

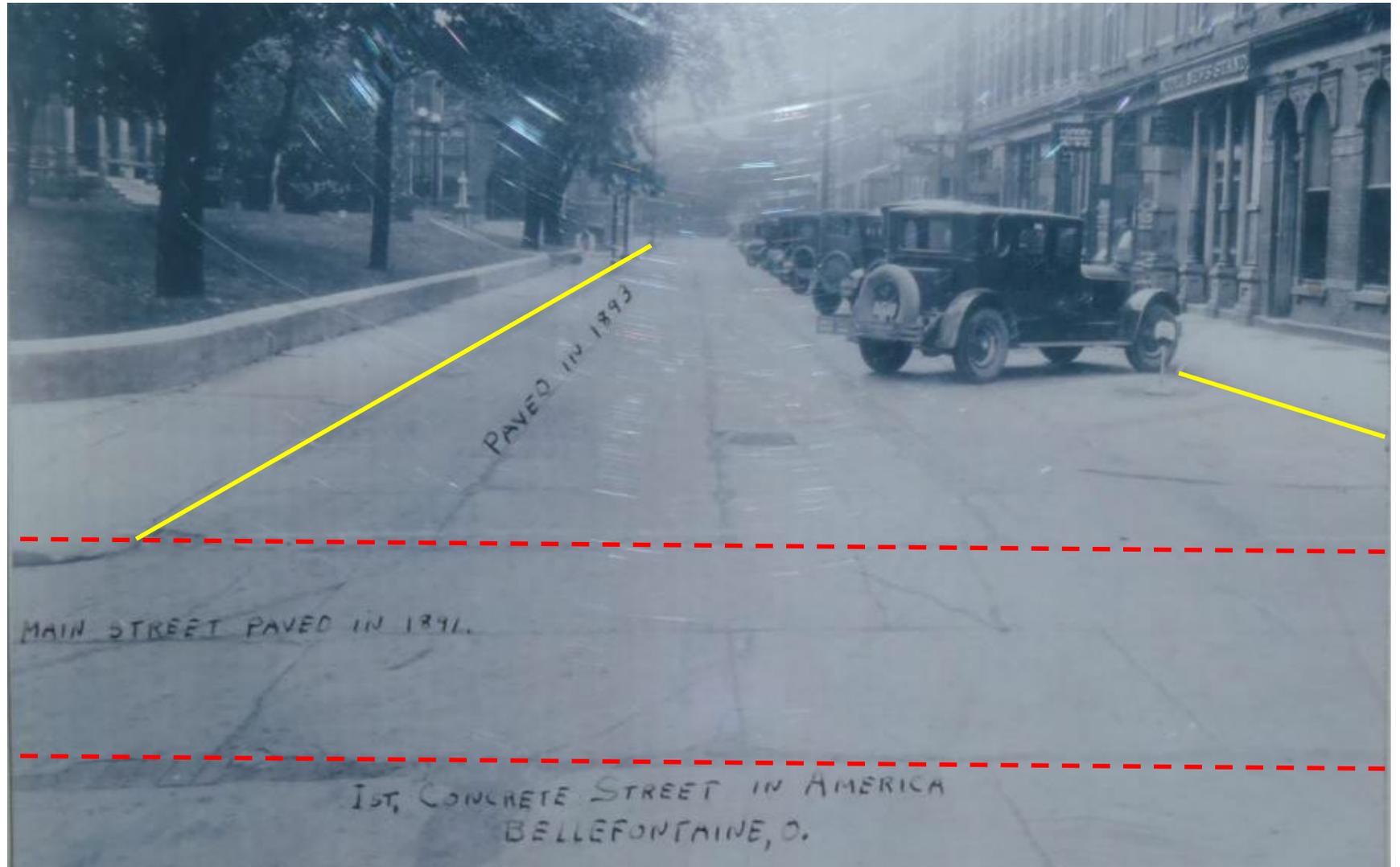
Concrete Preservation & Diamond Grinding in Municipalities



Larry Scofield, IGGA/ACPA

11-14-25

Why Concrete Pavement Preservation Bellefontaine, Ohio 1925



Court Avenue is 131 Years Old



You Need Strategies



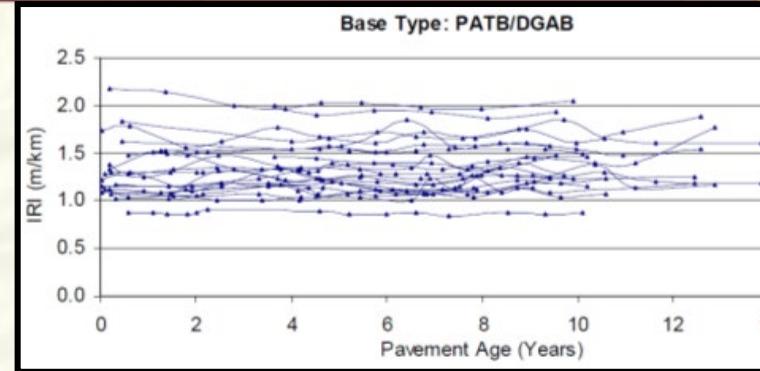
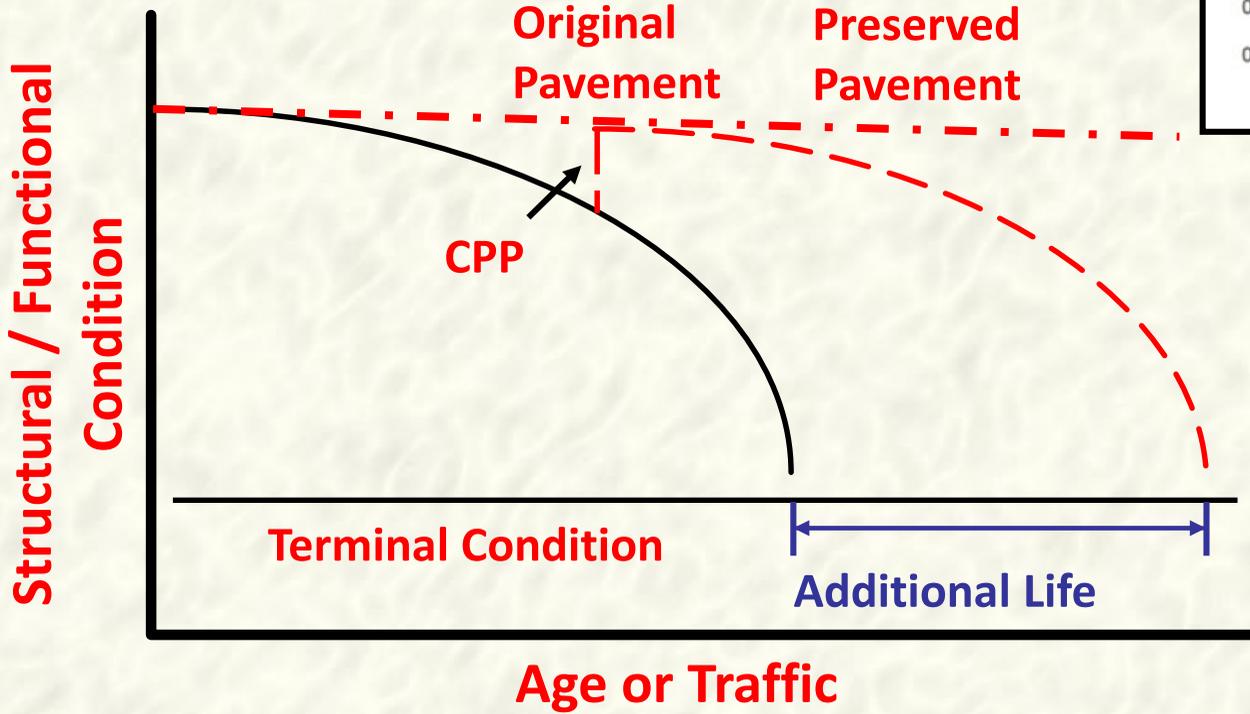
Purpose of Concrete Pavement Preservation

Used early when pavement has little deterioration.

- Repairs isolated areas of distress.
- Repairs some construction defects.
- Manages the rate of deterioration.

