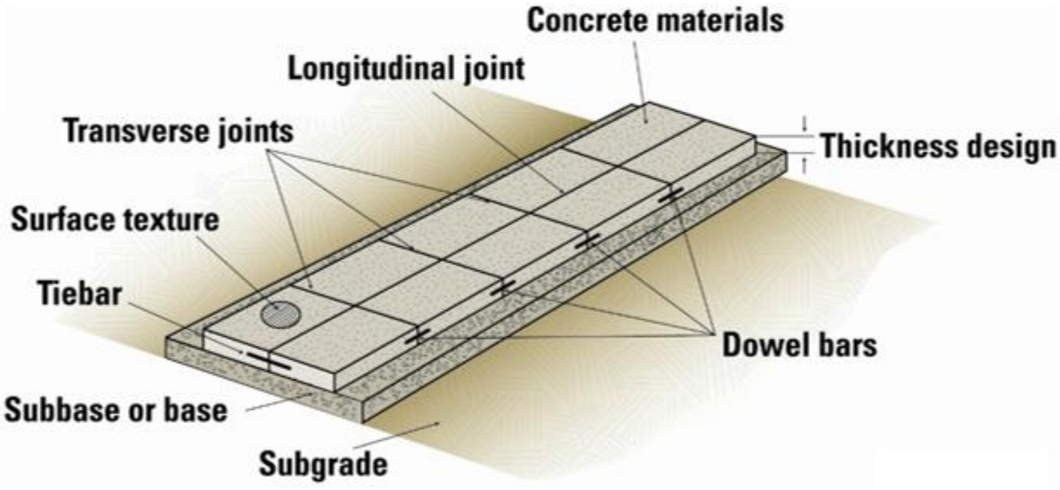
Sawing and Sealing Basics

Scott Eilken

Owner- Quality Saw and Seal, Inc.

IGGA
International Grooving & Grinding Association
Your Pavement Preservation Resource since 1972

QUALITY SAW & SEAL



Why Do We Make and Seal Joints

To Control Cracking

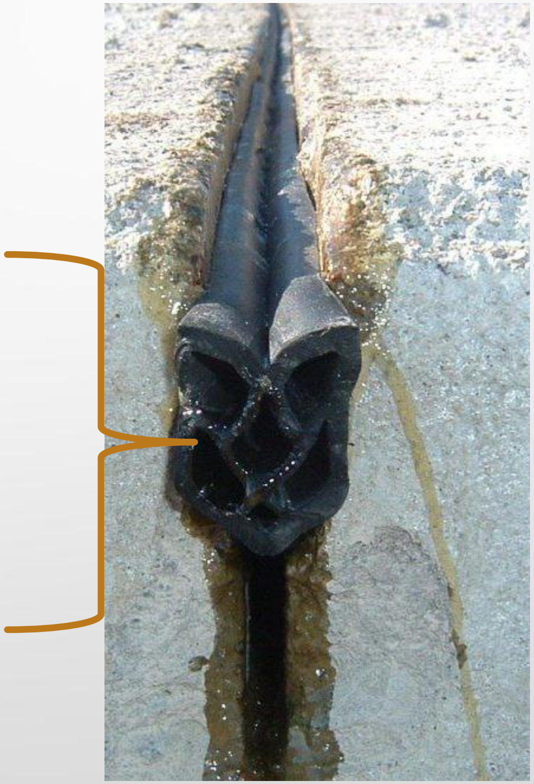
Controlled Cracking

Uncontrolled Cracking

Types of Saw Cuts

Initial Saw Cut

Reservoir Cut



Is Sealant Cost Effective?

FHWA Sealant Effectiveness Study

CONCRETE PAVEMENT
CPTP
TECHNOLOGY PROGRAM

TechBrief

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

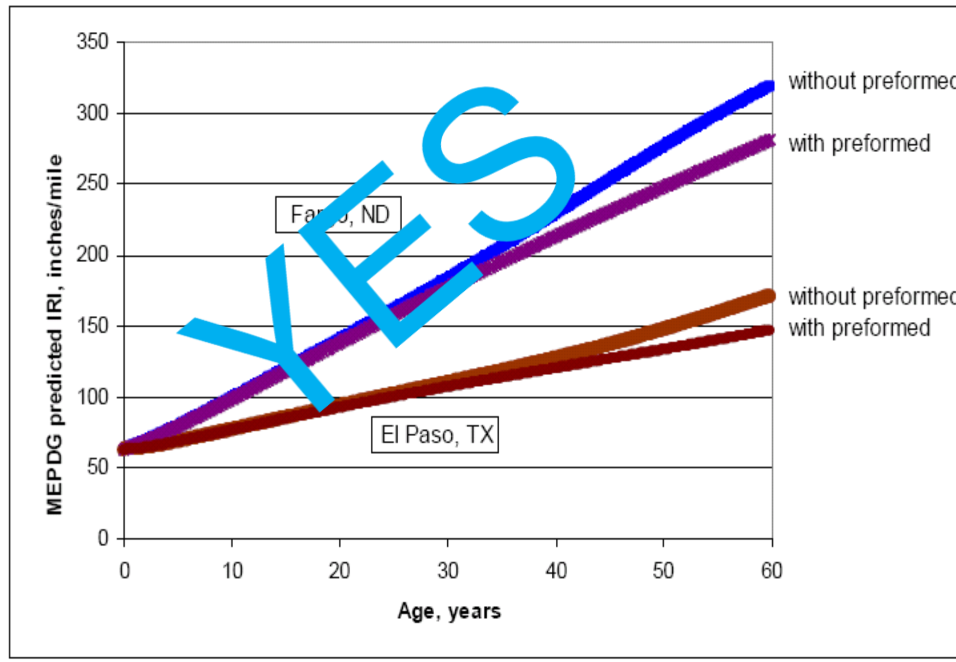
BACKGROUN

The sealing ... transverse ... traction joints in JPCP has been standard pr tice throu... out much of the ... ted States for many years. Its widespread is due to ... e common belief t... sealing joints improves concrete pavem ... rforma... in two ways: by ... ducing water infiltration into the pavem ... ucture, t... eby reducing th... ccurrence of moisture-related distresses su as ... mping ... 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 ... ints in jointed concrete pavement (JCP) are typically crea by making ... initial 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:

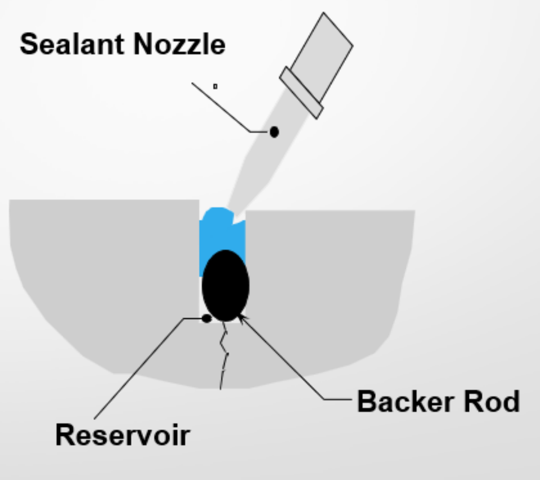
- Narrow unsealed joints, consisting of single saw cuts that are left unsealed.
- Narrow filled joints, consisting of single saw cuts that are filled with sealant that adheres to the sides and bottom of the saw cut.
- Narrow sealed joints, consisting of single saw cuts that contain a narrow backer rod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

AASHTO New Design Guide



Benefits of Joint Sealing

- Minimizes Water & Incompressibles into Pavement System
- Reduces Subgrade Softening, Pumping and Erosion of Fines and Spalling
- Prevents Joint Associated Distress?
- Extends Pavement Performance



