

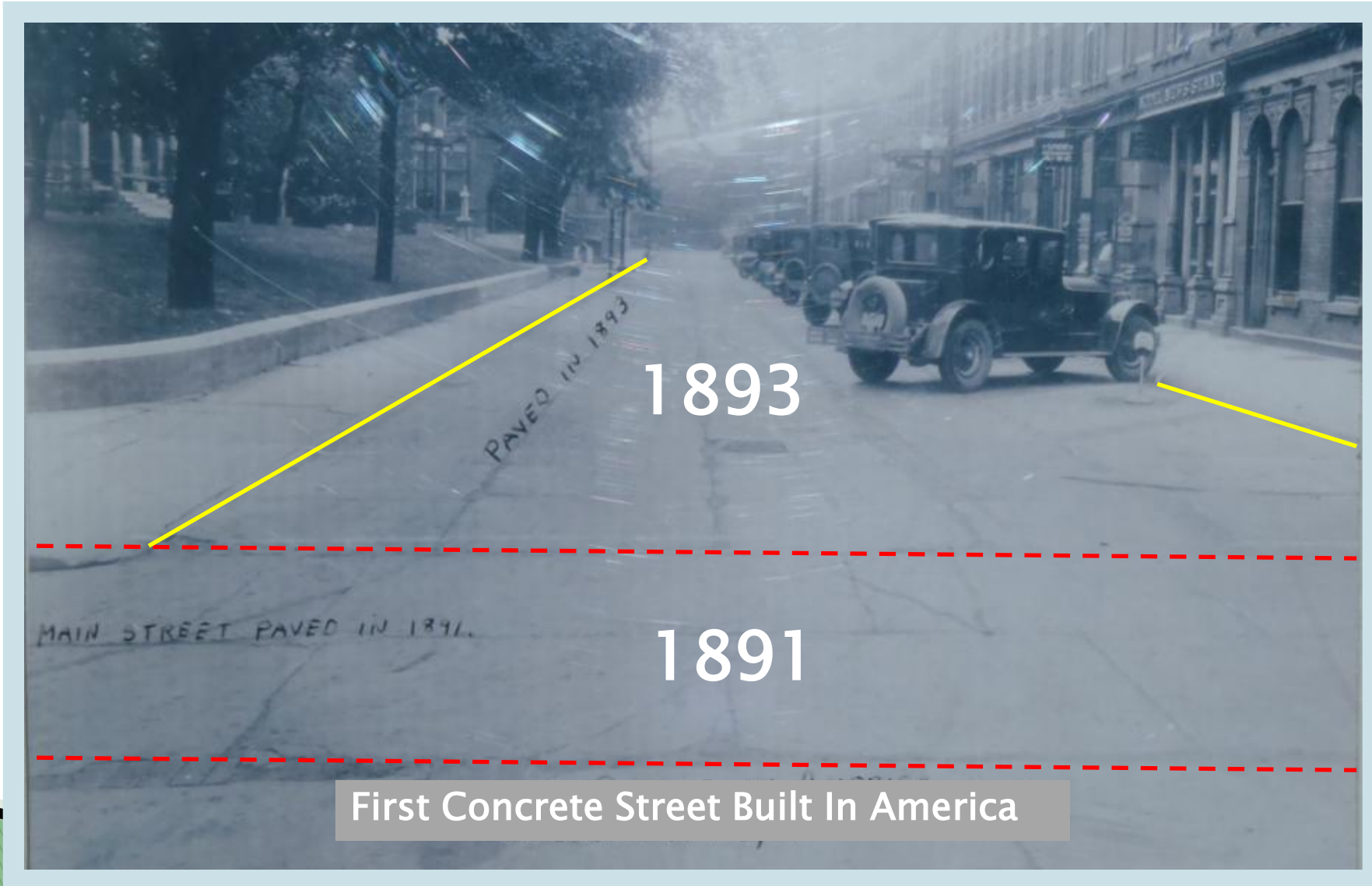
# Preserving Concrete Pavement

*Larry Scofield  
IGGA and ACPA*



# Why Concrete Pavement Preservation

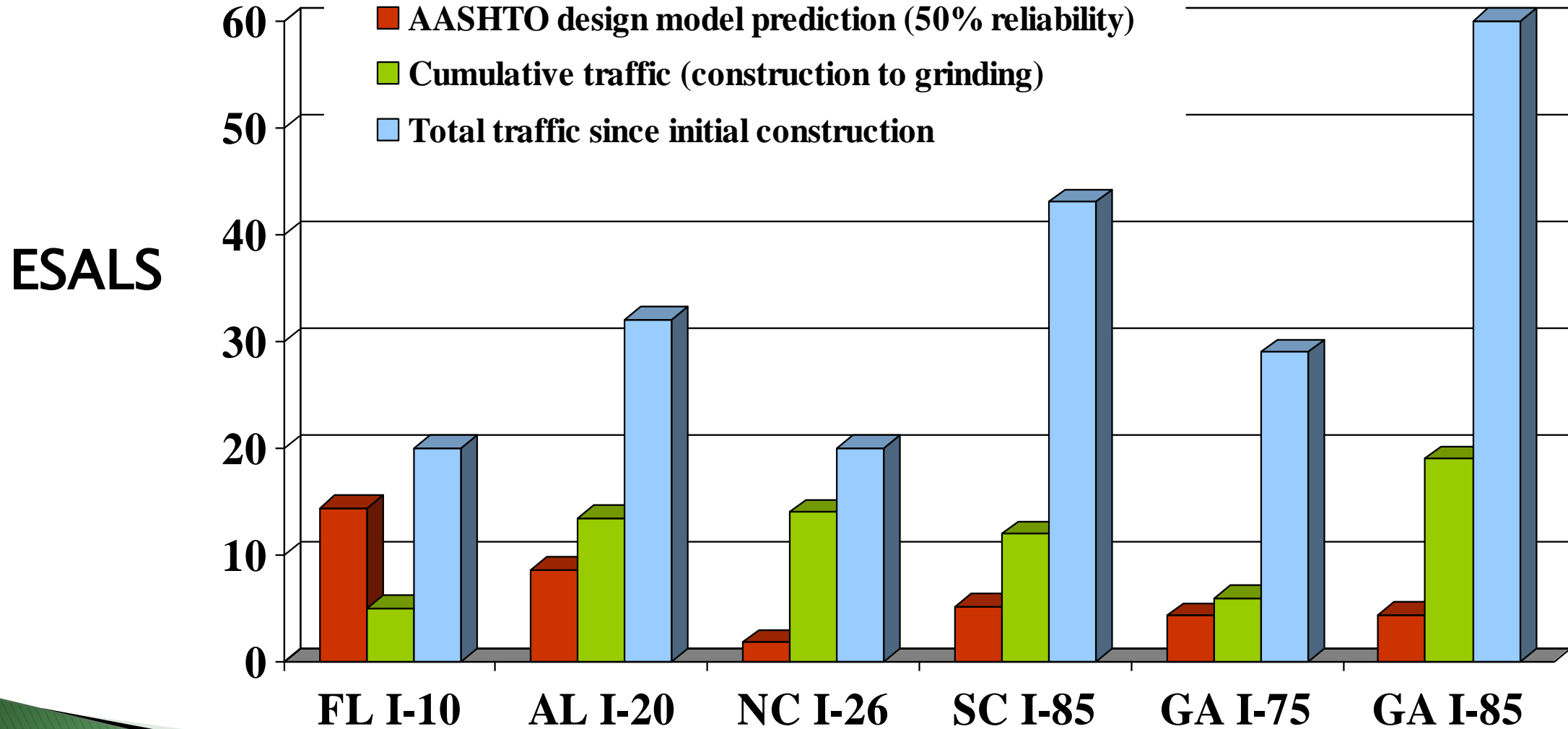
Bellefontaine, Ohio 1925



# 2023 = 130<sup>th</sup> Anniversary



# Design Life