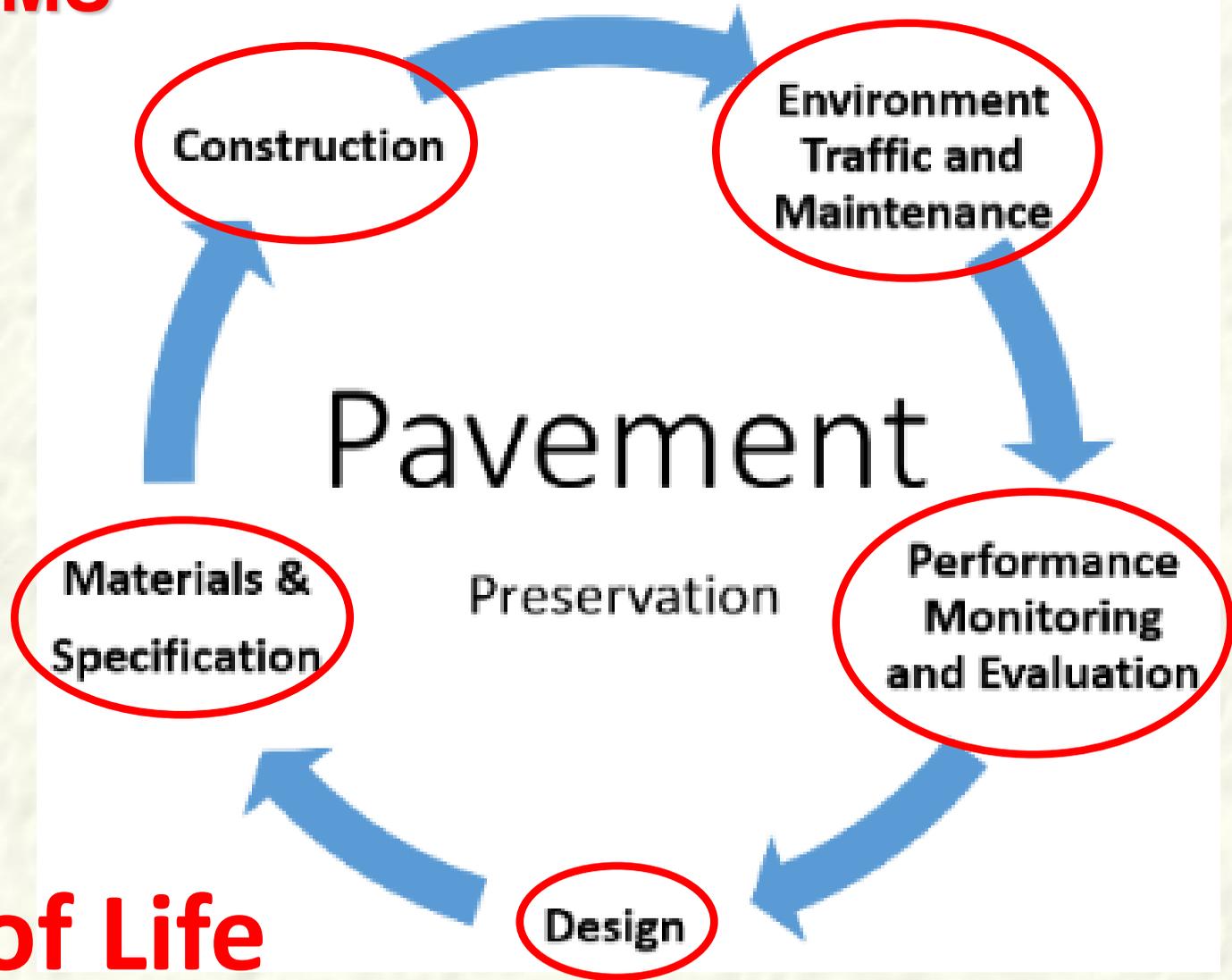


Portrayal of Pavement Performance



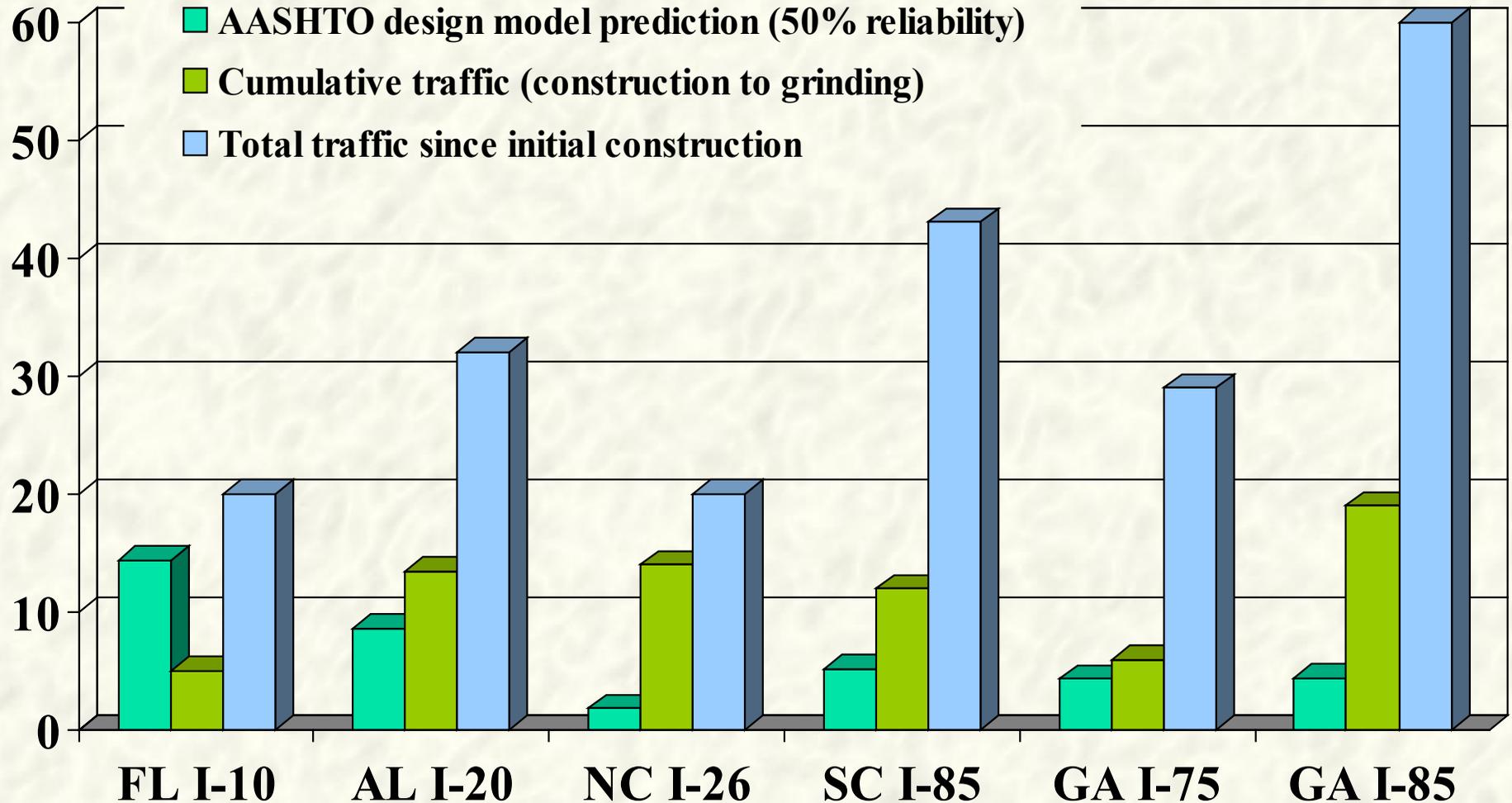
Concrete Pavement Preservation

Original PMS Concept



Circle of Life

AASHTO Design Prediction vs. Actual Traffic



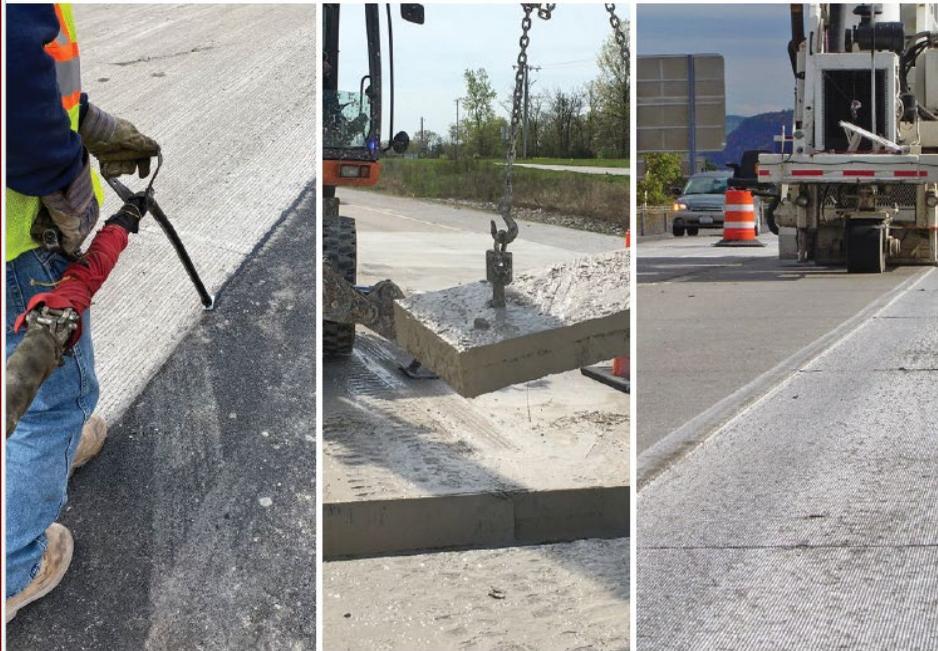
Concrete Preservation Activities

- Diamond Grinding or Diamond Grooving
- Dowel Bar Retrofit
- Joint Sealing or Resealing
- Slab Jacking/Stabilization
- Full Depth Repairs
- Partial Depth Repairs
- Longitudinal Crack Stitching
- Buried Treasure

Concrete Pavement Preservation

CONCRETE PAVEMENT PRESERVATION GUIDE

THIRD EDITION



IOWA STATE UNIVERSITY
Institute for Transportation

AUGUST 2022

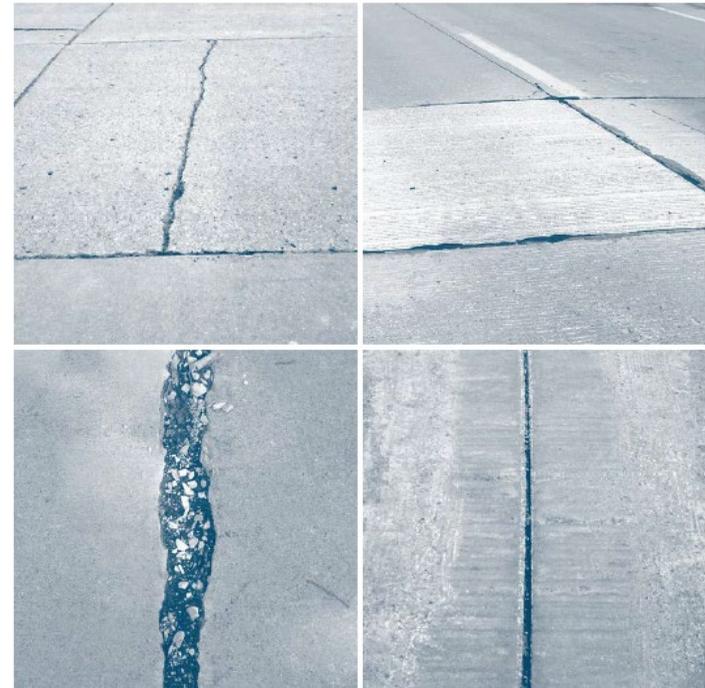
National Concrete Pavement
Technology Center



GUIDE FOR

Concrete Pavement Distress Assessments and Solutions

IDENTIFICATION, CAUSES, PREVENTION & REPAIR

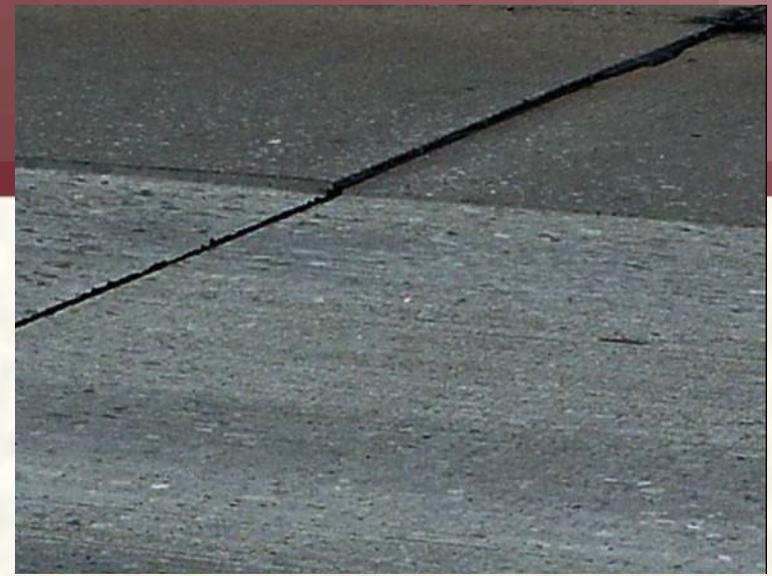


IOWA STATE UNIVERSITY
Institute for Transportation

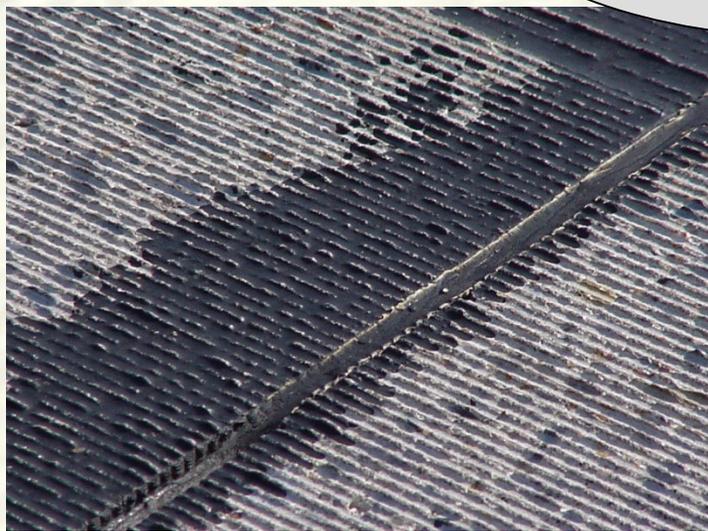
National Concrete Pavement
Technology Center



OCTOBER 2018



Grinding Concrete



What Is 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



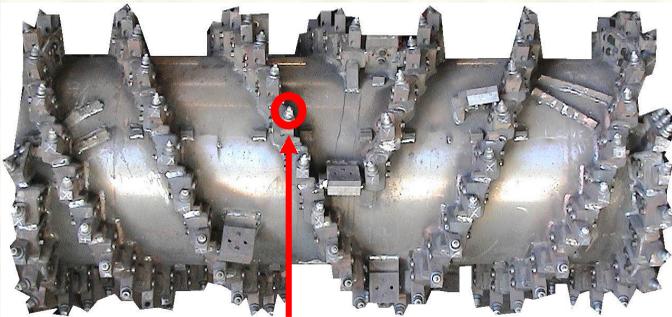
Pavement Problems Addressed

- **Faulting/Roughness at joints and cracks**
- **Built-in or construction roughness**
- **Polished concrete - Increases friction**
- **Unacceptable noise level**
- **Blends patching/surface irregularities into a consistent, identical surface**

Milling Vs Grinding

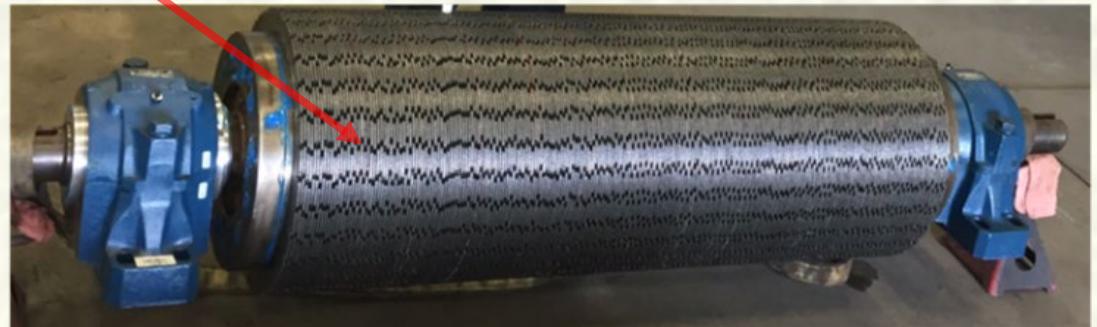
**13,000 to 19,000 Carats of Industrials
Diamonds**

Milling Head



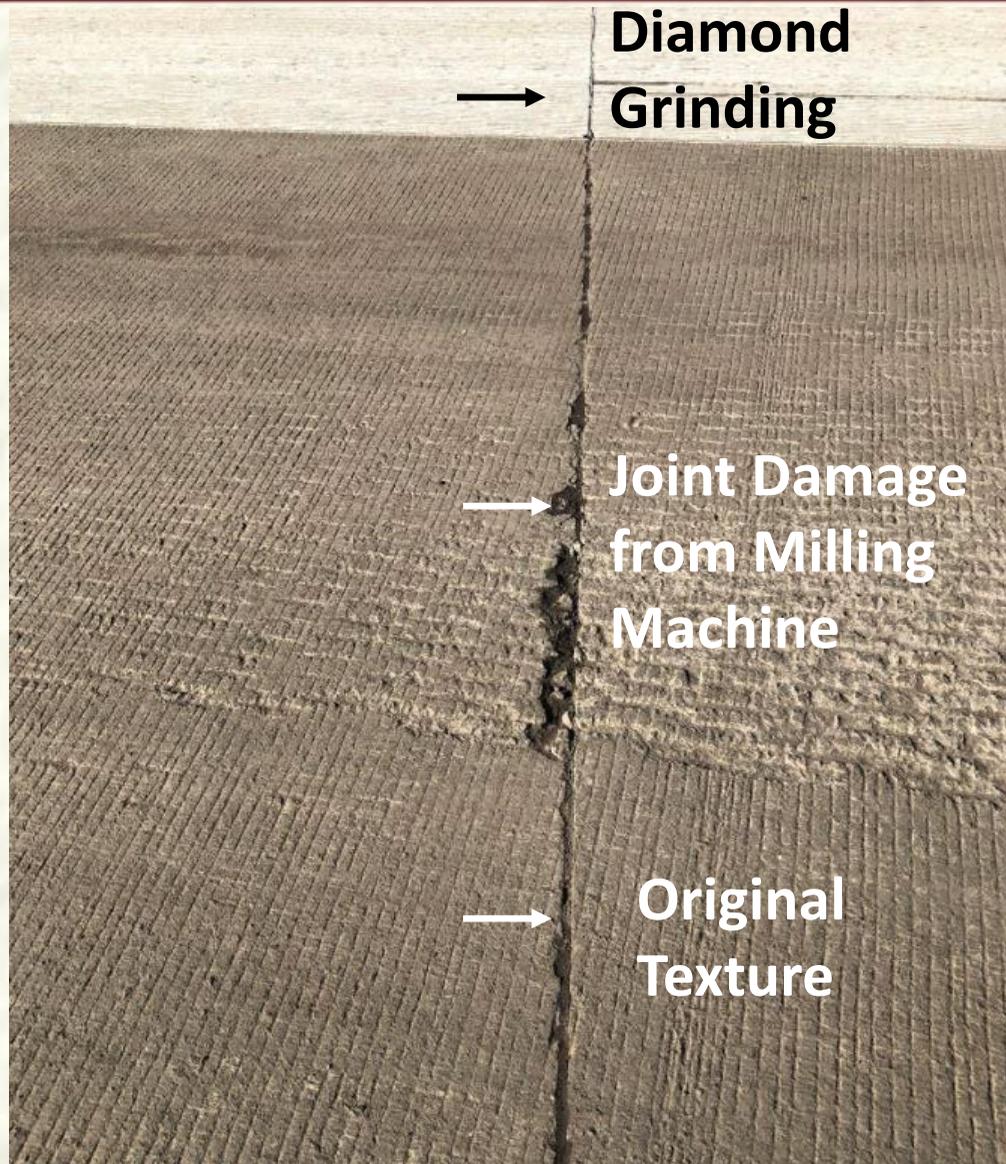
**Uses Carbide Bits to Impact
Concrete**