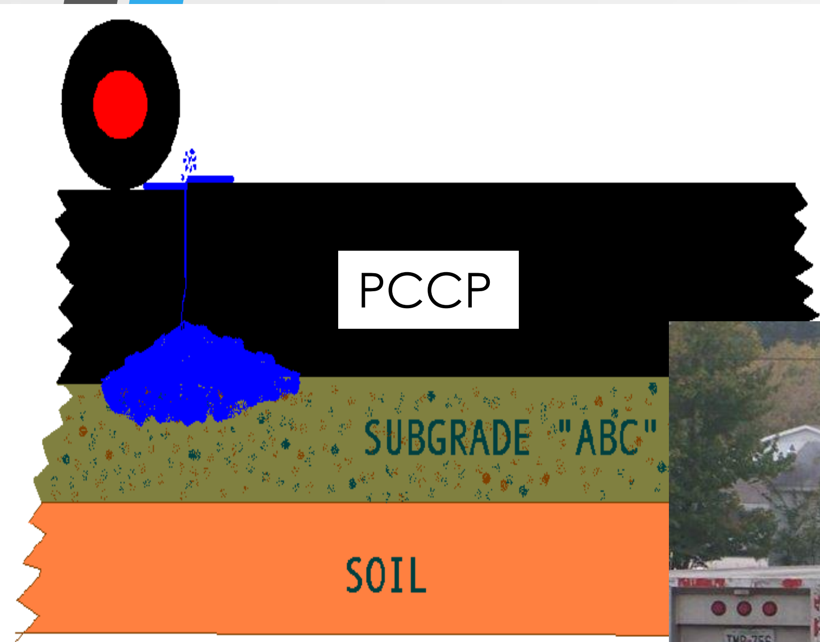
Why Seal Joints and Cracks

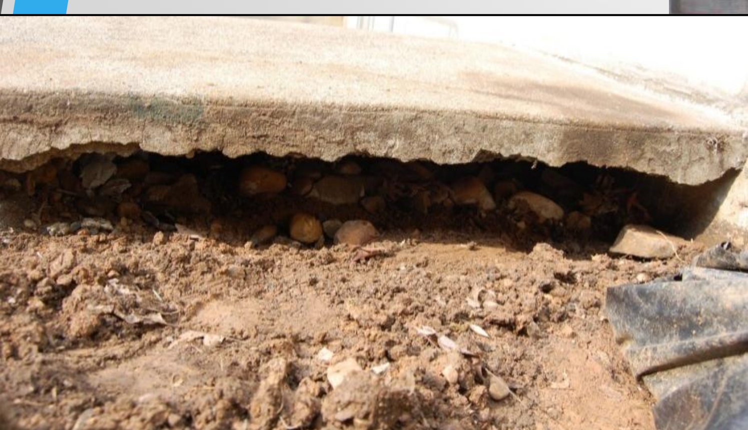
Prevents Incompressible from Lodging in the Joint — Slab Growth and Blow Ups

Why Seal Joints and Cracks

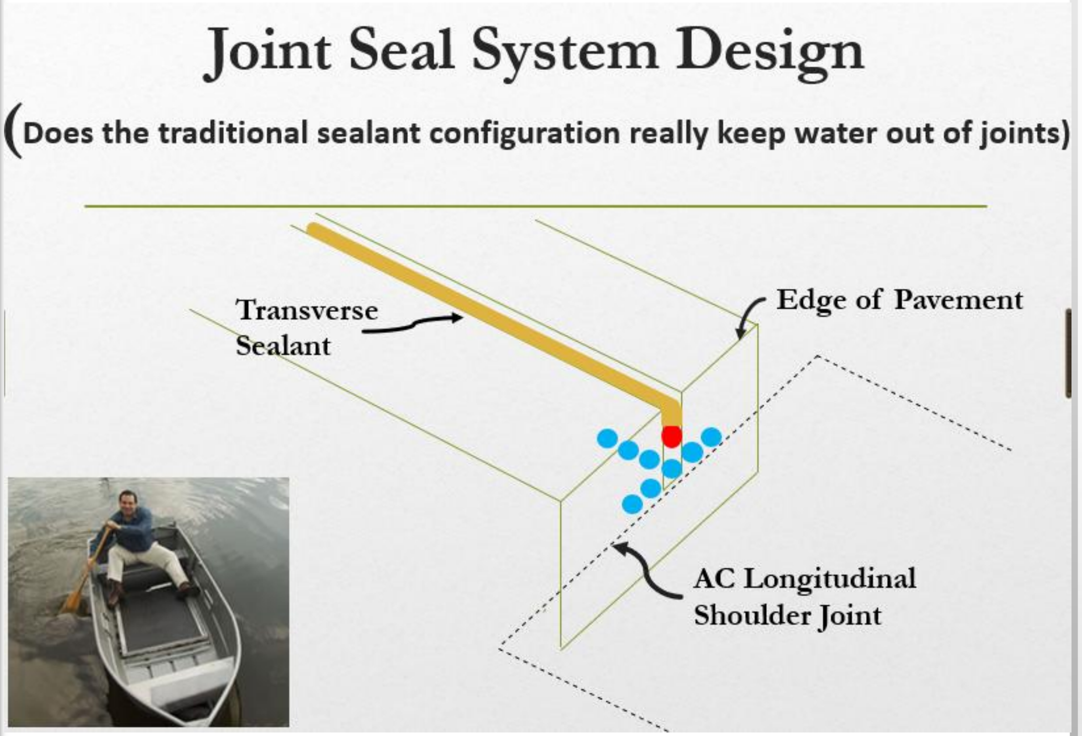
Prevents Water from Entering the Subgrade:

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



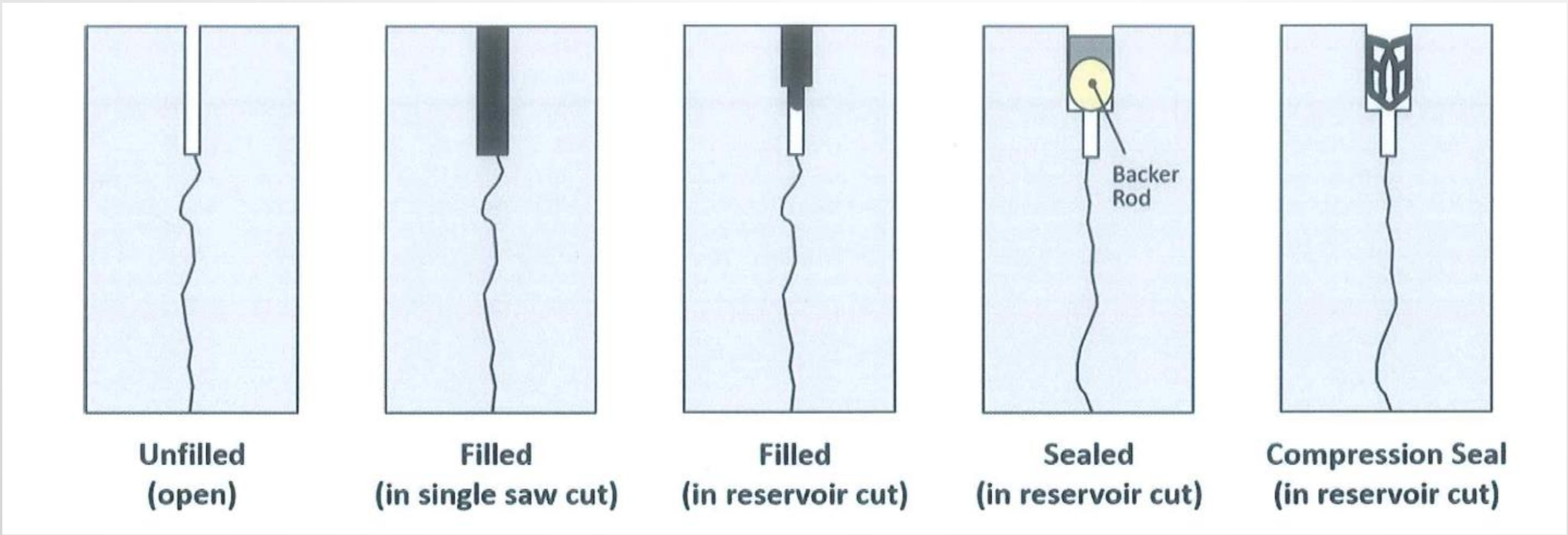


The Top Doesn't Always Tell the Story

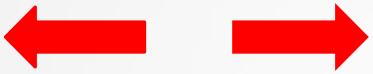


How Do You Design the Joint Sealant System

Reservoir Design and Cutting



How Does Vertical Load Impact Sealant Performance



Good for Hot Pour
Bad For Silicone

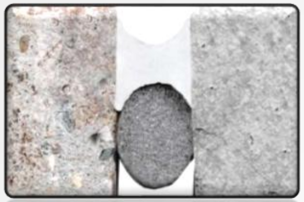
Good for Silicone
OK For Hot Pour

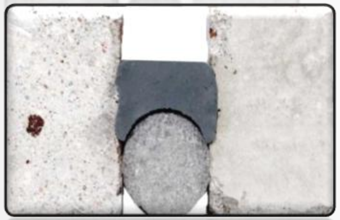
Bad For Silicone

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

Sealant Types

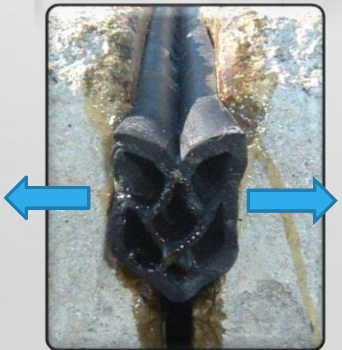
- Silicone
  - Non Sag
  - Self Leveling
  - Rapid Cure





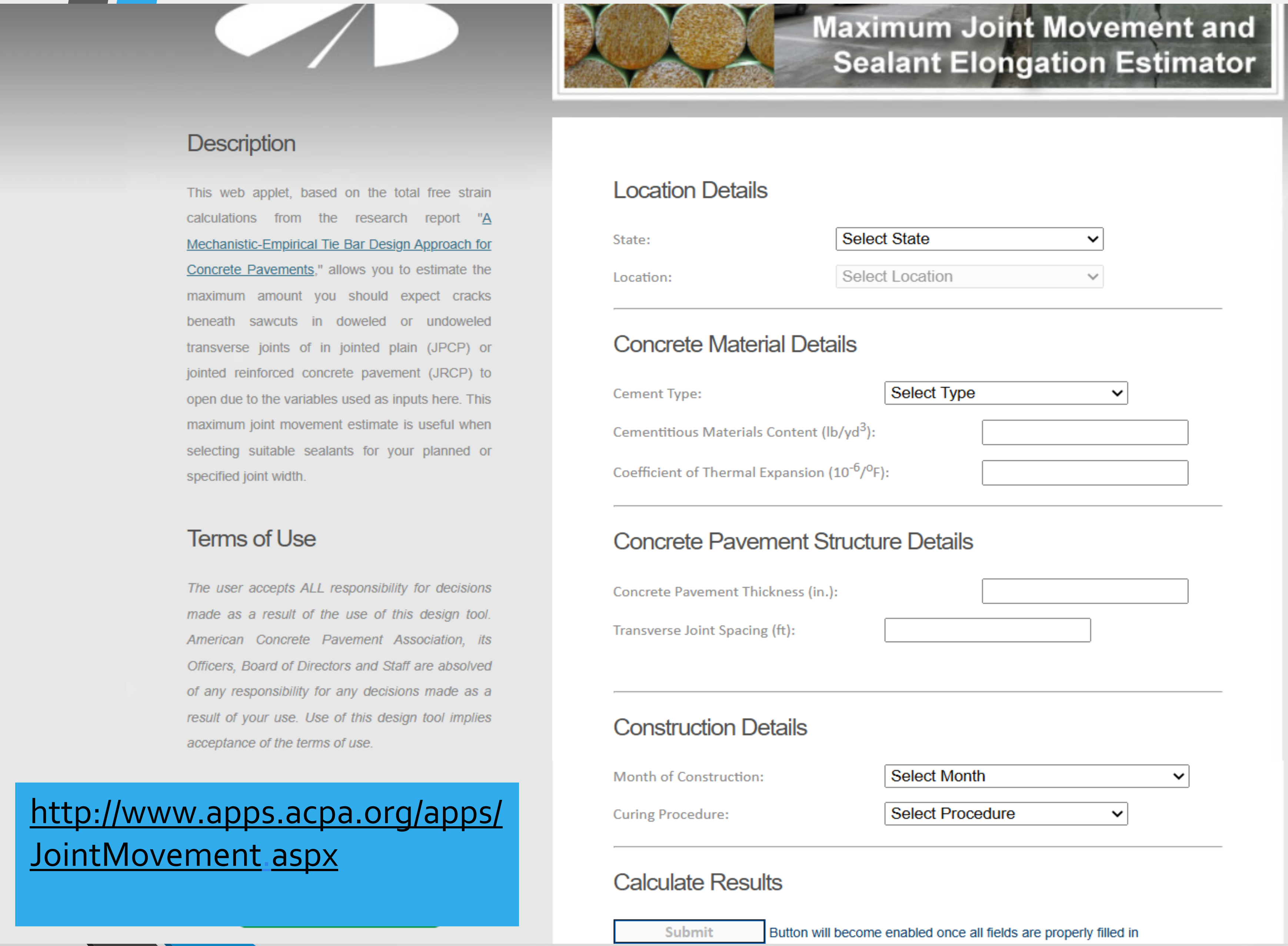
- Hot Pour
  - Standard Modulus
  - Low Modulus

- Compression Seal



Allowable Joint Opening Movements (Compression/Extension)

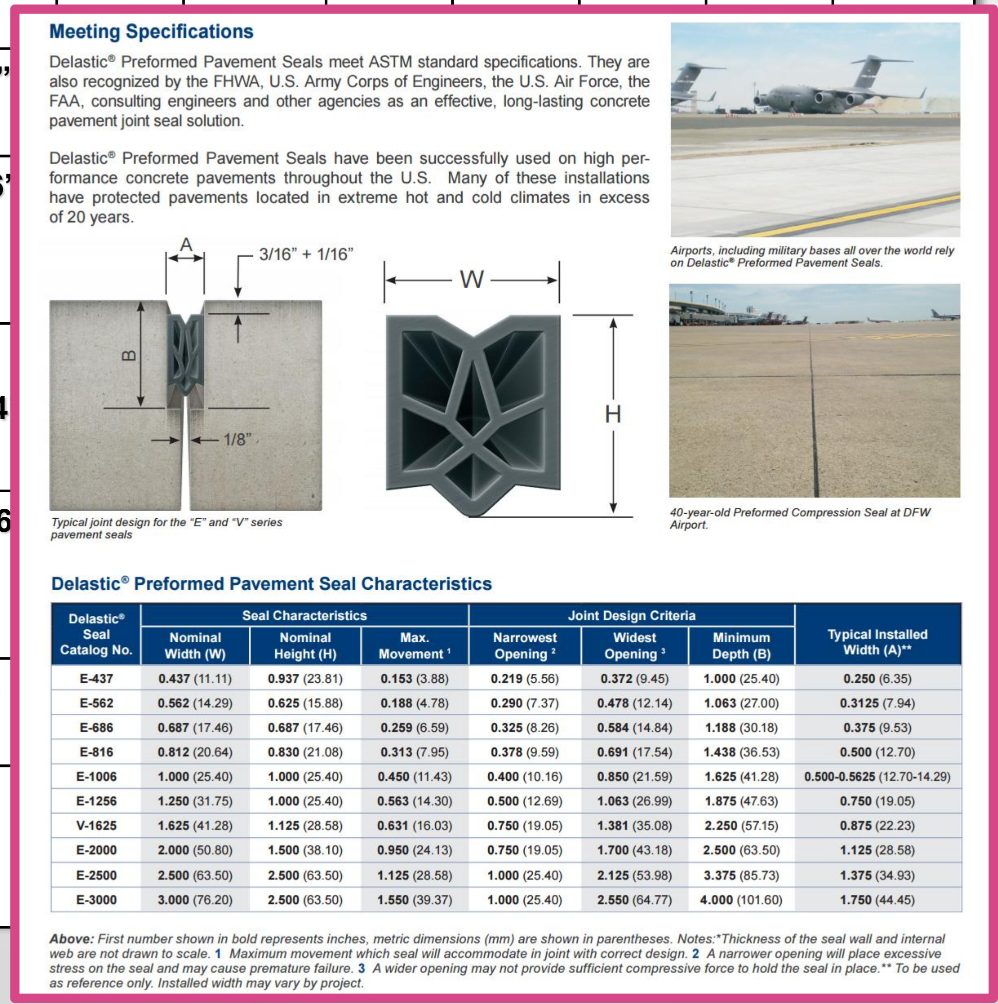
- **Hot Pour Sealants: 25% Extension**
- **Silicone Sealants: 50% Compression to 100% Extension**
- **Compression Seals: 15% min Compression to 50% Extension**



