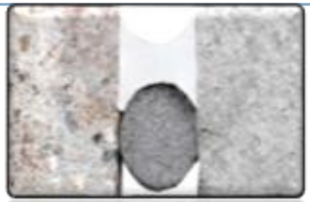
Reservoir Design and Cutting



Joint Resealing

Sealant Types

Silicone
- Non Sag
- Self Leveling
- Rapid Cure



Hot Pour
- Standard Modulus
- Low Modulus

Compression Seal

Joint Resealing

FHWA Sealant Effectiveness Study

AASHTO New Design Guide

Is Sealant Cost Effective?


CONCRETE PAVEMENT
CPTP
TECHNOLOGY PROGRAM

TechBrief

The Concrete Pavement Technology Program (CPTP) is an integrated, national effort to improve the long-term performance and cost-effectiveness of concrete pavements. Managed by the Federal Highway Administration through partnerships with State highway agencies, industry, and academia, CPTP's primary goals are to reduce congestion, improve safety, lower costs, improve performance, and foster innovation. The program was designed to produce user-friendly software, procedures, methods, guidelines, and other tools for use in materials selection, mixture proportioning, and the design, construction, and rehabilitation of concrete pavements.

U.S. Department of Transportation
Federal Highway Administration

Performance of Sealed and Unsealed Concrete Pavement Joints

This TechBrief presents the results of a nationwide study of the effects of transverse joint sealing on performance of jointed plain concrete pavement (JPCP). This study was conducted to assess whether JPCP designs with unsealed transverse joints performed differently from JPCP designs with sealed transverse joints. Distress and deflection data were collected from 117 test sections at 26 experimental joint sealing projects located in 11 states. Performance of the pavement test sections with unsealed joints was compared with the performance of pavement test sections with one or more types of sealed joints.

BACKGROUND

The sealing of transverse contraction [illegible] in JPCP has been standard practice throughout much of the U[illegible] States [illegible] many years. Its widespread use is due to the common belie[illegible] sealing joints [illegible] proves concrete pavement performance in two ways: [illegible] reducing water in[illegible] ation into the pavement structure, thereby reducing [illegible] e occurrence of mois[illegible] re-related distresses such as pumping and [illegible] ulting, [illegible] by preventing the [illegible] filtration of incompressibles (i.e., sand an[illegible] all sto[illegible] into the joints [illegible] ereby reducing the likelihood of pressure-rel[illegible] joint d[illegible] es such [illegible] joint spalling and blowups.

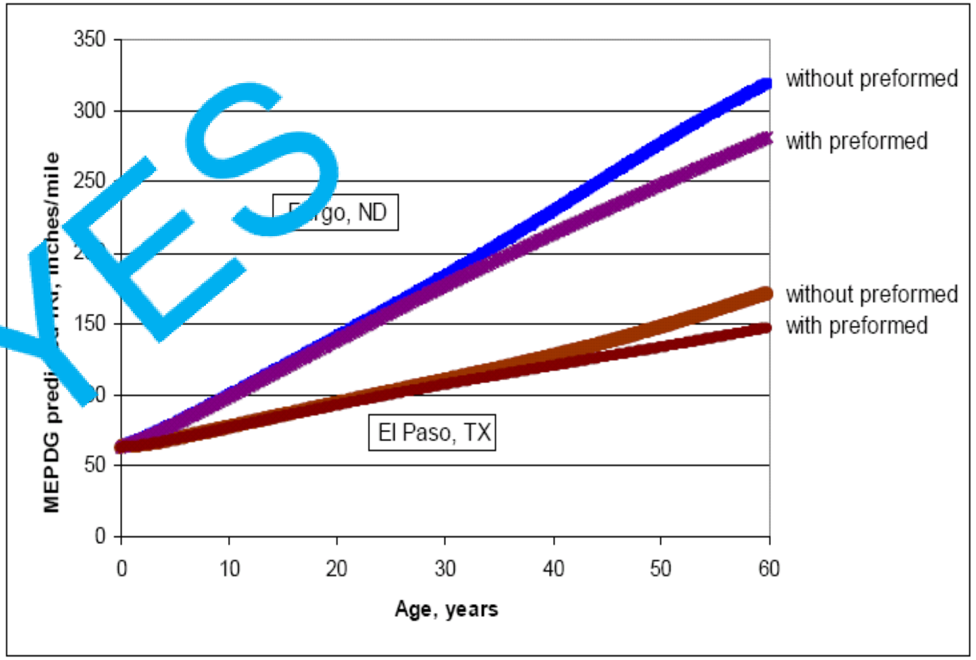
T[illegible] ransverse joints in j[illegible] ed concre[illegible] ment (JCP) are typically created by [illegible] itial saw [illegible] to force controlled cracking, followed by a second, [illegible] saw c[illegible] reservoir for the joint sealant material. This tradition[illegible] pproach of saw[illegible] and sealing transverse contraction joints is estimated t[illegible] ount for between 2 and 7 percent of the initial construction cost of a JCP. [illegible] reover, these sealed transverse joints require resealing one or more times o[illegible] the service life of the pavement, leading to additional costs in terms of labor, materials, operations, and lane closures.