Diamond Grinding Head

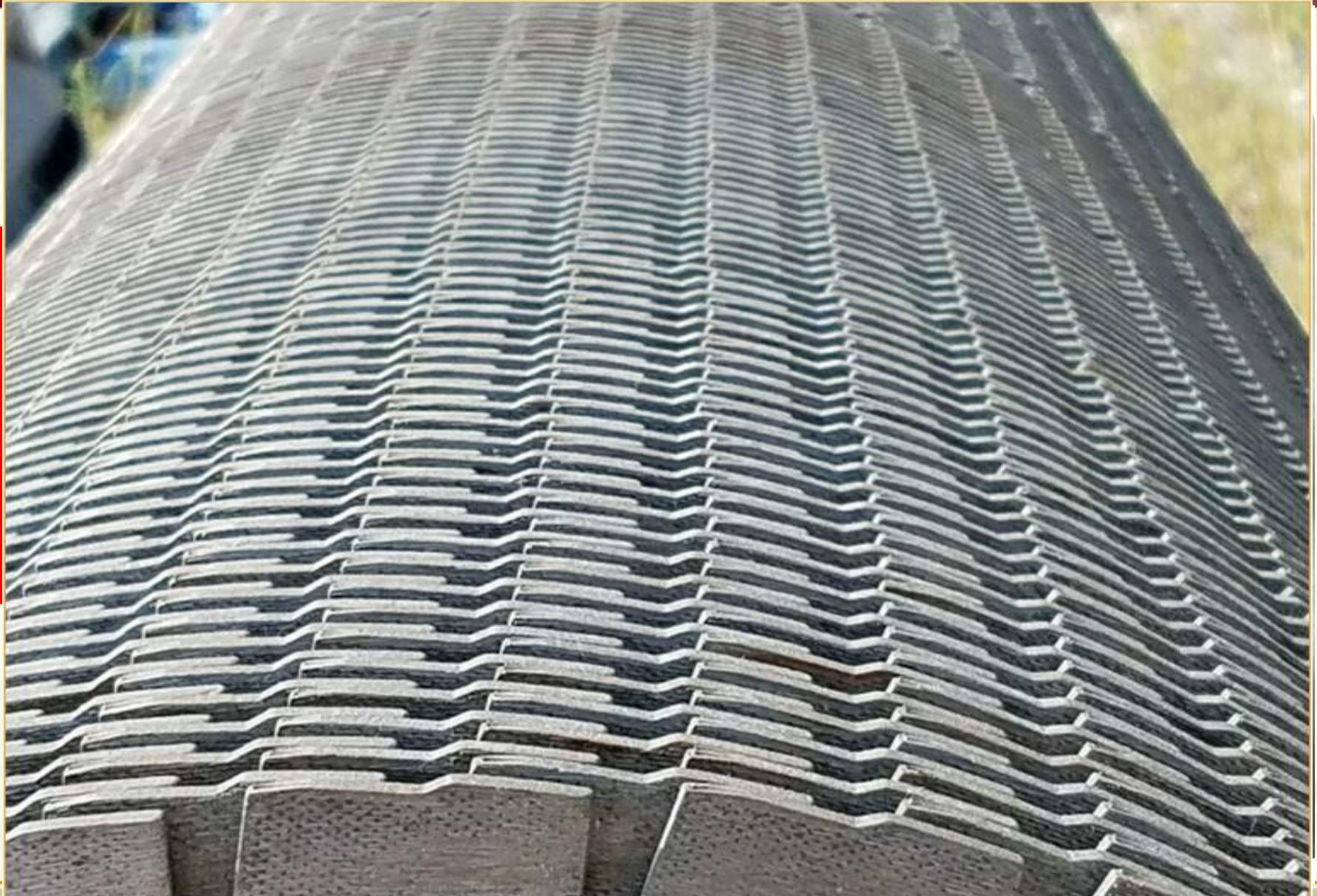


**Uses Diamond Impregnated
Blades to Grind Concrete**

Milling Vs Grinding



It all Starts with Blades and Spacers



Stacking a Diamond Grinding Head

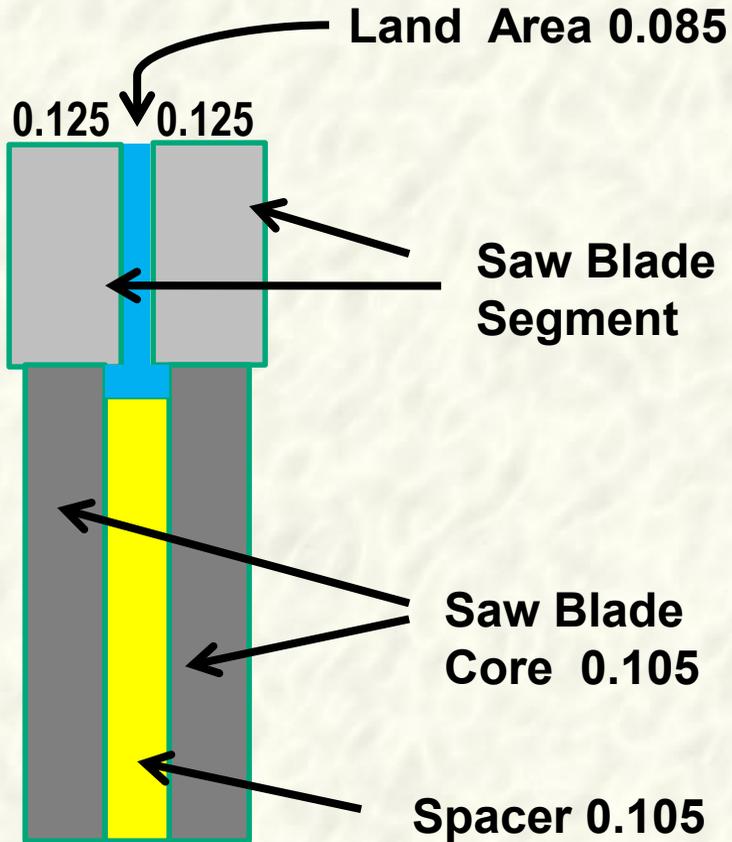


Field



Shop

Typical Conventional Diamond Grinding Blade Configuration

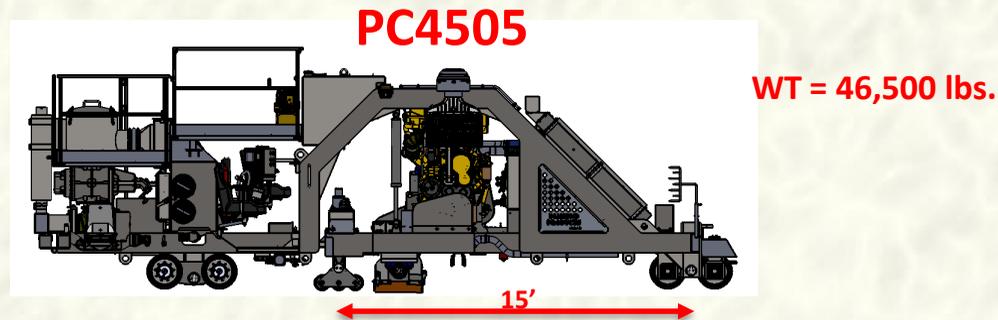
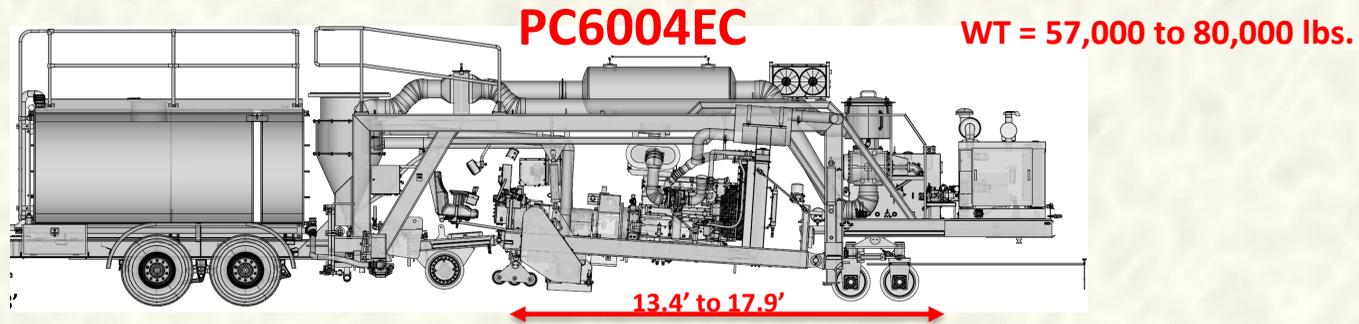


52 Blades
per foot

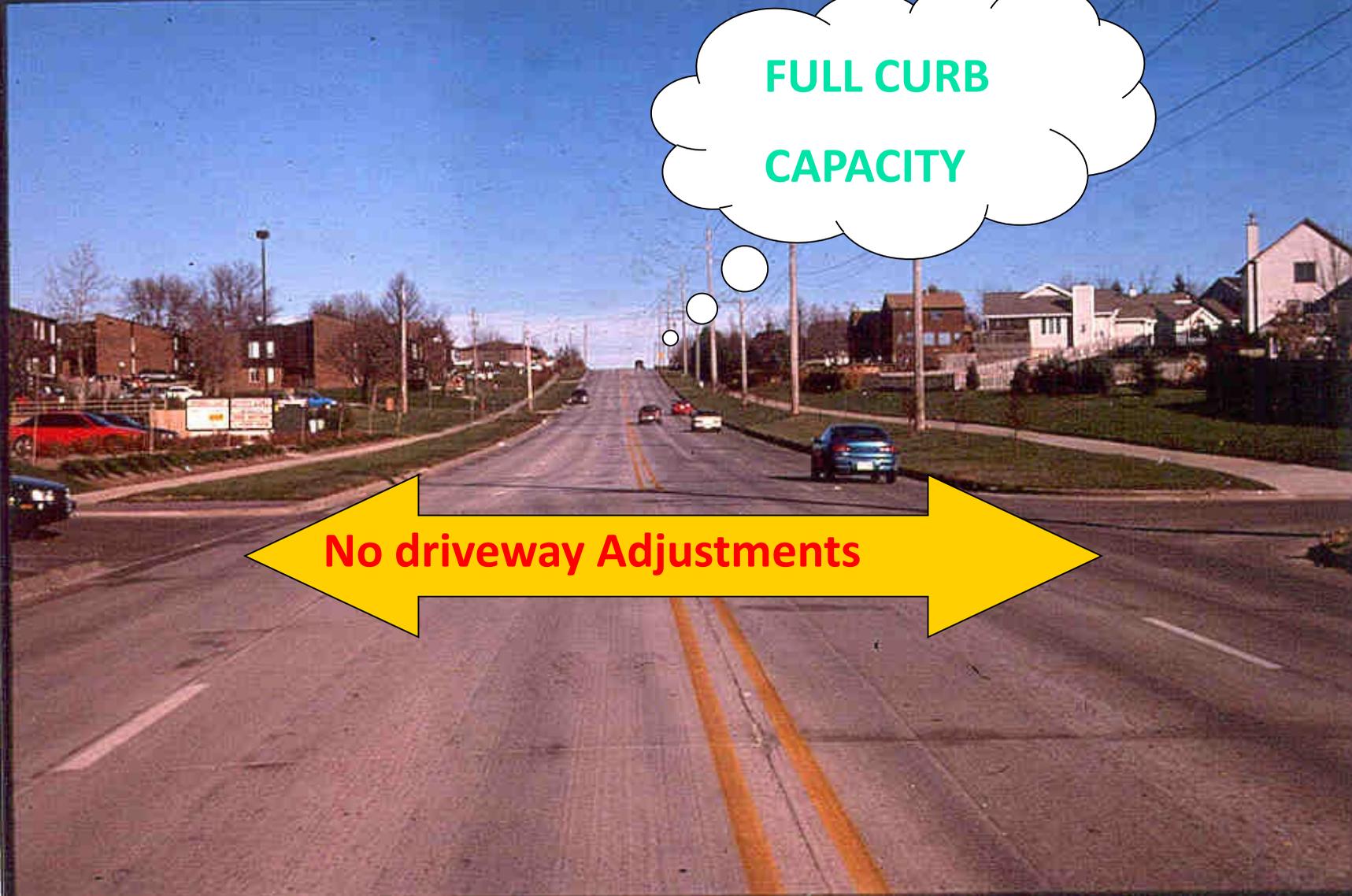
60 Blades
per foot



Typical Grinding Equipment





A photograph of a residential street with a yellow double-headed arrow and a thought bubble. The street is paved with asphalt and has a double yellow line down the center. On either side, there are houses and utility poles. A yellow double-headed arrow is superimposed over the road, pointing towards both ends. Above the arrow, a white thought bubble contains the text "FULL CURB CAPACITY".

