

The Concrete Pavement Preservation Series III Concrete Pavement Preservation Treatment Construction



June 16, 2020

Mr. John Roberts
Mr. Randy Everett



IOWA STATE UNIVERSITY
Institute for Transportation

National Concrete Pavement
Technology Center



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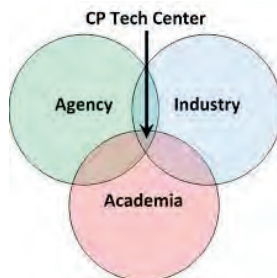
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The CP Tech Center

The National Concrete Pavement Technology Center (CP Tech Center) at Iowa State University is a national resource for concrete pavement research and **TECHNOLOGY TRANSFER**.



Upcoming Webinar Schedule – Technology Tuesday

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Concrete Pavement Management and Preservation
performance and resources

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- Identify the most commonly used techniques and tools when performing concrete pavement preservation activities.
- Identify the purpose and suitable application of various concrete pavement preservation treatments.
- List factors to consider in the selection of concrete pavement preservation treatments.
- Utilize methodical and data driven approaches to incorporate changes and innovation into an established system of practice.
- Balance the current cost of freeway preservation with horizon year costs to address the rapidly declining condition of freeway systems.
- Analyze methods of Portland concrete cement (PCC) surface treatments to best fit expectations of ride, noise and public expectation.



Your Pavement Preservation Resource® since 1977

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Concrete Pavement Preservation - III

Concrete Pavement Preservation Treatment Construction

Presented by John Roberts, Executive Director IGGA – June 16, 2020



Pavement Management– Circle of Life



Concrete Pavement Distress Evaluation

- Pavement Distress and Drainage Surveys
- Nondestructive Testing
- Surface Characteristics Testing
- Field Sampling and Testing



CPP – Treatments and Techniques



Priorities Have Shifted in Recent Years



- Minimal system expansion
- Maintain the present system
- Minimize traffic disruptions
- Increase safety
- Address operator comfort
 - Reduce roughness
 - Reduce noise
- Protect the environment
- Inadequate funding

Pavement Preservation Philosophy



Keeping good roads in Good Condition!

Concrete Pavement Preservation Origins

- Diamond grinding was first used as part of an engineered system to preserve PCC Pavement in the 1960's.

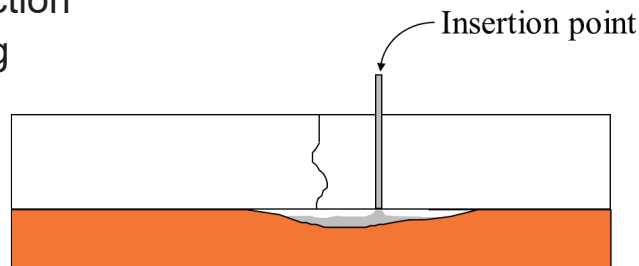


PCCP Preservation Techniques

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

Pavement Sub-Surface Rehabilitation

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



*NOTE – Slab stabilization ≠ slab jacking

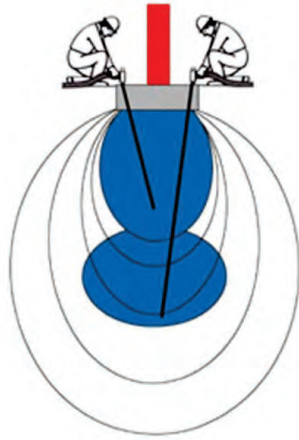
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- Used for sub-grade repair
- Soil collapse
- Poor compaction
- Helps reduce
 - Pumping
 - Joint faulting
 - Corner breaks



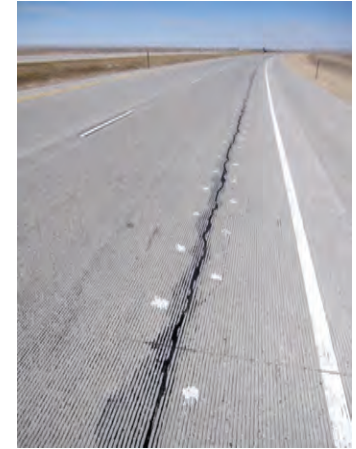
Material Types

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

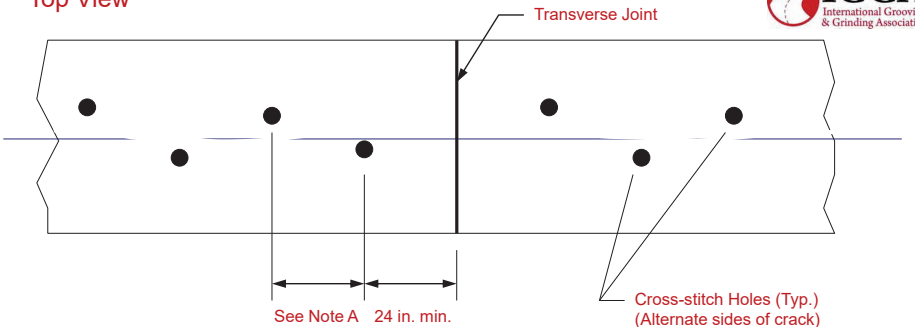


Cross Stitching

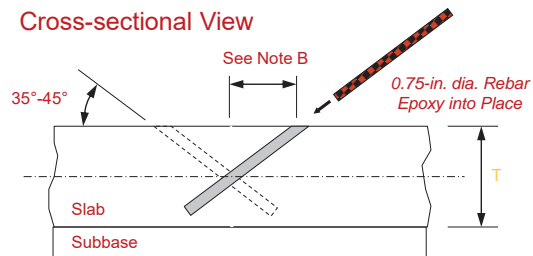
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- Helps maintain aggregate interlock and provide added reinforcement to crack
- Reduce slab migration
- Prevent longitudinal joint faulting



Top View



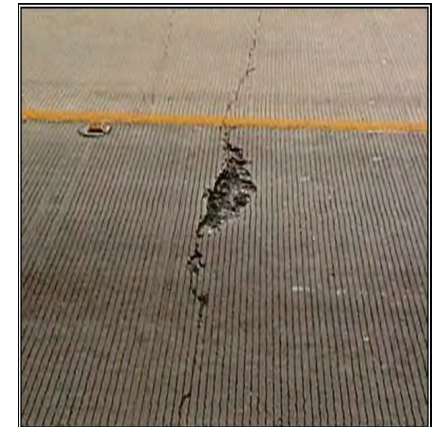
Cross-sectional View



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 slab.
- Restores ride quality and pavement functionality with minimal traffic interruption.
- Costs less than a full depth repair.



Sawing and Chipping Removal



Cold Milling Removal

- Concrete removal by modified cold-milling.
- Much 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).

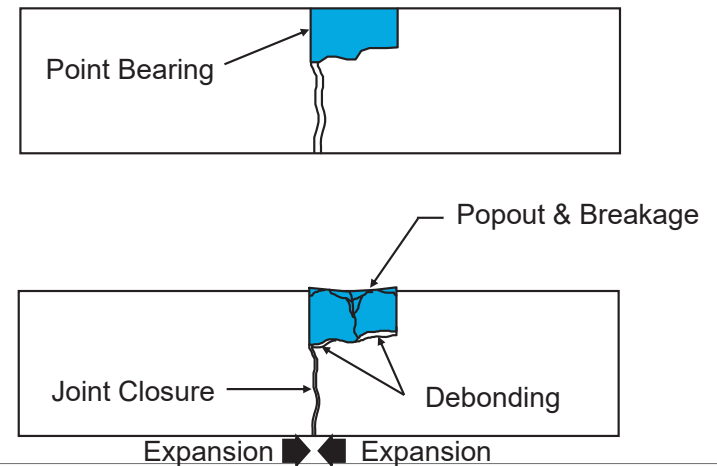


Cementitious vs Non-Cementitious

- 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



If Insert Not Used With Cementitious...