Recently, several State departments of transportation (DOTs) have been questioning conventional transverse joint sawing and sealing practices. These agencies contend that the benefits derived from sealing do not offset the costs associated with the placement and continued upkeep of the sealant over the life of the pavement. As a result, they have been experimenting with different sawing and sealing alternatives, for example:

- Narrow unsealed joints, consisting of single saw cuts that are left unsealed.
- Narrow filled joints, consisting of single saw cuts that are filled with sealant that adheres to the sides and bottom of the saw cut.
- Narrow sealed joints, consisting of single saw cuts that contain a narrow backer rod and sealant material.

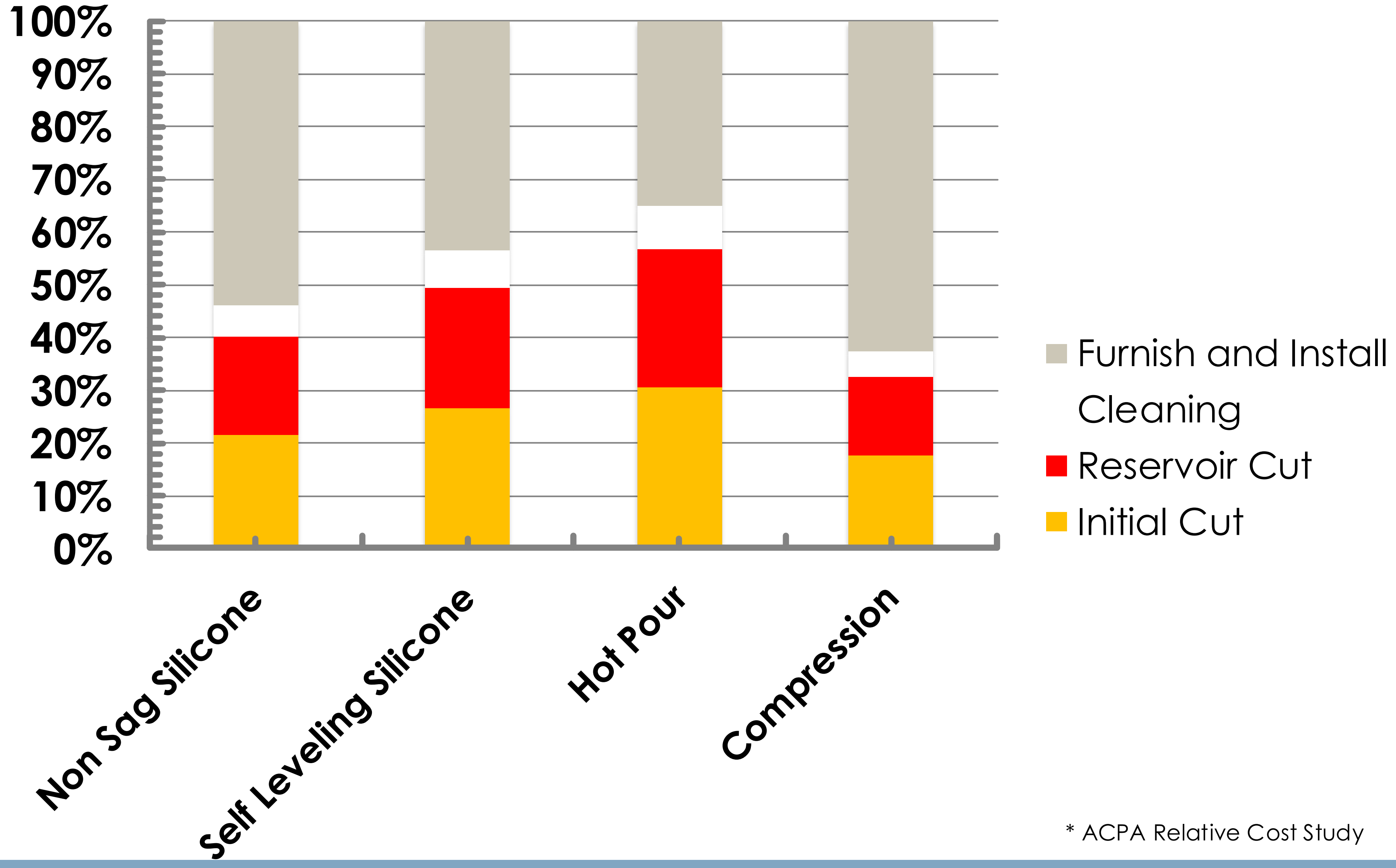
NO

YES



Joint Resealing

Percent of Total Cost For Each Operation of Sealing a Joint*

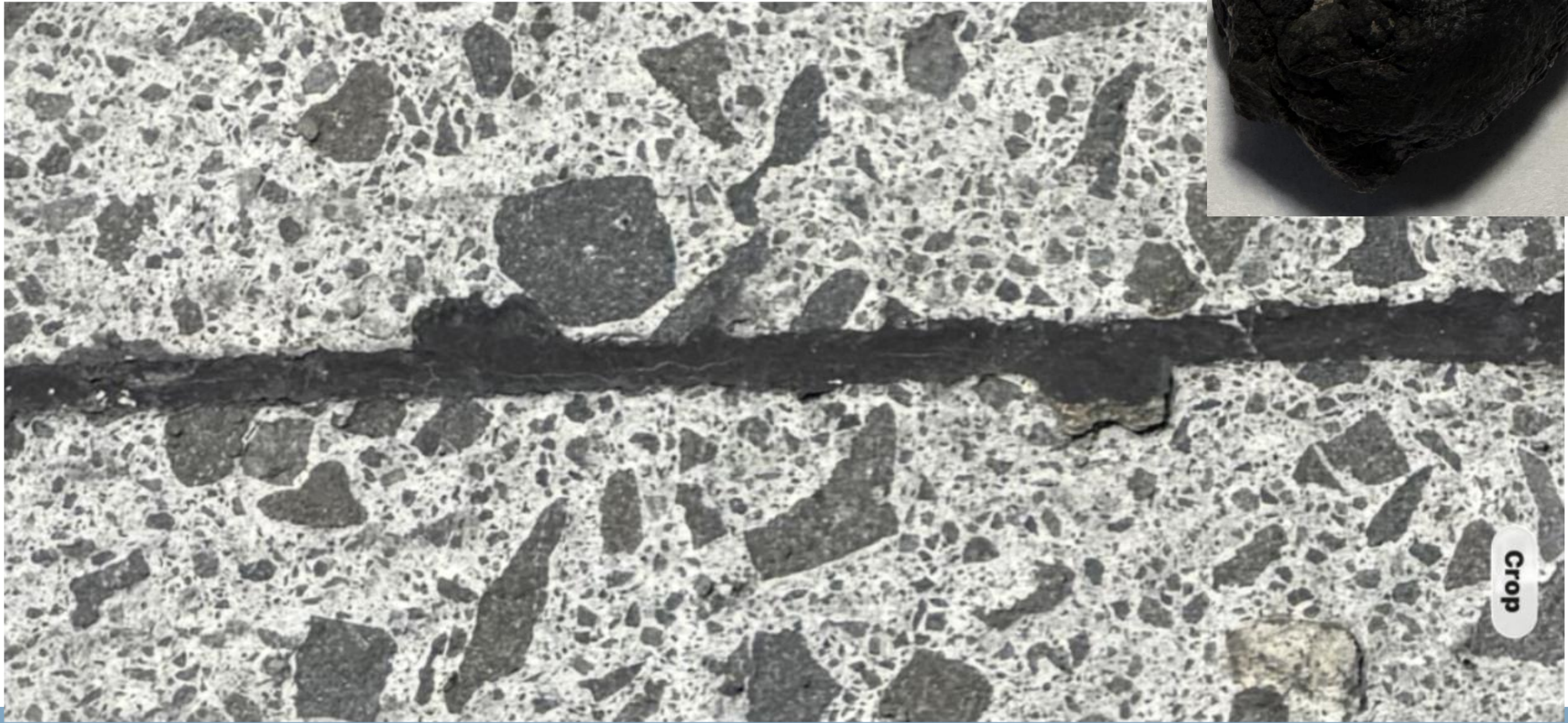


* ACPA Relative Cost Study

Joint Resealing

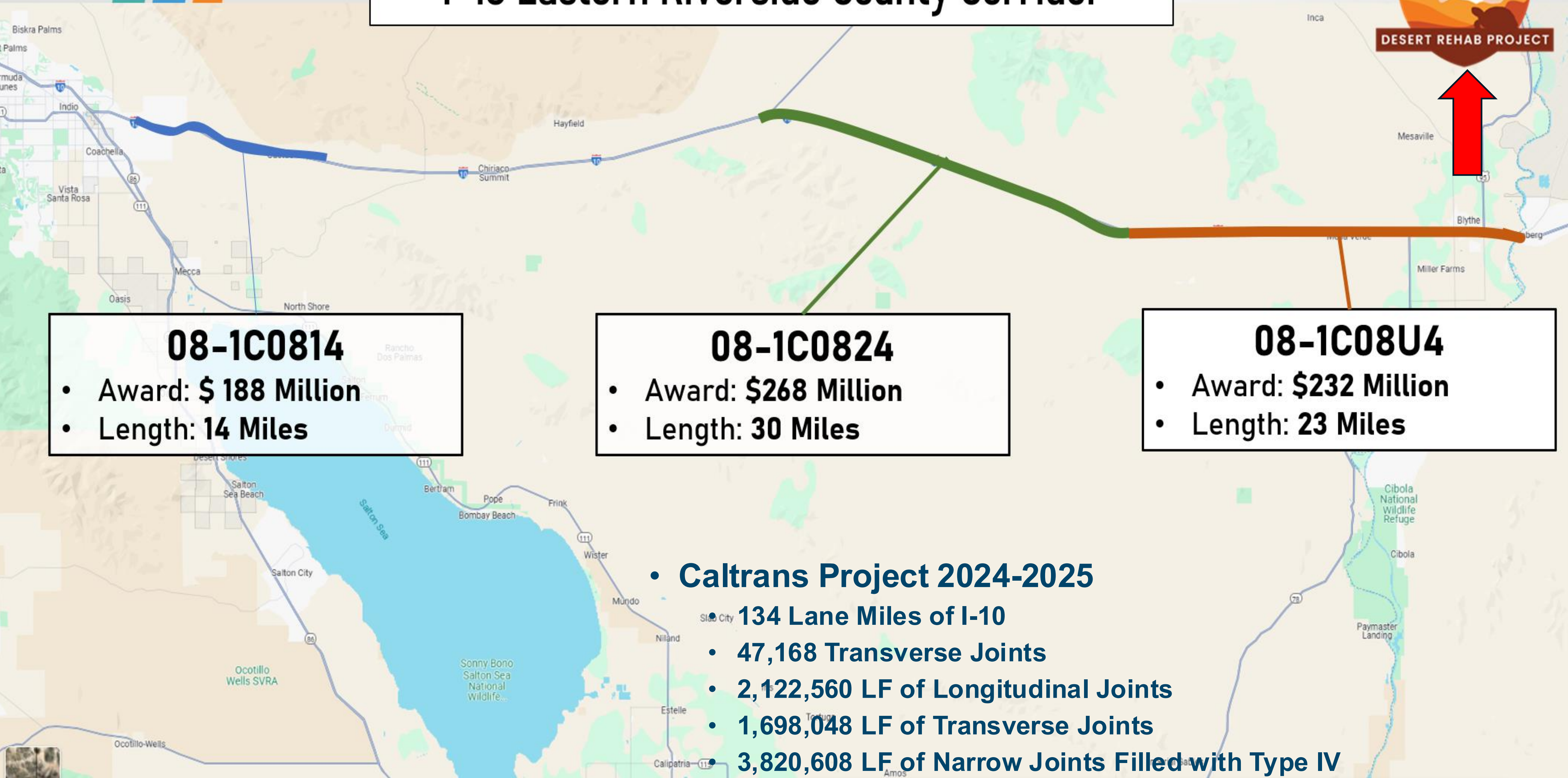
Need to Ensure that Depth of Sealant Penetration is <u>Specified</u> and Field <u>Verified</u>