**FULL CURB
CAPACITY**

No driveway Adjustments

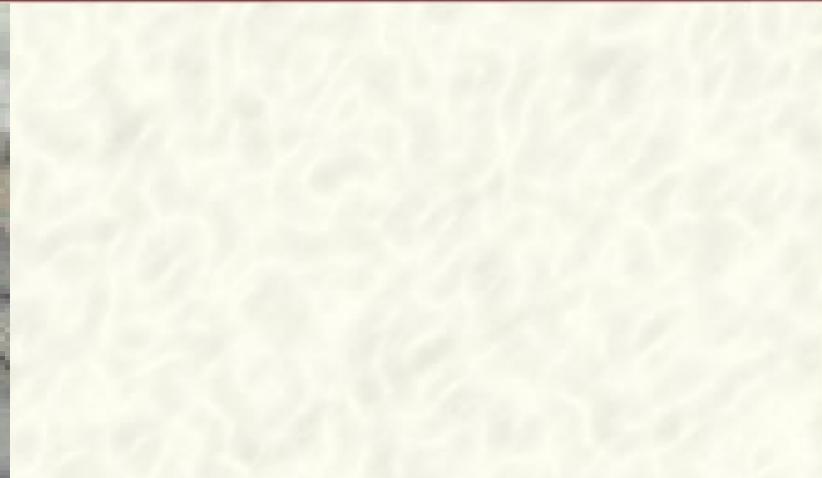
Gutter Capacity Unaffected



Maintain Curb Reveal



Manholes Do Not Require Adjustment



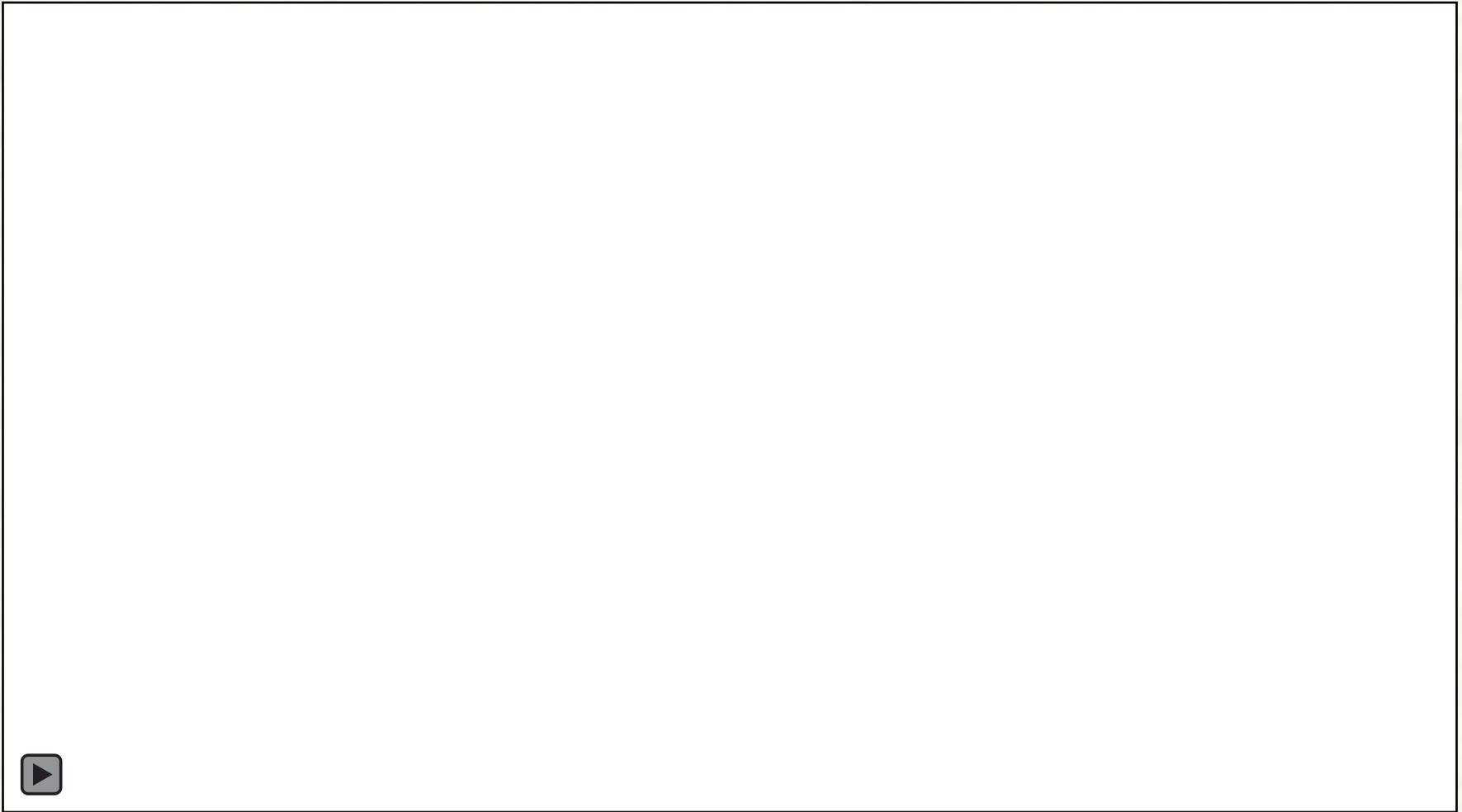
No Additional Work at Driveway Entrances



Intersections



Smoothness: US-45 West Bend WI – Pre Grind



Smoothness: US-45 West Bend WI - Post Grind

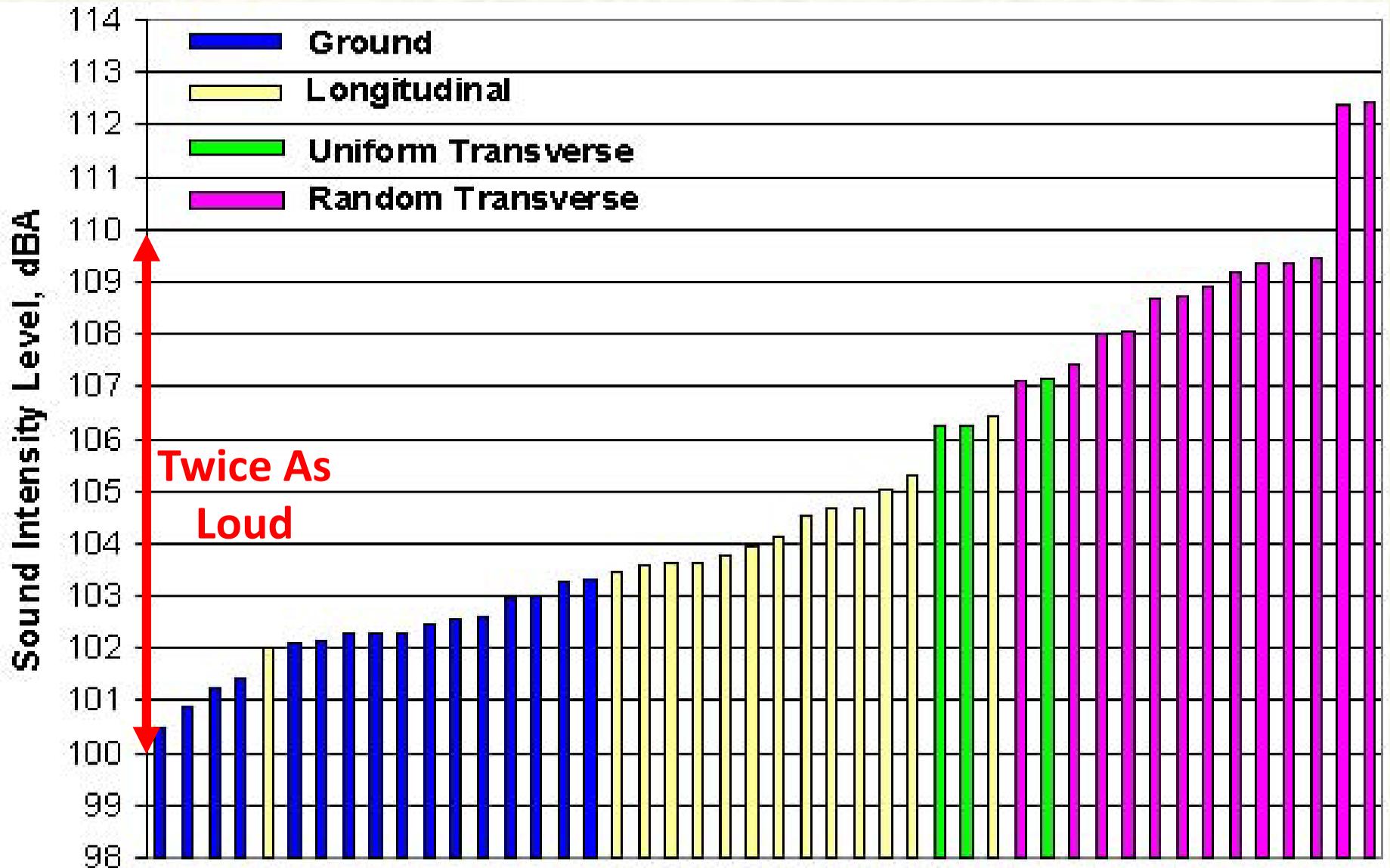


Unacceptable Noise Level



International Grooving and Grinding
Association

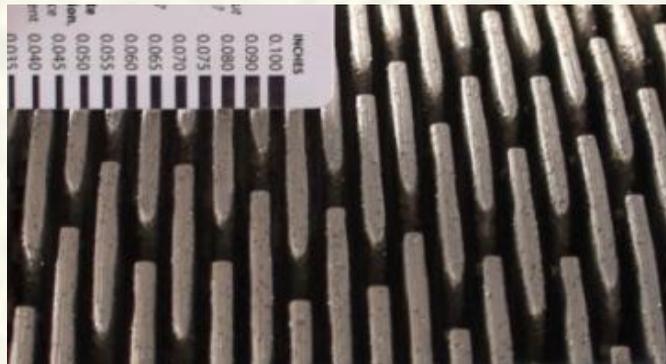
CA and AZ PCCP Noise Test Results



What is Next Generation Concrete Surface (NGCS)



CDG



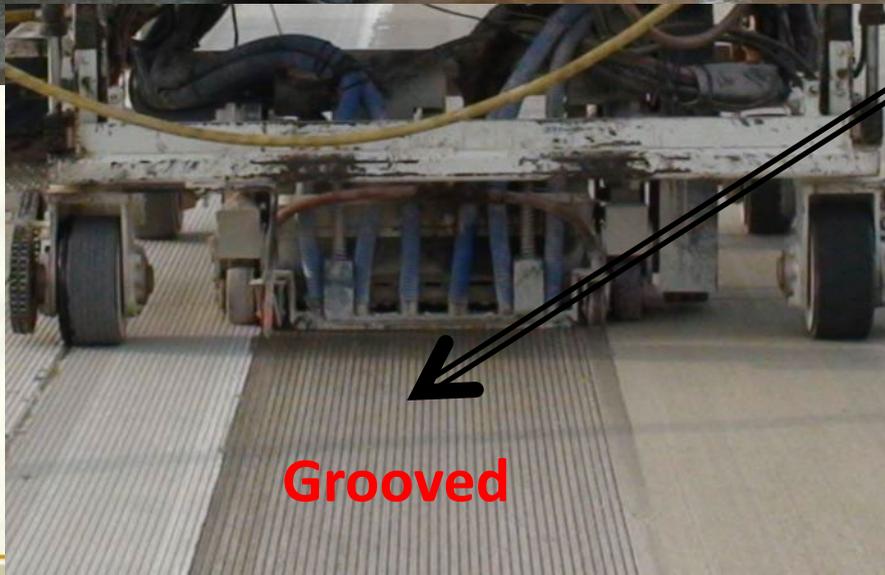
NGCS



NGCS Construction



Positive Texture Removal



Grooved

And Also on Tunnels Too!



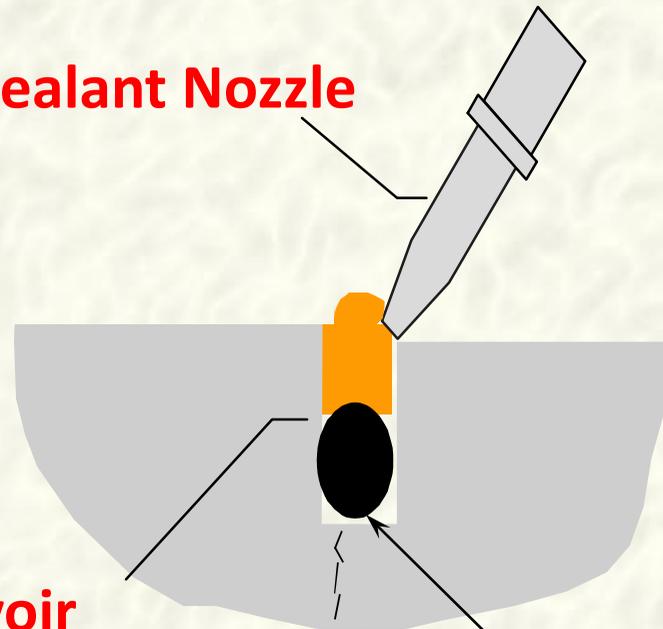
Safety, Surface Texture and Friction

- Increased macro-texture of diamond ground pavement surface provides for improved drainage of water at tire-pavement interface
- Longitudinal texture provides directional stability and reduces hydroplaning (side-force friction). Grooves provide "escape route" for water trapped between tire and pavement surface
- In Wisconsin, overall accident rates for ground surfaces were 40% less than for un-ground surfaces over a 6-year period, 57% in wet weather conditions