Dowel Bar Retrofit - DBR

- Placement of load transfer devices across joints or cracks of existing pavements
- Used in undoweled pavements and transverse cracks to limit future faulting
- First production use of DBR in 1993....WSDOT has retrofitted over 300 Lane-mi or 700,000 bars adding 20 years life



Cutting Slots- Diamond Saw Slot Cutter

- Cuts multiple slots in a single pass.
- Cuts form the edges of the slots
- Fins are removed later with jackhammer
- Some saws cut between 3 to 8 slots in a single pass
- Milling not permitted



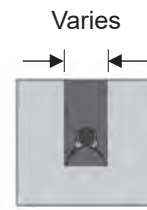
Dowel Slot Alignment

- Must always be parallel to centerline
- Must be cut so at least one-half of dowel can be on each side of the joint or crack

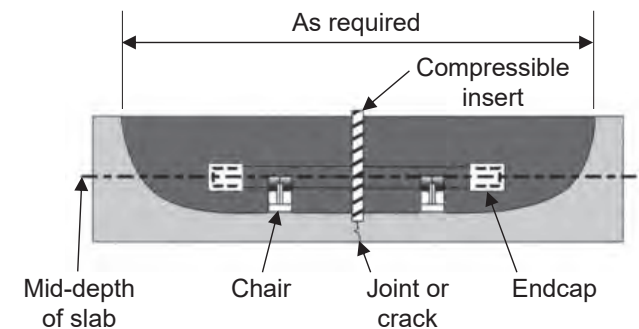


Retrofitted Dowel Bar

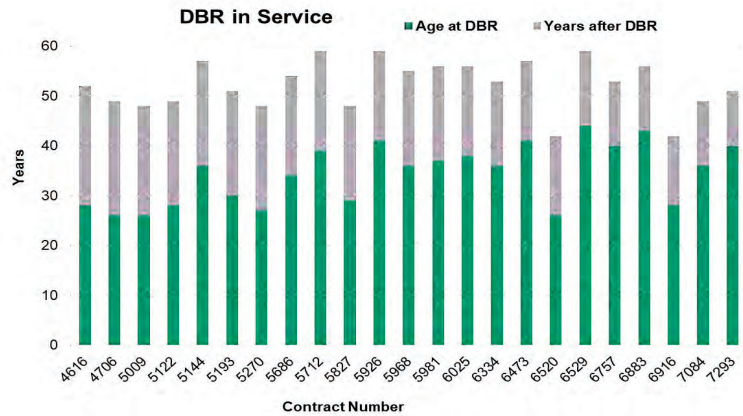
END VIEW



SIDE VIEW



WSDOT DBR Survival Data



Key Factors For Success

- Selection of proper candidates
- Proper dowel design and layout
- Cutting of dowel bar slots
- Proper preparation of slots
- Proper placement of dowels
- Selection of appropriate material
- Careful material placement and curing

Full-Depth Repair - Insitu

- 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

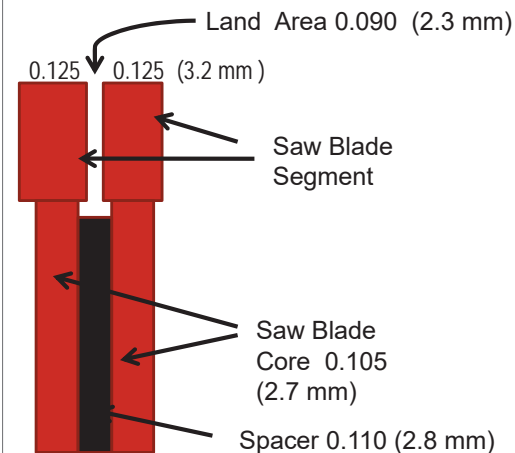
- Removal of thin surface layer of hardened PCC using closely spaced diamond saw blades
- Results in smooth, level pavement surface
- Provides a longitudinal texture with desirable friction and low noise characteristics