Washington DOT SPS-2 Original Sealant - 31 Years Later - Crafco Roadsaver 515



I-10 Eastern Riverside County Corridor

INTERSTATE 10 DESERT REHAB PROJECT



08-1C0814

- Award: **$ 188 Million**
- Length: **14 Miles**

08-1C0824

- Award: **$268 Million**
- Length: **30 Miles**

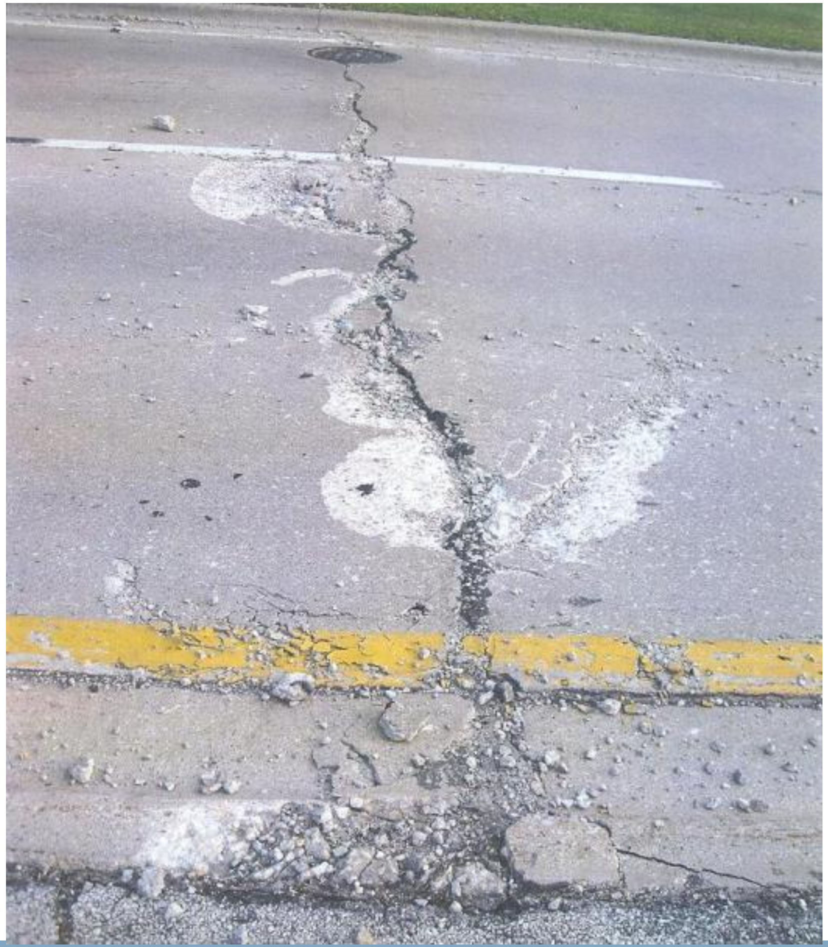
08-1C08U4

- Award: **$232 Million**
- Length: **23 Miles**

- **Caltrans Project 2024-2025**
  - 134 Lane Miles of I-10
  - 47,168 Transverse Joints
  - 2,122,560 LF of Longitudinal Joints
  - 1,698,048 LF of Transverse Joints
  - 3,820,608 LF of Narrow Joints Filled with Type IV

Why Seal Joints and Cracks?