Sealing and Resealing



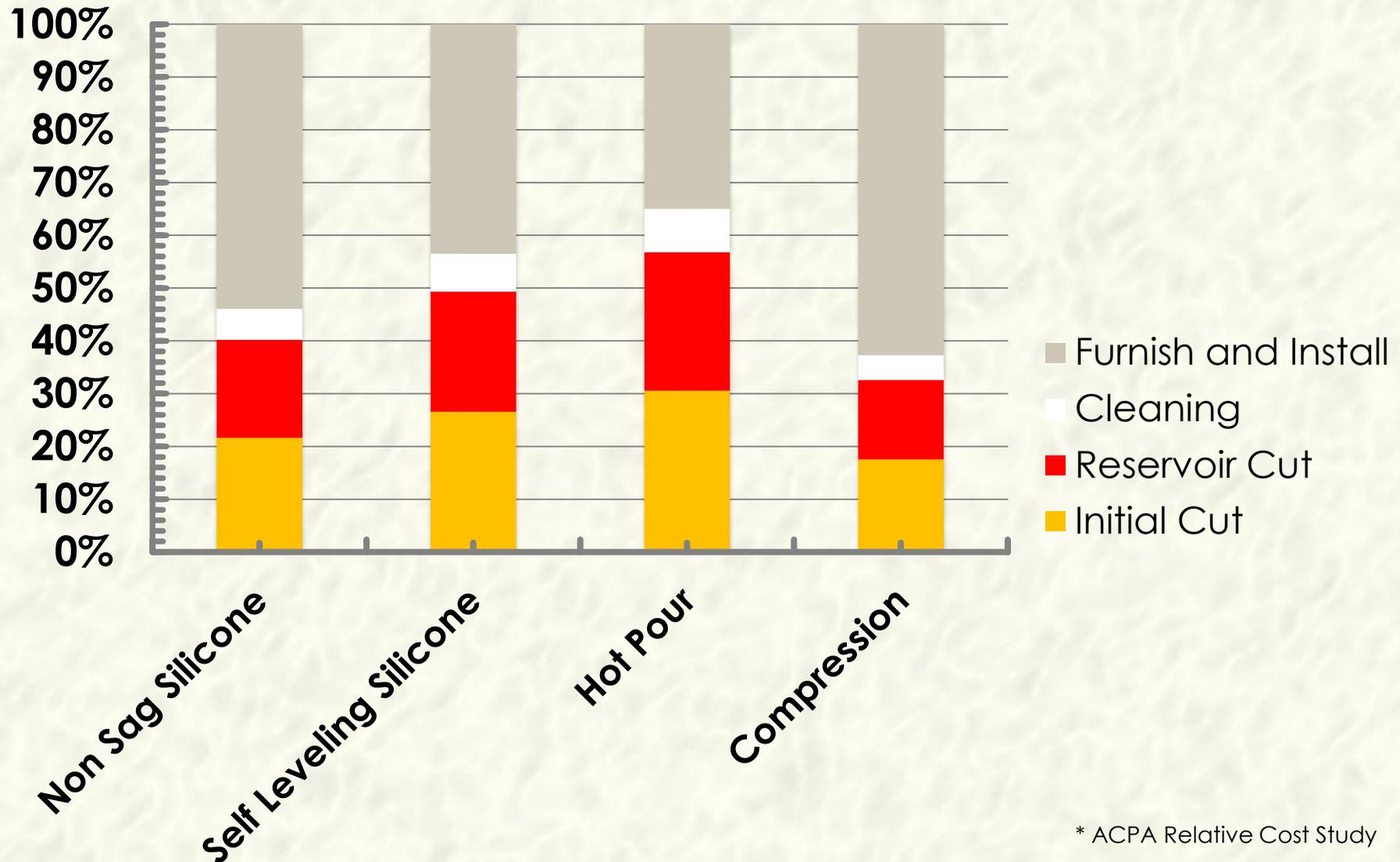
Sealant Nozzle



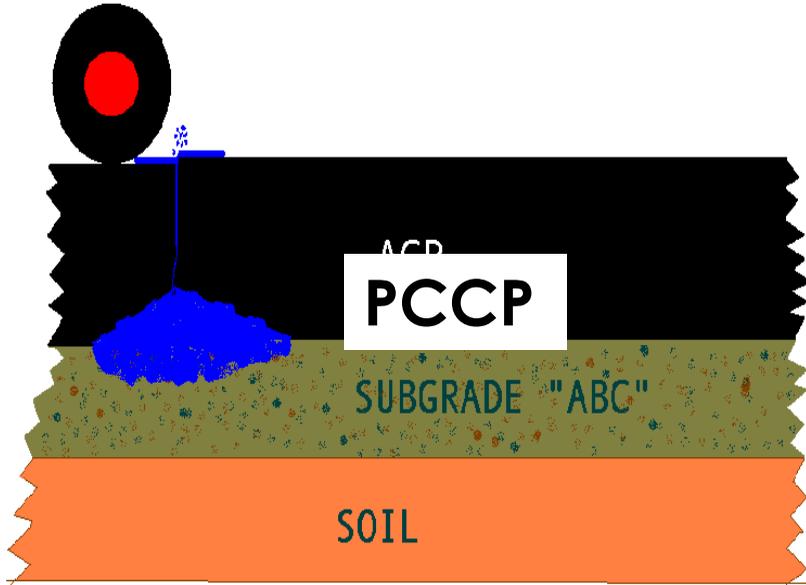
Reservoir

Backer Rod

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



Why Seal Joints and Cracks



Prevents Water from Entering the Subgrade:

- **-Prevents subgrade erosion**
- **-Voids beneath the slab**



Water Damage to Pavements

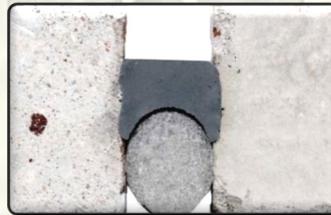
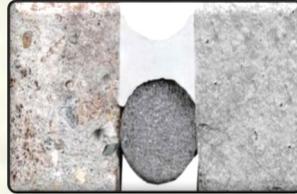


The Top Doesn't Always Tell the Story



Sealant Types

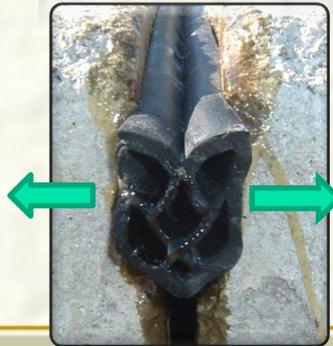
- ▶ **Silicone**
 - ▶ Non Sag
 - ▶ Self Leveling
 - ▶ Rapid Cure



- ▶ **Hot Pour**
 - ▶ ASTM 6690
 - ▶ Type 1-4

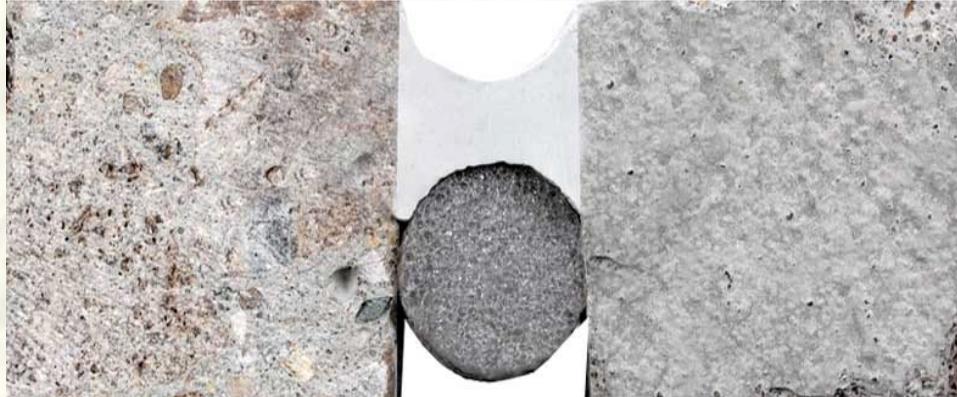


- ▶ **Compression Seal**



Silicone Joint Sealant Configuration

Non-Sag



Self-Leveling



Jet Fuel Resistance Testing – Airfield Applications

DAWY CORNING

As stated in FAA Engineering Brief No. 36 (dated 5/86), "The function of a sealant is to seal the joint between two concrete surfaces." Therefore, the sealant's strength characteristics are less important than its ability to withstand joint movement and maintain adhesion." This document goes on further to state that "Silicone sealant is not degraded by contact with fuel. Some swelling of the material will normally occur, but it will return to its original shape upon evaporation of the fuel, without loss of bond".

Generally, for a sealant to be successful in an airfield application, it must meet the following requirements:

- Resistance to ultraviolet light
- Wide temperature flexibility
- Cyclic movement capability (both extension and compression)
- Fuel/oil resistance
- Jet blast resistance

Federal Specifications SS-3-2000, SS-3-1414A and ASTM Specification D 3569 attempt to test for the above performance requirements. However, when it comes to cyclic movement capability, they all fall short. The best cyclic movement test that closely relates to actual field conditions is ASTM C 719. See Table I for a brief comparison of these specifications.

Since there are few federal or ASTM specifications presently written for silicones, Dow Corning developed a test method to verify that silicone sealants can meet the requirements for airfield applications mentioned above.

A simulated fuel spill test joint (see Figure 1) was chosen along with ASTM C 719 cyclic testing. This test joint in combination with C 719

appeared to be a more accurate depiction of actual field conditions.

The test consists of forming several sealant test joints between two concrete blocks with a dam on top of each block (see Figure 1). The sealant is allowed to cure. The dam is filled with the test fluid (i.e., jet fuel). The fluid is then allowed to dissipate, as it would in the field. If more than one fluid is to be tested on the same joint, then approximately one week separates each fluid application. At the end of the fluid exposure, these same test joints are then subjected to cyclic testing per the ASTM C 719 specification.

Figure 1. Simulated Fuel Spill Test Joint

Figure 2. Effect of Fuel Spill on Dow Corning® Silicone Joint Sealant

Table I. Specification Comparison

| Specification | Sealant Type | Exposition | Cyclic Movement Capability |
|---------------|--------------|---------------------------|----------------------------|
| SS-3-2000 | Cold Applied | 3 cycles @ 0°F (-17°C) | None |
| SS-3-1414A | Hot Applied | 3 cycles @ 0°F (-17°C) | None |
| ASTM D 3569 | Hot Applied | 3 cycles @ 0°F (-17°C) | None |
| ASTM C 719 | Cold Applied | 10 cycles @ -15°F (-26°C) | 10 cycles @ 150°F (70°C) |

Table II. Approximate Volume Change after Exposure to Fluids

| Fluid | Percent Volume Change - Typical | |
|------------------------------|---|--|
| | Dow Corning® 888 Silicone Joint Sealant | Dow Corning® 990-SL Silicone Joint Sealant |
| IP-4 | 9 percent | 15-20 percent |
| sky-ol-1 | None | None |
| 50/50 Glycol/Ethylene Glycol | None | None |
| Hydraulic Fluid | None | None |

*After drying, all samples passed 1000-50 percent movement testing.

- Recess min 1/8"- 1/2" Below Surface
- 2 to 1 Ratio
- Tooling Required (non sag)

Hot Pour Joint Sealant Configuration

40° F Minimum Pavement Temperatures
Flush Fill, Recessed or Over-band



Flush Filled

Recessed

Flush Filled



Clean Isn't an Option



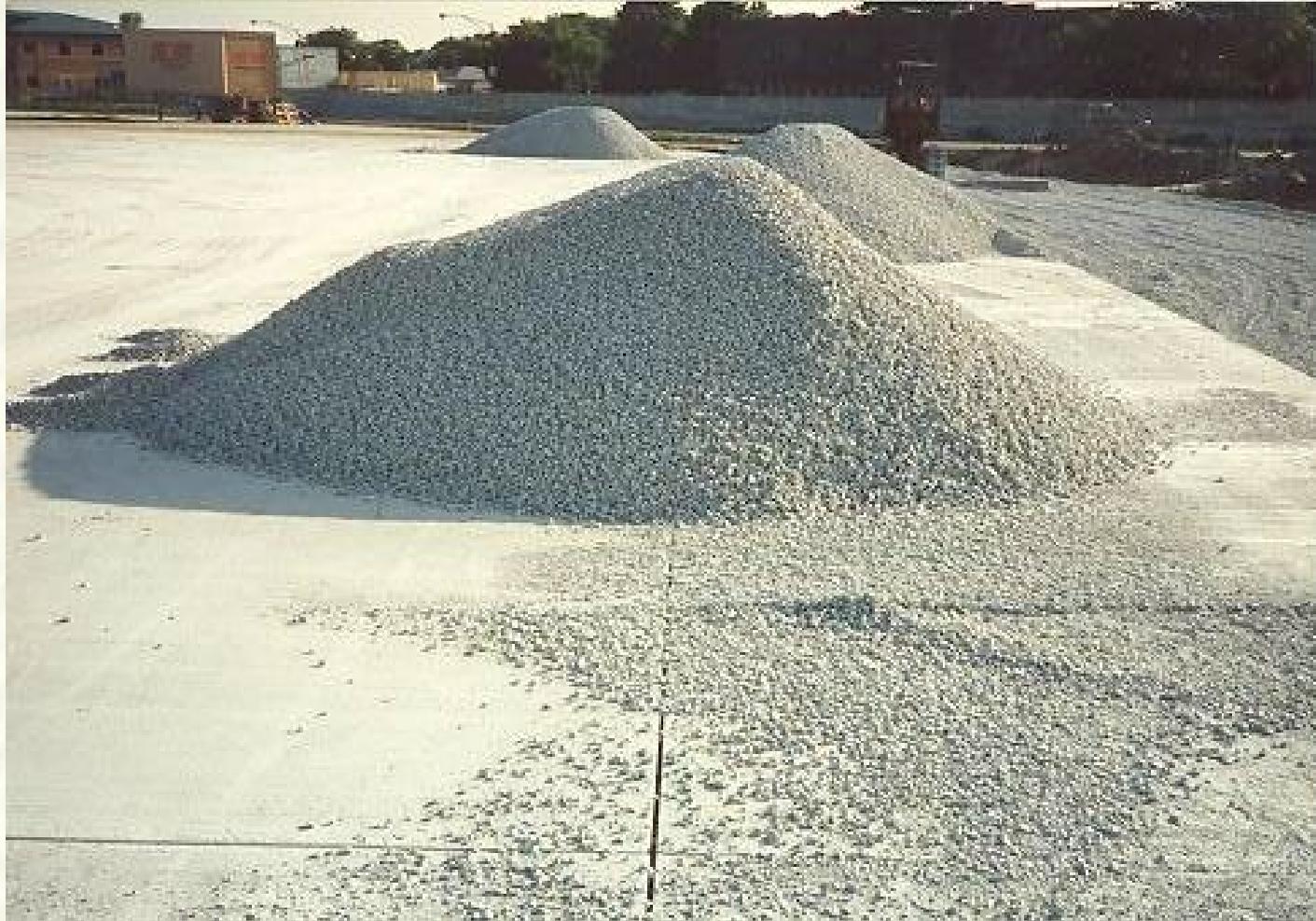
Power Washing After Green Sawing



Intersecting Joints After Power Washing



Where Do Incompressibles Come From



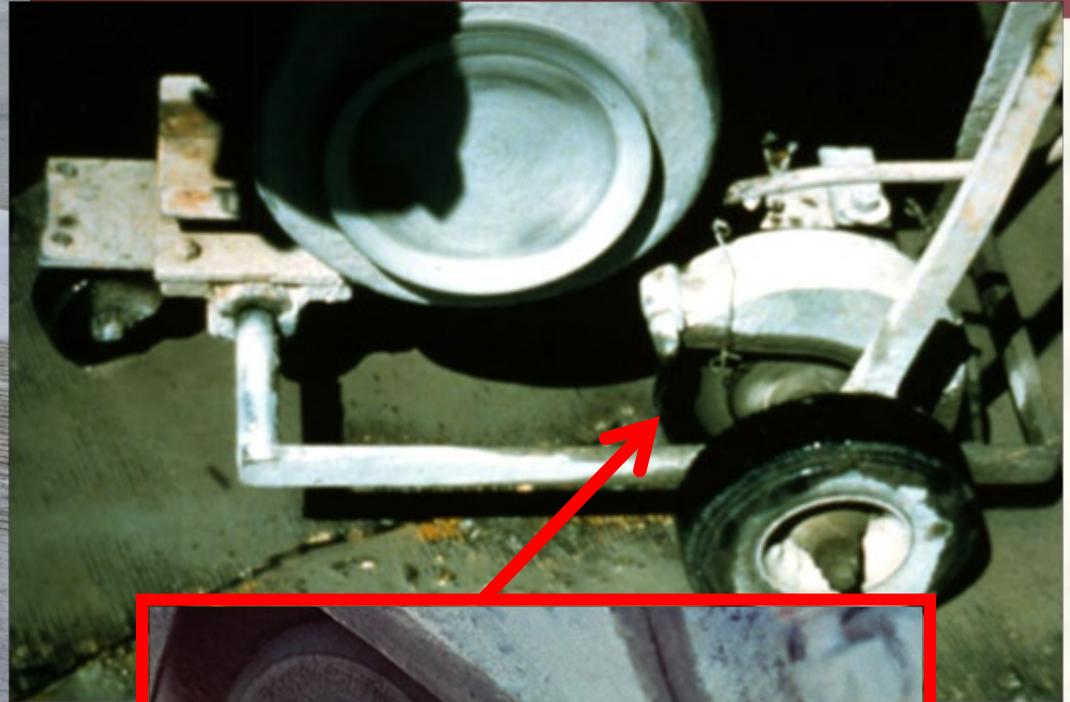
Keep the Joints Clean During Construction