Vs Actual Performance



# Things to Remember About PMS and Concrete Pavement Preservation

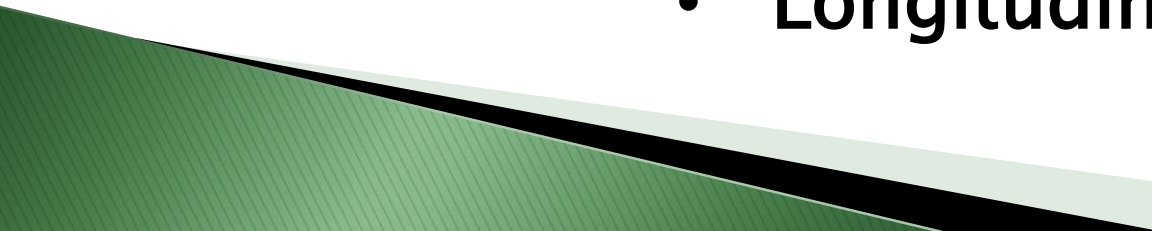


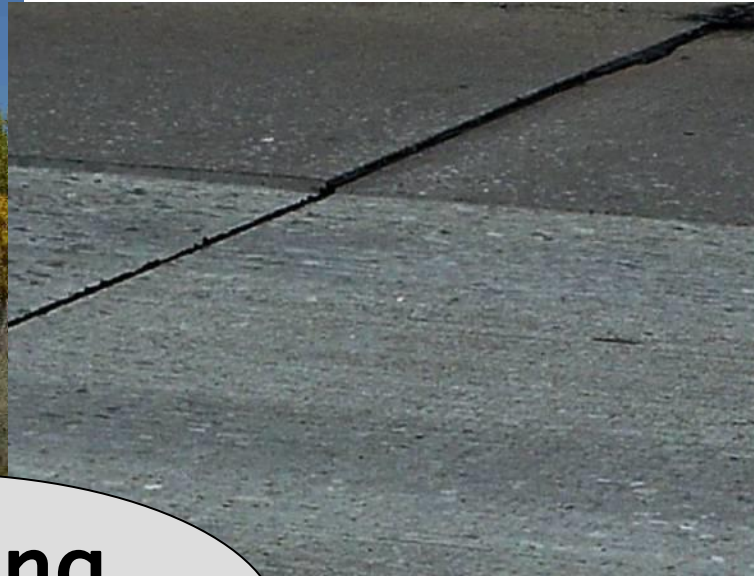
Photo Courtesy Amarjeet Benipal -- Caltrans

# Cradle to Grave Management!

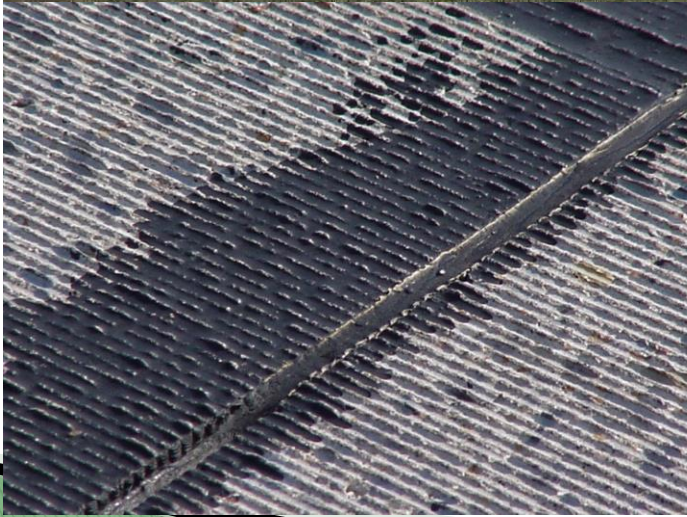


# Typical Concrete Preservation Activities

- Diamond Grinding or Diamond Grooving
  - Full Depth or **Partial Depth Repairs (Gordy Bruhn)**
  - Dowel Bar Retrofit
  - Joint Sealing or Resealing
  - Slab Jacking
  - Longitudinal Crack Stitching
- 