http://www.apps.acpa.org/apps/JointMovement.aspx

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.

Typical joint design for the "E" and "V" series pavement seals

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

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

Delastic® Preformed Pavement Seal Characteristics

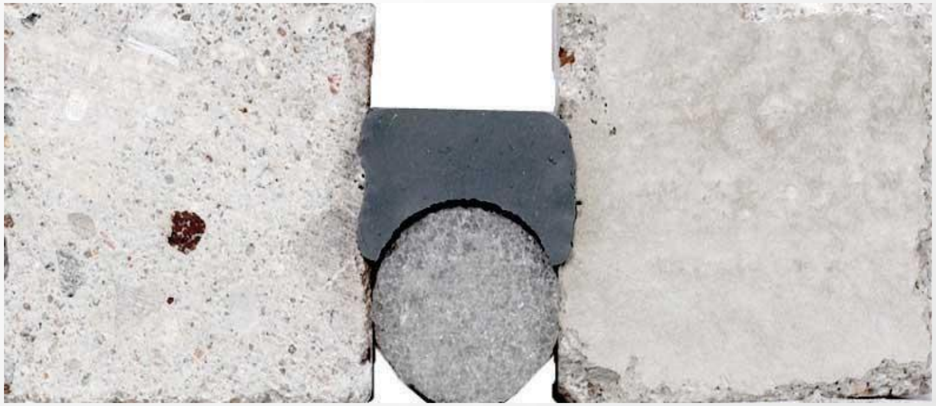
Delastic® Seal Catalog No.	Seal Characteristics			Joint Design Criteria			Typical Installed Width (A)**
	Nominal Width (W)	Nominal Height (H)	Max. Movement [1]	Narrowest Opening [2]	Widest Opening [3]	Minimum Depth (B)	
E-437	**0.437** (11.11)	**0.937** (23.81)	**0.153** (3.88)	**0.219** (5.56)	**0.372** (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)

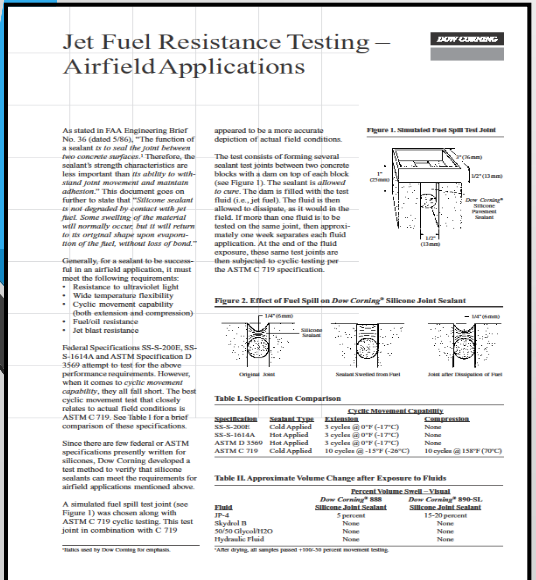
Above: *First number shown in bold represents inches, metric dimensions (mm) are shown in parentheses. Notes:*Thickness of the seal wall and internal web are not drawn to scale. 1 Maximum movement which seal will accommodate in joint with correct design. 2 A narrower opening will place excessive stress 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

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

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

Table I. Specification Comparison

Specification	Sealant Type	Cyclic Movement Capability: 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

Fluid	Percent Volume Swell – Visual: *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

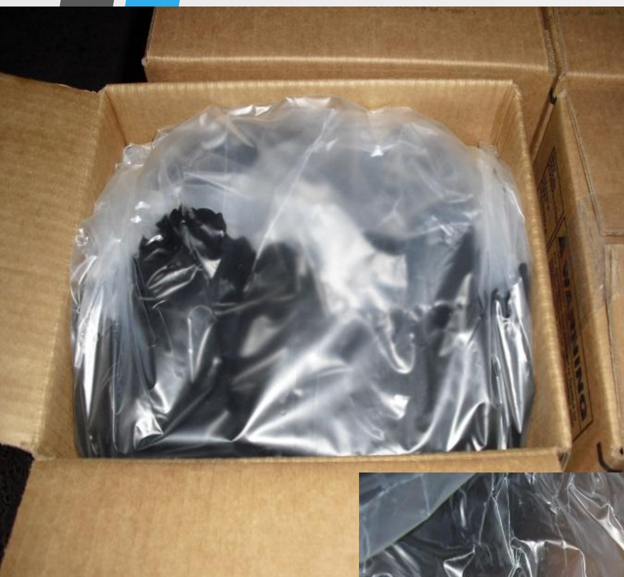
40° F Minimum Pavement Temperatures

Flush Fill, Recessed or Over-band

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

Shipping And Storing Materials

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.