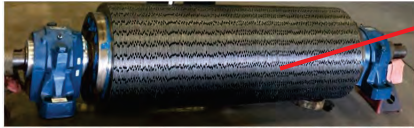
Blades and Spacers



Typical Conventional Diamond Grinding (CDG) Blade Configuration



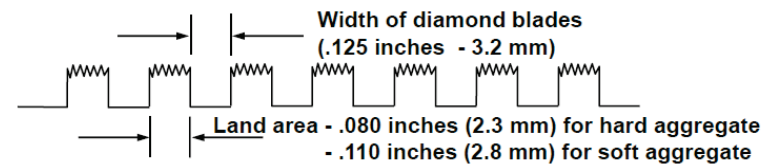
Diamond Grinding Equipment



Conventional Diamond Ground Surface

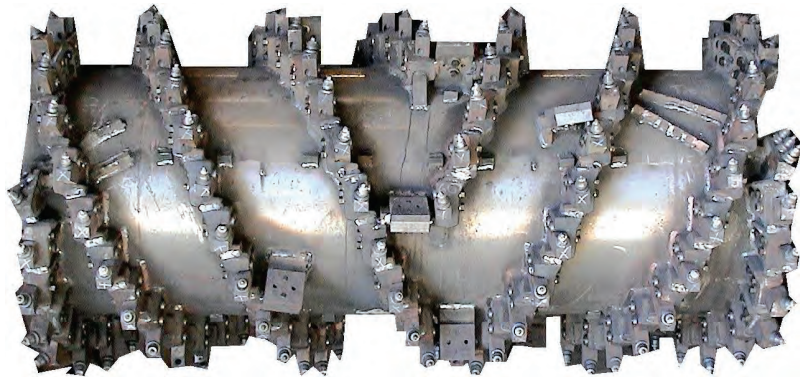


Diamond Grinding



Diamond Smoothing Is Not Diamond Grinding

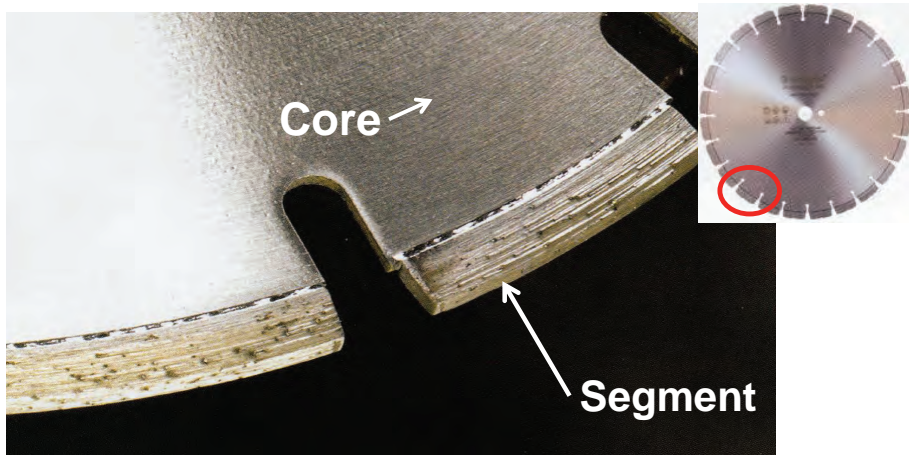
Milling Drum



Milled Surfaces



Impact vs Abrasion



Diamond Grinding vs Milling

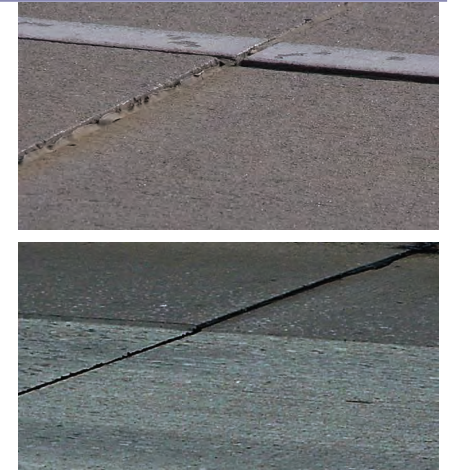


Advantages of Diamond Grinding

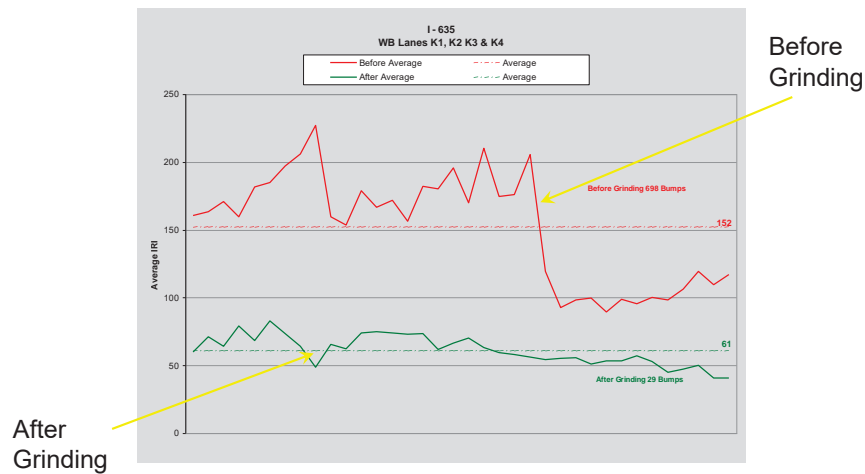
- Can be used on both concrete and asphalt pavements
- Cost competitive
- Enhances surface friction and safety
- Can be accomplished during off-peak hours with short lane closures and without encroaching into adjacent lanes
- Grinding of one lane does not require grinding of the adjacent lane
- Does not affect overhead clearances underneath bridges
- Blends patching and other surface irregularities into a consistent, identical surface

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 50% to 70% improvement over the pre-grind profile on average!

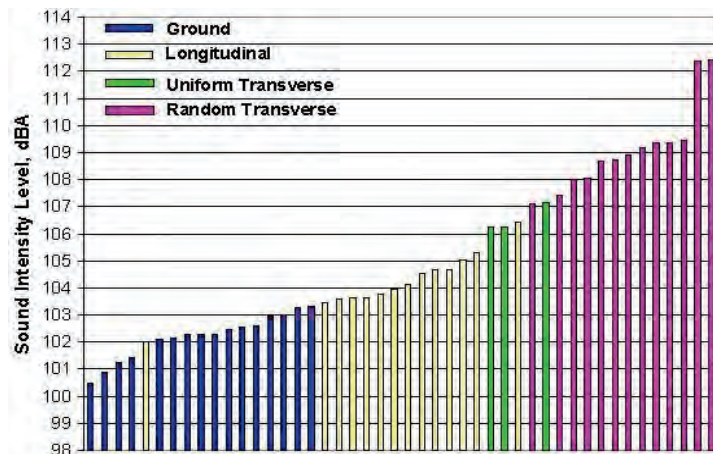


Safety, Surface Texture and Friction

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

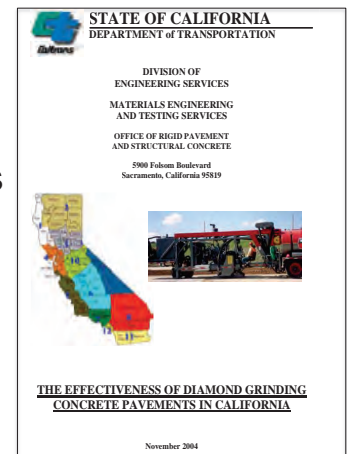


CA and AZ PCCP Noise Test Results



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

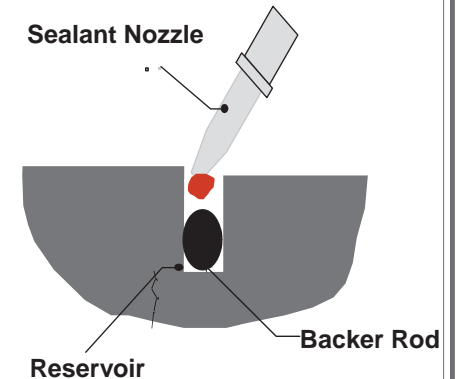


Joint and Crack Resealing

- Minimizes water & incompressibles into pavement system

Reduces:

- Subgrade softening
- Pumping
- Erosion of fines
- Spalling



Key Factors for Success

- 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



Influence of Moisture Infiltration



Loss of Fines
(Pumping)



Transverse Joint Faulting



Corner Breaks

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

Visit Us on the Web

International Grooving and Grinding Association

at

www.igga.net

Concrete Pavement Preservation Phoenix Diamond Grind Story

Presentation By: Randy Everett Sr. Division Administrator

Date: June 16, 2020

CENTRAL DISTRICT MAP



Who We Are?

- 160 Maintenance Personnel
15 District Units
- 90 Construction Personnel
9 District Units

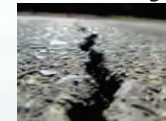


What We Do?

- 435 (5,500 lane miles) Miles of Roadway & Bridge Maintenance
- 258 Miles of Landscape Maintenance
- \$500M Yearly Construction Budget (not including South Mountain)
- 20-25 Projects Occurring Per Year

3 Types of Projects

- Preservation
- Modernization
- Expansion



2003 Solution to Noise Reduction

- **Problem:** Concrete (PCC) was originally transversally tined – Very Loud
- **Solution:** Apply 1" Asphaltic Rubber friction Course (AR-ACFC) atop all PCC surfaces to reduce noise



