Joint Sealing and Re-Sealing

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IGGA
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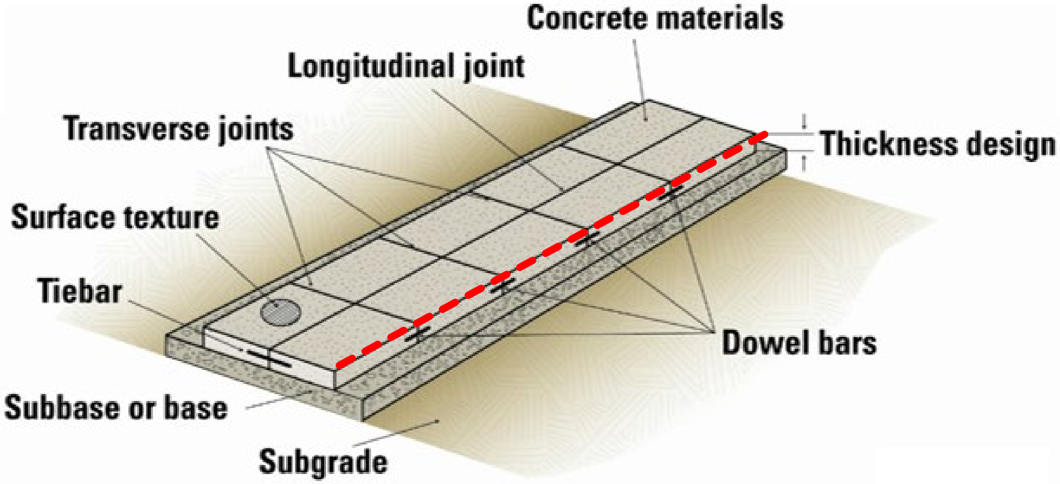
ACPA



Why Do We Make and Seal Joints (Owner)

To Control Cracking

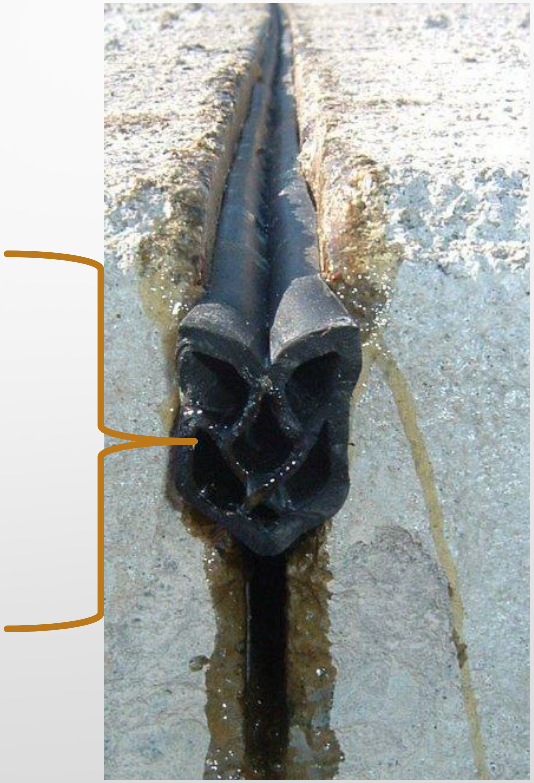
Controlled Cracking

Uncontrolled Cracking

Types of Saw Cuts

Initial Saw Cut

Reservoir Cut



Is Sealant Cost Effective?

FHWA Sealant Effectiveness Study

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.

www.fhwa.dot.gov/pavement/concrete

U.S. Department of Transportation
Federal Highway Administration

Performance of Sealed and Unsealed Concrete Pavement Joint:

This TechBrief presents the results of a nationwide study of the effects of transvers joint sealing on performance of jointed plain concrete pavement (JPCP). This stud 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 seal ing projects located in 11 states. Performance of the pavement test sections with unsealed joints was compared with the performance of pavement test sections w one or more types of sealed joints.

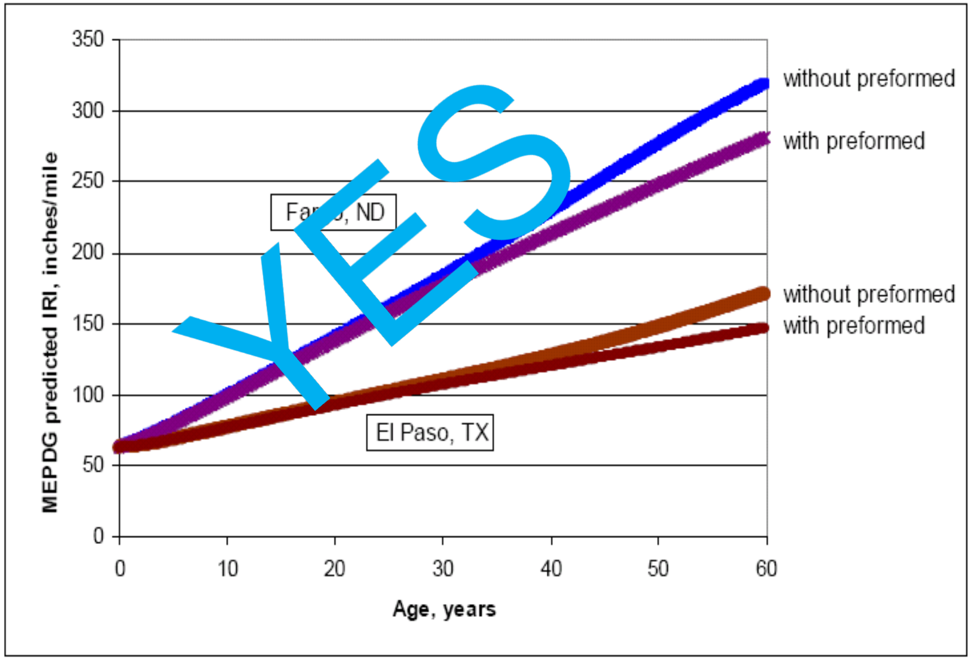
BACKGROUN

The sealing ... transverse ... traction joints in JPCP has been standard pr tice throu... ...out much of the ... ...ited States for many years. Its widespread is due to ... common belief t... sealing joints improves concrete pavem ...rforma... in two ways: by ...ucing water infiltration into the pavem ...cture, t... ...by reducing th... ...ccurrence of moisture-related distresses su as p... ...ping ... faulting, ... by preventing the infiltration of incompre ibles (... sand an... ...stones) into the joints, thereby reducing the lik hood of p... ...ure-related joint distresses such as joint spalling and blowup ... ...oints in jointed concrete pavement (JCP) are typically crea by making a... ...nitial saw cut to force controlled cracking, followed by a s ond, wider saw cut to produce a reservoir for the joint sealant material. T ...ditional approach of sawing and sealing transverse contraction joint e...mated to account for between 2 and 7 percent of the initial construct cost of a JCP. Moreover, these sealed transverse joints require resealing o or more times over the service life of the pavement, leading to additio costs in terms of labor, materials, operations, and lane closures.

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

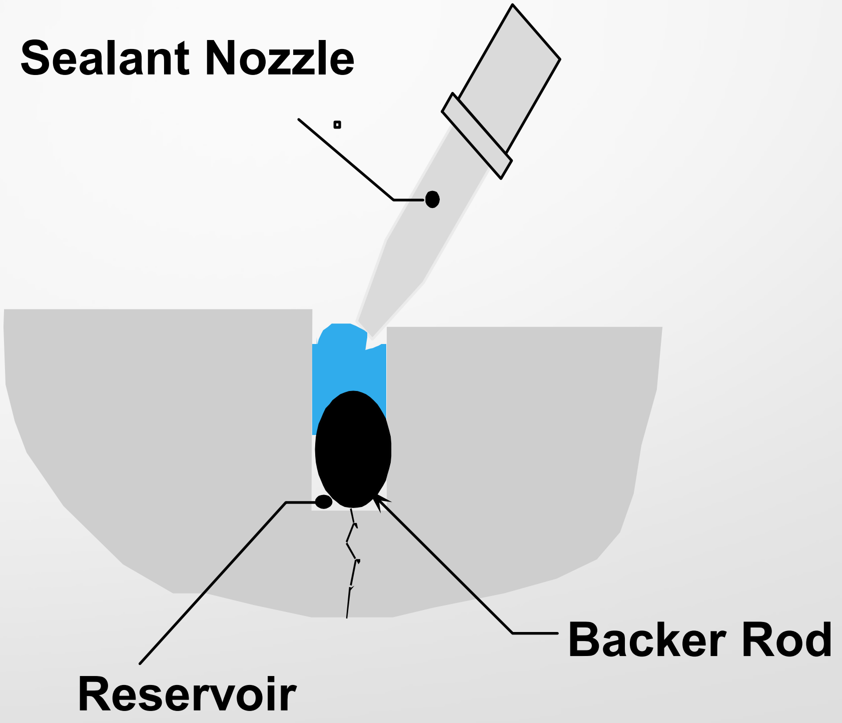
- Narrow unsealed joints, consisting of single saw cuts that are left unsealed.
- Narrow filled joints, consisting of single saw cuts that are filled with sealant that adheres to the sides and bottom of the saw cut.
- Narrow sealed joints, consisting of single saw cuts that contain a narrow backer rod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

AASHTO New Design Guide



Reasons for Joint Sealing

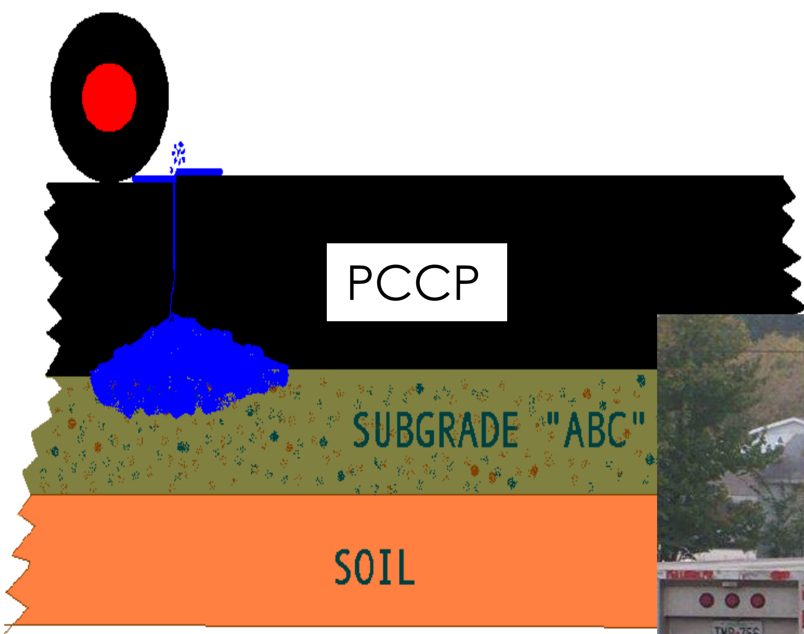
- Minimizes water & incompressibles into pavement system
- Reduces subgrade softening, pumping and erosion of fines and spalling
- Prevents Joint Associated Distress?
- Reduces Noise (Joint Slap)



Why Seal Joints and Cracks

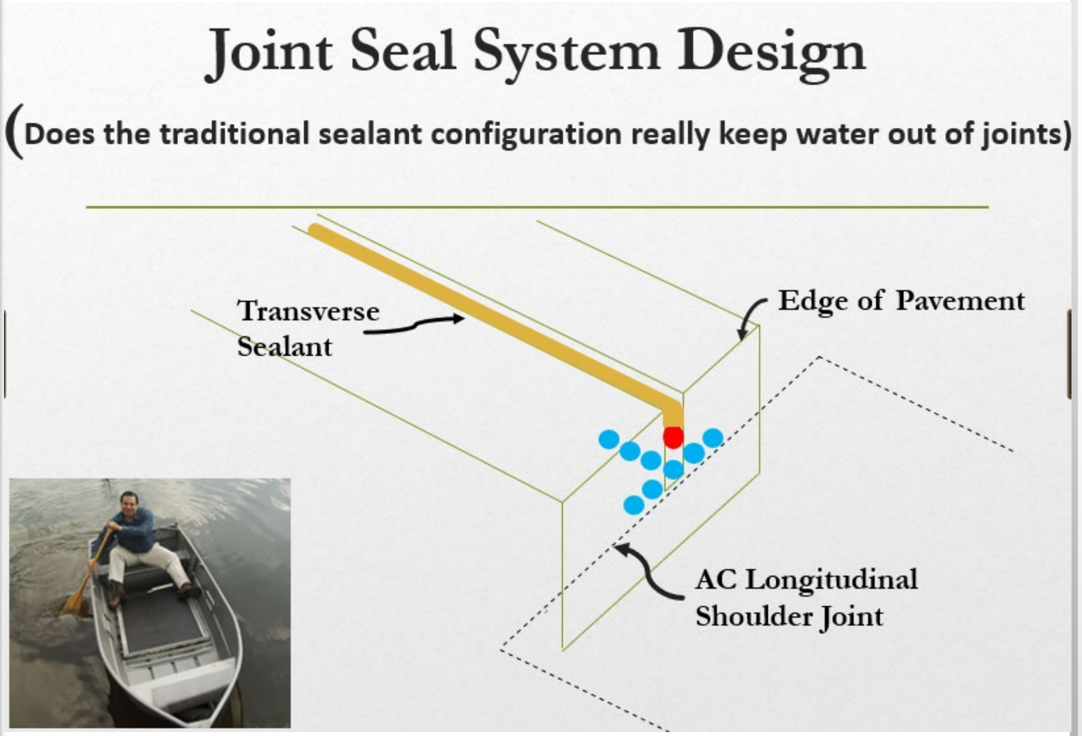
Prevents Incompressible from Lodging in the Joint — Slab Growth and Blow Ups

Why Seal Joints and Cracks



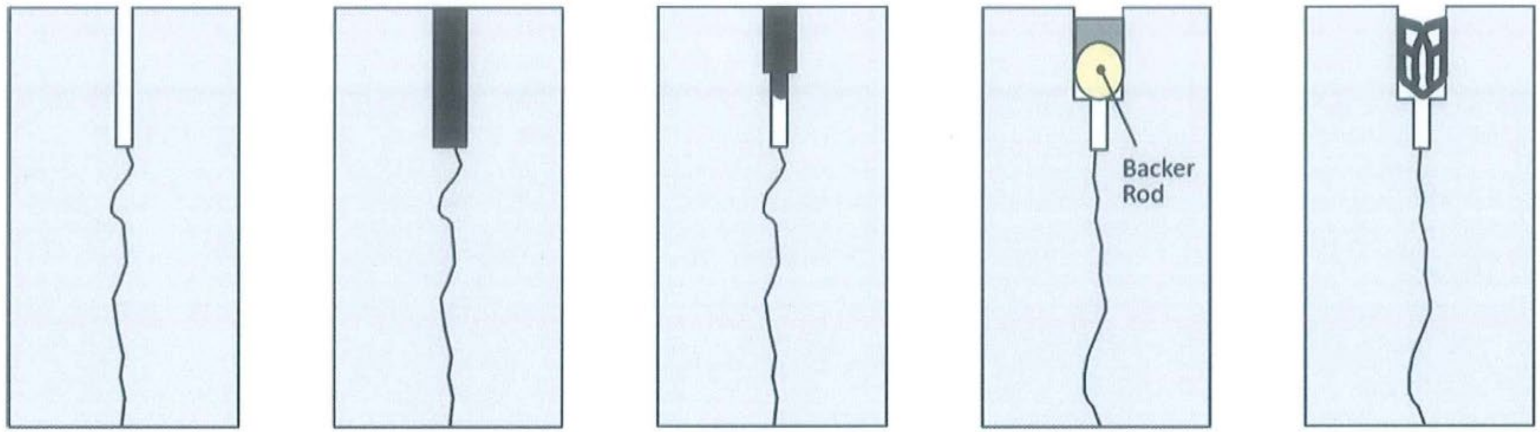
Prevents Water from Entering the Subgrade:

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



How Do You Design the Joint Sealant System (Owner)

Reservoir Design and Cutting



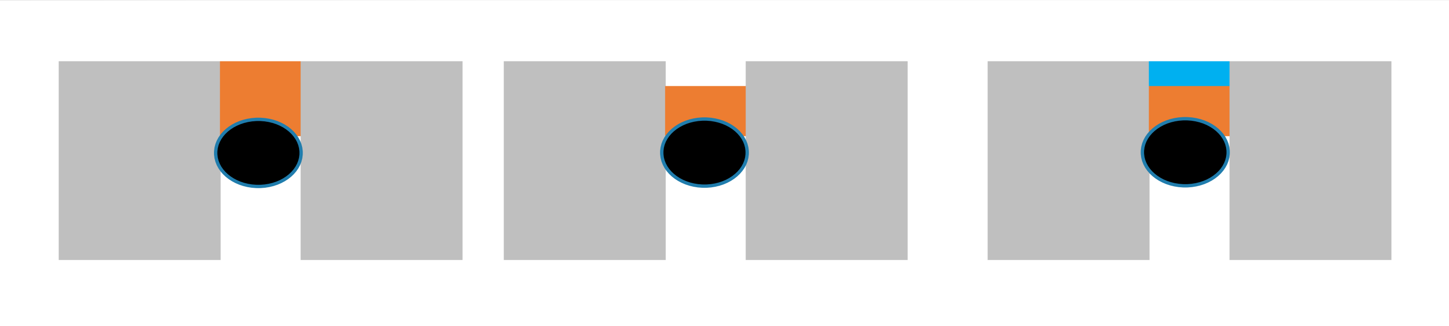
Unfilled (open) | Filled (in single saw cut) | Filled (in reservoir cut) | Sealed (in reservoir cut) | Compression Seal (in reservoir cut)

How Does Vertical Load Impact Sealant Performance

Good for Hot Pour
Bad For Silicone

Good for Silicone
OK For Hot Pour

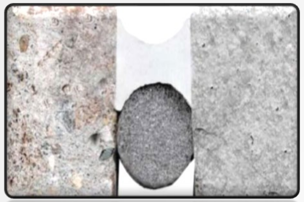
Bad For Silicone

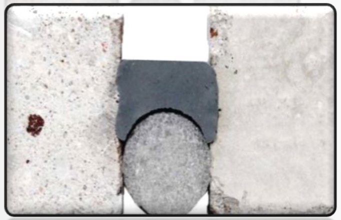


Ton, E., "Factors in Joint Seal Design, "Highway Research Record No. 80, Highway Research Board, National Research Council, 1965

Sealant Types

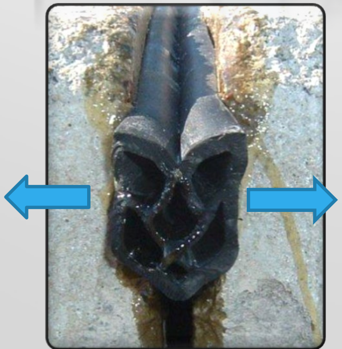
- Silicone
  - Non Sag
  - Self Leveling
  - Rapid Cure





- Hot Pour
  - Standard Modulus
  - Low Modulus

- Compression Seal



Allowable Joint Opening Movements (Compression/Extension)

- Hot Pour Sealants: 25% Extension
- Silicone Sealants: 50% Compression to 100% Extension
- Compression Seals: 15% min Compression to 50% Extension

Manufacturer Design Tables
Silicone and Compression Seal

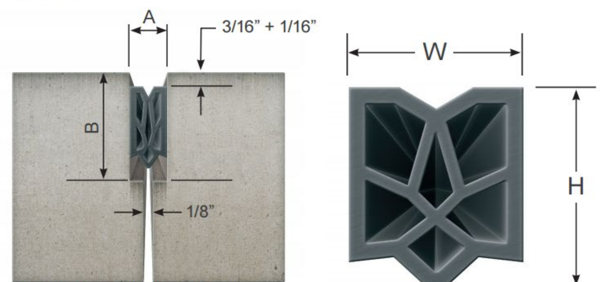
*Joint Width	1/4”	3/8”	1/2”	5/8”	3/4”	7/8”	1”	1 1/8”	1 1/4”	1 3/8”	1 1/2”
Minimum Sealant Recess	1/4”	1/4”	5/16”	5/16”	3/8”	3/8”	3/8”	1/2”	1/2”	1/2”	1/2”
Backer Rod Diameter [1]	3/8”	1/2”	5/8”	3/4”							
Sealant Bead Thickness	1/4”	1/4”	1/4”	5/16’							
Minimum Joint Saw/Reservoir Depth	1 1/8”	1 1/4”	1 1/2”	1 3/4							
Minimum Backer Rod Depth	1/2”	1/2”	5/8”	11/16							
Estimated Usage Non-Sag	245	149	112	70							
Estimated Usage Self-leveling(ft./gal)	273	172	130	82							

Meeting Specifications

Delastic® Preformed Pavement Seals meet ASTM standard specifications. They are also recognized by the FHWA, U.S. Army Corps of Engineers, the U.S. Air Force, the FAA, consulting engineers and other agencies as an effective, long-lasting concrete pavement joint seal solution.