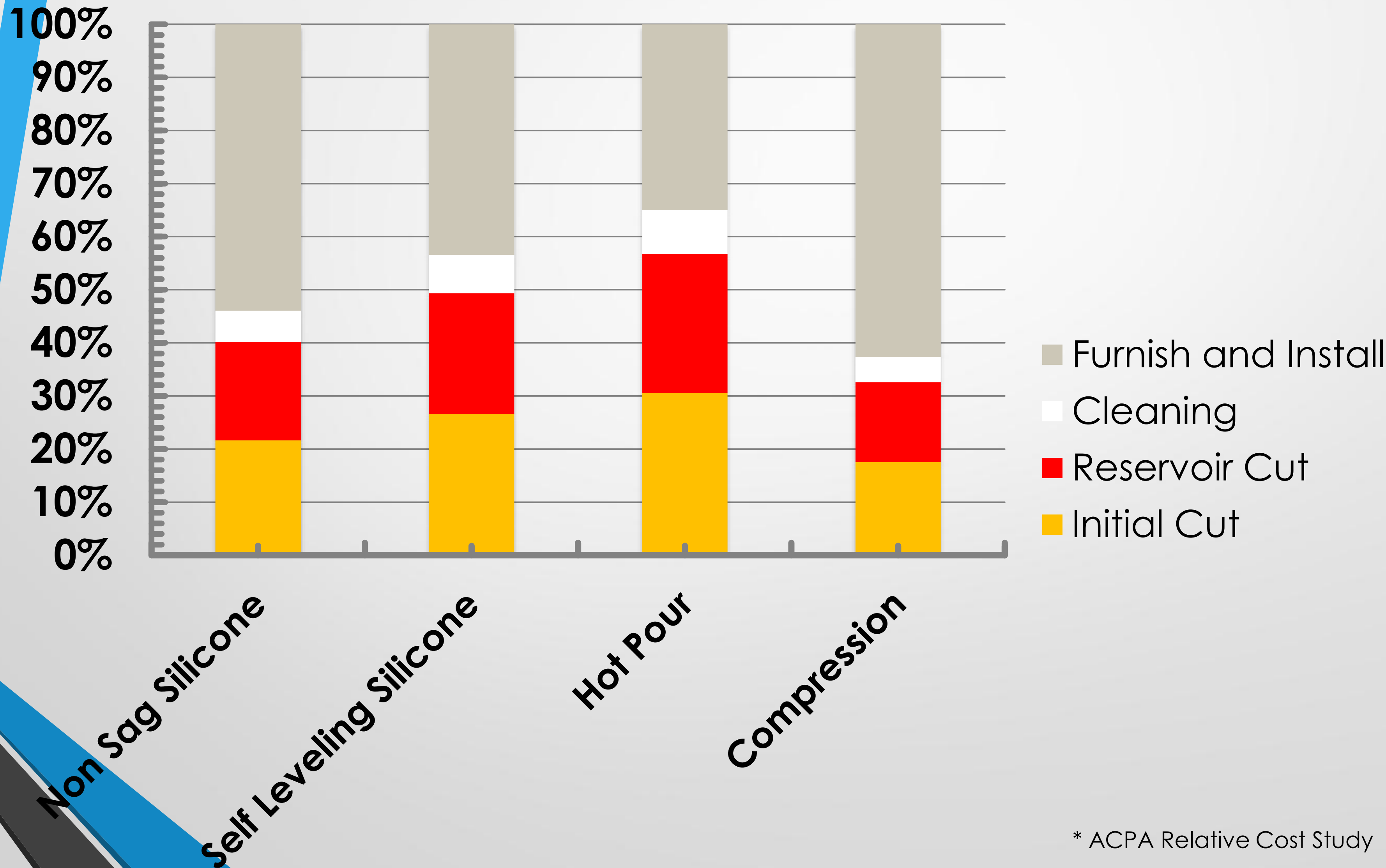
Keep out of excessive humidity

How Are Materials Tested?

- Certification
- Owner Laboratory
- Outsourced Testing

Joint Sealant Installation

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



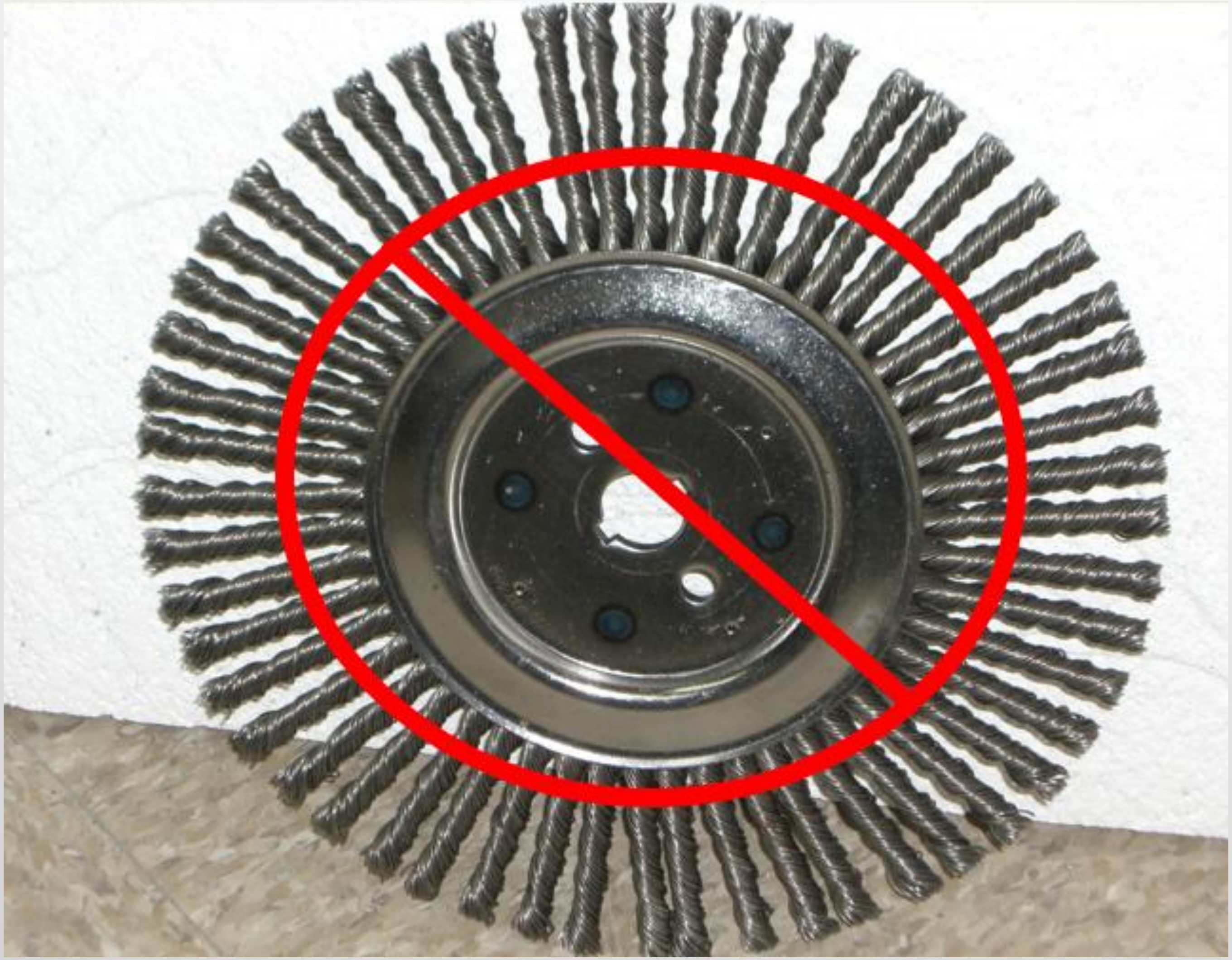
* ACPA Relative Cost Study

Power Washing After Green Sawing

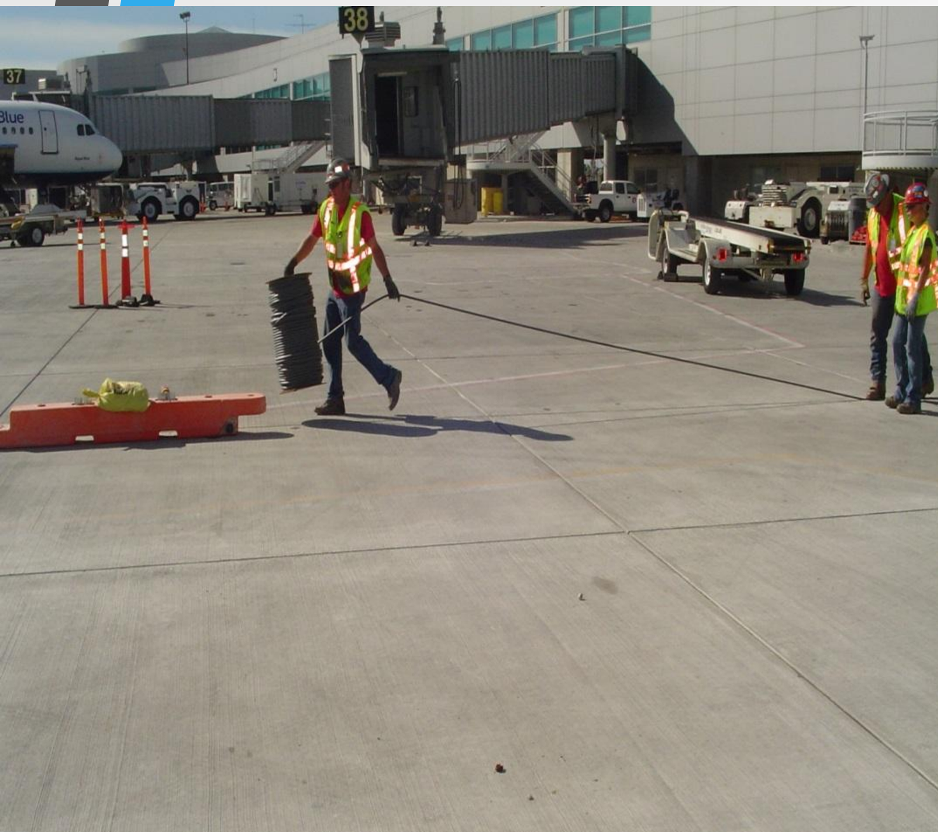
Media Blasting

Personal Protective Equipment

No Cleaning Brushes!