Installing Hot Pour Sealants



Crack Chaser Saw



What Happens When the Plate is Not Right



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**

Full Depth Repair



Full Depth
Repair



Full-Depth Repair Use

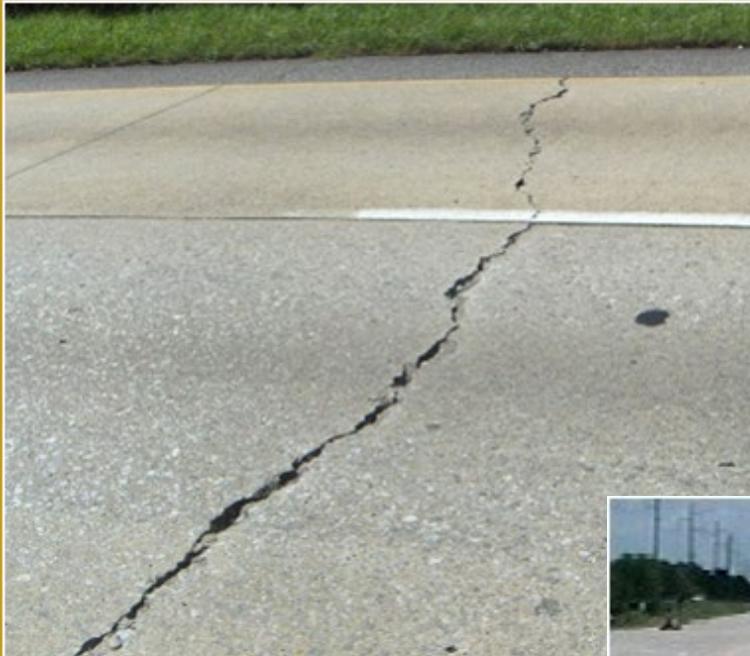
- **Purpose**

- **Restore Structure**
- **Restore Ride**

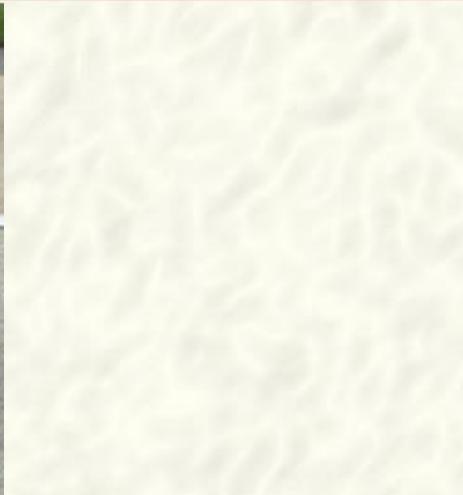
- **Used For**

- **Joint Deterioration**
- **Transverse Cracking**
- **Longitudinal Cracking**
- **Broken Slabs and Corner Breaks**

Repairing Cracking



Transverse Cracks



Corner Breaks



Longitudinal Cracks

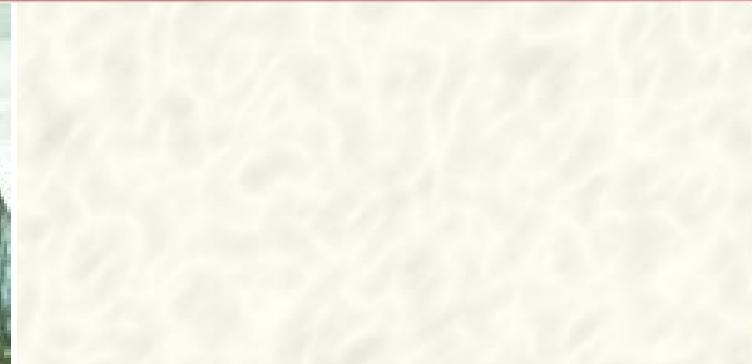
Repairing Broken Slabs



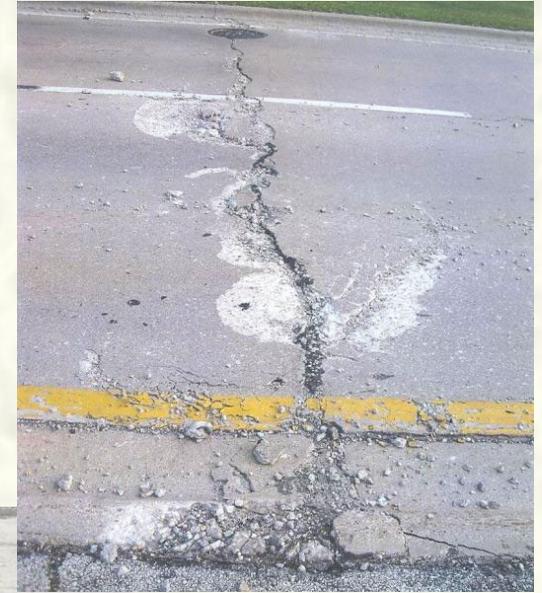
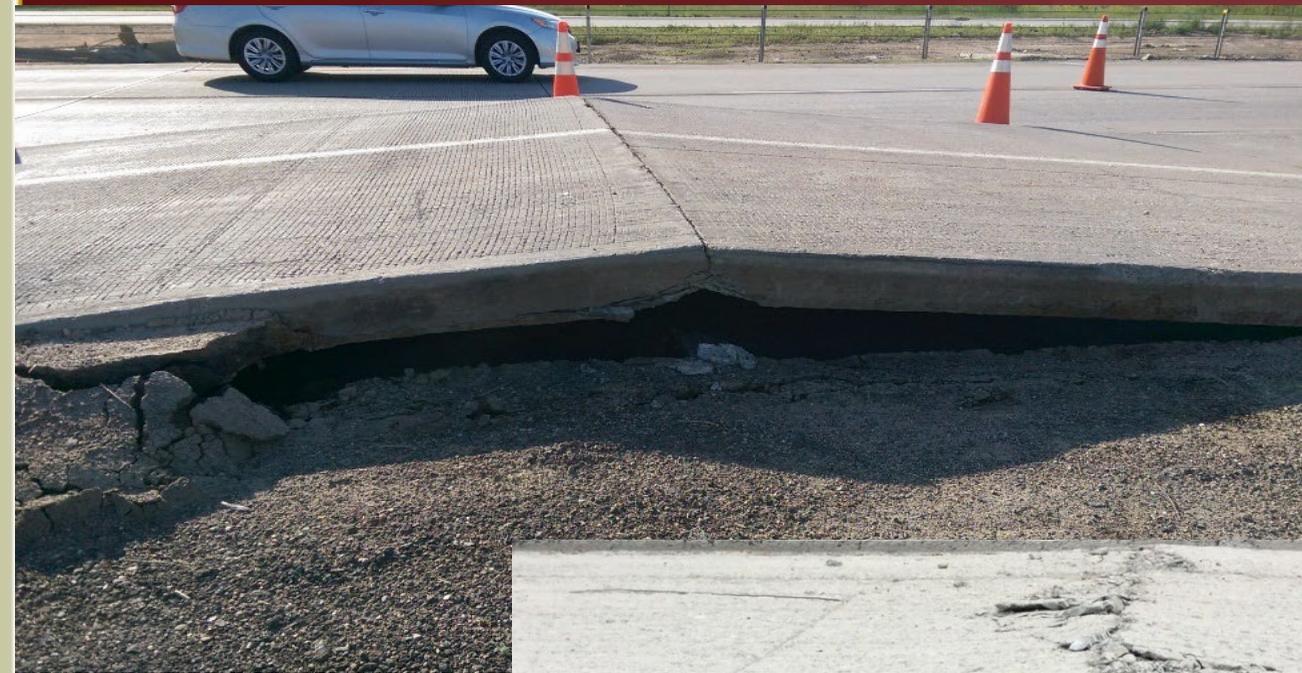
Repairing Joint/Crack Deterioration



Its Not Only What You See From Above!



Replacing Vaulted and Shattered Slabs



Types of Distress That Cannot Be Addressed

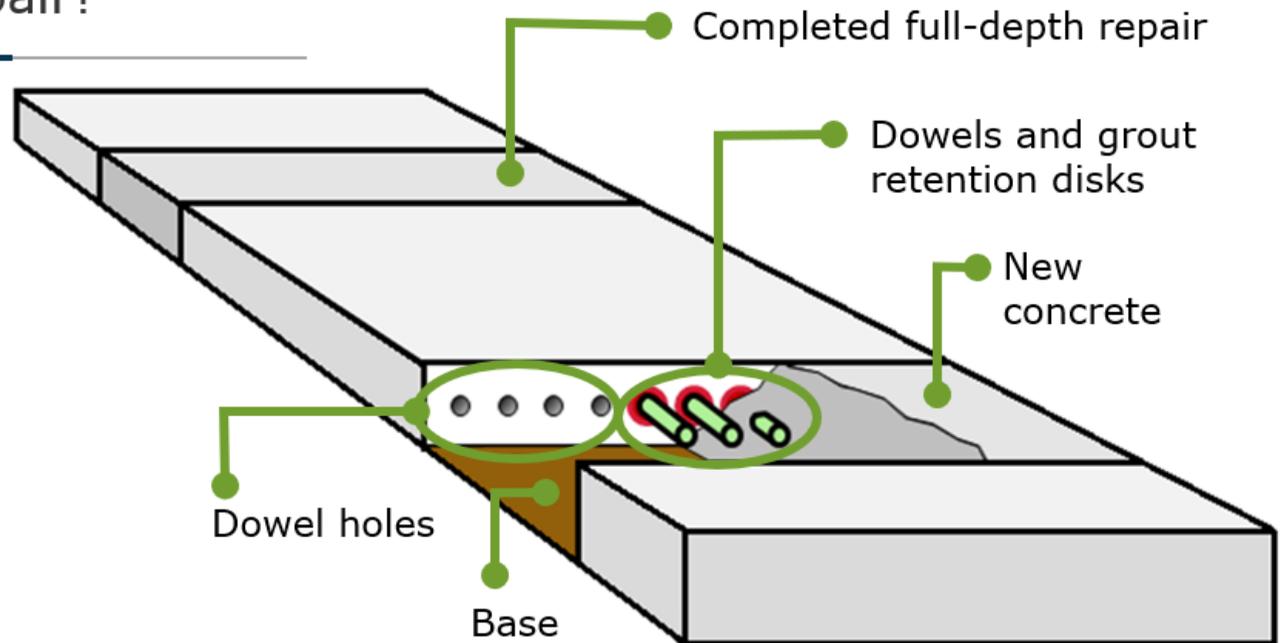


Excessive Pavement Deterioration

What Is A Full Depth Repair

What is Full-Depth Repair?

- Patching method used to restore structural integrity and rideability to concrete pavements
- Involves multiple steps:
 - Sawing boundaries
 - Removing old material
 - Repairing base
 - Installing dowels and new concrete or precast panels









Full Depth Repair Process

- **Identify and Mark Areas**
- **Selection of Materials**
- **Sawing Repair Boundaries**
- **Removal Methods**
- **Base Preparation**
- **Installing Dowels and Tie Bars**
- **Casting and Finishing Slabs**