Delastic® Preformed Pavement Seals have been successfully used on high performance concrete pavements throughout the U.S. Many of these installations have protected pavements located in extreme hot and cold climates in excess of 20 years.

Airports, including military bases all over the world rely on Delastic® Preformed Pavement Seals.



Typical joint design for the “E” and “V” series pavement seals

40-year-old Preformed Compression Seal at DFW Airport.

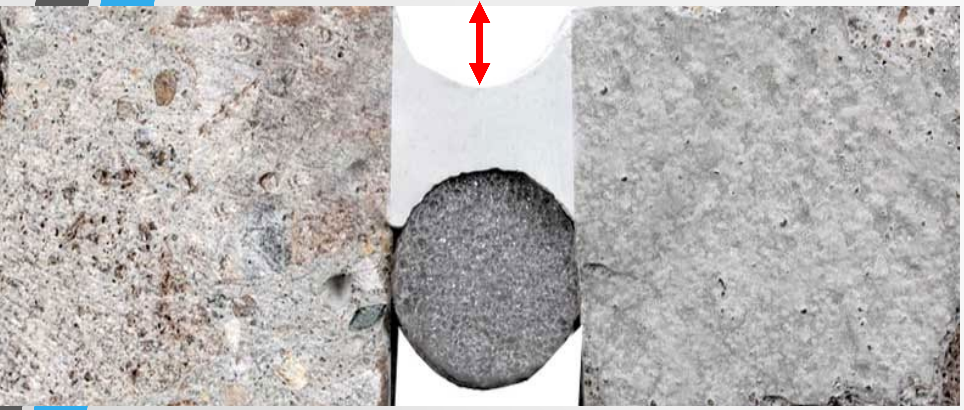
Delastic® Preformed Pavement Seal Characteristics

Delastic® Seal Catalog No.	Seal Characteristics			Joint Design Criteria			Typical Installed Width (A)**
	Nominal Width (W)	Nominal Height (H)	Max. Movement [1]	Narrowest Opening [2]	Widest Opening [3]	Minimum Depth (B)	
E-437	**0.437** (11.11)	**0.937** (23.81)	**0.153** (3.88)	**0.219** (5.56)	**0.372** (9.45)	**1.000** (25.40)	**0.250** (6.35)
E-562	**0.562** (14.29)	**0.625** (15.88)	**0.188** (4.78)	**0.290** (7.37)	**0.478** (12.14)	**1.063** (27.00)	**0.3125** (7.94)
E-686	**0.687** (17.46)	**0.687** (17.46)	**0.259** (6.59)	**0.325** (8.26)	**0.584** (14.84)	**1.188** (30.18)	**0.375** (9.53)
E-816	**0.812** (20.64)	**0.830** (21.08)	**0.313** (7.95)	**0.378** (9.59)	**0.691** (17.54)	**1.438** (36.53)	**0.500** (12.70)
E-1006	**1.000** (25.40)	**1.000** (25.40)	**0.450** (11.43)	**0.400** (10.16)	**0.850** (21.59)	**1.625** (41.28)	**0.500-0.5625** (12.70-14.29)
E-1256	**1.250** (31.75)	**1.000** (25.40)	**0.563** (14.30)	**0.500** (12.69)	**1.063** (26.99)	**1.875** (47.63)	**0.750** (19.05)
V-1625	**1.625** (41.28)	**1.125** (28.58)	**0.631** (16.03)	**0.750** (19.05)	**1.381** (35.08)	**2.250** (57.15)	**0.875** (22.23)
E-2000	**2.000** (50.80)	**1.500** (38.10)	**0.950** (24.13)	**0.750** (19.05)	**1.700** (43.18)	**2.500** (63.50)	**1.125** (28.58)
E-2500	**2.500** (63.50)	**2.500** (63.50)	**1.125** (28.58)	**1.000** (25.40)	**2.125** (53.98)	**3.375** (85.73)	**1.375** (34.93)
E-3000	**3.000** (76.20)	**2.500** (63.50)	**1.550** (39.37)	**1.000** (25.40)	**2.550** (64.77)	**4.000** (101.60)	**1.750** (44.45)

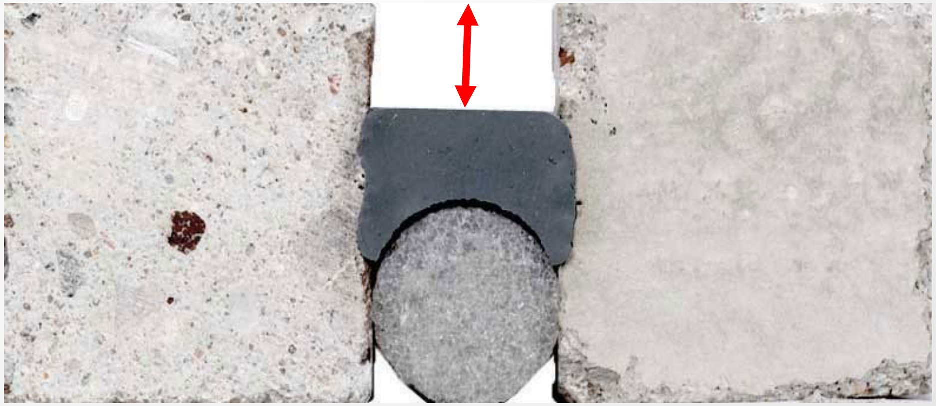
***Above:** First number shown in bold represents inches, metric dimensions (mm) are shown in parentheses. Notes:*Thickness of the seal wall and internal web are not drawn to scale. 1 Maximum movement which seal will accommodate in joint with correct design. 2 A narrower opening will place excessive stress on the seal and may cause premature failure. 3 A wider opening may not provide sufficient compressive force to hold the seal in place.** To be used as reference only. Installed width may vary by project.*

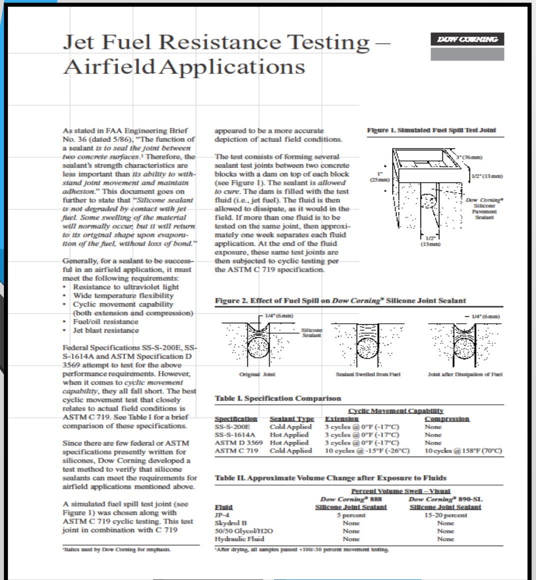
Silicone Joint Sealant Configuration

Non-Sag



Self-Leveling





Jet Fuel Resistance Testing – Airfield Applications

DOW 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*.[1] 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 jet 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-S-200E, SS-S-1614A 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.

[1]Italics used by Dow Corning for emphasis.

Figure 1. Simulated Fuel Spill Test Joint

3" (76mm)
1/2" (13mm)
1" (25mm)
Dow Corning® Silicone Pavement Sealant
1/2" (13mm)

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

1/4" (6mm)
Silicone Sealant
Original Joint
Sealant Swelled from Fuel
1/4" (6mm)
Joint after Dissipation of Fuel

Table I. Specification Comparison

		Cyclic Movement Capability	
Specification	Sealant Type	Extension	Compression
SS-S-200E	Cold Applied	3 cycles @ 0°F (-17°C)	None
SS-S-1614A	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 @ 158°F (70°C)

Table II. Approximate Volume Change after Exposure to Fluids

	Percent Volume Swell – Visual	
Fluid	*Dow Corning*® 888 Silicone Joint Sealant	*Dow Corning*® 890-SL Silicone Joint Sealant
JP-4	5 percent	15-20 percent
Skydrol B	None	None
50/50 Glycol/H2O	None	None
Hydraulic Fluid	None	None

[1]After drying, all samples passed +100/-50 percent movement testing.

1. Recess min 1/4"- 3/8" Below Surface
2. 2 to 1 Ratio
3. Tooling Required

Hot Pour Joint Sealant Configuration

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

Flush Filled | **Recessed** | **Flush Filled**

Shipping And Storing Materials (Contractor)

Asphalt Hot Pour Joint/crack Sealants

- ASTM D-6690:

  Type I - ASTM D1190

  Type II - ASTM D3405

  Type III – Low Modulus

  Type IV - Fed Spec SS-S-1401C

  FAA P 605-ASTM D-6690

  State Specifications

SILICONE PACKAGING

- Drums-50 gals of Material
- 5 Gallon Pails
- 29 oz. Tubes (6 per case)
- Store out of direct sun

Do not store in freezing

temperatures or above 90˚F.

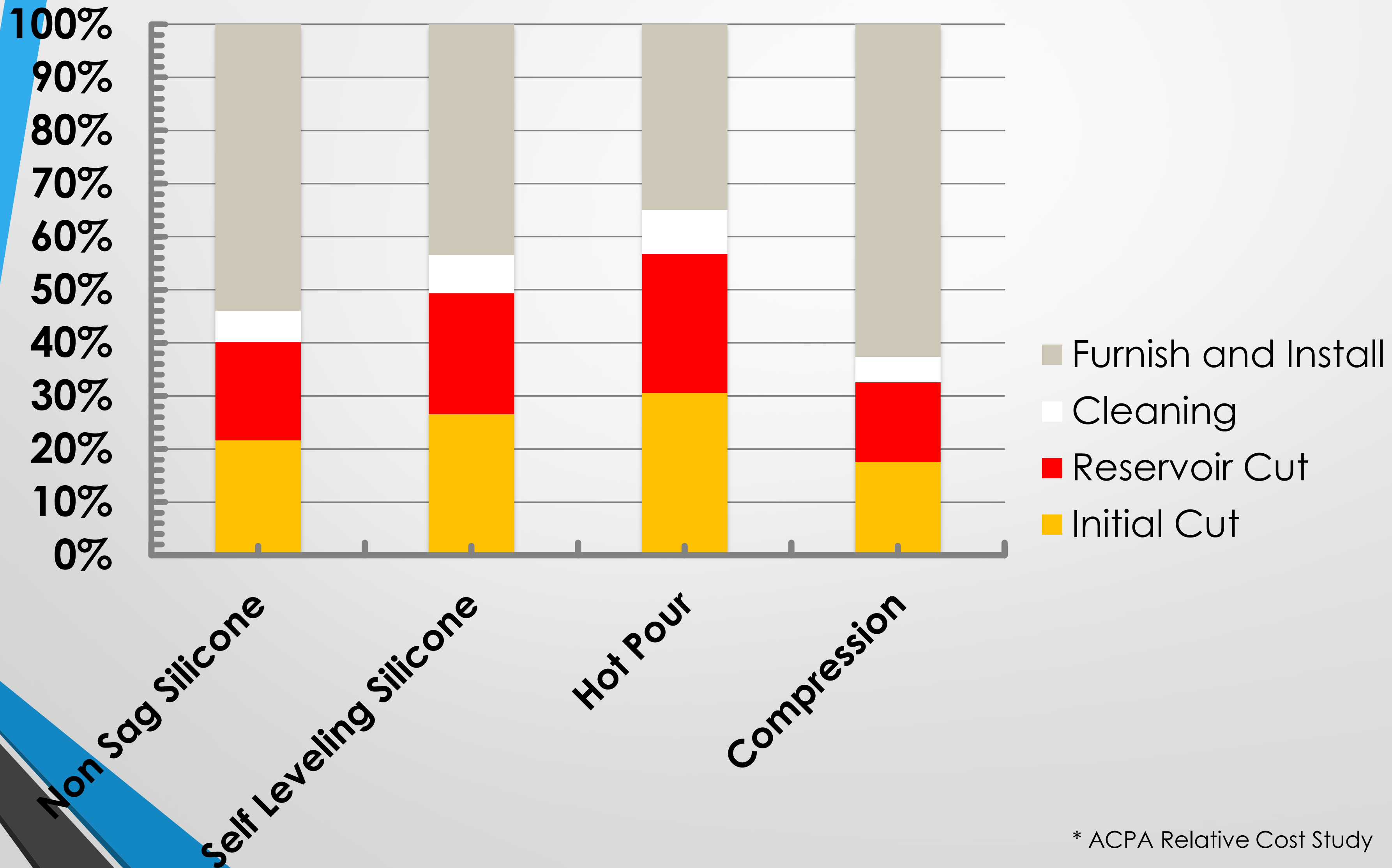
Keep out of excessive humidity

How Are Materials Tested?

- **Certification**
- **Owner Laboratory**
- **Outsourced Testing**

Joint Sealant Installation (Contractor)