Beautiful New Overlays



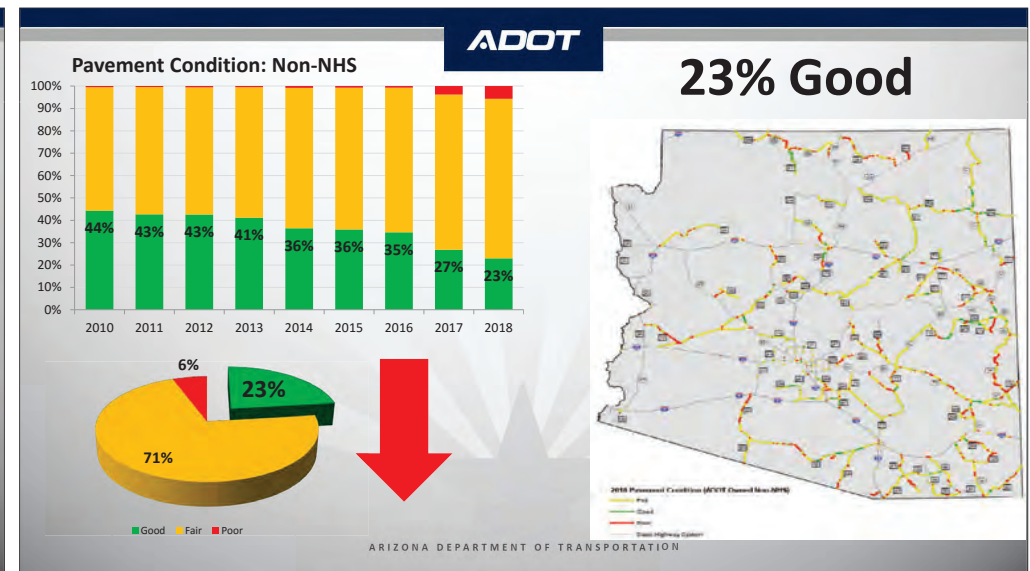
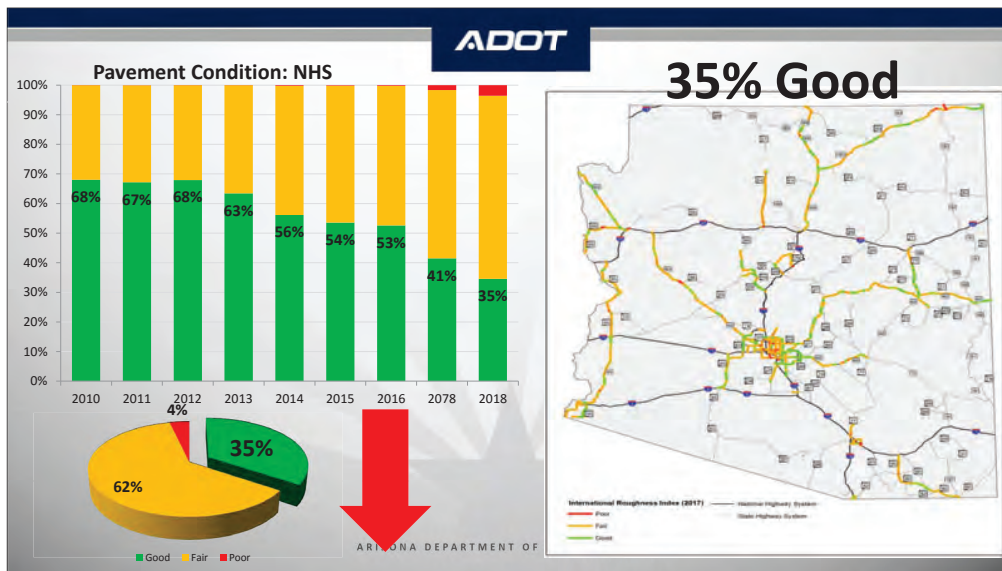
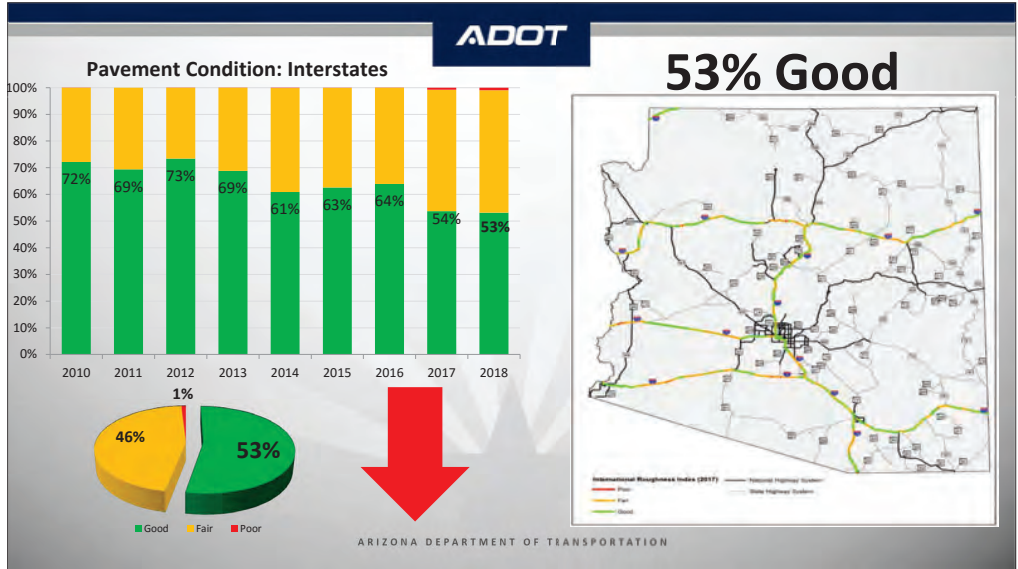
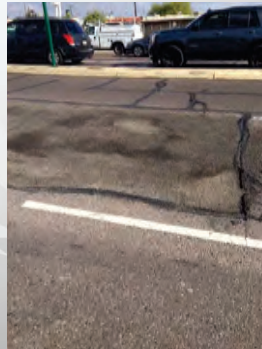
How Do We **Preserve** Our Freeways?

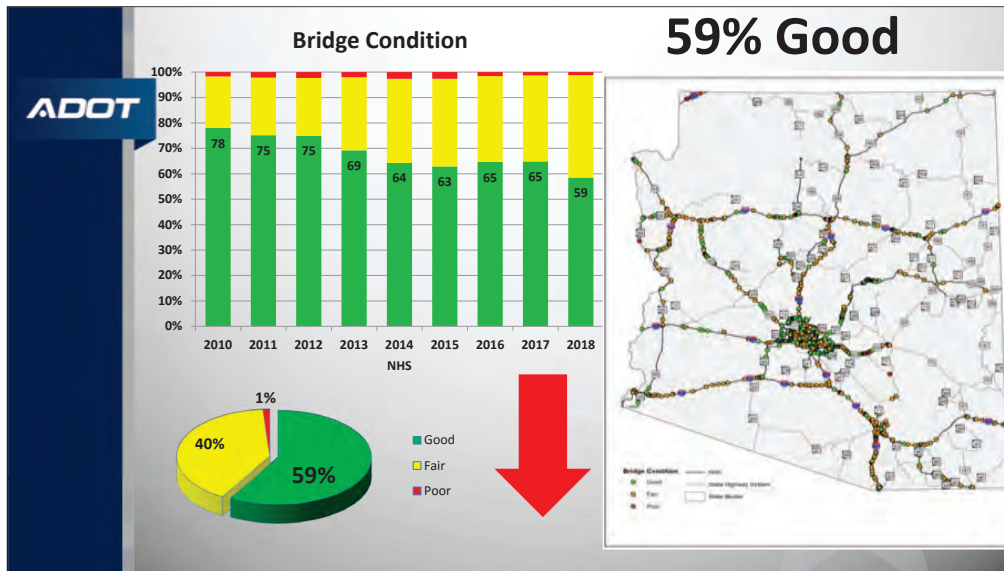


Aging Conditions Cost Big \$



We Have a Whole Lot of This





ADOT ARIZONA DEPARTMENT OF TRANSPORTATION

Keep the Good Good

- Crack Seal
- Flush
- Pot Hole Repair (Delamination of 1" Asphalt Surface)

ADOT ARIZONA DEPARTMENT OF TRANSPORTATION

Pavement Preservation - Flush

This image shows a close-up of a paving machine's screed and rollers as it applies a fresh layer of asphalt, creating a smooth, dark surface.

ADOT ARIZONA DEPARTMENT OF TRANSPORTATION

New Asphalt Overlay

This image shows a wider view of a road construction project. A large paving machine is laying a new asphalt overlay on an existing road. Two workers in high-visibility vests are walking on the newly laid surface. In the background, there are power lines and a clear sky.

Options Are Needed

- What if we went back to a PCC Surface?
- What if we could make the underlying PCC Pavement Surface better?
- Would it/Could it last a lot longer with little need for maintenance or replacement?



What if: Instead of?



Tears Into the Concrete



Damaged Joints from Typical Milling



Kyrene Road Ramp Area Experiment (April 6, 2019)



Distressed Rubberized Asphalt



Rideable Surface in Good Condition



SR101 EB Test Section (April 27, 2019)

- 4 Test Sections
- Diamond Grind, Next Gen, Skid Abrader & Micro-Mill
- Ride, Sound, Appearance
- What does the public think?