Inserting and Rolling Backer Rod

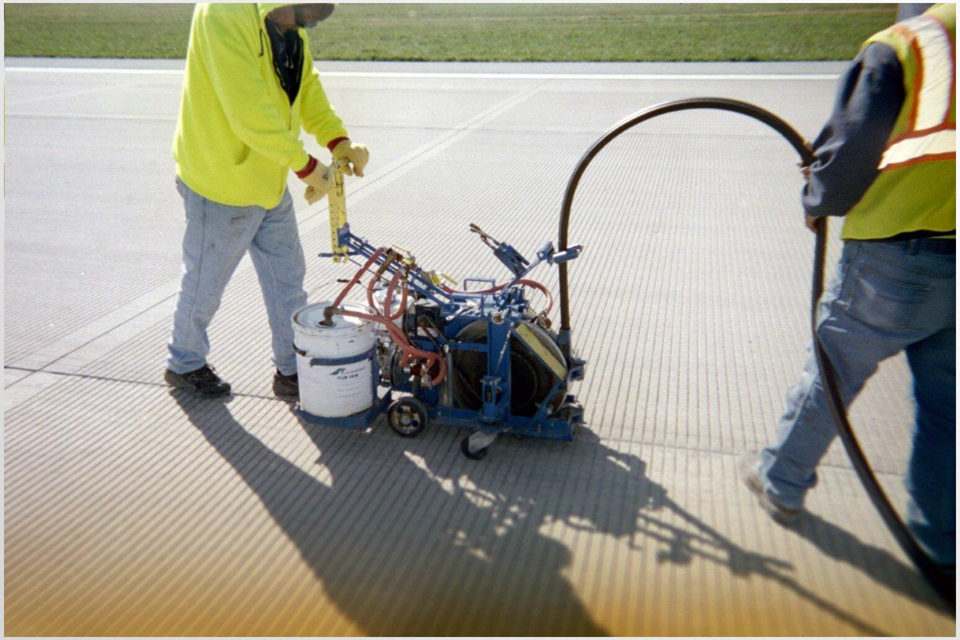


BACKER ROD

- 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

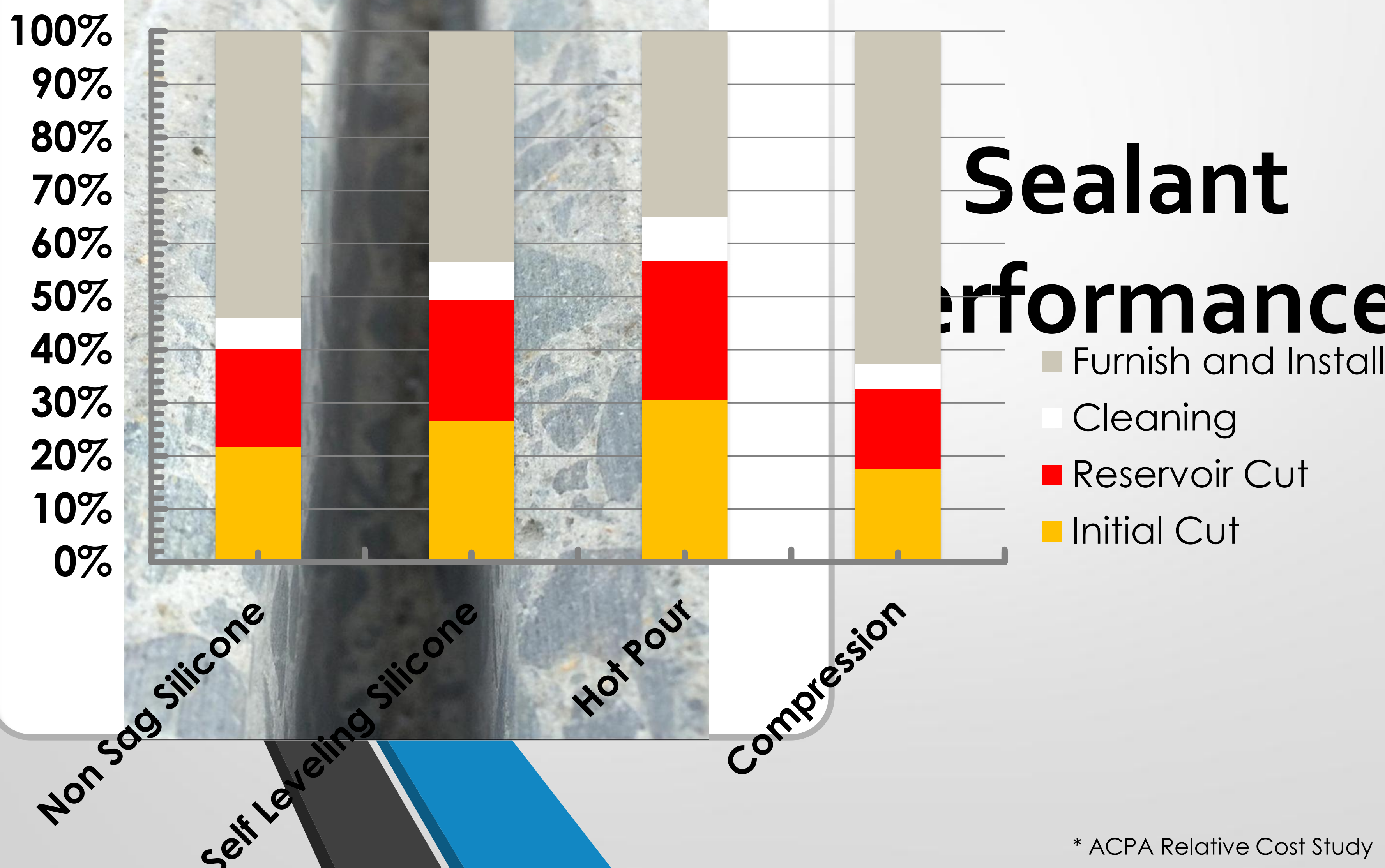
Compression Seal Installation



- 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

Sealant
erformance



* ACPA Relative Cost Study

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.