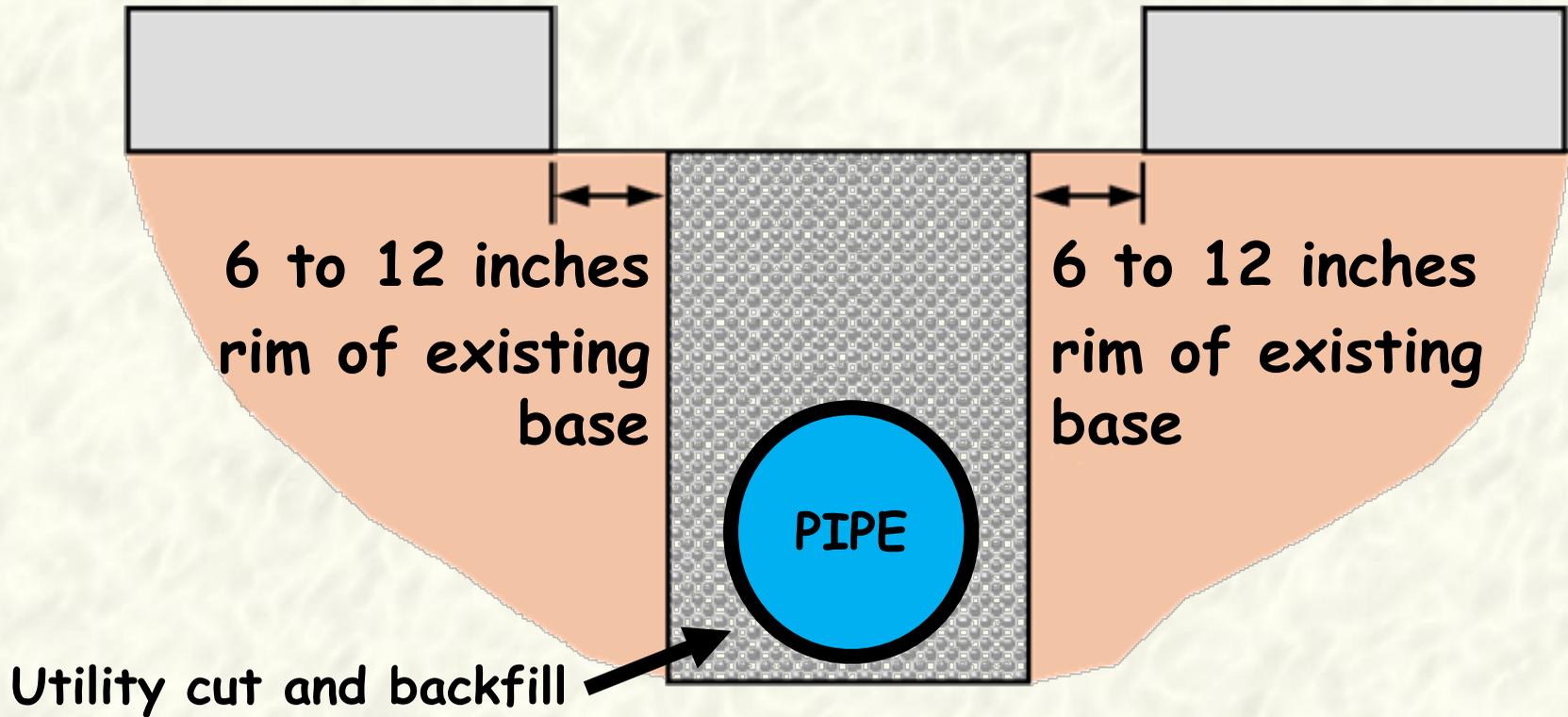
Identify and Mark Repair Areas



6 Ft Minimum Width Requirement



Utility Cuts



Repair Boundary Determination

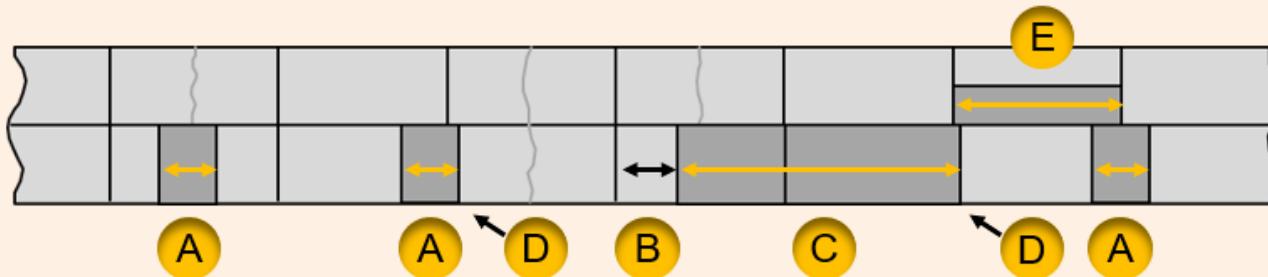
How Are Repair Boundaries Determined for JCP?



BEFORE



AFTER



Severity

| | |
|---|--------|
| L | Low |
| M | Medium |
| H | High |

- Minimum patch length is 6 feet for doweled joints; 8 to 10 feet for aggregate interlock joints.
- Check distance between patches and nearby joints.
- Replace the entire slab if there are multiple intersecting cracks.
- Extend the patch beyond joint by about 1 foot to remove existing dowels, even if there is not any deterioration to that side of the joint.
- When marking partial-width patches for longitudinal cracks, keep the joint off of the wheel paths.

Sawing Repair Boundaries



Perimeter Cut



Pressure Relief

Two Types of Longitudinal Joint Face

- Smooth-faced, separated longitudinal joint
 - For repairs less than one slab length (usually 15 feet or less)
- Smooth-faced, tied joint
 - For repairs greater than one slab length (usually more than 15 feet)
- Both require same perimeter sawing



Sawing Procedure for Full-Depth, Transverse Cuts

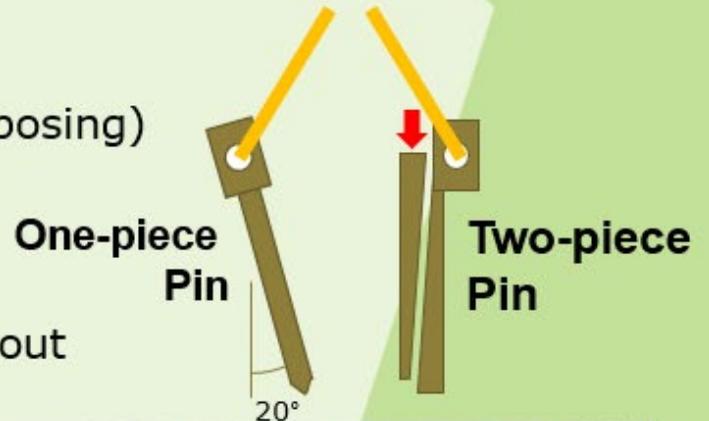
- **Set cut depth to fully reach slab bottom**
 - Nominal thickness plus 1/2 inch
- **Saw toward any live traffic lane and avoid turning your back on traffic if possible (use spotter if necessary)**
- **If saw blade binds then use pressure-relief cut in repair area**
- **Determine if over-sawing is acceptable**
 - OK if sawing over existing joint
 - OK if sawing into shoulder
 - Avoid if would weaken an adjacent traffic lane

The rule of thumb is to set the depth to the nominal thickness plus 1/2 inch.



Slab Removal (Pin and Chain)

- Drill holes
 - One-piece requires 20-degree angled holes (opposing)
 - Two-piece uses compression fit in vertical holes
- Insert pins
- Secure chains to loader bucket or excavator and lift out



Vacuum Suction

- Mount attachment to equipment
- Position vacuum pad over repair area
- Apply suction
- Lift out



Restore, Grade, and Compact

- Add new base material, if needed
 - Backfill utility excavation
 - Replace soft materials
- Compact base
 - Use vibratory plate compactor with 4,000–6,000-lb. centrifugal force rating
 - Consider roller for larger patch areas



Handheld Drilling

- Mobile
- Needed in cases of tight access
- Slower drill speed
- Adequate for small projects or low number of holes
- Less alignment control
- Adequate for tie bars



Base Referenced Drill

- Single or ganged to three drills
- Self-propelled
- Wheels ride on base to position drill
- Simultaneous drilling control



Slab Referenced Drill

- Ganged (up to 5)
- Self-propelled or mounted to other equipment
- Wheels ride on slab to position drill bit
- Simultaneous drilling controls



Anchoring Dowel Bars or Tie Bars

Step 1: Clean the Hole

Step 2: Mix and Place Bar Anchoring Material

Step 3: Insert Dowels and Tie Bars

Step 4: Place Grout Retention Disk and Oil Bar

Cleaning Hole

- No additional effort is needed to clean holes when using drills equipped with a dust mitigation vacuum system; holes are cleaned by drilling equipment
- If using handheld drills or older gang-drill equipment, then remove dust and debris from holes by:
 - Low-pressure compressed air (avoid creating dust clouds)
 - Vacuum
- Always wear protective dust masks and clothing when performing these operations

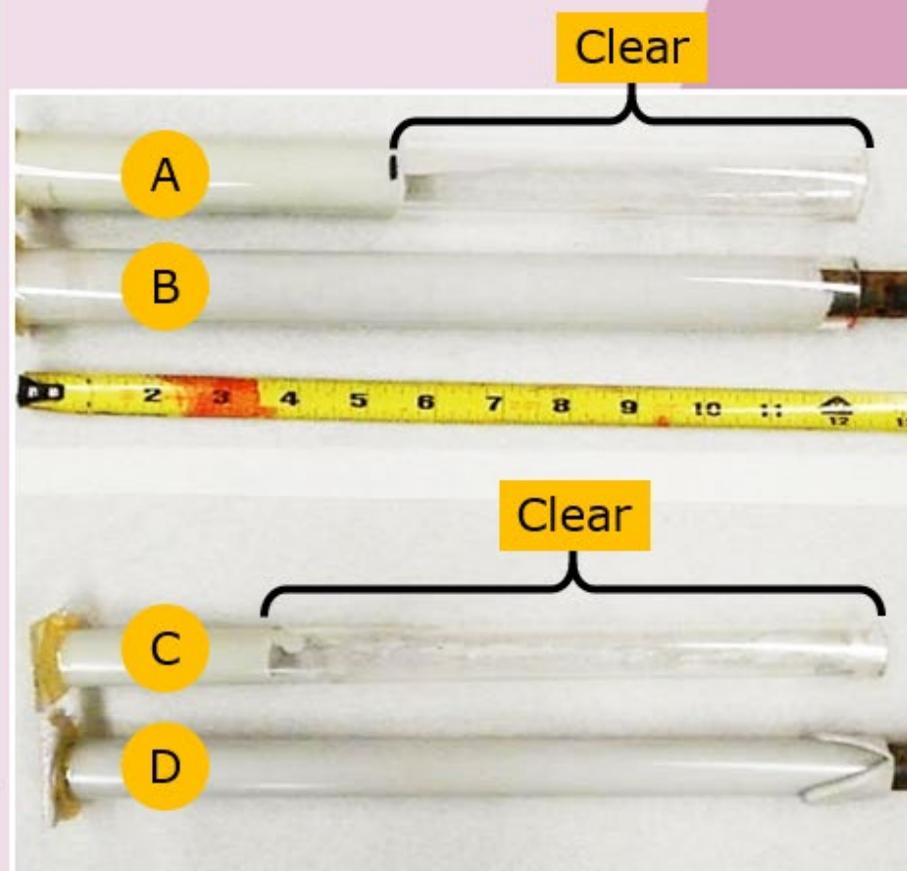
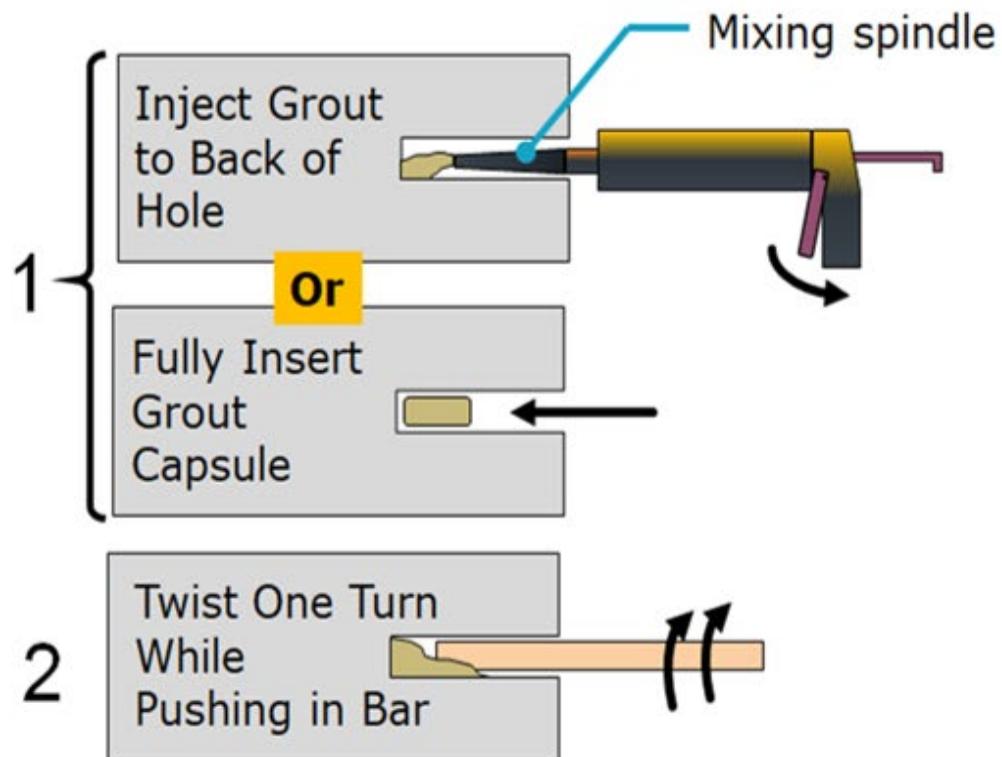


Mix and Place Bar Anchoring Materials

- Vital step for quality!
- Follow manufacturer's directions
 - Proportions important
 - Prepackaged materials offer better control than mix-on-site materials
 - Grout capsule
 - Prefabricated cartridge with mixing spindle or injection unit for epoxy
- Determine proper volume to fill gaps



Mixing and Insertion Procedure



Insert Dowels and Tie Bars

- Before inserting, make sure bar is clean of mud and debris
- Optionally add one bead of anchoring material to each side of the bar
- When inserting dowel, twist bar one full revolution to help encasement
- Use mallet to ensure bar is fully inserted (as needed if tight)



Place Grout Retention Disk & Oil Bars

- Place disk over bar before inserting dowel
- Ensure some material is evident through weep hole after bar is inserted
- Alternatively, trowel extra grout around bar at joint face
- Lightly oil protruding end of dowel



Placing and Complete a Full-Depth Repair

**Step 1:
Place Concrete**



**Step 2:
Finish & Texture**



**Step 3:
Cure Concrete**



**Step 4:
Saw & Seal Joints**



Concrete Placement



- **Place from chute to distribute**
- **Keep drop height below 3 feet**
- **Avoid excessive shoveling**
- **Consolidate with spud vibrator**
 - **Stay vertical**
 - **Do not drag through concrete**
 - **Avoid touching dowels or rebar**

Finish and Texture, Finish the Surface



Only use well-maintained equipment

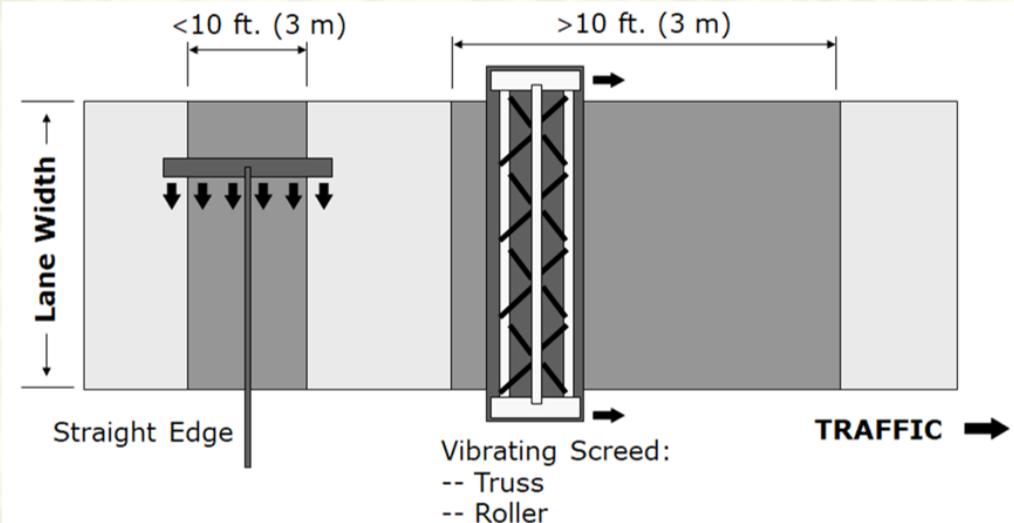
- **Screed should be straight, true**
- **If mechanical, moving parts greased**