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



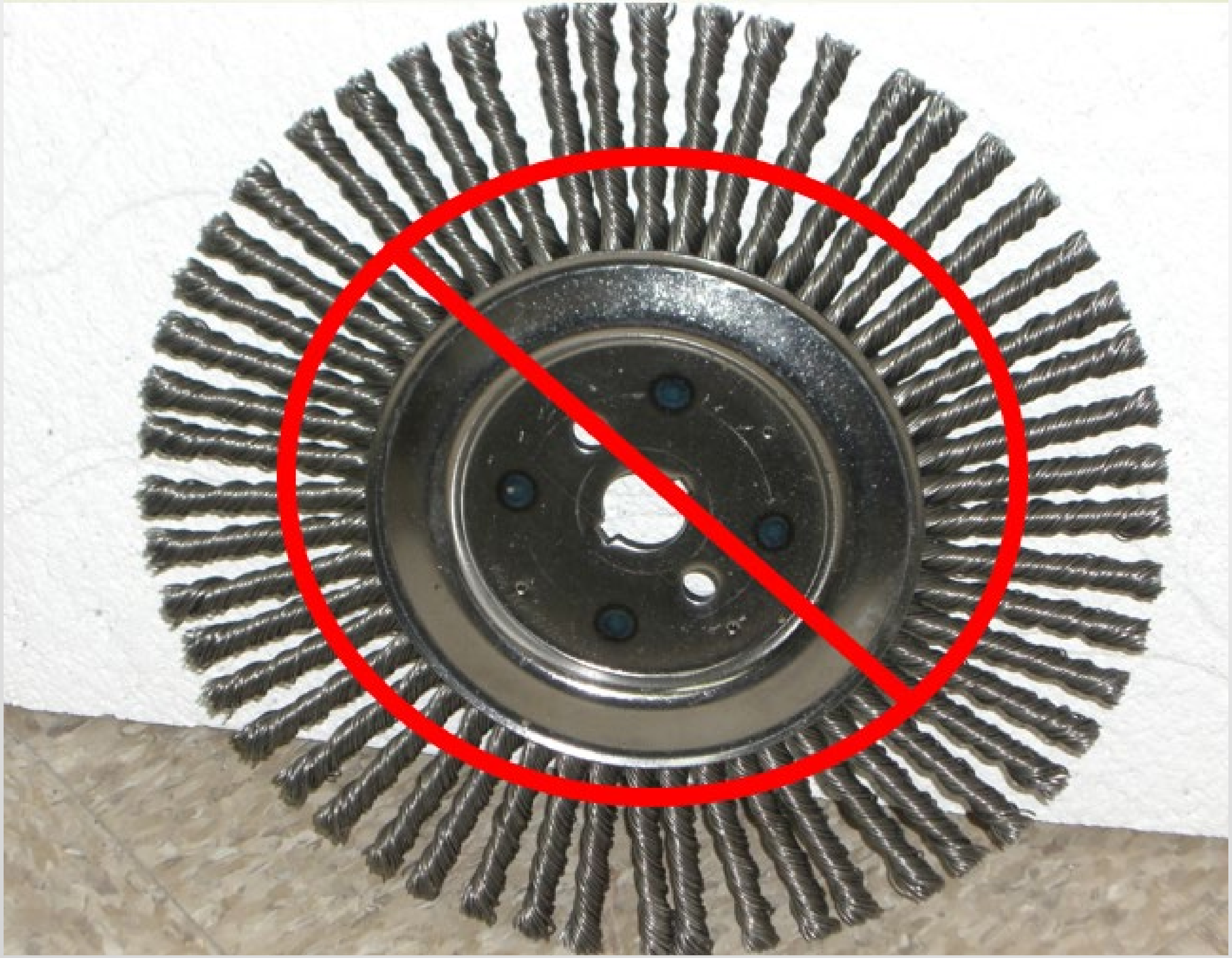
* ACPA Relative Cost Study

Power Washing After Green Sawing

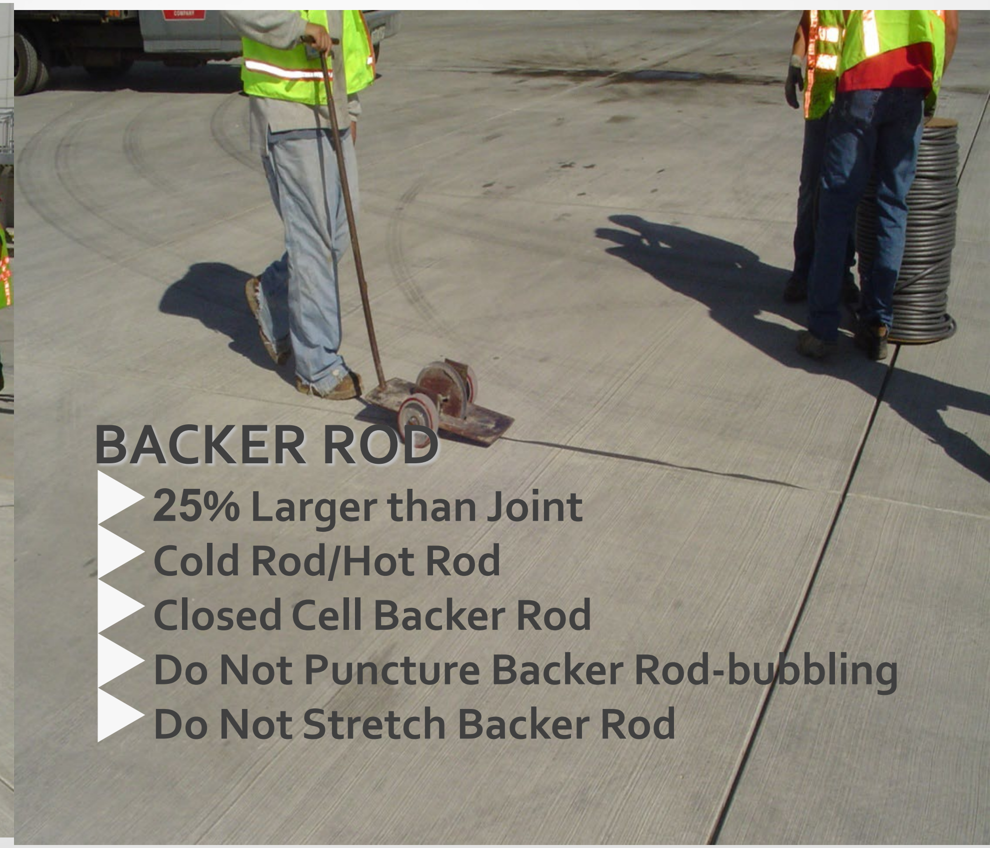
Media Blasting

Personal Protective Equipment

No Cleaning Brushes!



Inserting and Rolling Backer Rod

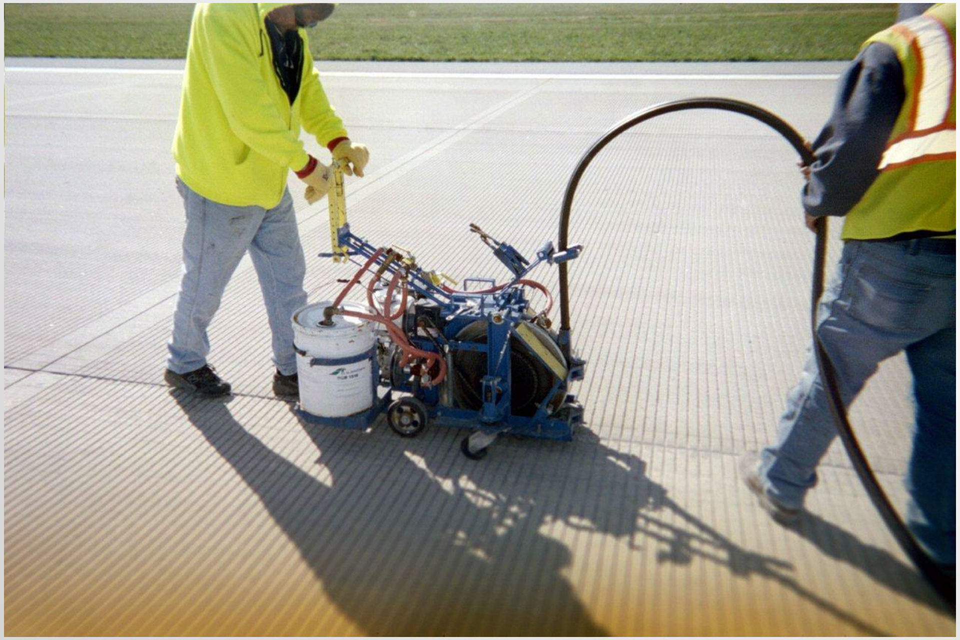


BACKER ROD

- 25% Larger than Joint
- Cold Rod/Hot Rod
- Closed Cell Backer Rod
- Do Not Puncture Backer Rod-bubbling
- Do Not Stretch Backer Rod

Installing Sealant

Compression Seal Installation



- Lubricant-Adhesive shall meet ASTM D2835
- Installation Above 32 F
- Install Sealant in Longitudinal Joint First
- Cut Longitudinal Joint in Center of Each Transverse Joint
- Install Transverse Joint Continuously Across
- Sealant Stretch Should be Less than 4 %
- Recess Sealant 3/16”

Sealant Acceptance (Owner)

Defining Sealant Life

LTPP Pavement Maintenance Materials: SHRP Joint Reseal Experiment, Final Report

PUBLICATION NO. FHWA-RD-99-142 SEPTEMBER 199

Crafco 221 = 5.4 – 9.8 yrs
Crafco 231 = 6.4 – 9.5 yrs
Dow 888 SL = 12.8 yrs
Dow 888 = 13.9

232% to 348% Increase for Silicone

U.S. Department of Transportation
Federal Highway Administration

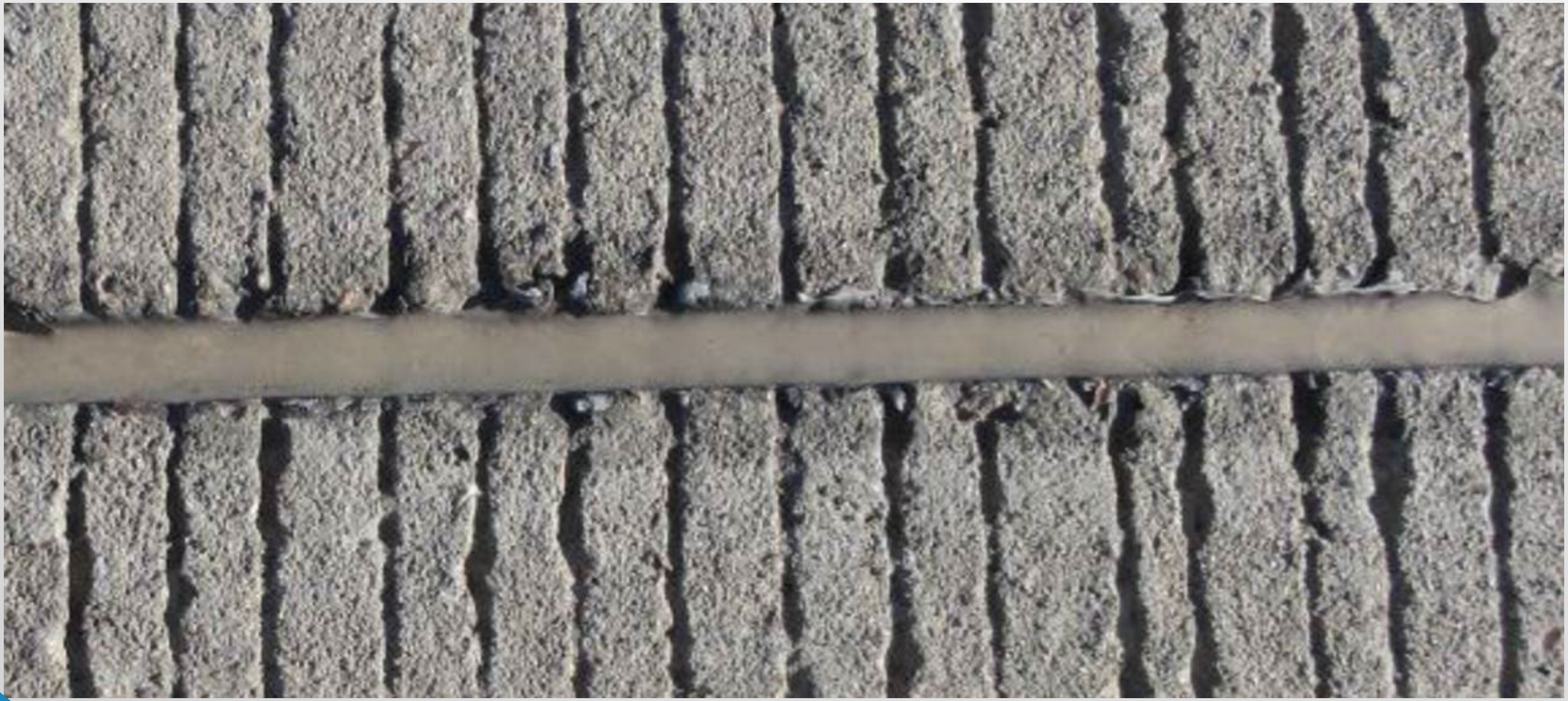
Research, Development, and Technology
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, VA 22101-2296

LTPP

Sealant Material	Configuration	Time at Which 75% Effectiveness Level Was Reached, months *					
		Arizona	Colorado	Iowa	Kentucky	South Carolina	Average
Koch 9005	1	116	66	94	156	63	99
	2	112	66	91	191	90	110
	3			148	182	49	126
	4	105	61				83
Crafco RS 231	1	52	80	76	86	92	77
	2	135	69	118	108	138	114
	3			103	155	80	113
	4	83	72				78
Meadows Sof-Seal	1		34	40	39	55	42
	2		40	51	64	46	50
	3			57	161	31	83
	4		43				43
Koch 9030	1		31	50	60	41	46
	2		32	63	50	58	51
	3			59	143	15	72
	4		37				37
Meadows Hi-Spec	1	43					43
	2	94					94
	4	76					76
Crafco RS 221	1	65					65
	2	105					105
	4	117					117
Dow 888	1	198	145	130	186	178	167
Dow 888-SL	1	183	110	125	164	186	154
Mobay 960-SL	1	194	93	65	115	168	127
Mobay 960	1			143			143
Crafco 903-SL	1	194					194
Koch 9050	1		19		136		78
Dow 888 w/ primer	1			151			151
Dow 888-SL w/ primer	1			143			143
Koch 9005 w/primer	1				173		173

* Times greater than 82 months are extrapolated to a maximum of 200 months.

Arizona SPS-2 Silicone Sealant Life



Arizona Sealant Performance

SPS-2 I-10

Technical Memorandum

Arizona SPS-2 PCC Joint Seal Performance

Overview

The Arizona Special Pavement Studies (SPS) 2 jointed concrete pavement test site, located on eastbound I-10 between mileposts 106 and 109 was constructed in 1993 with 12 LTPP and 9 ADOT test sections. Each test section includes about 33 transverse joints, spaced at 15 ft, which were reportedly sealed using Crafco 34902 non-sag RoadSaver Silicone sealant. Various combinations of base type, concrete strength, slab width, and slab thickness, as shown below, were designed to allow statistical analysis of the contributions of each factor. A March 2013 evaluation of the condition of the joints and seals indicates correlations of base type and Portland cement concrete (PCC) strength with adhesion and sliver spall failures.

Section	Base*	PCC Strength, psi	Slab width, ft	Thickness, in
213	DGAB	550	14	8
214	DGAB	900	12	8
215	DGAB	900	12	11
216	DGAB	900	14	11
217	LCB	550	14	8
218	LCB	900	12	8
219	LCB	550	12	11
220	LCB	900	14	11
221	PB/DG	550	14	8
222	PB/DG	900	12	8
223	PB/DG	550	12	11
224	PB/DG	900	14	11
262	DGAB	550	14	8
263	PB/DG	550	14	11
264	PB/DG	550	12	11

* 6-in dense graded aggregate (DGAB); 4-in PBTB/4-in DGAB (PB/DG); 6-in Lean Concrete (LCB)

Transverse Seal Findings

Overall performance of the SPS-2 joint seal systems is extraordinarily good, considering the seals have been in place for 20 years and the truck lane has carried about 31 million Equivalent Single Axle Loads (ESALs). As figure 1 illustrates, no section exhibits more than 35 percent overall seal failure with six sections remaining below ten percent. Five randomly-selected transverse joints were evaluated in each section.

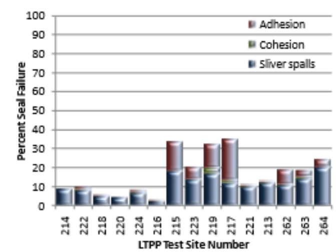


Figure 1. Overall failure rates on transverse joints

Primary modes of failure include sliver spalls and loss of adhesion with the joint walls. Additionally, slight cohesive failure was identified when the installed seal thickness (less than 0.125 in) fell below the design thickness (0.25 in). Full depth sliver spalls, shown in figure 2, typically progress around or through the aggregate adjacent to the joint wall.

These sliver spalls accounted for more than 65 percent of the seal system failures with 2.4 times more failure noted in 550 psi than the 900 psi compressive strength

ARA

SPS-4 US 60

evaluated. Other sealant types, such as the hot-applied seals, that had reached more than 85 percent failure in 2002, were not included in this evaluation). Silicone seal failure modes included full-depth adhesion loss, full-depth sliver spalls (typically less than 1 in long and 0.5 in wide), and occasional full-depth cohesion loss. Several of these failure modes are shown in figure 3. Figure 4 provides a summary of the failure types and amounts noted for each combination of sealant and joint configuration.

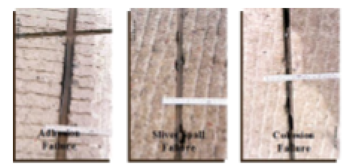


Figure 3. Failure modes of joint seal materials at the Mesa SPS-4 site.

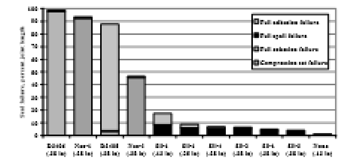


Figure 4. Seal failure levels by type after 15 years.

Statistical Analysis

Using the data collected and assembled, an analysis of variance (ANOVA) was conducted to determine joint seal effectiveness and the effect of sealing on pavement performance by answering the following questions:

- Is there a statistically significant difference in the overall 2006 seal performance? Also, rank the seal/joint configurations combinations evaluated according to their 2006 performance.
- Is there statistically significantly more spalling in the wheelpaths?
- Is spalling statistically greater for the combinations of seal/joint configurations evaluated?
- Is measured faulting significantly influenced by the presence of seals (i.e., no seal, partial, or well sealed joints)?
- Is there a statistically significant difference in faulting when measured 1- or 2.5-ft from the slab edge?

Summary of Results, Conclusions, and Recommendations

Results of the statistical analysis are presented in table 2. Based on the results shown, the following conclusions and recommendations are given for ADOT joint seal design:

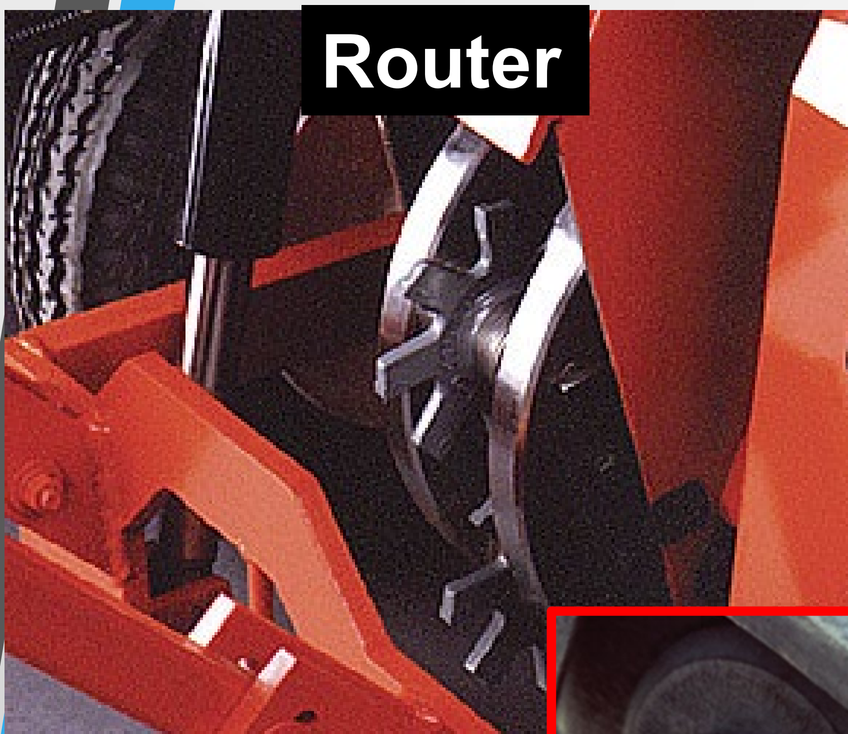
- Overall, silicone sealants (placed using configuration C) had the least amount of adhesion failure, cohesion failure, and sliver spalls. Neoprene sealants (placed using configuration C) had the most distress. Silicone sealants (placed using configurations A & B) experienced moderate levels of distress.
- Statistically significantly more spalling was observed in the wheelpath areas across a joint as compared to the non-wheelpath areas. This observation was true for both sealed (i.e., all joint configurations and sealant types evaluated) and unsealed joints. The level of spalling was, however, low and thus not significant from an engineering point of view.
- In general, joints fully sealed with silicone reported significantly higher levels of spalling (all joint configurations) than the other seal/joint configuration types. The joints with the