SR101 EB Test Section (April 27, 2019)

Diamond
Grind



ARIZONA DEPARTMENT OF TRANSPORTATION

SR101 EB Test Section (April 27, 2019)

Next
Generation



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SR101 EB Test Section (April 27, 2019)

Skid
Abrader



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SR101 EB Test Section (April 27, 2019)

Micro-Mill



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SR 202 Diamond Grind Real Life Project (May 11, 2019)



Loader to Remove Rubber Asphalt



Small Diamond Grinders



Finished Condition



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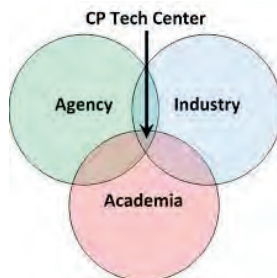
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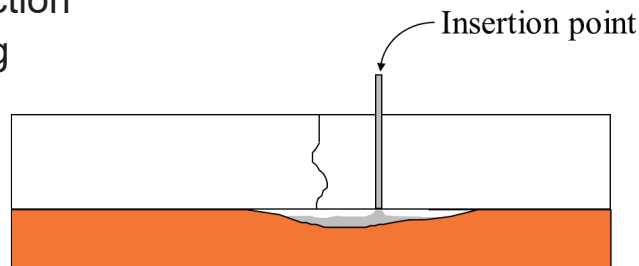


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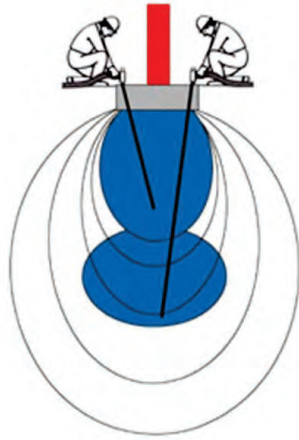
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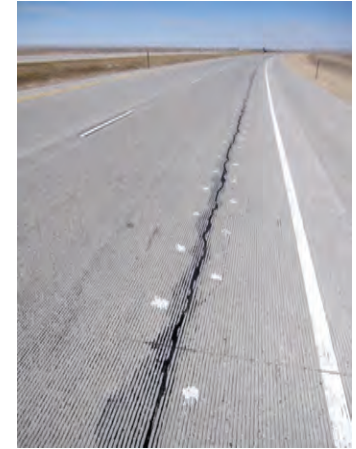
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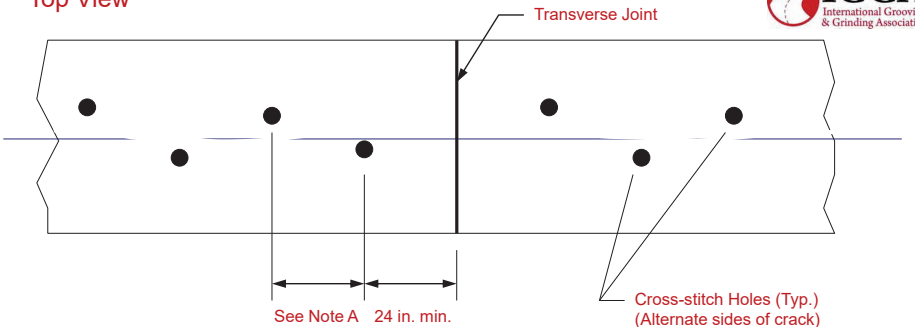


Cross Stitching

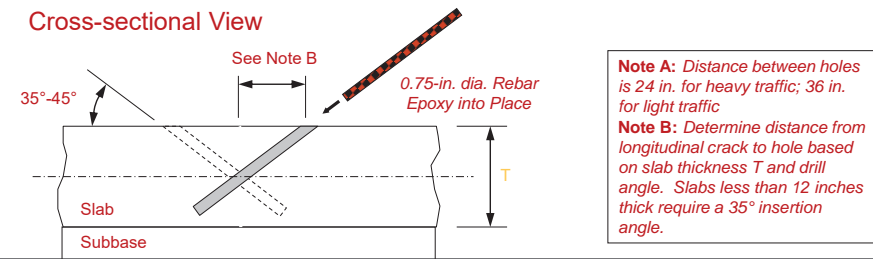
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Cross-sectional View



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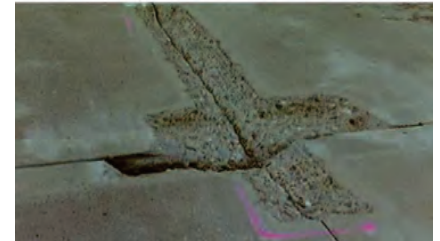


Sawing and Chipping Removal



Cold Milling Removal

- Concrete removal by modified cold-milling.
- Much 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).

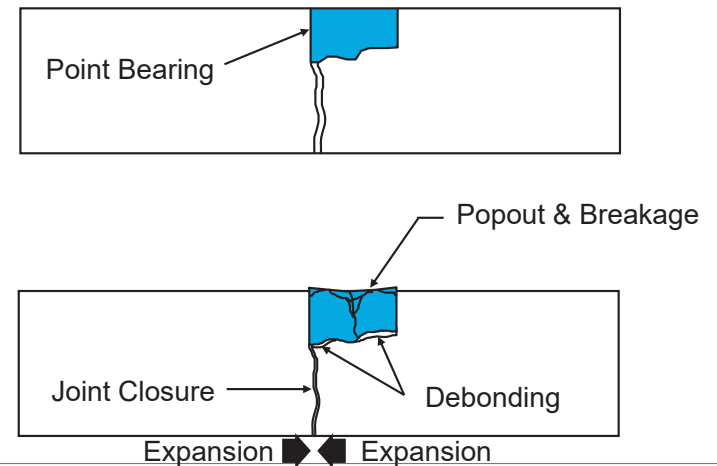


Cementitious vs Non-Cementitious

- 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



If Insert Not Used With Cementitious...



Dowel Bar Retrofit - DBR

- Placement of load transfer devices across joints or cracks of existing pavements
- Used in undoweled pavements and transverse cracks to limit future faulting
- First production use of DBR in 1993....WSDOT has retrofitted over 300 Lane-mi or 700,000 bars adding 20 years life



Cutting Slots- Diamond Saw Slot Cutter

- Cuts multiple slots in a single pass.
- Cuts form the edges of the slots
- Fins are removed later with jackhammer
- Some saws cut between 3 to 8 slots in a single pass
- Milling not permitted



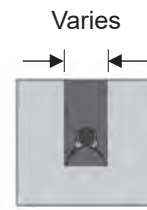
Dowel Slot Alignment

- Must always be parallel to centerline
- Must be cut so at least one-half of dowel can be on each side of the joint or crack