Prevents Incompressible from Lodging in the Joint — Slab Growth and Blow Ups



Joint Resealing

Summary

- Design Joint Sealant System for the Expected Joint Movements
- Select a Joint Sealant Material and Backer Rod Appropriate for the Intended Purpose
- Ensure Proper Cleaning and Preparation– Clean, Dry and Bondable
- Inspect the Work and Verify its Acceptability

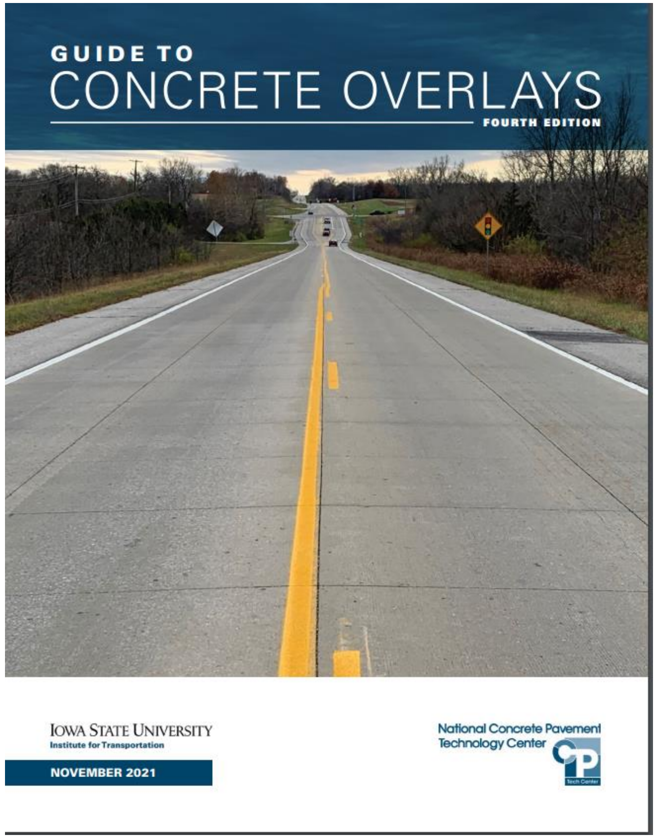
Preservation and Rehabilitation Using Concrete Overlays

Concrete Overlays

- Placement of a concrete overlay on:
  - Existing concrete pavement
  - Existing asphalt pavement
  - Existing composite (AC/PCC) pavement
- Used to address a range of pavement conditions and levels of deterioration