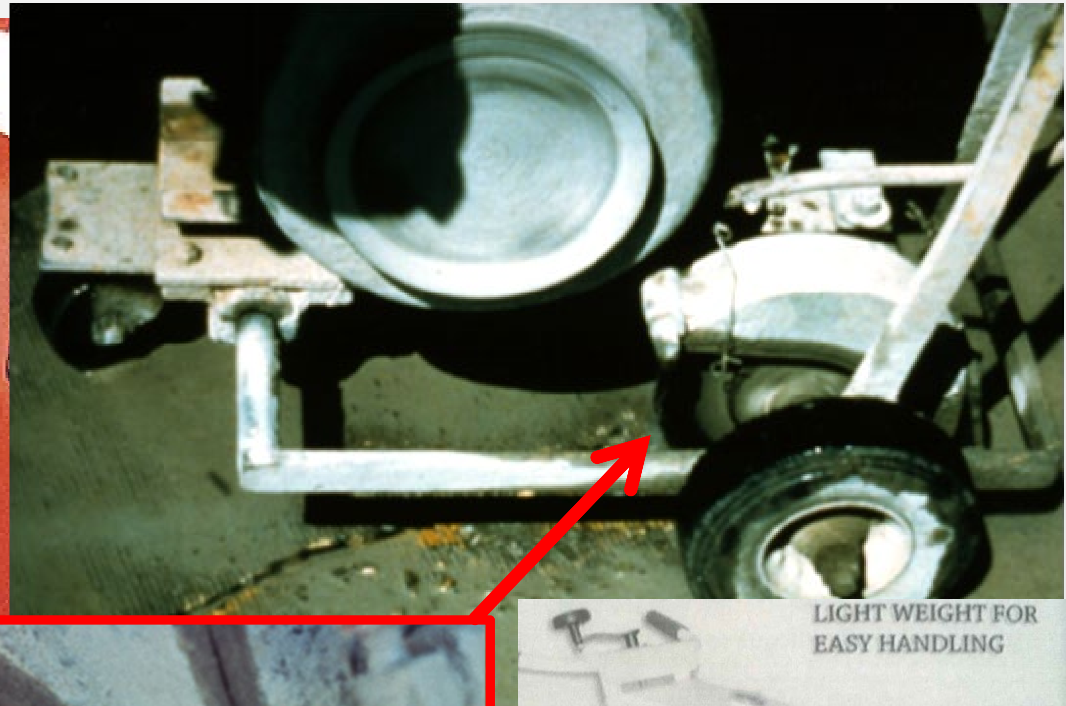
When to Reseal & Sealant Longevity

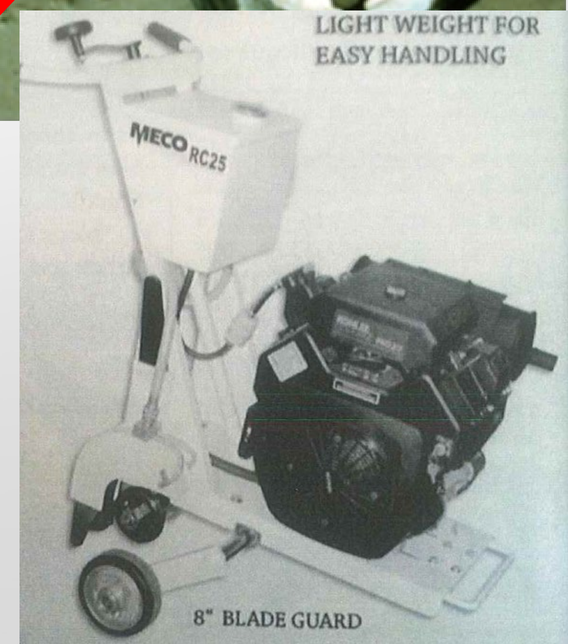
- Adhesive Failures
- Cohesive Failures
- % Damaged or Missing

When the Sealant is No Longer Serving its Intended Function

Crack Chaser Saw







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

NHI Training: Constructing Quality PCC Pavement Preservation Treatments

- How to Construct Durable Full-Depth Repairs in Concrete Pavements (FHWA-NHI-134207A)
- How to Construct Durable Partial-Depth Repairs in Concrete Pavements (FHWA-NHI-134207B)
- Proper Diamond Grinding Techniques for Pavement Preservation (FHWA-NHI-134207C)
- Proper Construction Techniques for Dowel Bar Retrofit (DBR) and Cross-Stitching (FHWA-NHI-134207D)
- Proper Joint Sealing Techniques for Pavement Preservation (FHWA-NHI-134207E)

Questions

Adding Longevity to Concrete Roads

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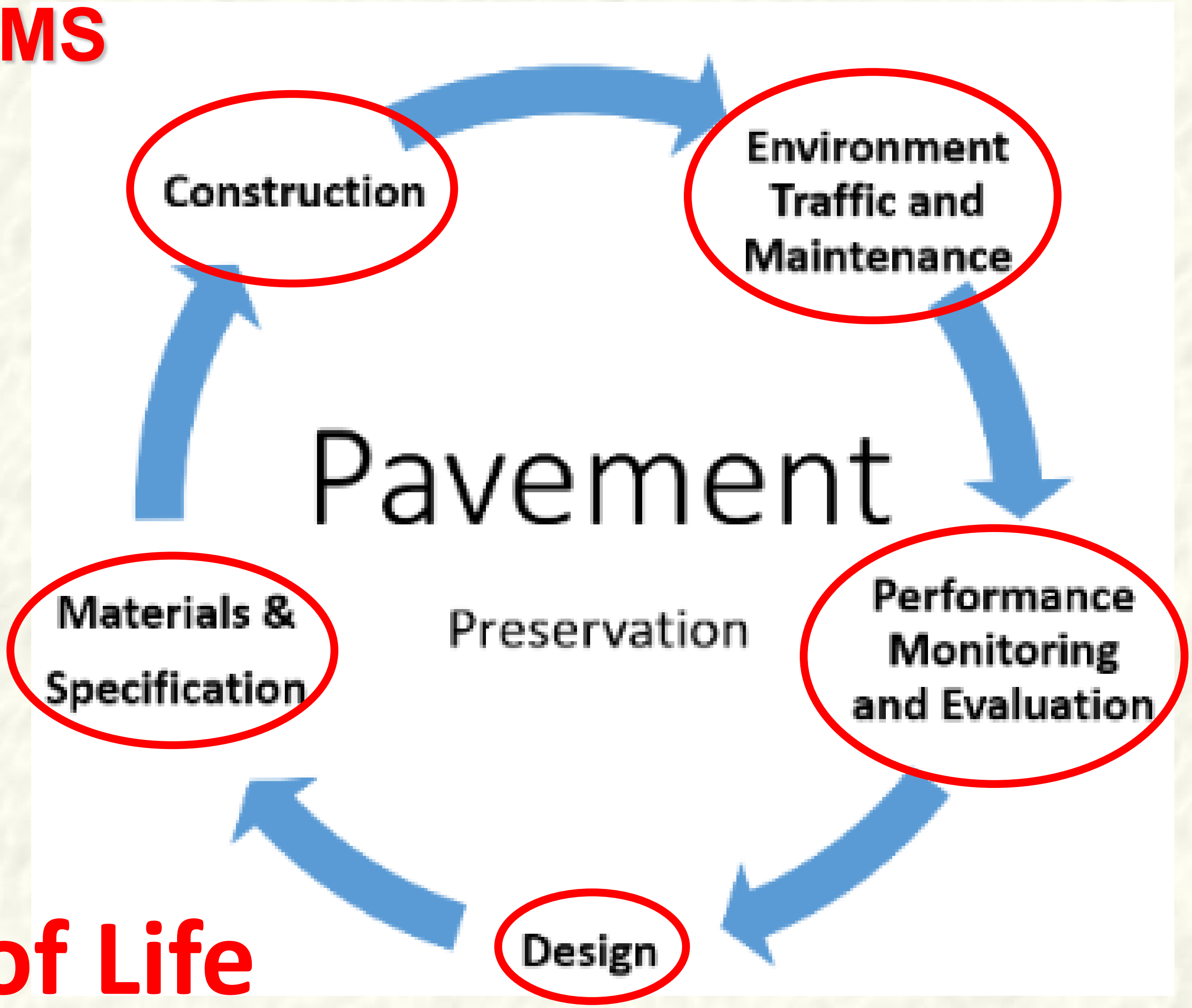
ACPA

Larry Scofield, IGGA/ACPA

3-30-23

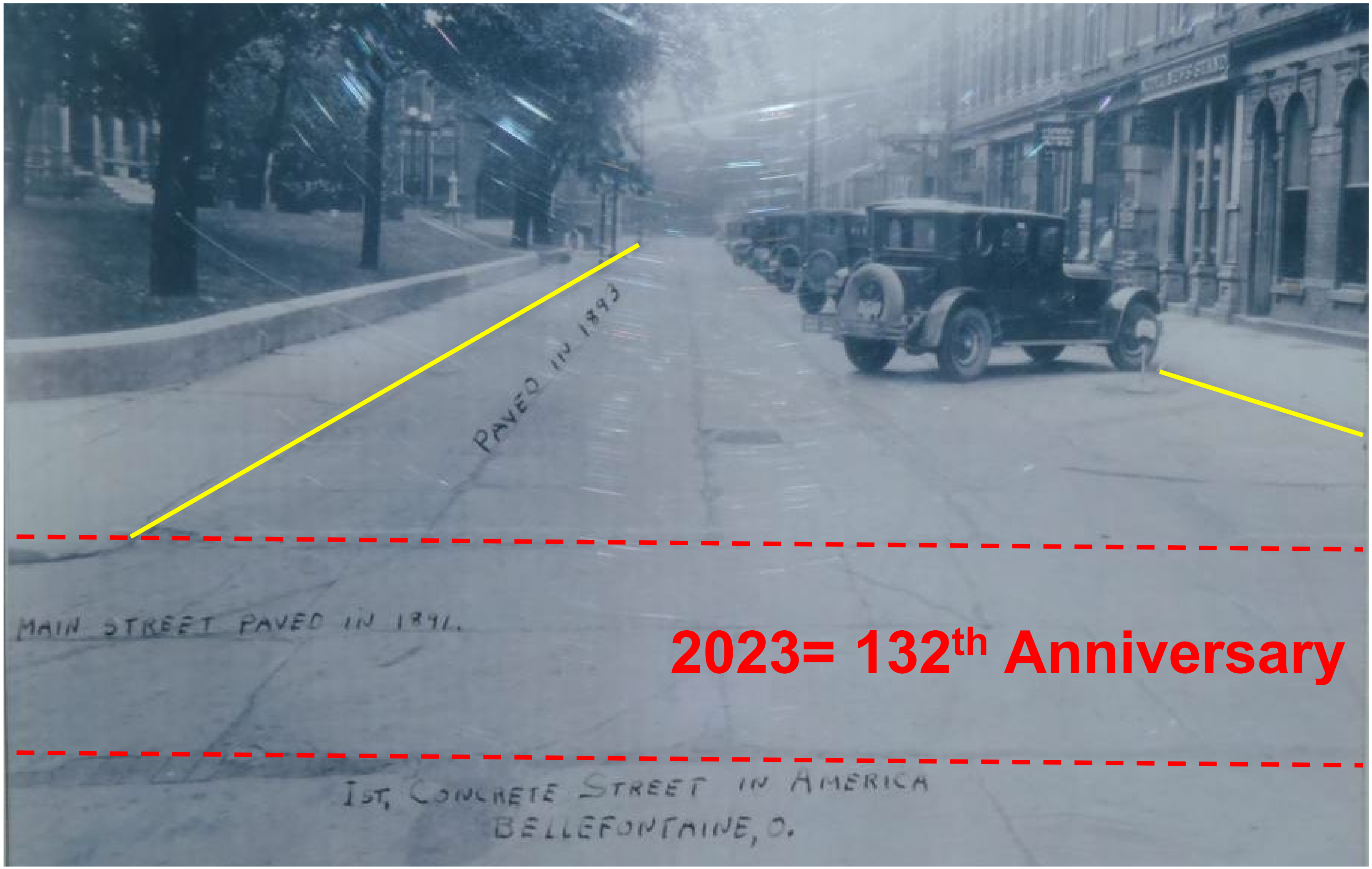
Concrete Pavement Preservation

Original PMS Concept



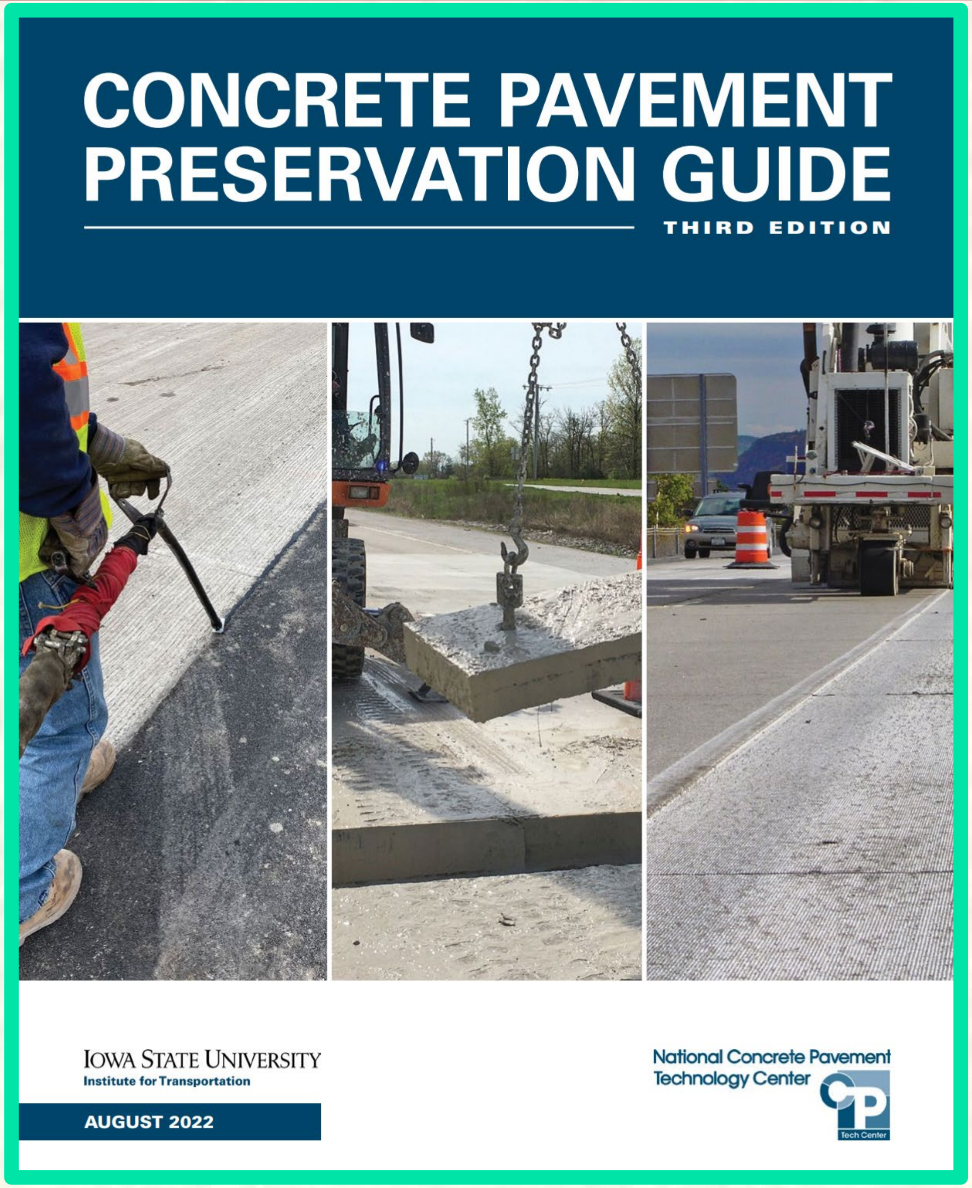
Circle of Life

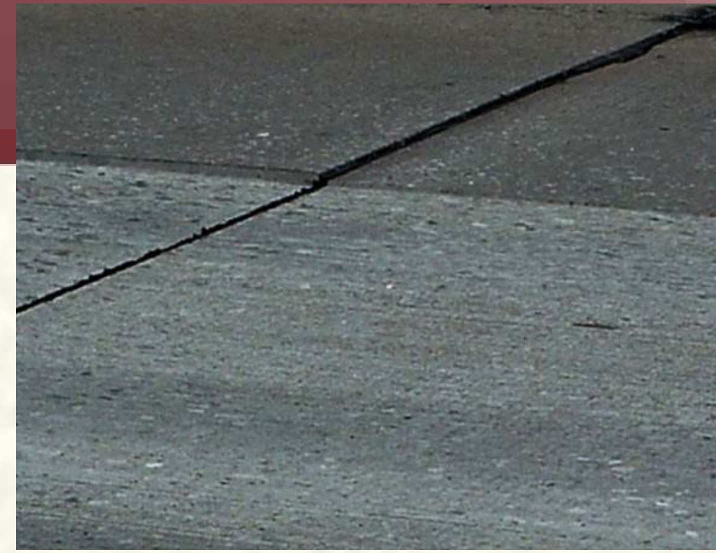
Why Concrete Pavement Preservation
Bellefontaine, Ohio 1925