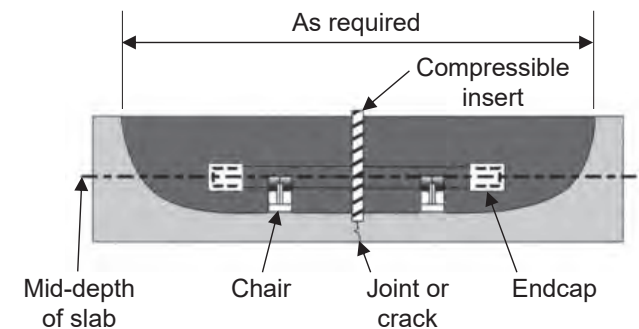


Retrofitted Dowel Bar

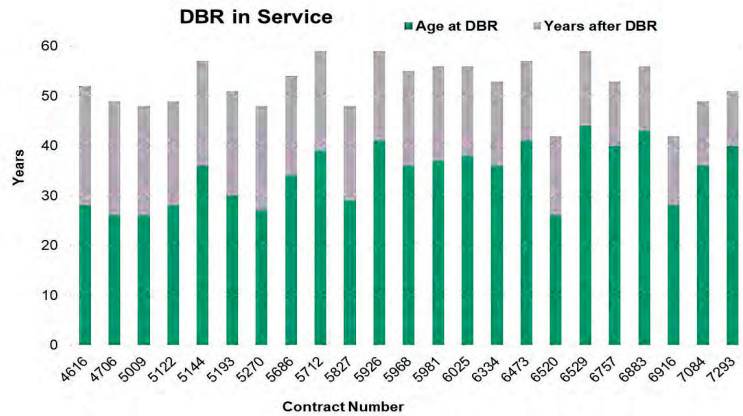
END VIEW



SIDE VIEW



WSDOT DBR Survival Data



Key Factors For Success

- Selection of proper candidates
- Proper dowel design and layout
- Cutting of dowel bar slots
- Proper preparation of slots
- Proper placement of dowels
- Selection of appropriate material
- Careful material placement and curing

Full-Depth Repair - Insitu

- 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

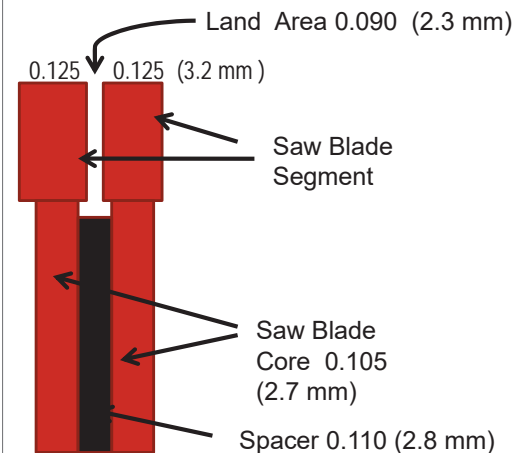
- Removal of thin surface layer of hardened PCC using closely spaced diamond saw blades
- Results in smooth, level pavement surface
- Provides a longitudinal texture with desirable friction and low noise characteristics



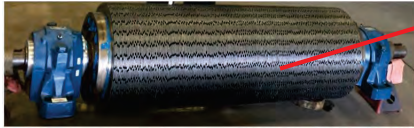
Blades and Spacers



Typical Conventional Diamond Grinding (CDG) Blade Configuration



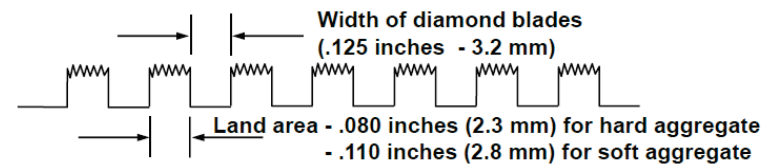
Diamond Grinding Equipment



Conventional Diamond Ground Surface

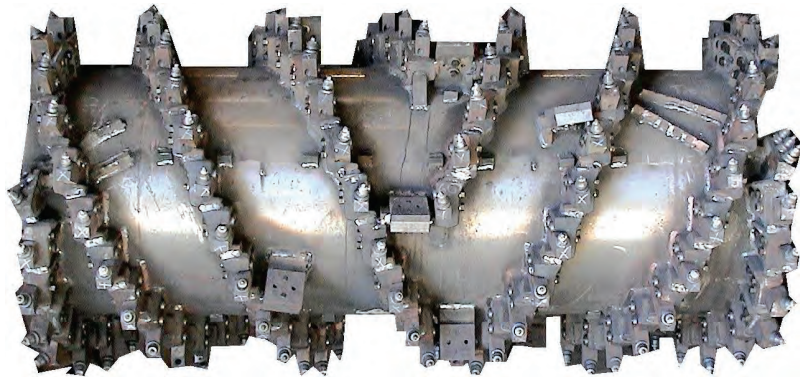


Diamond Grinding



Diamond Smoothing Is Not Diamond Grinding

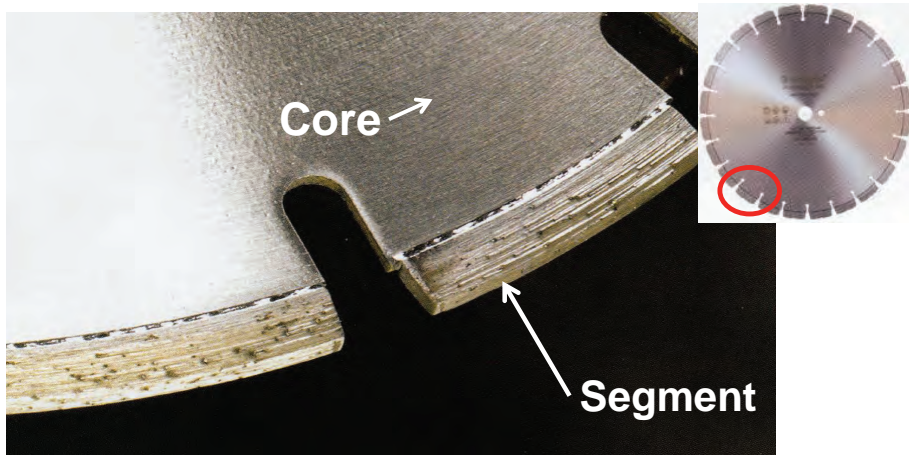
Milling Drum



Milled Surfaces



Impact vs Abrasion



Diamond Grinding vs Milling

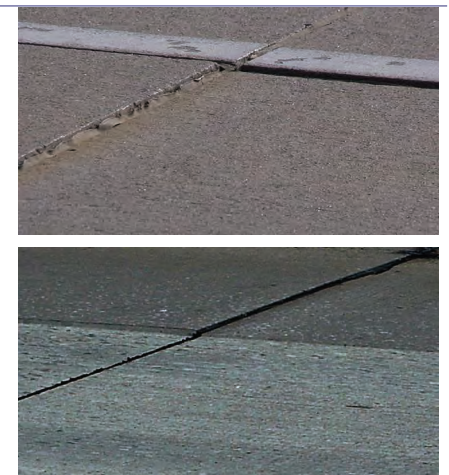


Advantages of Diamond Grinding

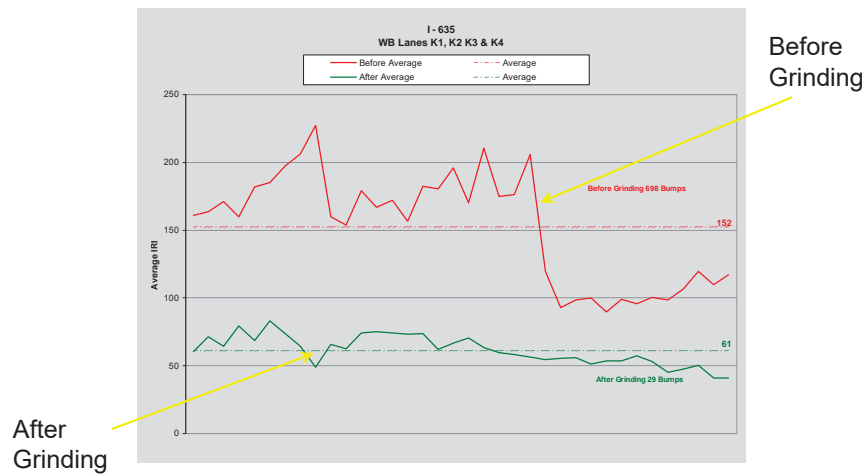
- Can be used on both concrete and asphalt pavements
- Cost competitive
- Enhances surface friction and safety
- Can be accomplished during off-peak hours with short lane closures and without encroaching into adjacent lanes
- Grinding of one lane does not require grinding of the adjacent lane
- Does not affect overhead clearances underneath bridges
- Blends patching and other surface irregularities into a consistent, identical surface

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 50% to 70% improvement over the pre-grind profile on average!