20 Year Old Hot Pour Sealant

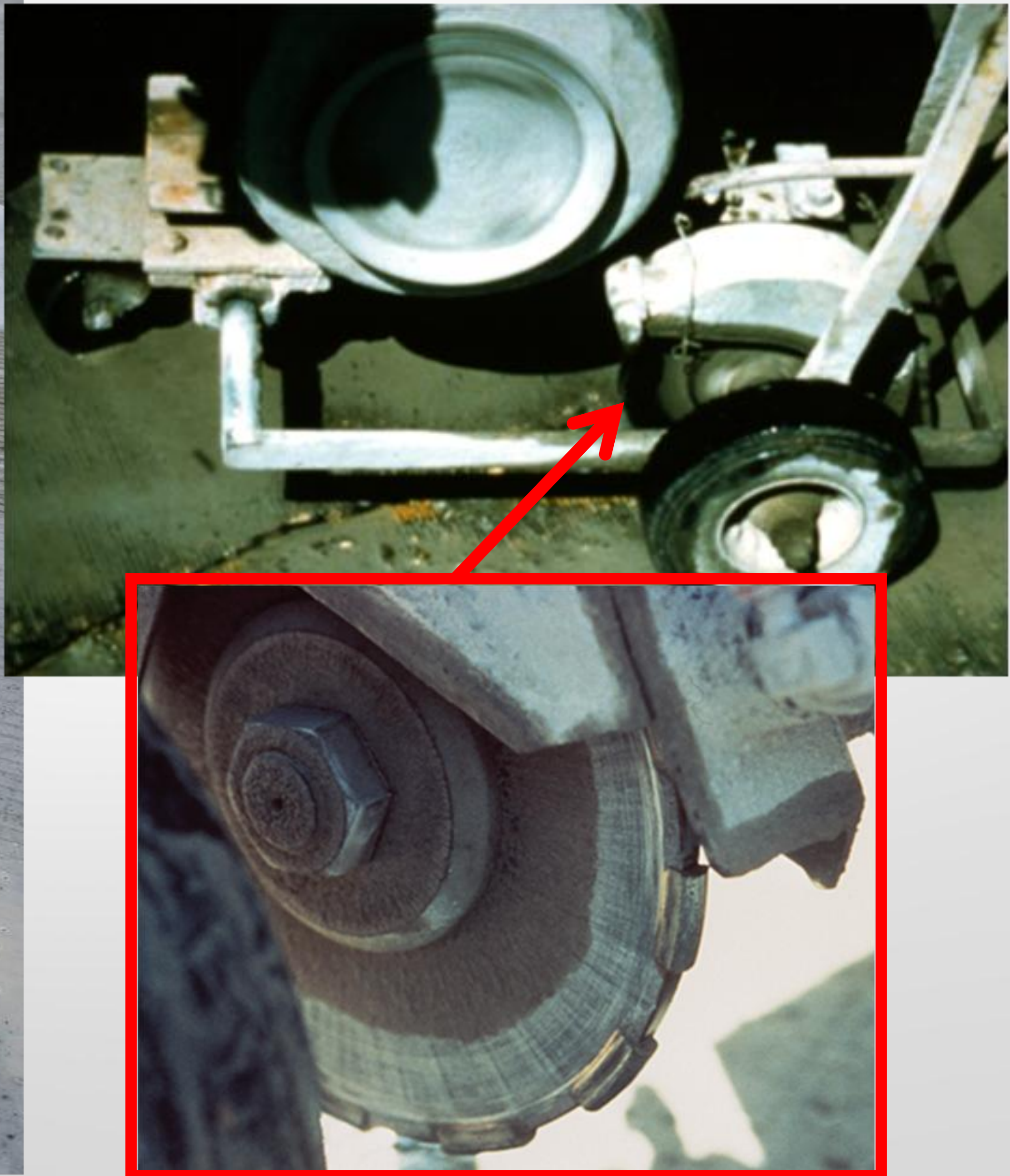
Can We Seal a Joint?

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



Routing Cracks In AC

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

Seal No Seal GROUP

Tech Brief

Proper Joint Preparation Prior to Sealing and Resealing Concrete Joints

Introduction

To seal or not to seal has been a strongly debated question for more than a quarter century. This debate has continued due to the variable performance of installed sealants and the inability to relate sealant condition to pavement performance[1].

Joint sealing has been a process in constructing concrete pavements for over a hundred years, yet the challenge of quality installation continues. With the introduction of the OSHA PM10 regulations (29 CFR 1926.1153), this challenge has become even greater with the need to ensure environmental worker safety.

The cost of cleaning joints amounts to about 5% to 8% of the total installed sealant cost; however, if done correctly, it can significantly increase sealant performance life[1]. Quality of installation may be the single most important factor in sealant performance.

The purpose of joint sealing is to reduce the amount of water entering a pavement structure and to prevent the filling of joints with incompressible materials. Water entering a pavement structure through joints can lead to pumping, faulting, base and subbase erosion, and loss of support. Unsealed joints also allow the introduction of deicing chemicals and other contaminants. Incompressible materials filling pavement joints can result in joint spalling, blowups/buckling, or shattered slabs.[2]

Independent of the type of sealant, or final joint configuration, the following steps should be used to ensure proper joint preparation prior to sealing and resealing operations.

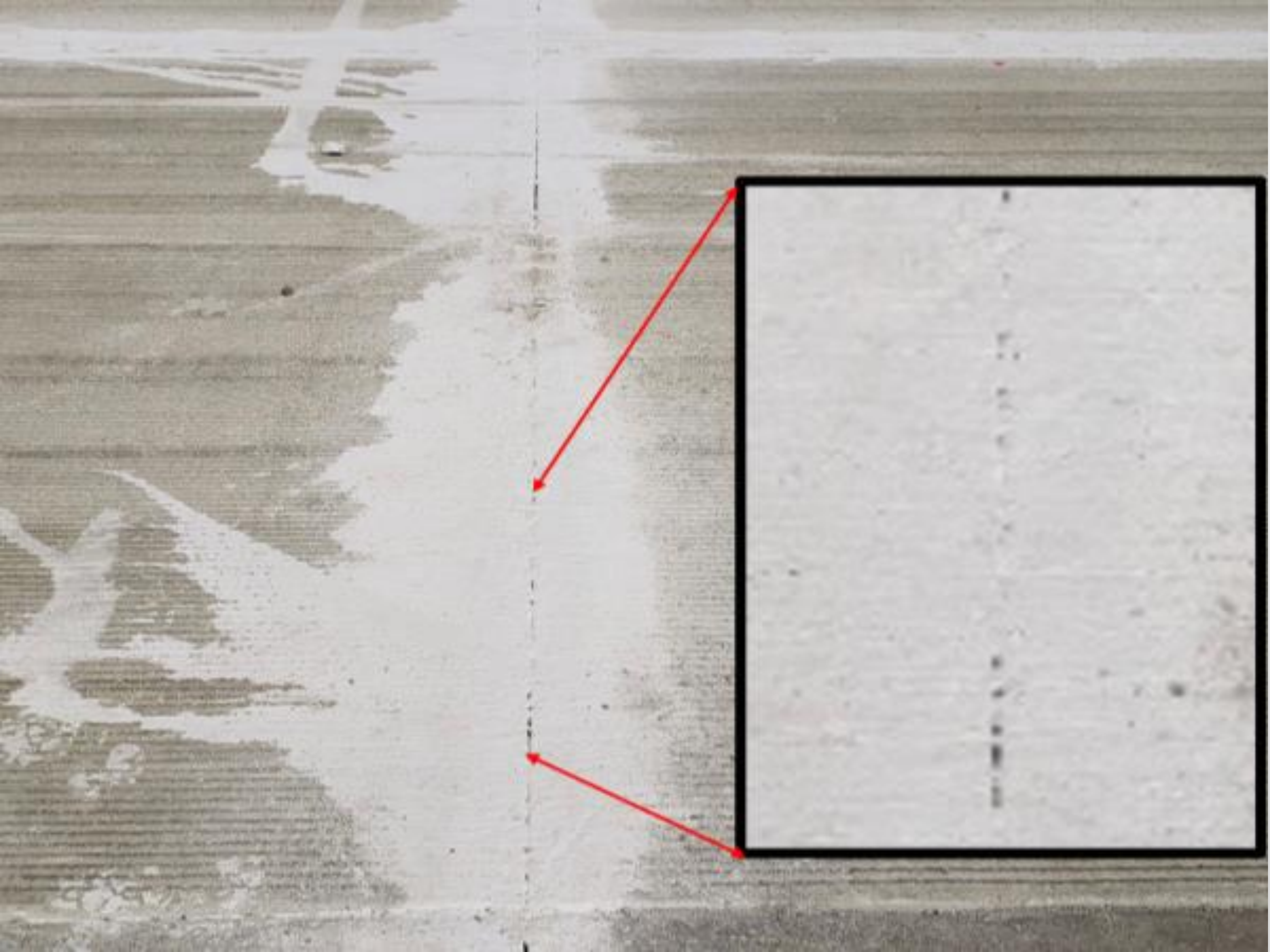
- Power wash joint immediately after "final" sawing
- Media blast joint faces followed by air blowing joints prior to sealant installation
- Visually check for cleanliness and moisture to approve workmanship – See RTU 17.01-2017 Wikipave.org
- Air blow joints again, just before backer rod and sealant Installation

Narrow joints are generally more difficult to clean and should be at least 3/16 inch minimum in width and preferably a minimum of 1/4 inch. (See SNS Tech Brief on Narrow Joints[1]).