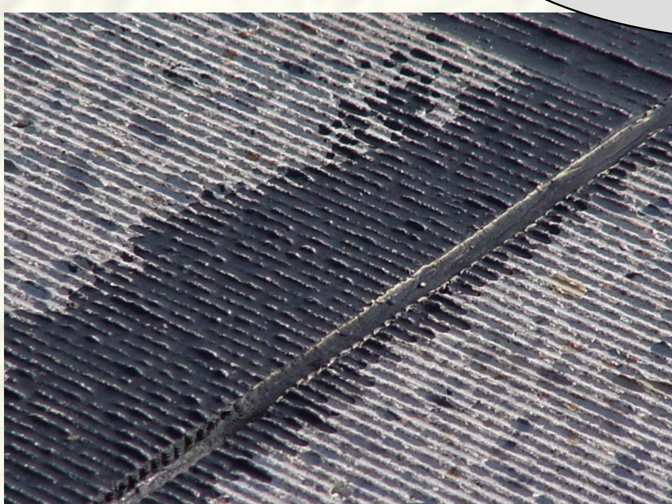
Court Avenue is 130 Years Old

Concrete Pavement Preservation Guide

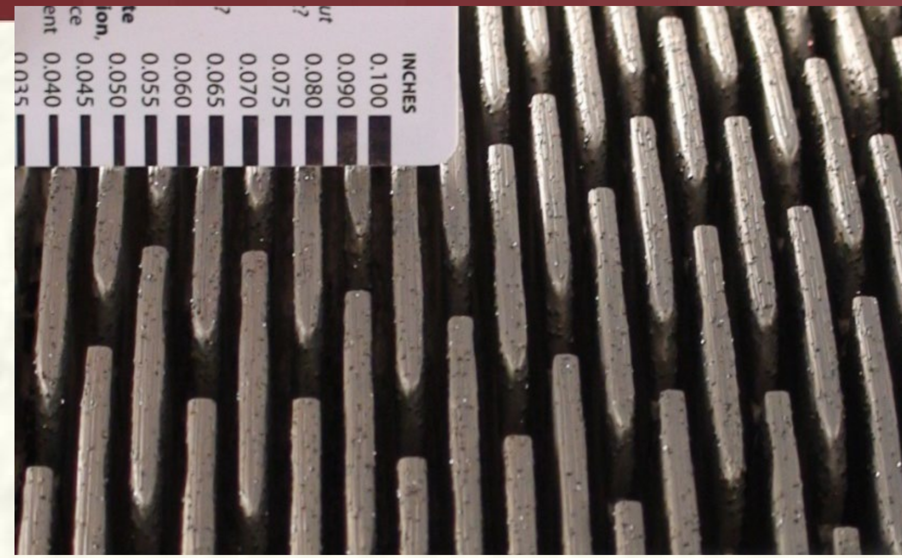




Grinding Concrete

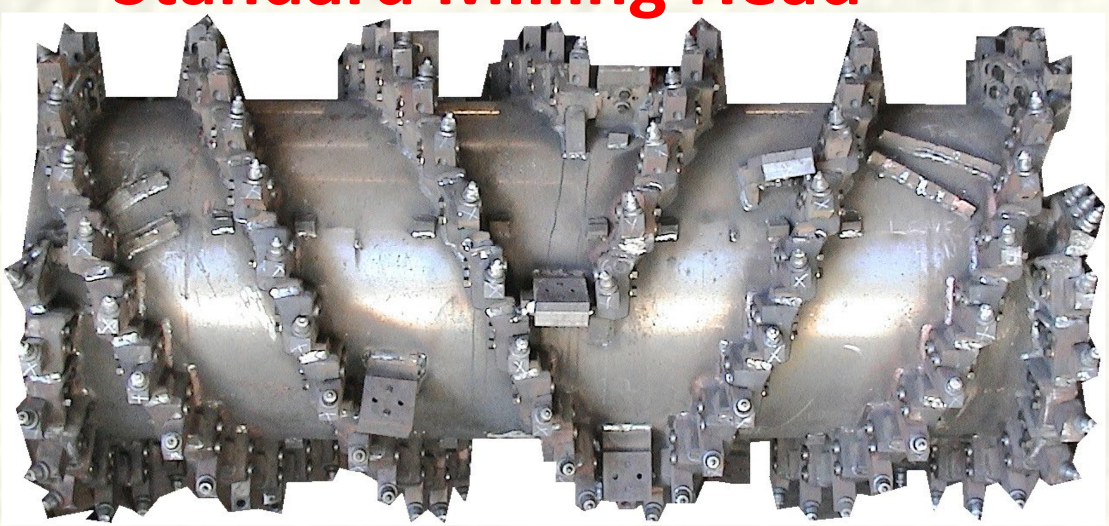


Grinding Versus Milling



Grinding Head

Standard Milling Head



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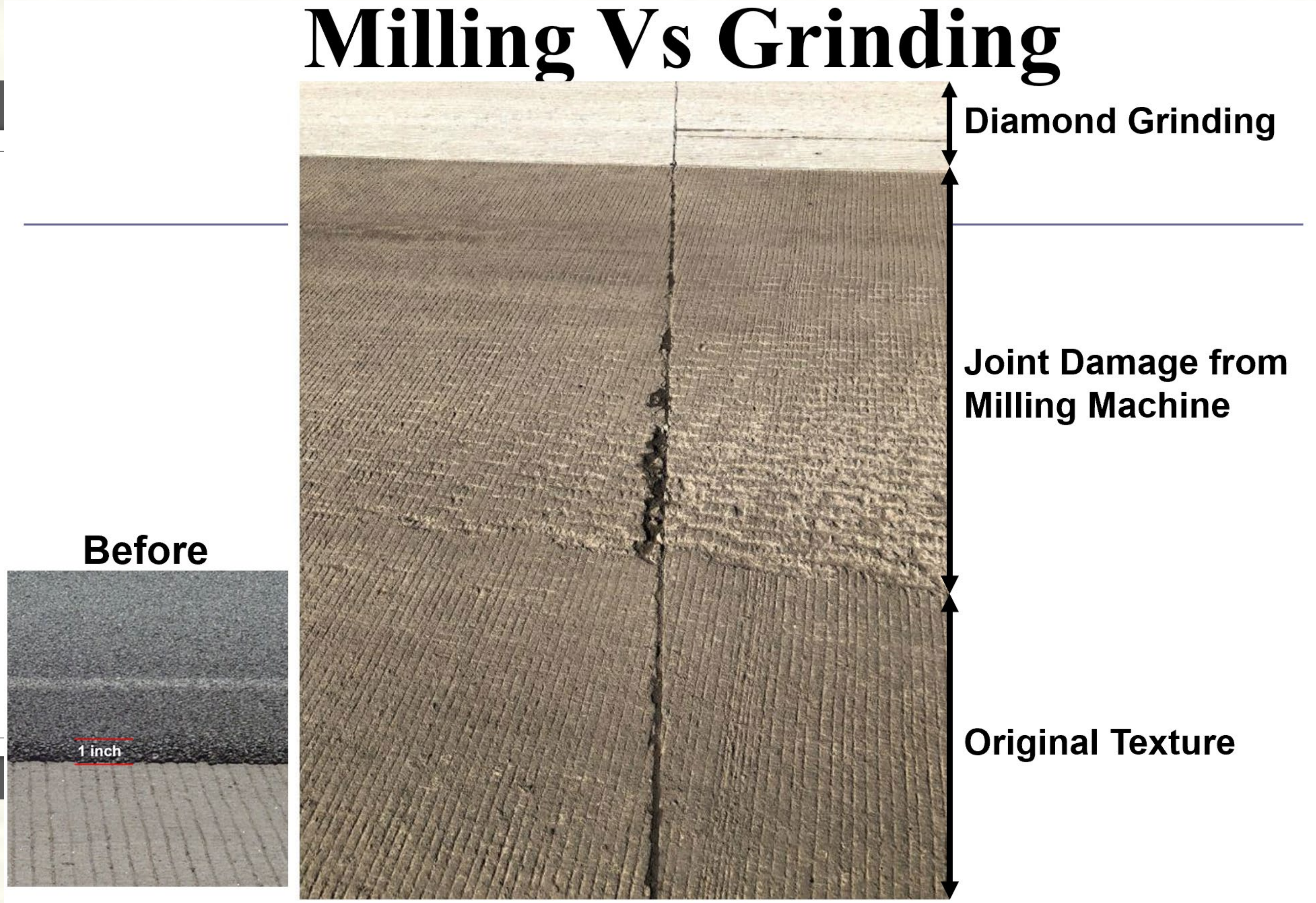
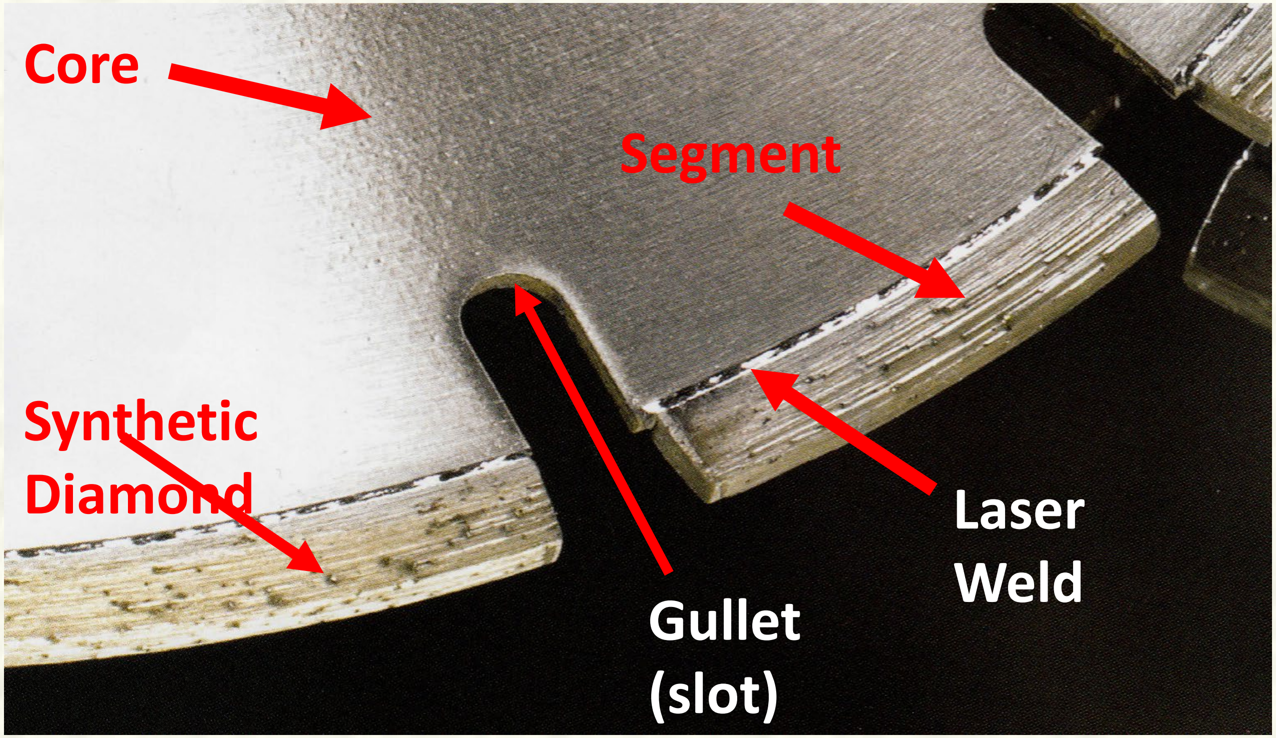
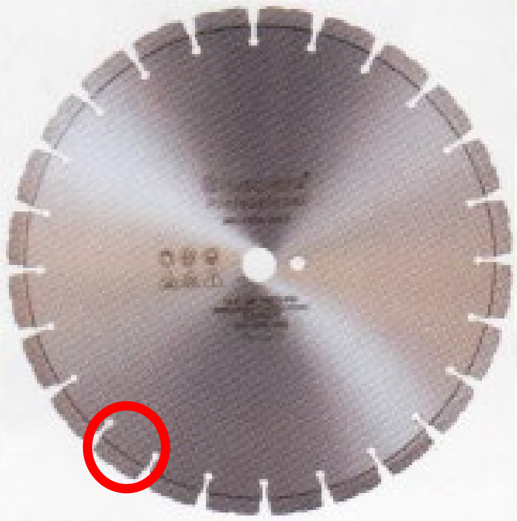
Damage from Milling ARFC of PCCP