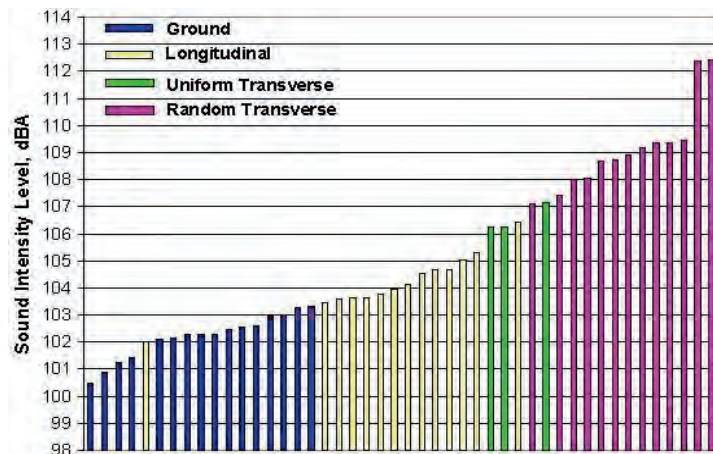


Safety, Surface Texture and Friction

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

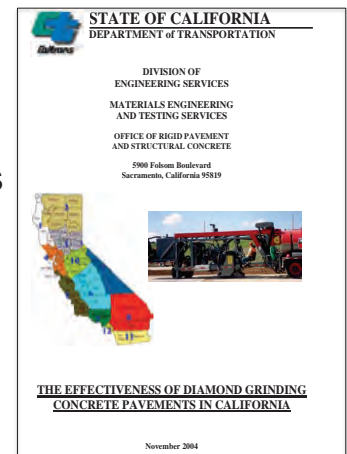


CA and AZ PCCP Noise Test Results



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

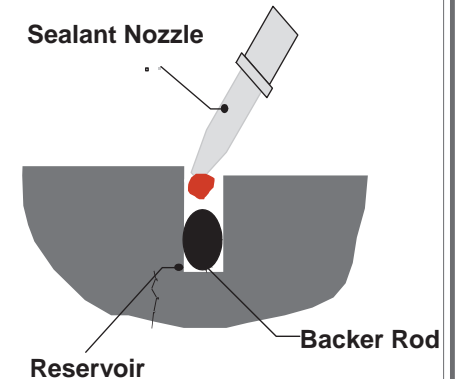


Joint and Crack Resealing

- Minimizes water & incompressibles into pavement system

Reduces:

- Subgrade softening
- Pumping
- Erosion of fines
- Spalling



Key Factors for Success

- 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



Influence of Moisture Infiltration



Loss of Fines
(Pumping)



Transverse Joint Faulting



Corner Breaks

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

Visit Us on the Web

International Grooving and Grinding Association
at
www.igga.net

Concrete Pavement Preservation Phoenix Diamond Grind Story

Presentation By: Randy Everett Sr. Division Administrator

Date: June 16, 2020

CENTRAL DISTRICT MAP



Who We Are?

- 160 Maintenance Personnel
15 District Units
- 90 Construction Personnel
9 District Units

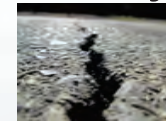


What We Do?

- 435 (5,500 lane miles) Miles of Roadway & Bridge Maintenance
- 258 Miles of Landscape Maintenance
- \$500M Yearly Construction Budget (not including South Mountain)
- 20-25 Projects Occurring Per Year

3 Types of Projects

- Preservation
- Modernization
- Expansion



2003 Solution to Noise Reduction

- **Problem:** Concrete (PCC) was originally transversally tined – Very Loud
- **Solution:** Apply 1" Asphaltic Rubber friction Course (AR-ACFC) atop all PCC surfaces to reduce noise



Beautiful New Overlays



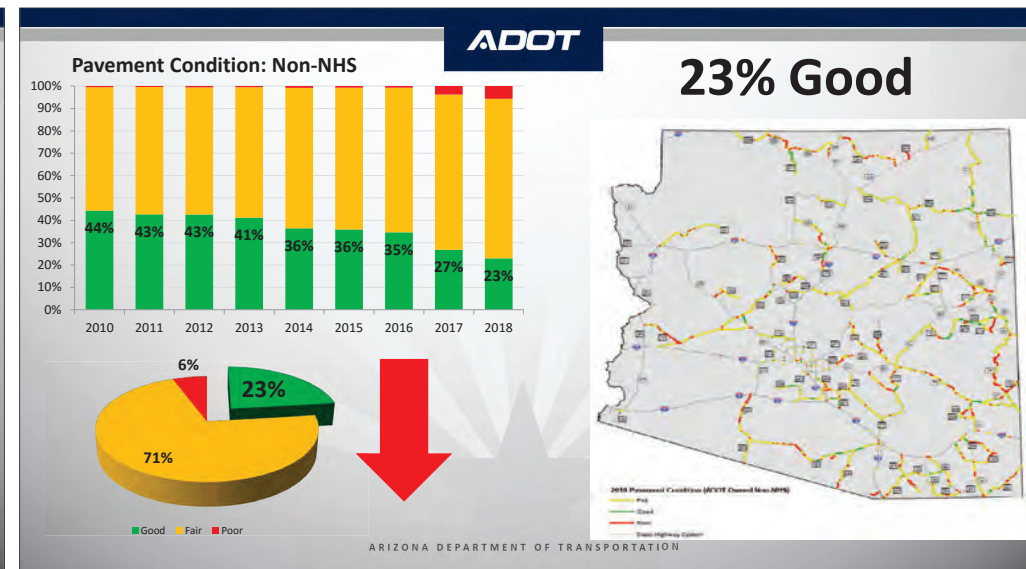
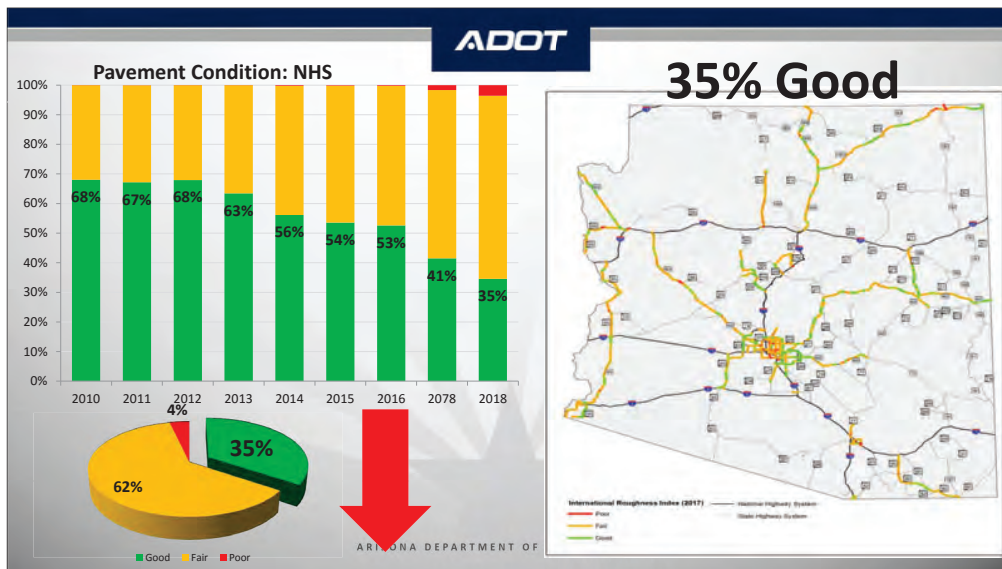
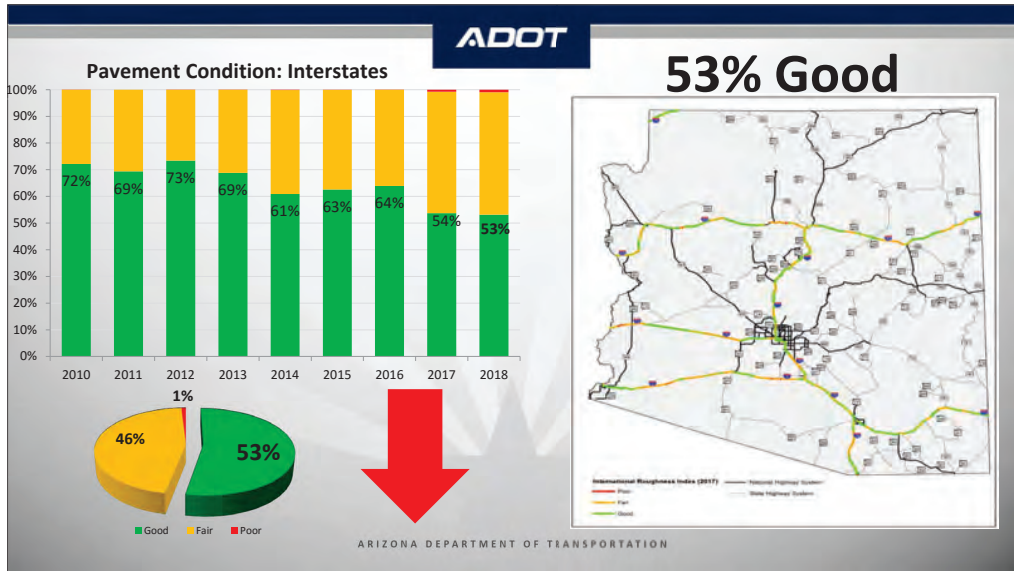
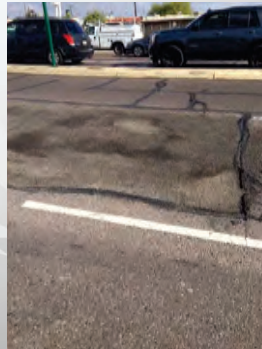
How Do We **Preserve** Our Freeways?