Coordinate timing closely with placement

- **Fast-setting mixes less working time**
- **Don't add water to help finishing**

Overlap edge at least 6 to 12 inches with screed

Repeat 2 to 3 times if hand screeding



Using Skid Steer Screed



Texturing Repair Surface

- **Match texture of concrete as close as possible**
- **Practical options (broom, tine)**
- **Consider:**
 - **Direction of texture**
 - **Distance between combs (for tining)**
- **Texture as soon as possible after finishing**
 - **Apply with consistent pressure on tool**



Applying Curing Compound

- Apply soon after final finishing
 - Use power-driven sprayer for even nozzle pressure
 - Apply evenly to the surface at rate of 1 gallon per 200 sq. ft.
 - Clean nozzle periodically
- Cover the repair surface completely
 - Properly applied curing compound should resemble a solid sheet of white paper



GOOD

POOR

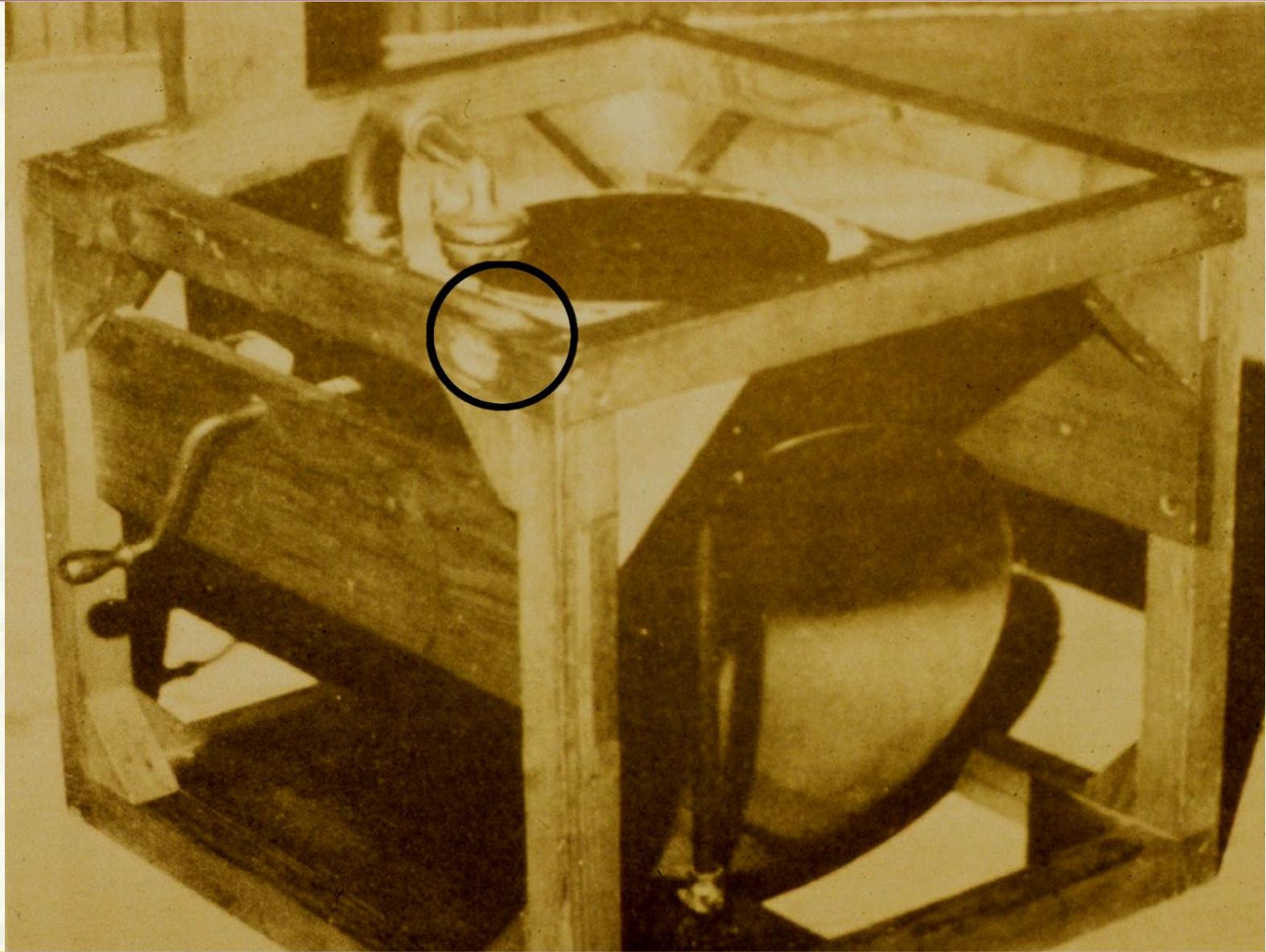
Using Curing Compound



Using Curing Sheets or Mats



Audience Participation Time



Thank You

and

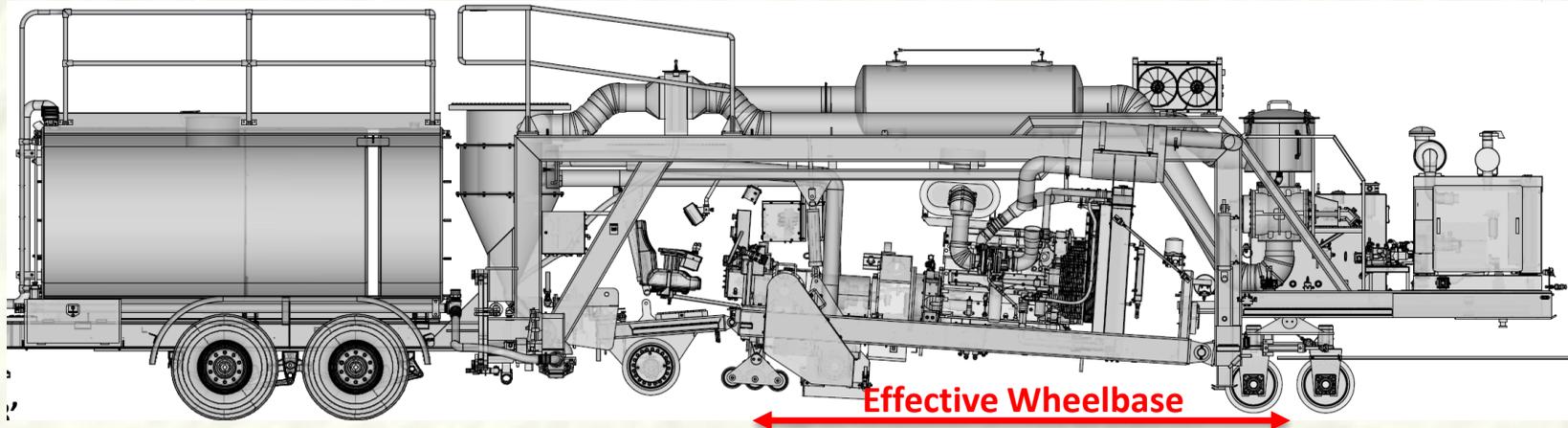
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All Machines are Not Created Equal in Terms of Effective Wheelbase



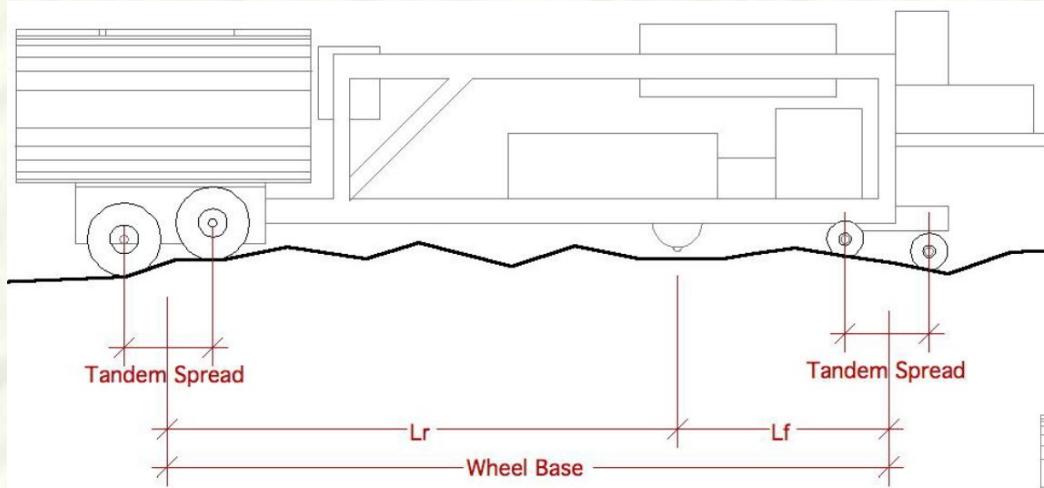
Swing Frame Machines

| Equipmnet Model | Effective Wheel Base |
|---|--------------------------------------|
| PC5000, PC5000B, PC6000, PC6000EC, PC6004EC | 13' 5" Retracted to 17' 11" Extended |
| Target PRM3800, PRM3804 | 12' 5" |

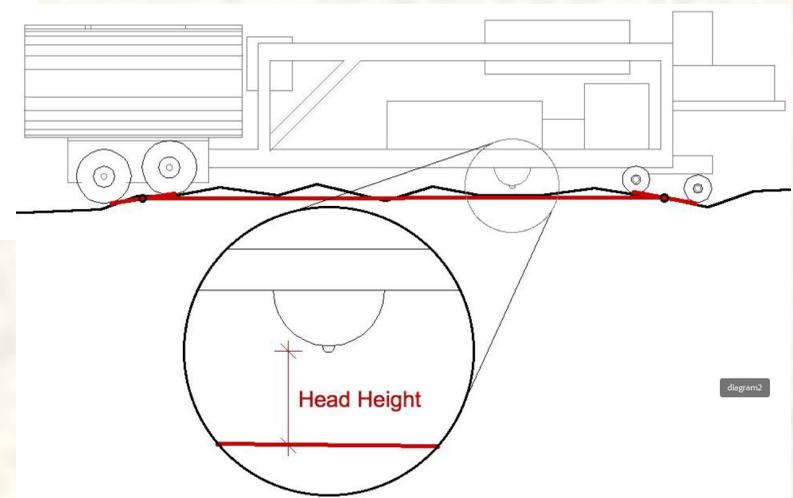
Fixed Frame Machines

| Equipmnet Model | Effective Wheel Base |
|------------------------------------|-------------------------------------|
| PC150, PC1500, PC1504, PC1505XL | 11' 6" Retracted to 13' 5" Extended |
| PenHall G38 | 13' 10" (?) |
| PenHall G50 | 13' 10" (?) |

ProVal Grinder Simulation Model Representations

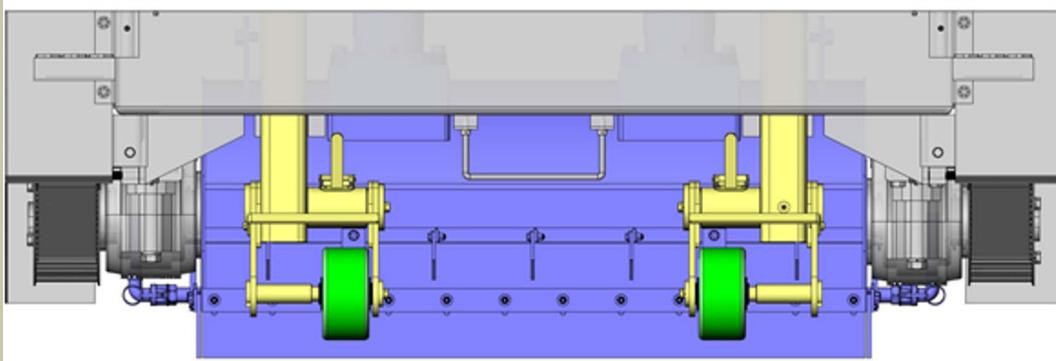


$$\text{Head Position} = L_f / \text{Wheel Base}$$



Depth Control Wheel Assemblies and Positions

Inboard Position



Depth Control Wheel Clamp

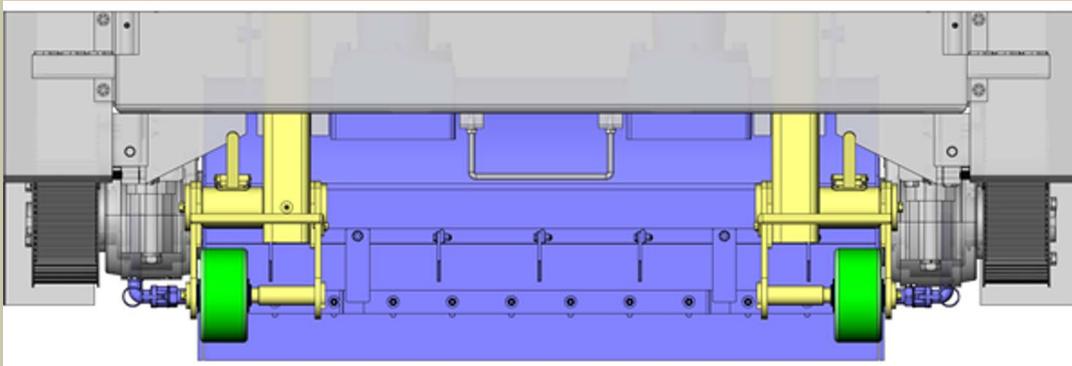


Closed



Open

Outboard Position



Clamp on inboard view above was removed, assembly shifted to outboard position, and is ready for clamp to be re-installed on opposite side of leg brace

Types of Slurry Disposal

Shoulder Disposal



- Most Cost Effective Approach



diamond grinding
SLURRY
handling

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& Grinding Association

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April 2013

Filter Press



- Essentially Squeezes the Water Out to Separate Fines