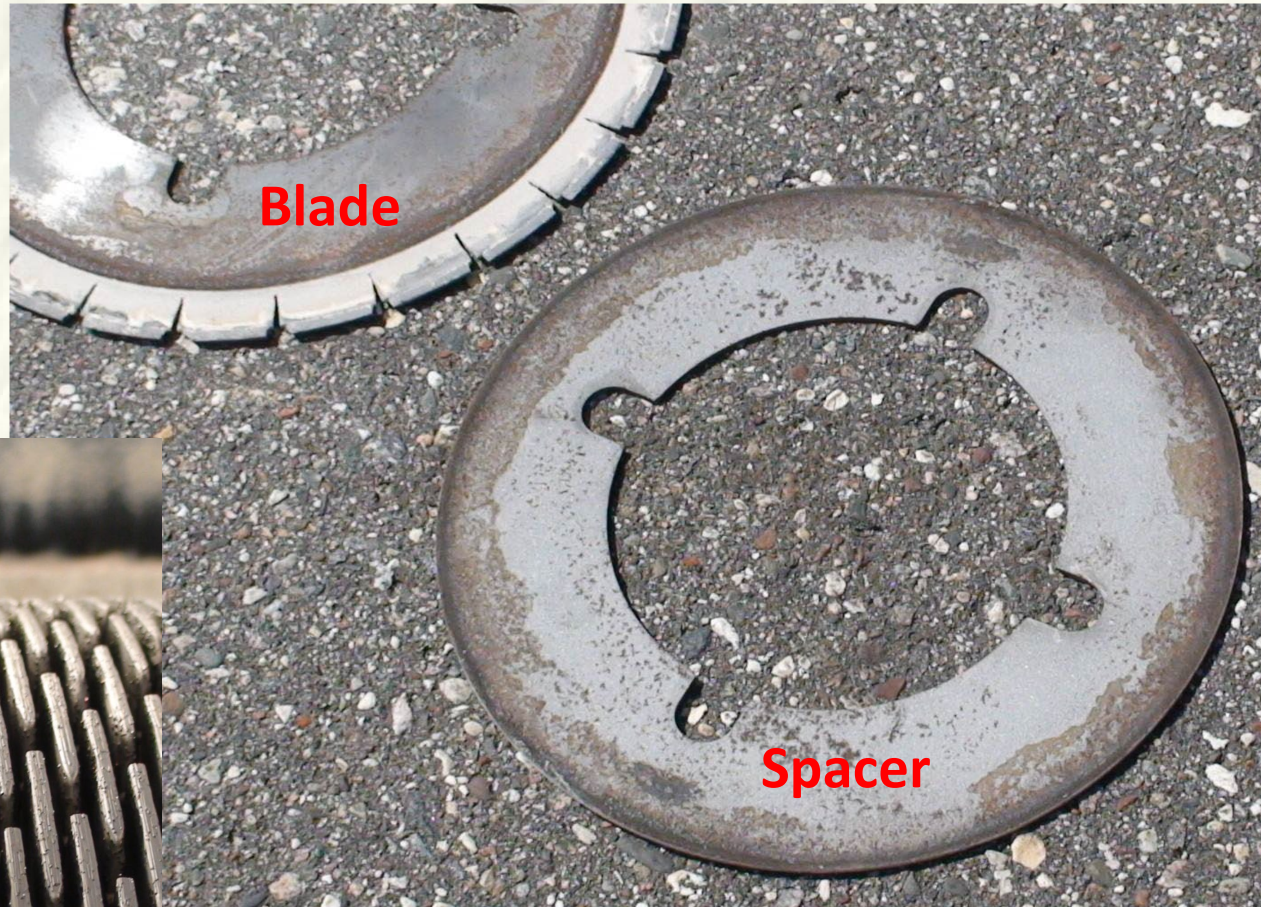


Diamond Blade Components

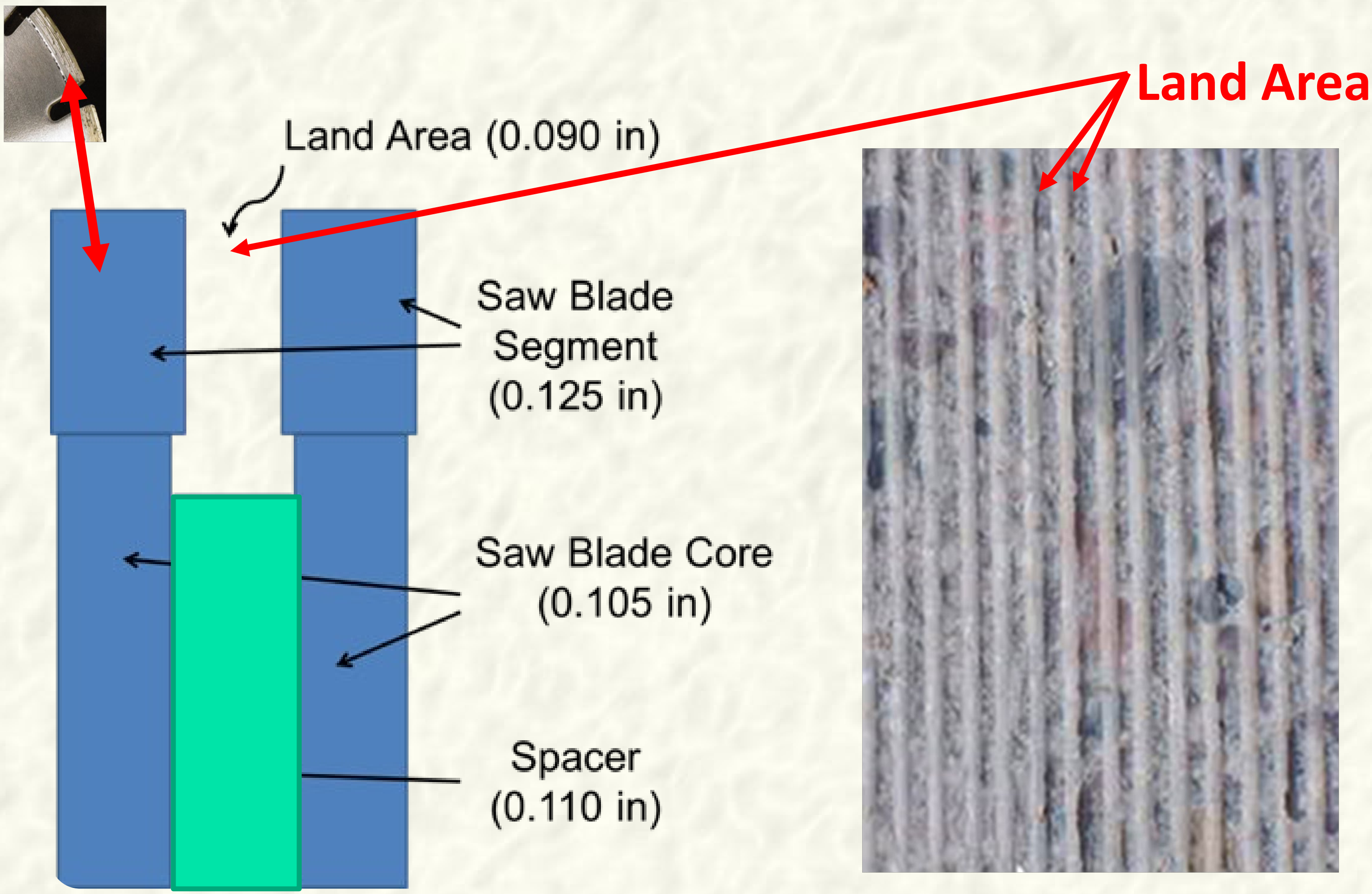




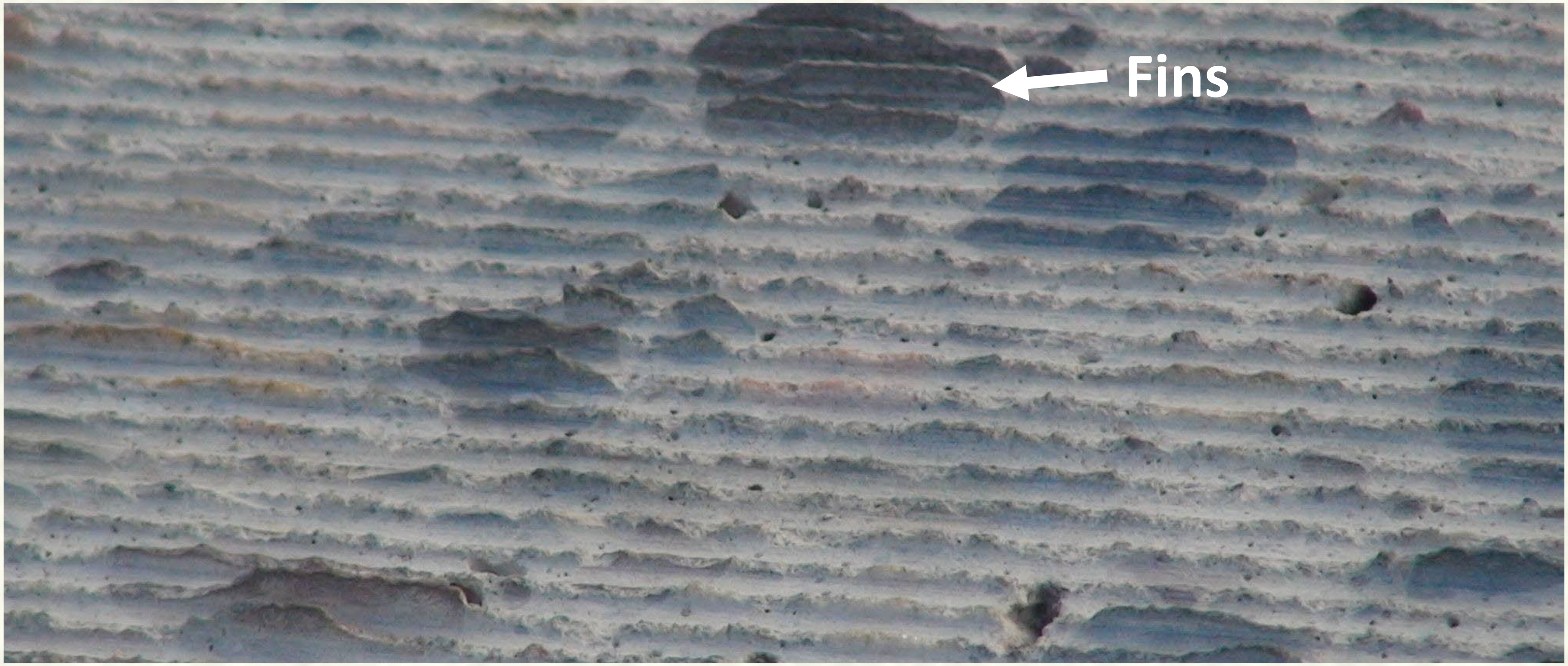
Spacers Are Used To Separate the Cutting Blades



How Blades Create the Corduroy Texture



Why Blade Spacing is Important

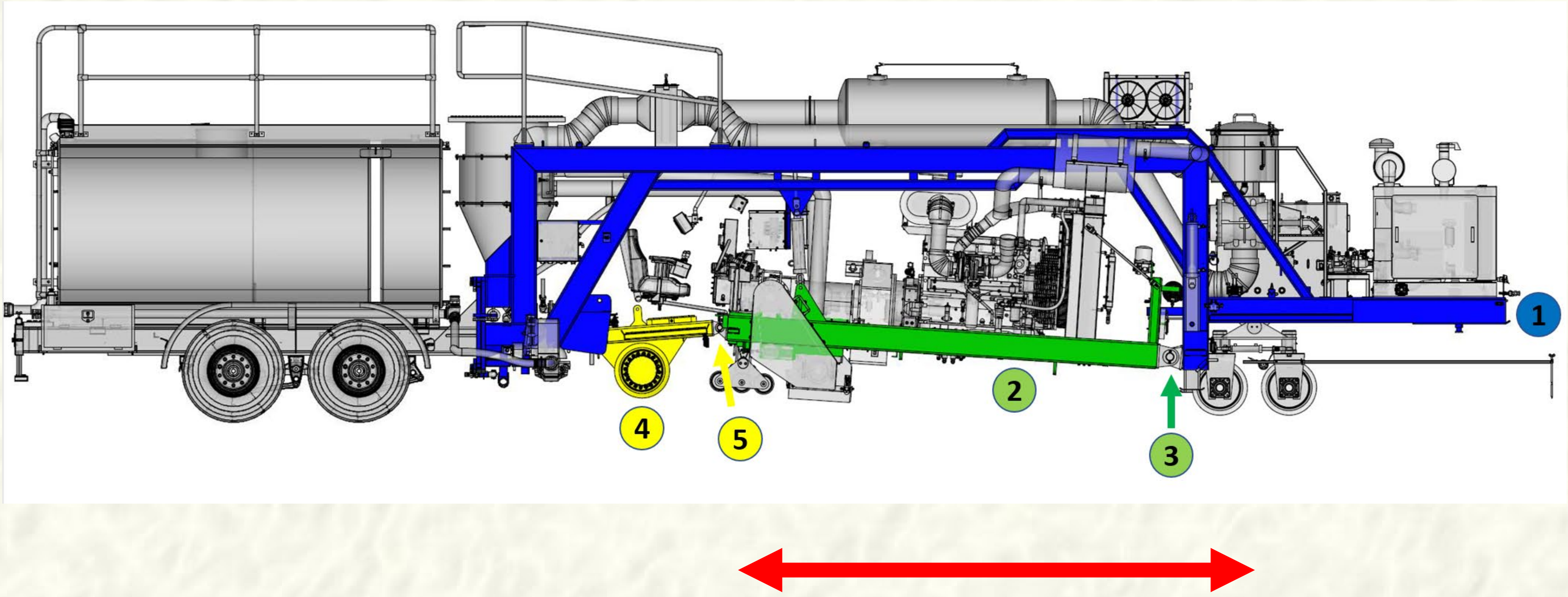


60 Blades vs 52 Blades per Foot

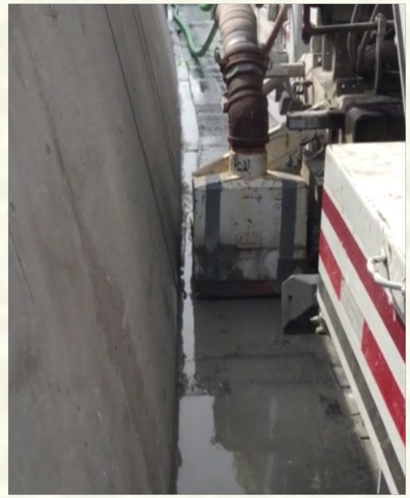
Well Constructed Texture

Diamond Grinding Equipment

Frames on Diamond Grinder



Grinding Close to Barriers and Obstructions



Back Next

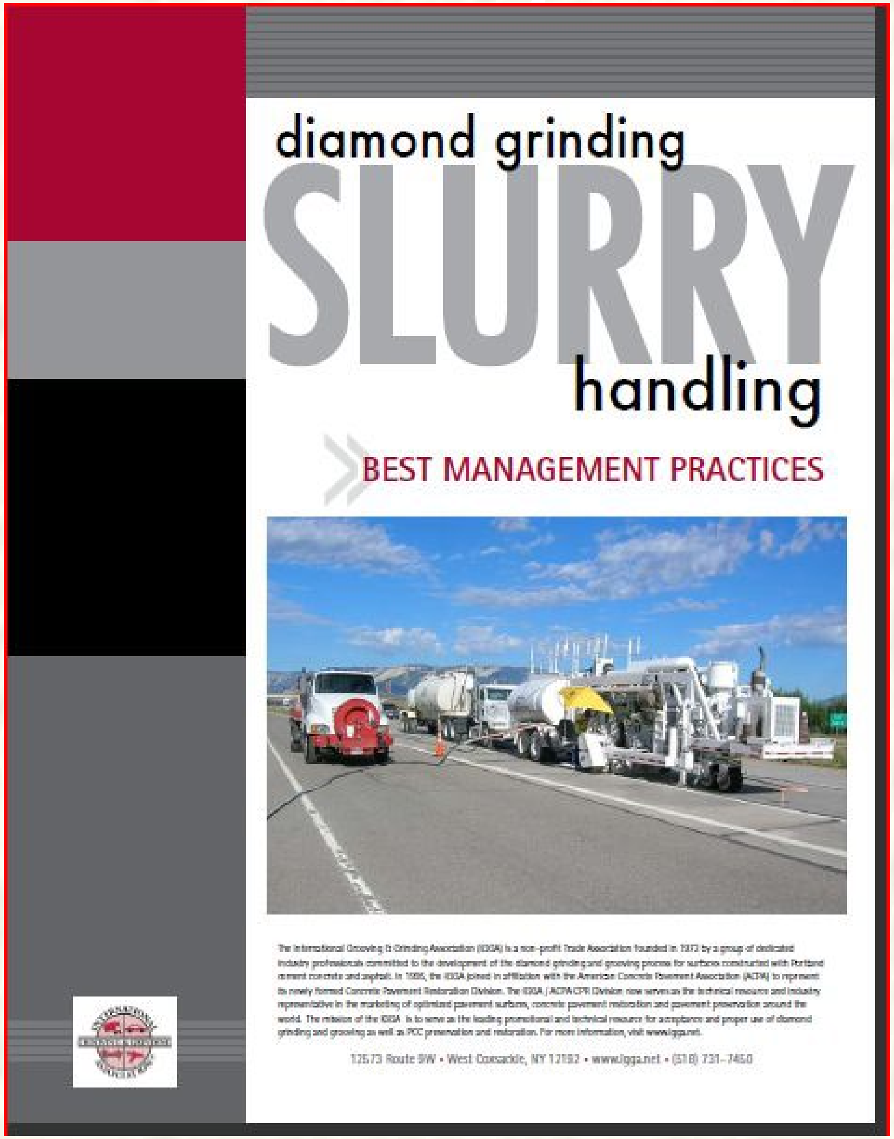
Diamond Grinding Slurry

Slurry Recovery Failure

Proper Slurry Recovery System

Poor Recovery

IGGA Best Management Practices for Slurry Handling


diamond grinding
SLURRY
handling
BEST MANAGEMENT PRACTICES

The International Grooving & Grinding Association (IGGA) is a non-profit Trade Association founded in 1972 by a group of dedicated industry professionals committed to the development of the diamond grinding and grooving process for surfaces constructed with Portland cement concrete and asphalt. In 1995, the IGGA joined in affiliation with the American Concrete Pavement Association (ACPA) to represent its newly formed Concrete Pavement Restoration Division. The IGGA / ACPA CPR Division now serves as the technical resource and industry representative in the marketing of optimized pavement surfaces, concrete pavement restoration and pavement preservation around the world. The mission of the IGGA is to serve as the leading promotional and technical resource for acceptance and proper use of diamond grinding and grooving as well as PCC preservation and restoration. For more information, visit www.igga.net.

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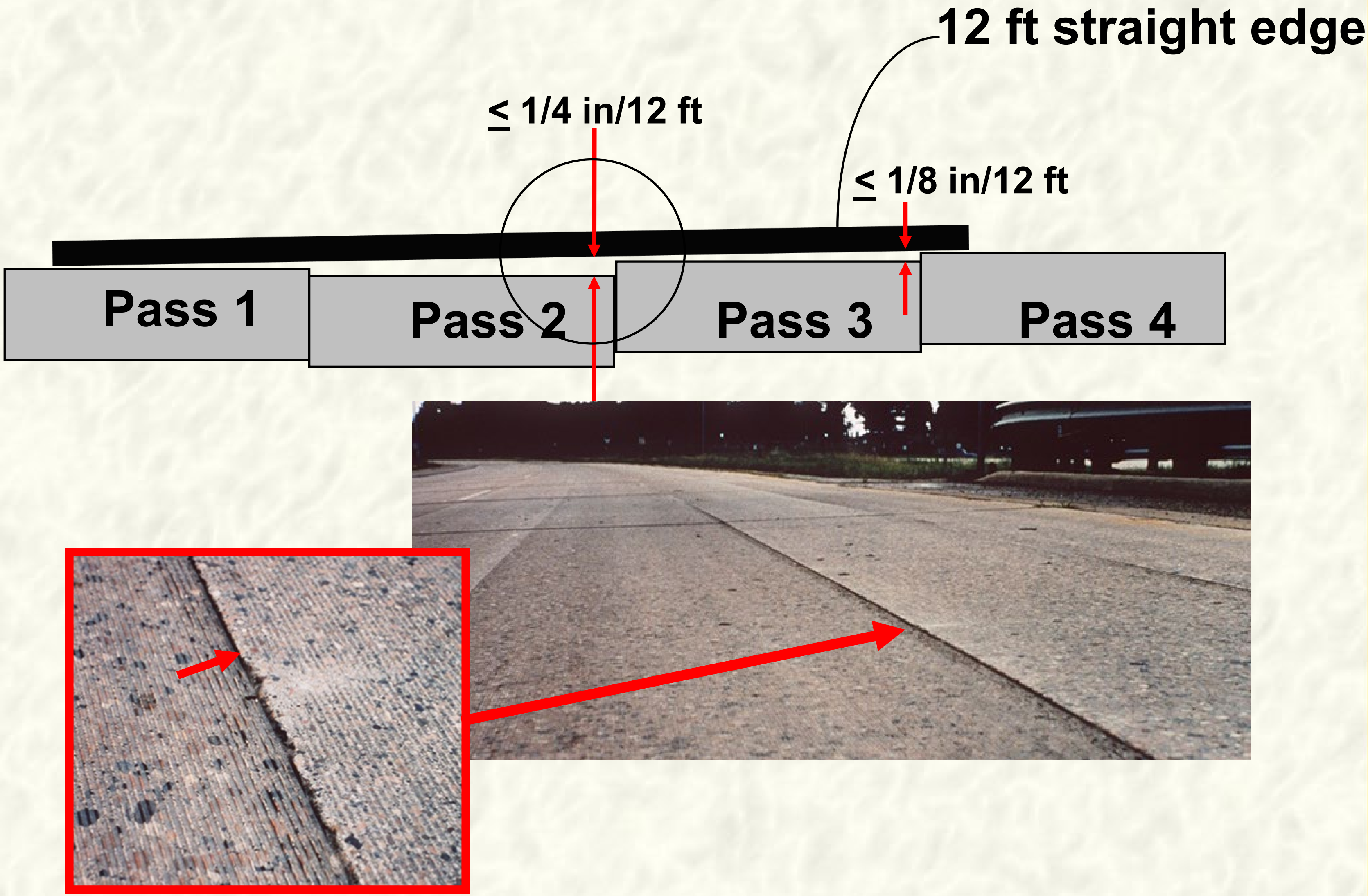
Poor Match Between Passes