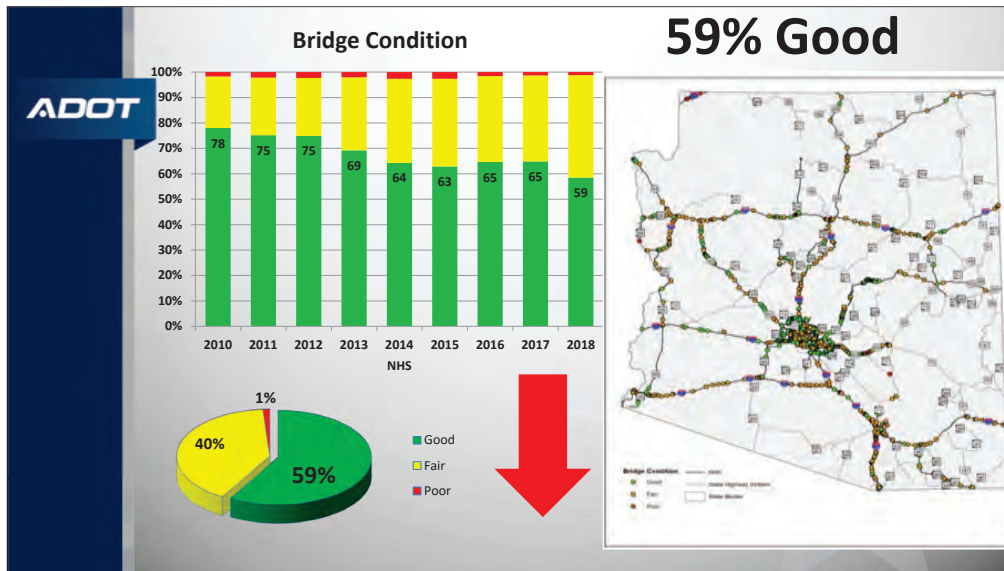


Aging Conditions Cost Big \$



We Have a Whole Lot of This





ADOT ARIZONA DEPARTMENT OF TRANSPORTATION

Keep the Good **Good**

- Crack Seal
- Flush
- Pot Hole Repair (Delamination of 1" Asphalt Surface)

ADOT ARIZONA DEPARTMENT OF TRANSPORTATION

Pavement Preservation - Flush

ADOT ARIZONA DEPARTMENT OF TRANSPORTATION

New Asphalt Overlay

Options Are Needed

- What if we went back to a PCC Surface?
- What if we could make the underlying PCC Pavement Surface better?
- Would it/Could it last a lot longer with little need for maintenance or replacement?



What if: Instead of?



Tears Into the Concrete



Damaged Joints from Typical Milling



Kyrene Road Ramp Area Experiment (April 6, 2019)



Distressed Rubberized Asphalt



Rideable Surface in Good Condition



SR101 EB Test Section (April 27, 2019)

- 4 Test Sections
- Diamond Grind, Next Gen, Skid Abrader & Micro-Mill
- Ride, Sound, Appearance
- What does the public think?

SR101 EB Test Section (April 27, 2019)

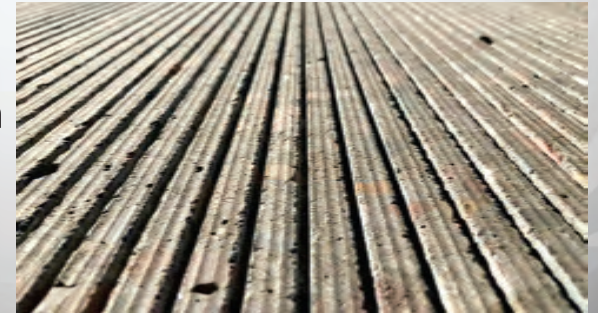
Diamond
Grind



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SR101 EB Test Section (April 27, 2019)

Next
Generation



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SR101 EB Test Section (April 27, 2019)

Skid
Abrader



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SR101 EB Test Section (April 27, 2019)

Micro-Mill



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SR 202 Diamond Grind Real Life Project (May 11, 2019)



Loader to Remove Rubber Asphalt



Small Diamond Grinders



Finished Condition



Maricopa Association of Governments

MAG Report

Considering the challenges the MAG region and state have had in recent years – and are projected to continue to have in the future – to secure adequate funding for roadway maintenance, consideration should be given to replacement of the rubberized asphalt overlay with a diamond grind treatment.



ARIZONA DEPARTMENT OF TRANSPORTATION

Maintenance Procurement Contract

- Contractor Prices bid items associated with diamond grinding



SR 202 EB **Go Big** Project (February 2020)

- 4 Mile Section
- 4 Lanes Wide
- Ramp Sections Included

Cut Strips through Rubberized Asphalt to Control Milling Head



ARIZONA DEPARTMENT OF TRANSPORTATION

Large Diamond Grinders



3 Grinders Working Side by Side



Final Diamond Ground Product



Rideable



Quiet



Looks Good



Diamond Grind Pilot Projects

- Loop 101 Price Freeway
- Loop 101 Pima Freeway
- Loop 101 I-17 to 75th Ave



Questions?