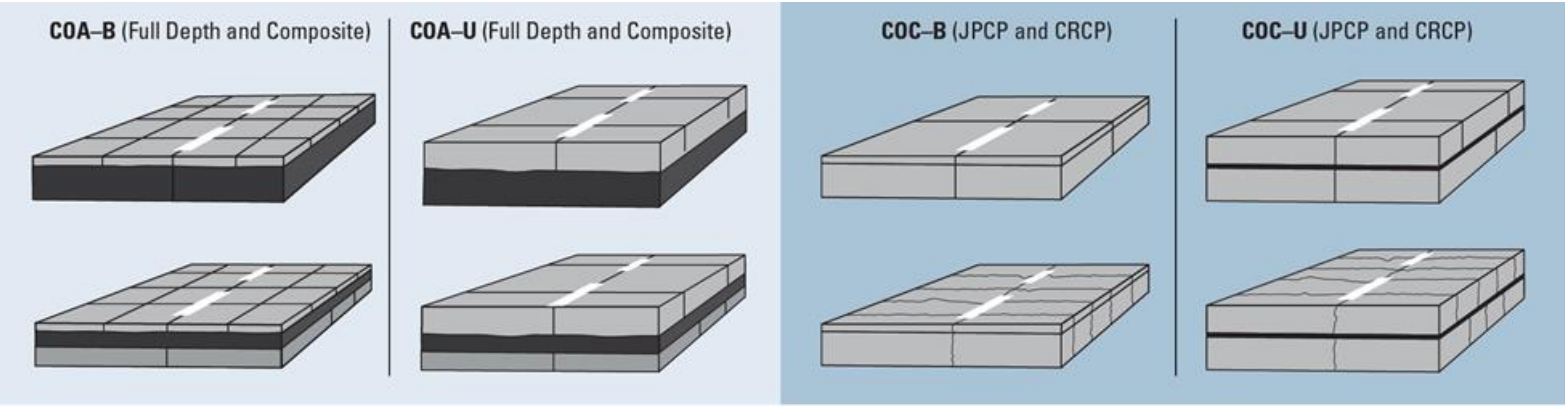
Benefits of Concrete Overlays

- Improves functional/structural characteristics
- Provides extended performance
- Has low maintenance requirements
- Enhances pavement sustainability
  - Reuse of existing pavement
  - Reduced use of virgin materials
  - Reduced landfilling
  - Safe, smooth-riding, and long-lasting pavement
  - Surface reflectance (higher albedo)



Types of Concrete Overlays

- Concrete on Asphalt
  - Existing asphalt or composite
  - Bonded or unbonded
    - COA-B
    - COA-U
- Concrete on Concrete
  - Existing JCP or CRCP
  - Bonded or unbonded
    - COC-B
    - COC-U

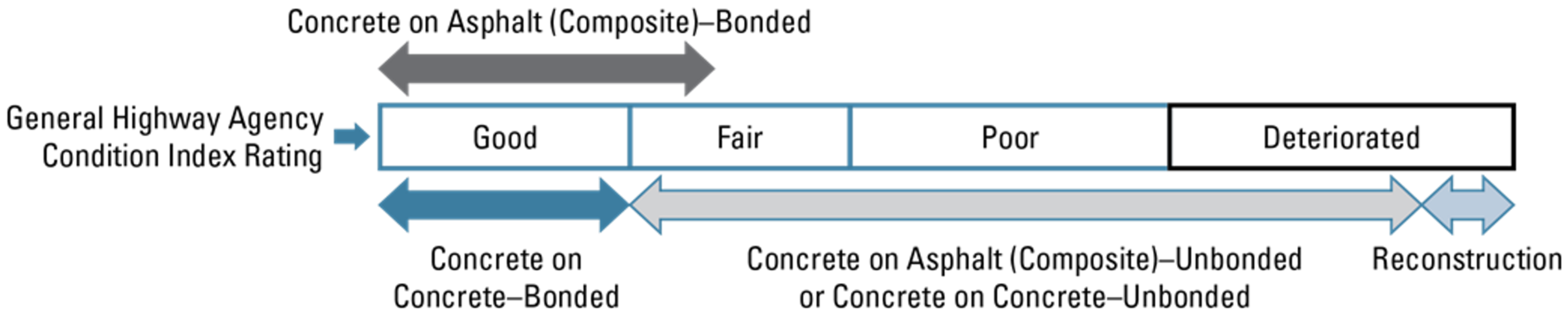


General Concrete Overlay Characteristics

- Bonded Overlays
  - Bonded to old pavement to help carry load
  - Existing pavement in good condition
  - Thinner slabs

- Unbonded Overlays
  - Separated from old pavement to isolate distress
  - Existing pavement in fair to poor condition
  - Thicker slabs

General Applicability



Concrete Overlays: Ensuring Success

- Characterization of existing pavement
- Thickness as appropriate for traffic
- Pre-overlay repair/preparation
- Achievement of desired bonding condition
- Effective construction (including jointing/sawing)
- Performance: Variable depending on type of overlay and condition

Note that other factors may affect the selection of concrete overlays as a preservation/rehabilitation solution (bridges, grades/cross streets, geometrics).

Summary

Summary

- Concrete pavements are inherently long lasting
- Various treatments are available to:
  - Maintain/improve serviceability
  - Prevent future deterioration and extend service life
  - Protect concrete pavement investment
- Treatment selection/application:
  - Be practical: use appropriate treatments to address specific distresses and conditions
  - Be proactive: prevention is cheaper that rehabilitation
  - Be prompt: timing is everything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