Holidays

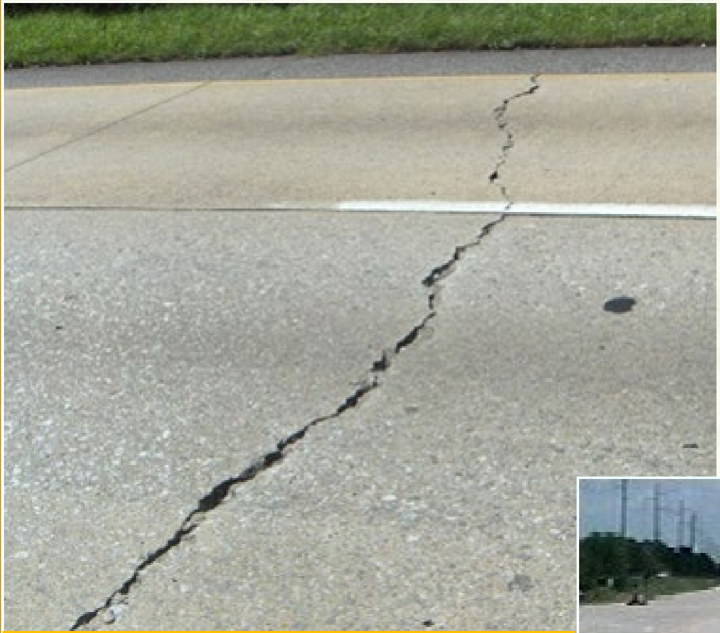
Different Types of Full Depth Repair

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

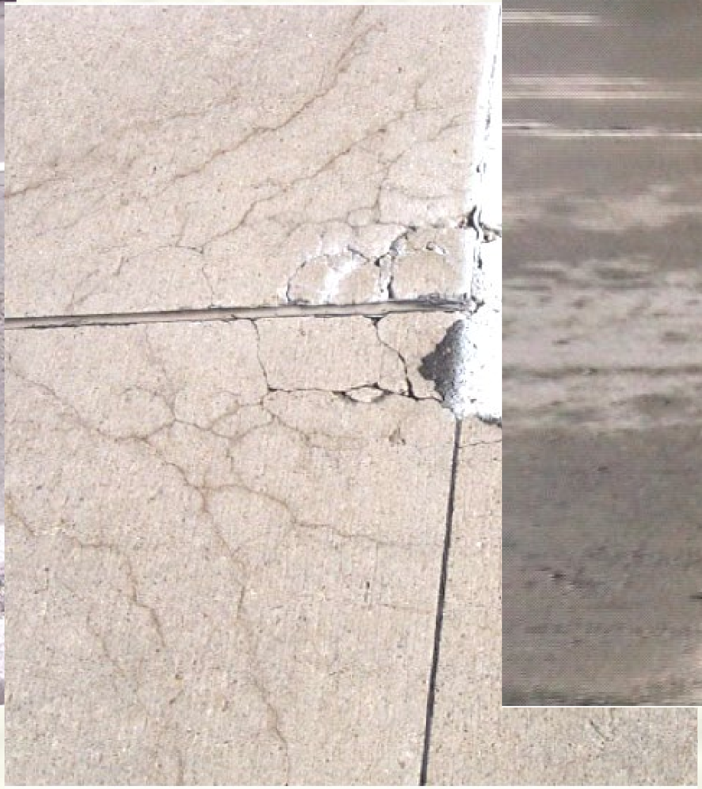

Transverse Cracks

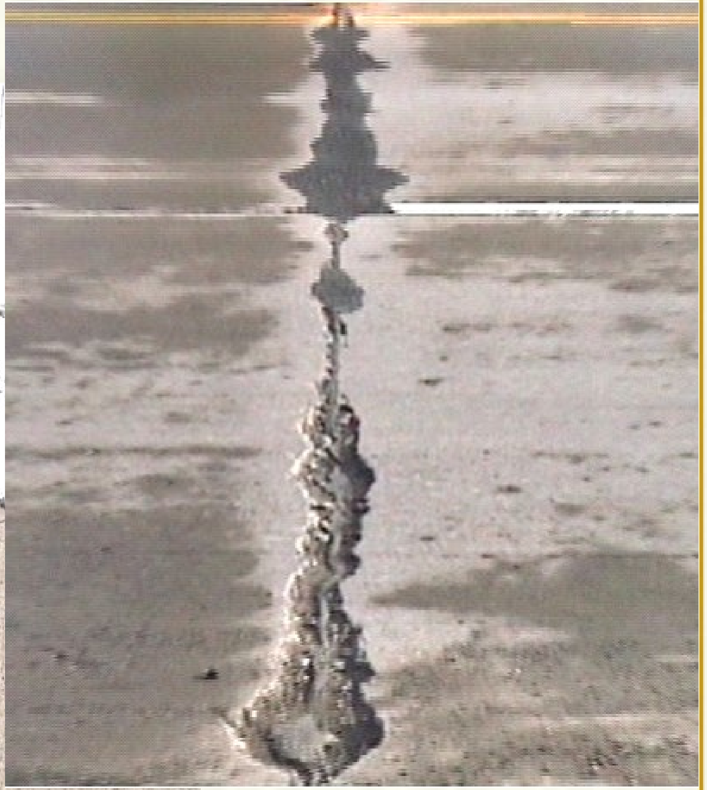

Corner Breaks


Longitudinal Cracks

Repairing Broken Slabs

Repairing Joint/Crack Deterioration





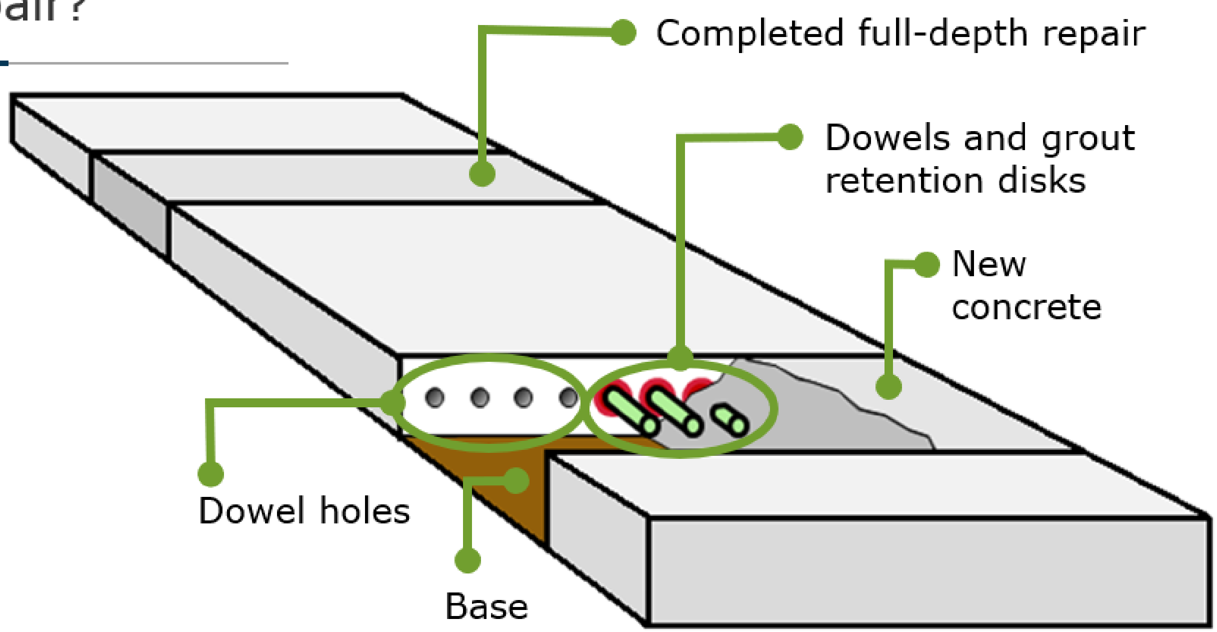
Types of Distress That Cannot Be Addressed

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

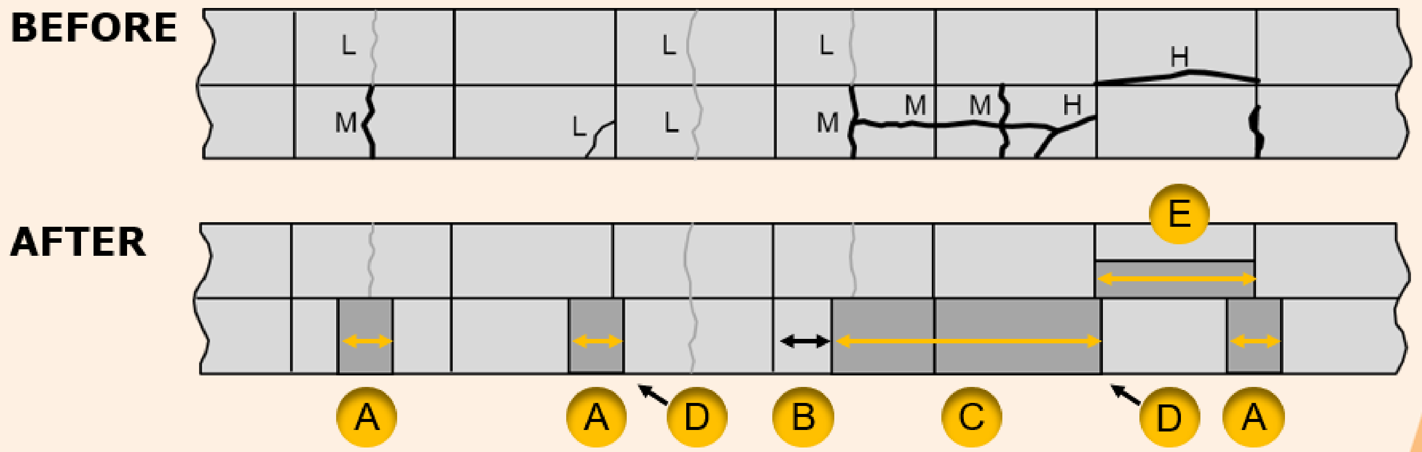
- Identify and Mark Areas
- Selection of Materials
- Sawing Repair Boundaries
- Removal Methods
- Base Preparation
- Installing Dowels and Tie Bars
- Casting and Finishing Slabs

Identify and Mark Repair Areas

6 Ft Minimum Width Requirement

Repair Boundary Determination

How Are Repair Boundaries Determined for JCP?



Severity	
L	Low
M	Medium
H	High

A. Minimum patch length is 6 feet for doweled joints; 8 to 10 feet for aggregate interlock joints.

B. Check distance between patches and nearby joints.

C. Replace the entire slab if there are multiple intersecting cracks.

D. 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.

E. When marking partial-width patches for longitudinal cracks, keep the joint off of the wheel paths.

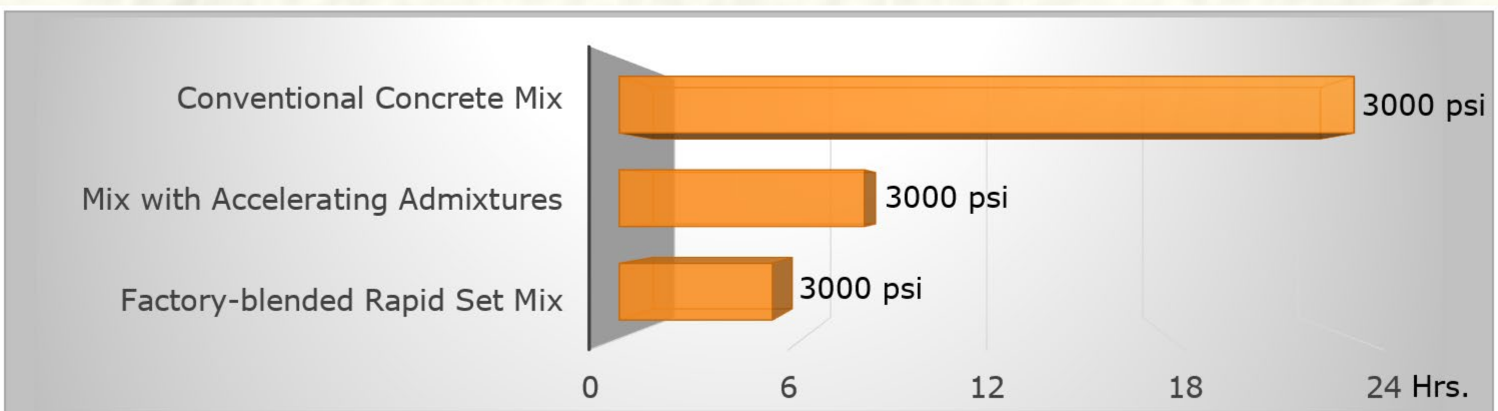
Materials

Materials Used in Full-Depth Repair

- Patching concrete
  - Ready-mixed concrete
  - Field-mixed concrete
  - Proprietary fast-setting mixtures
- Dowels
- Dowel bar epoxy or grout
- Plastic grout retention disks
- Curing compound
- Joint sealant

How Patching Materials Are Selected

- To meet specification provisions:
  - — 28-day strength
  - — Freeze-thaw resistance
  - — Durability
  - — Opening to traffic (early strength)
  - — Matching color
- Can incorporate:
  - — Conventional cements
  - — Accelerating admixtures
  - — Specialty or proprietary cements
  - — Proprietary factory-blended mixtures



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

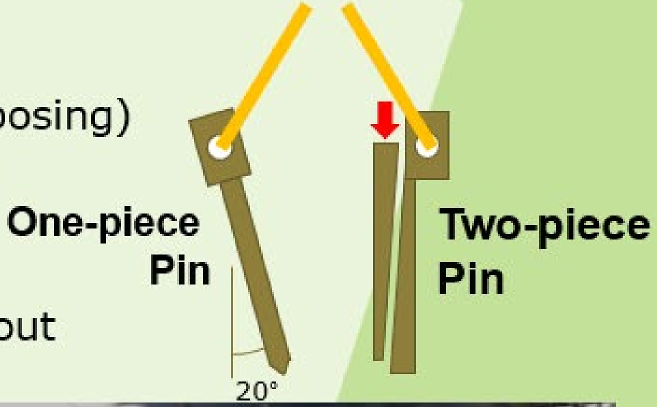
- **Set cut depth to fully reach slab bottom**
  - **Nominal thickness plus 1/2 inch**
- **Saw toward any live traffic lane and avoid turning your back on traffic if possible (use spotter if necessary)**
- **If saw blade binds then use pressure-relief cut in patch area**
- **Determine if over-sawing 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.

Removal Methods

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

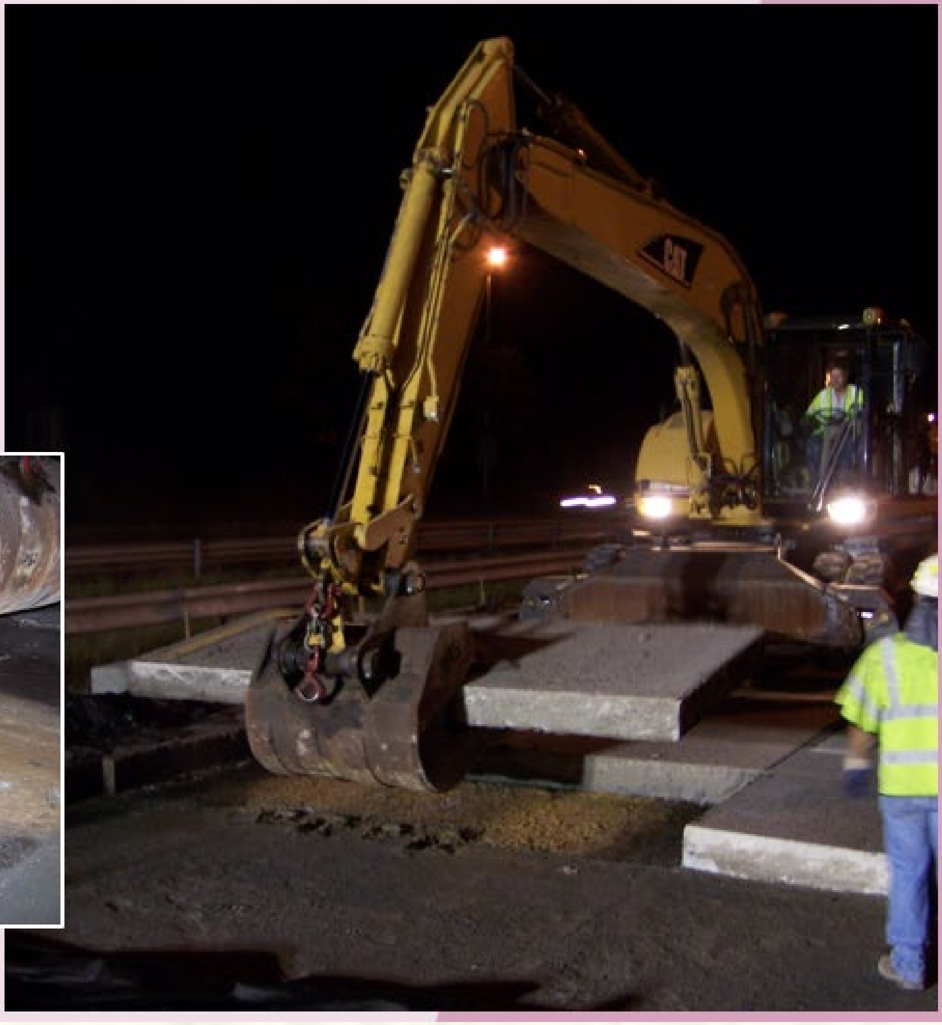



Drilling 20° Angled Holes for Lift Pins


Lift Out Using Chains

Torque Claw

- Mount claw to equipment
- Make relief cut
- Angle into position
- Lift out



Lateral Pressure

- Mount attachment to equipment
- Drill holes
- Insert device pins on equipment
- Apply pressure
- Lift out

Vacuum Suction

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

Base Preparation

- Check the base for the following:
  - Disturbed (need leveling)?
  - Soft or saturated?
  - Standing water evident?
- Drain any standing rainwater
- Dry excessive moisture

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

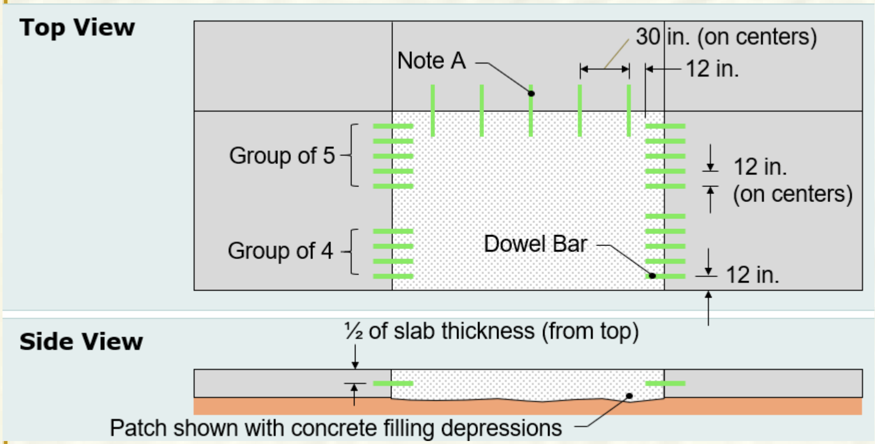
Checking Perimeter Edges

- Look for:
  - Damage to perimeter joint from removal operations
  - Distress that was not fully removed
  - An inadequate joint face for anchoring dowels or tiebars (sounding)
- If damage is evident:
  - Cut back perimeter
  - Remove concrete
  - Compact base along new edge

Dowels and Tiebars

- Dowels
  - Smooth, round
  - Intended to allow slippage
  - Diameter (1.25 to 1.5 inches)
  - Specifications:
    - AASHTO M254 Standard Specification for Corrosion-Resistant Coated Dowel Bars
    - ASTM A1078 Standard Specification for Epoxy-Coated Steel Dowels for Concrete Pavement
  - Purpose: load transfer

NOTE A: Tie bars are used only if the pavement joint was designed to be tied and then only if repair is full slab length or at least 15 feet long;



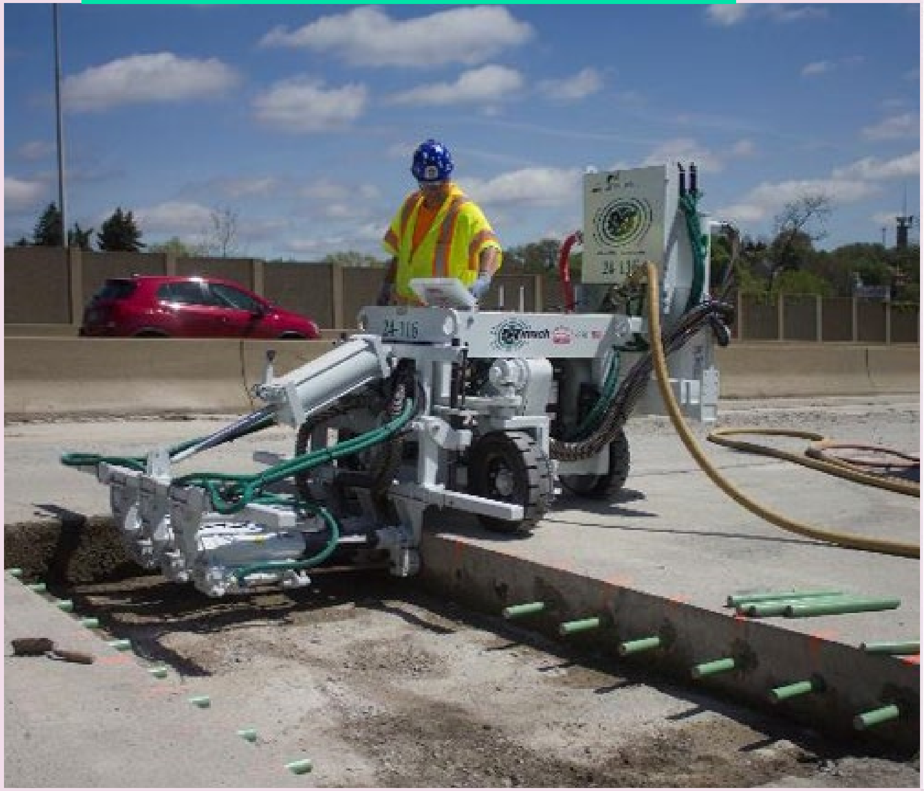
- Rebar or tie bars
  - Deformed
  - Intended to hold in concrete
  - For full-depth repair, diameter usually:
    - #4 (1/2 inch)
    - #5 (5/8 inch)
    - #6 (3/4 inch)
  - Typical length is 36 inches
  - Specifications: AASHTO M31; ASTM A615; ASTM A934
  - Purpose: hold joint or crack closed