Although some specifications indicate that a separate pass for each side of the joint should be made, for narrow joints, a single pass with an alignment nozzle has been successfully used[1] (see Figure 1). The alignment tool directs

Figure 1 Media Blast Alignment Fixture

Figure 2 Incompressibles Accumulating in Joint During Construction



Seal / No Seal GROUP

Tech Brief

The Use of Vacuums to Clean Sawed Pavement Joints

Introduction

Sawing joints in concrete pavements potentially exposes workers to respirable crystalline silica dust which may increase the risk of health issues. OSHA has standards designed to protect workers from these risks: Respirable Crystalline Silica Standard (29 CFR 1926.1153) and Respiratory Protection Standard (29 CFR 1910.134) among others [1,2,3].

This Tech Brief is not intended to address the health risks, but instead to provide information on devices which can be used to minimize them. Specifically, the use of vacuum equipment to extract slurry residue from the pavement surface and partially the joint.

Figure 1 Safety Warnings

Wet Sawing Vacuum Equipment

When properly conducted, wet sawing is acceptable under OSHA standards. However, once the slurry dries, it can become a problem if excessive amounts remain and there is a mechanism such as traffic or wind to make it airborne. In these situations, it may be desirable to use a vacuum during the sawing operation. Figure 1 is a photo of a contractor constructed vacuum system for wet sawing.

It should be noted that the equipment used for vacuuming wet sawing is different than that used for early entry sawing. In Figure 1, the slurry recovery tank can be seen in the upper right-hand corner of the photo. The slurry tank allows the vacuum to work continuously until the tank is full. No filters are involved in the retrieval process.

Vacuuming of joints is more common on airfield construction than on highway construction. Figure 2 indicates the cleaned joint after power washing and vacuuming.

Figure 1 Photo of Wet Saw Vacuum Pickup Equipment

Figure 2 Photo of Wet Saw Joint Condition After Power Washing and Vacuuming

Early Entry Saw Vacuum Equipment

Similar to wet sawing, if done properly, early entry sawing is acceptable under OSHA standards. However, Figure 3 indicates the remains from an early entry sawing operation without vacuuming. Obviously, based on environmental and traffic conditions at a given site, the dried slurry may pose a problem.

Figure 3 Photo of Concrete Remains from Early Entry Sawing without Vacuuming

Figure 4 is a photo of commercial vacuum equipment designed for early entry sawing. Note that this type of equipment uses HEPA filters that need to be cleaned out several times during a work shift to keep them functioning properly. Note also that there is a need for a second person to push the vacuum as with the wet saw vacuuming.

Figure 4 Photo of Early Entry Saw Vacuum Pickup Equipment

Figure 5 Photo of Early Entry Saw Joint With Vacuum Attachment

References

1. OSHA Fact Sheet, "OSHA's Respirable Crystalline Silica Standard for Construction", Occupational Safety and Health Organization, 2017
2. OSHA Fact Sheet, "Control of Silica Dust in Construction Walk-behind Saws", Occupational Safety and Health Organization, 2017
3. www.osha.gov/silica

Seal No Seal GROUP

Tech Brief

Filling Narrow Joints in Concrete Pavements

Introduction

Traditionally, sealing joints requires a specific sealant shape factor, backer rod, and reservoir cut. The reservoir cut is typically ¼" to 3/8" wide for highway applications. Sealant materials include hot pour, silicone, or compression seal (which does not use a backer rod).

In recent times, filling of narrow joints in concrete pavements has become more common. With this increased interest, it is important to understand the procedures and materials necessary to provide quality installations and acceptable performance.

Width of Initial Saw Cut

It is not possible to successfully install hot pour sealant in a 1/8" sawn joint. The product does not penetrate sufficiently into the joint as indicated in Figure 1. The volume of hot pour being placed is small, so it is difficult to control and often results in excess material on the surface.

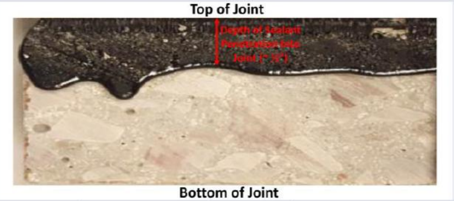


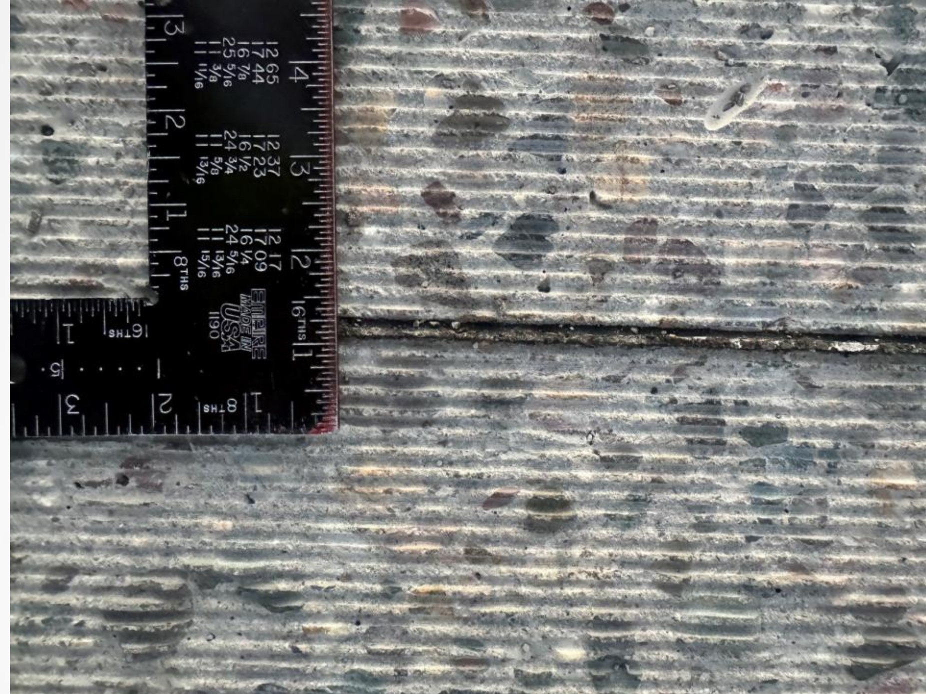
Figure 1 Hot Pour Penetration Depth

Figure 1 represents the sealant penetration into a 1/8" inch wide laboratory prepared joint sealant installation with a resulting penetration of approximately 1/2". Penetration into a 3/16" wide joint opening was at least two inches. The laboratory penetration results for both joint widths were based on an ASTM D6690 Type II sealant applied at the high end of the recommended application temperature.

Figure 2 indicates a core retrieved from a project which specified a 1/8-inch-wide joint width. Penetration was limited to ½ inch with a large deposit on the surface. This field result supports the lab results.

It is recommended that for new construction, a minimum blade width of 5/32" be used for contraction joints unless a second widening cut is to be performed. This also assumes that with shrinkage, the final joint opening width will be at least 3/16 inch before sealant installation.

Narrow Joint Installation



Questions