Handheld Drilling

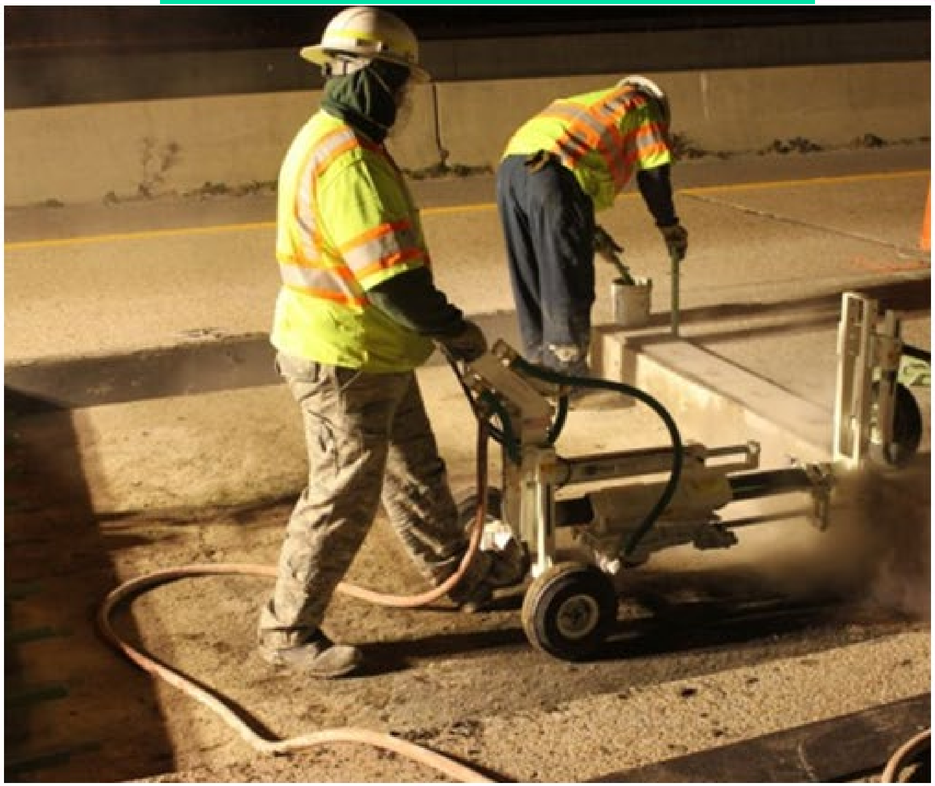
- Mobile
- Needed in cases of tight access
- Slower drill speed
- Adequate for small projects or low number of holes
- Less alignment control
- Adequate for tie bars

Reference for Drilling

Slab Referenced

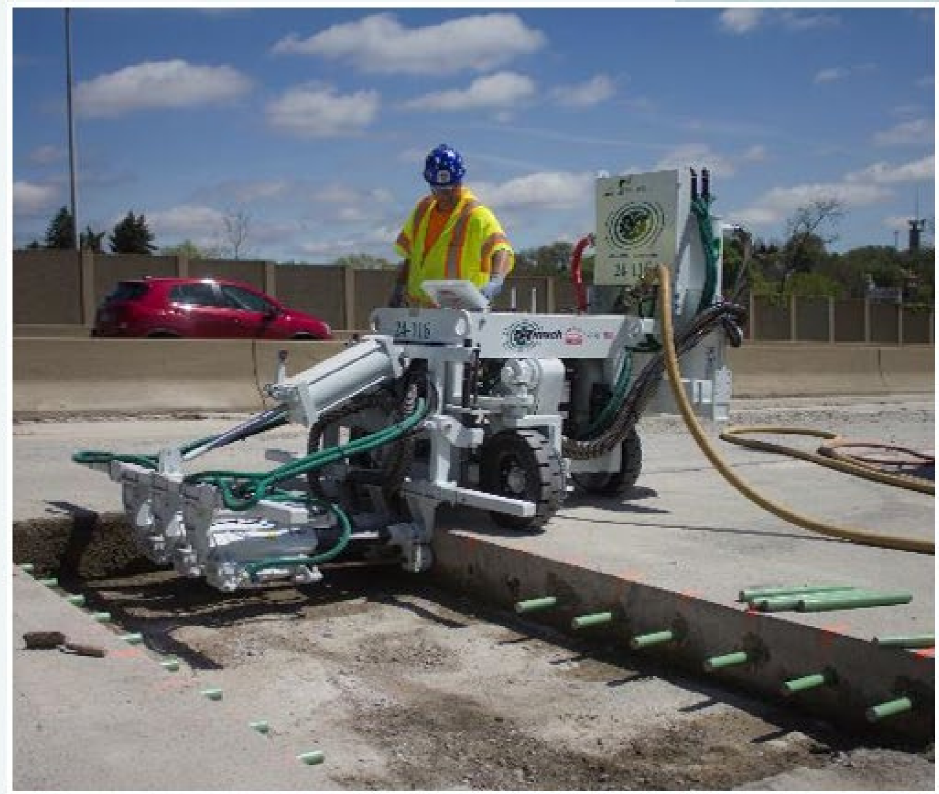


Base Referenced



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



Boom Mounted Drills

- Ganged (up to 6)
- Mounted to backhoe or other equipment
- Rotates 360 degrees to drill both sides of repair
- Simultaneous drilling controls

Anchoring Dowel Bars or Tie Bars

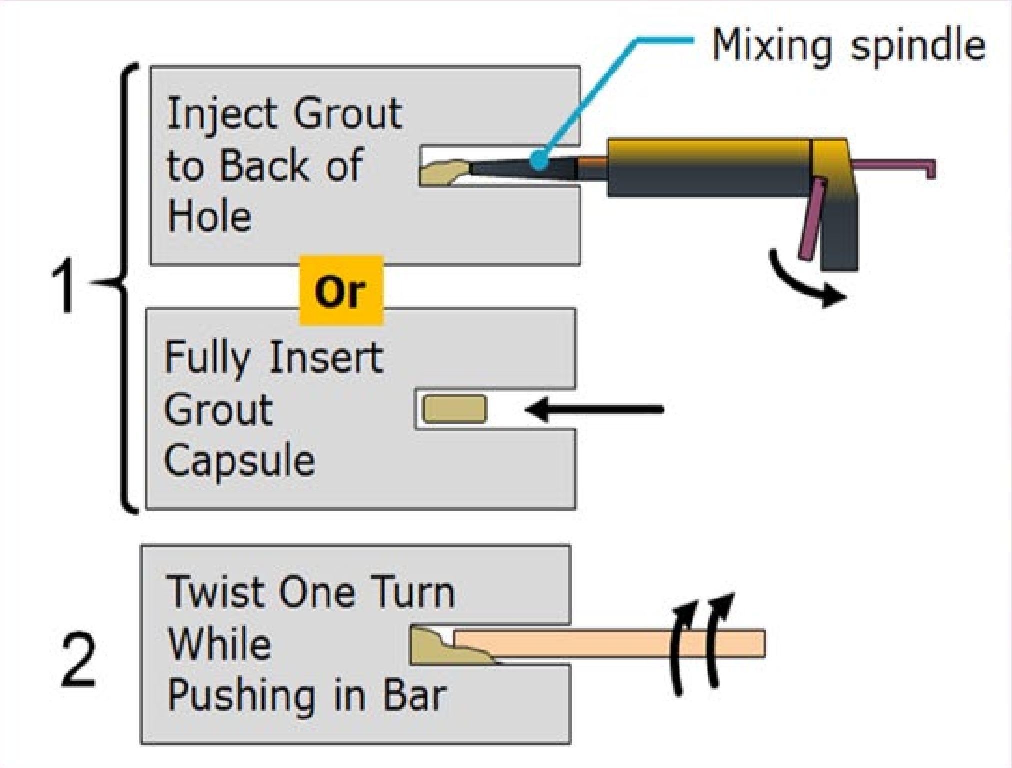
Step 1: Clean the Hole

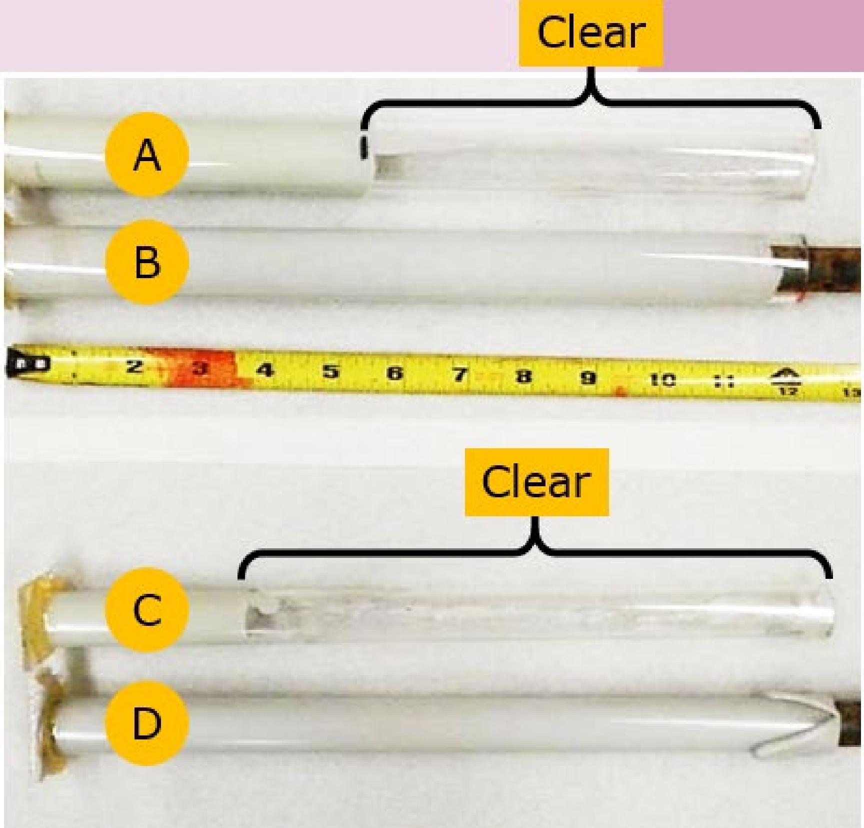
Step 2: Mix and Place Bar Anchoring Material

Step 3: Insert Dowels and Tie Bars

Step 4: Place Grout Retention Disk and Oil Bar

Mixing and Insertion Procedure





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

Preparing Longitudinal Joint and Installing Separator

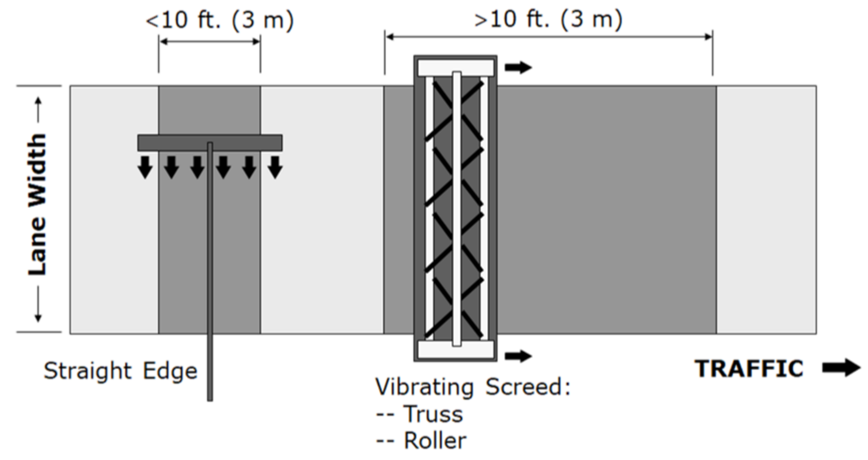
- **Use minimum 1/4-inch thick separator for repairs less than one slab length (typically 15 feet)**
- **Place only along longitudinal edges with existing concrete lane or shoulder**
- **Typical materials:**
  - **Asphalt fiberboard**
  - **Closed-cell polypropylene foam**
- **Cut to match depth and length of edge**

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

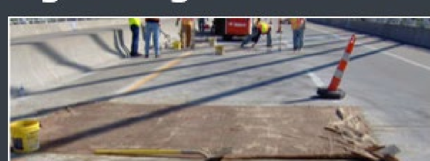
- Match texture of concrete as close as possible
- Practical options (broom, tine)
- Consider:
  - Direction of texture
  - Distance between combs (for tining)
- Texture as soon as possible after finishing
  - Apply with consistent pressure on tool

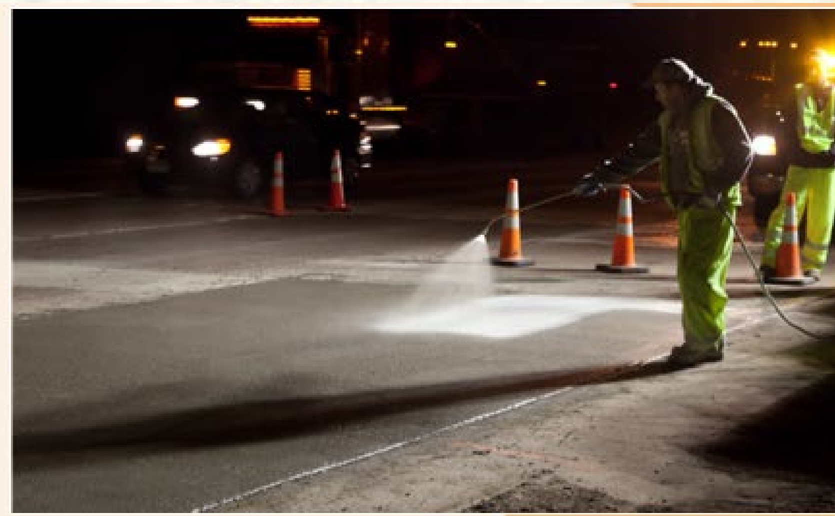
Applying Curing Compound

- 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

Using Curing Compound

Using Curing Sheets or Mat





GOOD

POOR

Questions?

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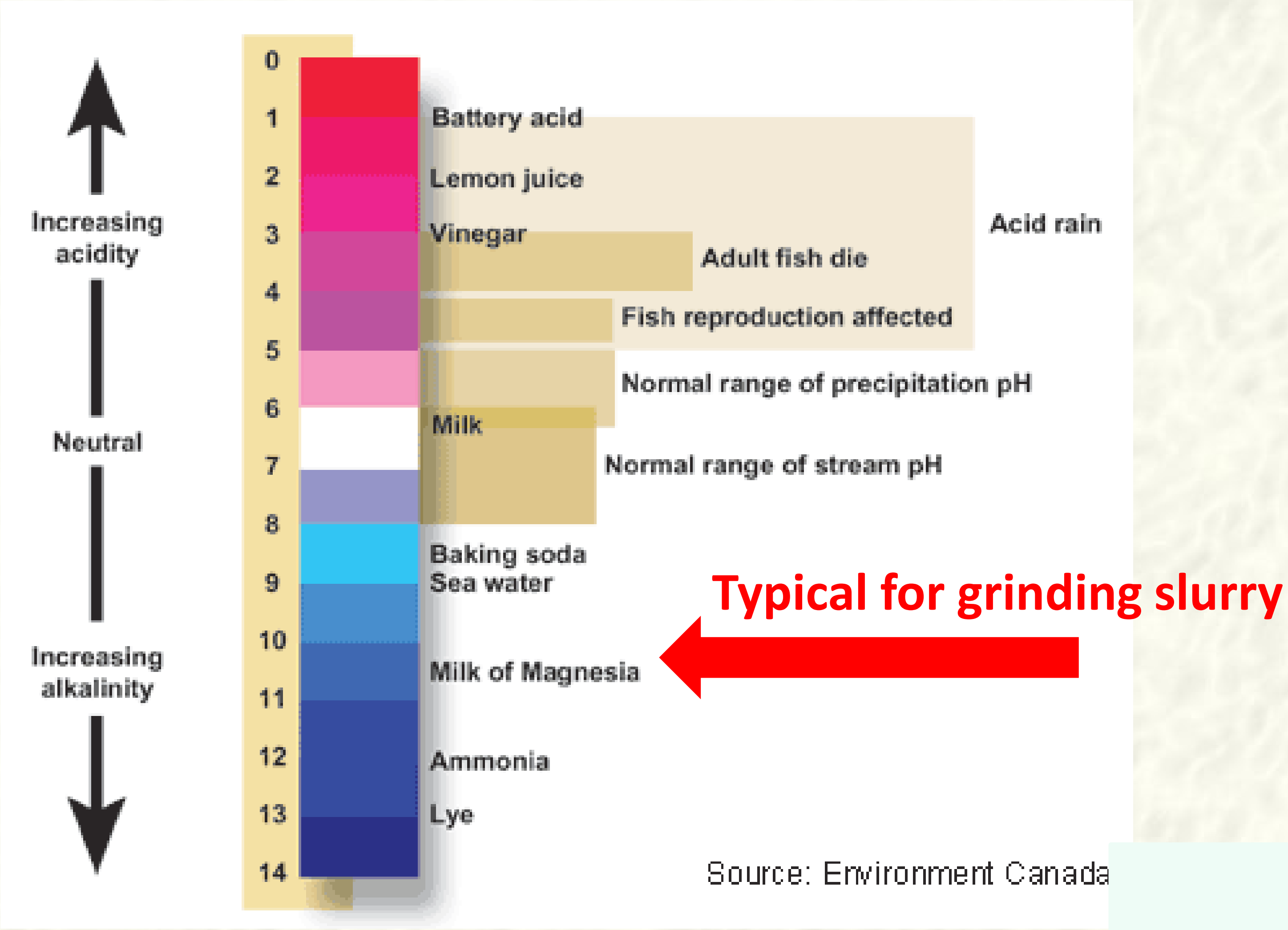
Means for Improving pH prior to Slurry Recovery and Disposal



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