# Grinding Concrete



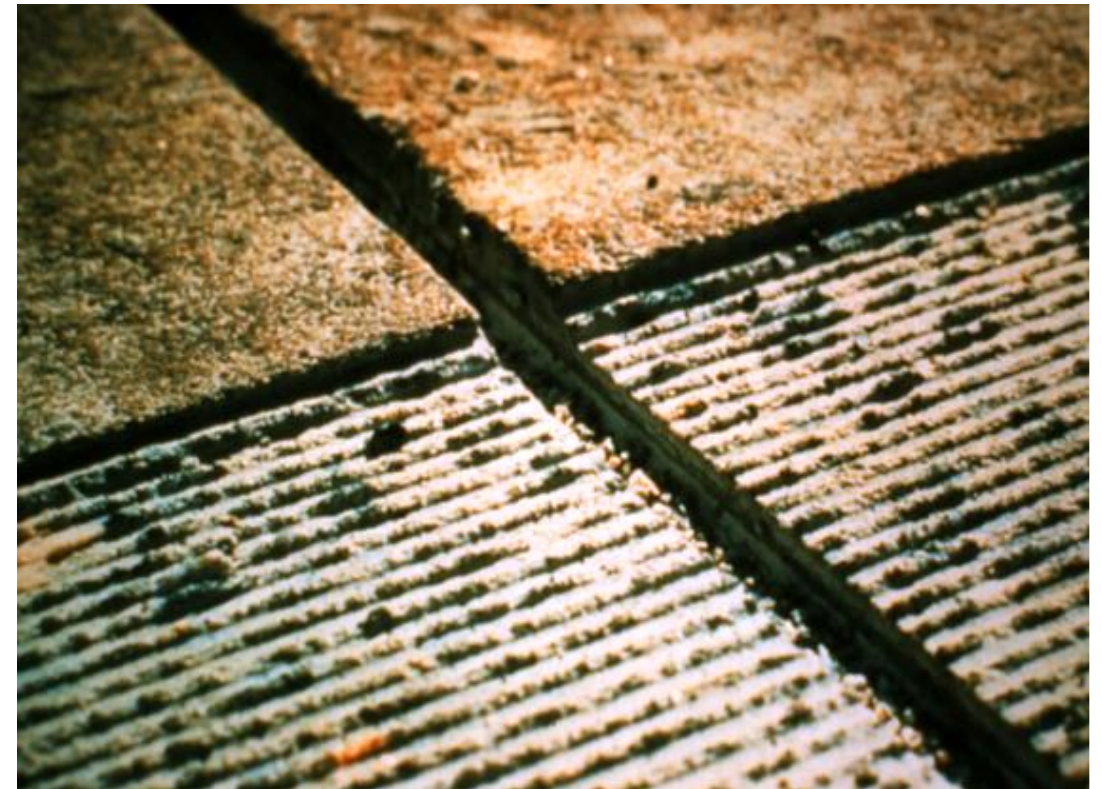


# Diamond Grinding

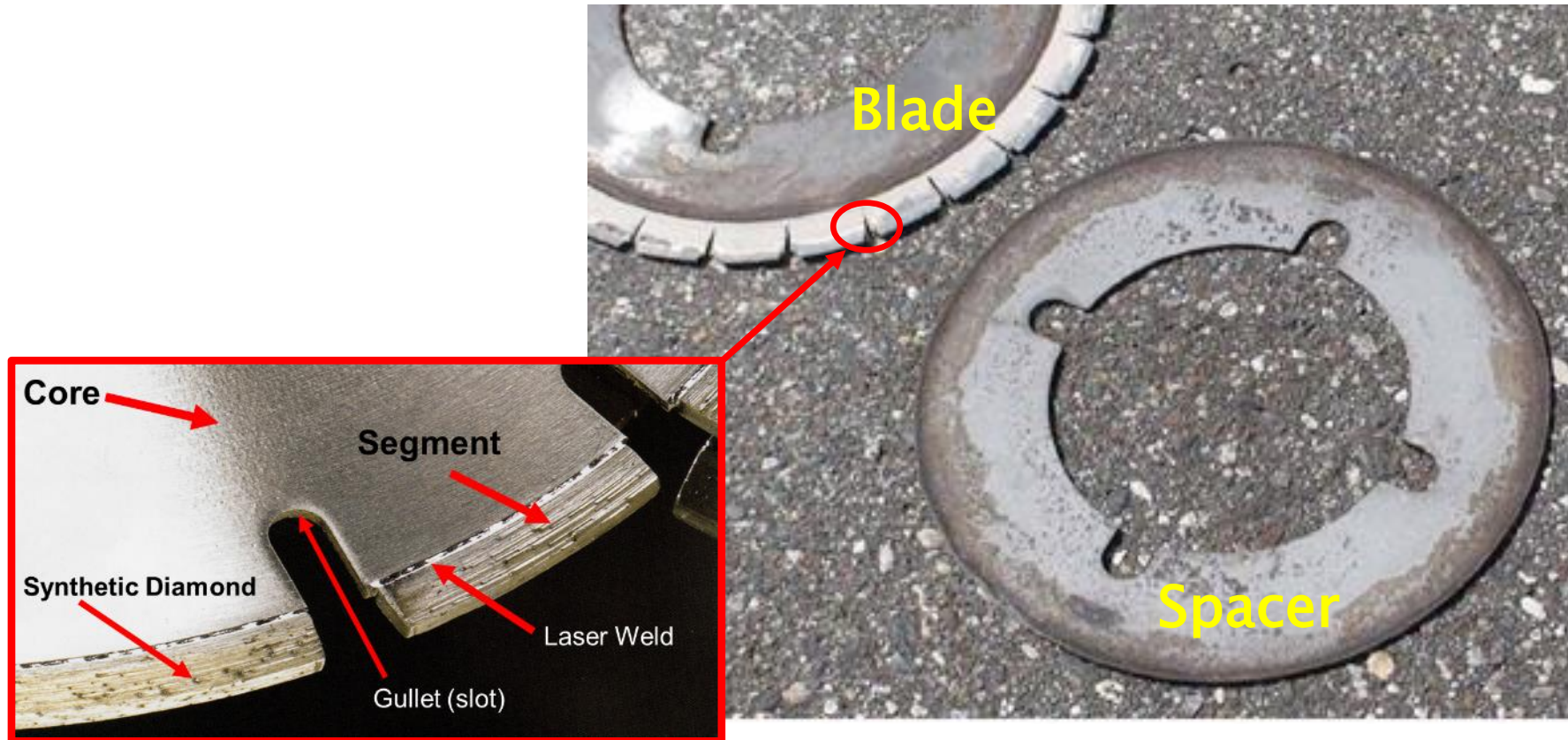


- Improves Friction
- Reduces Noise

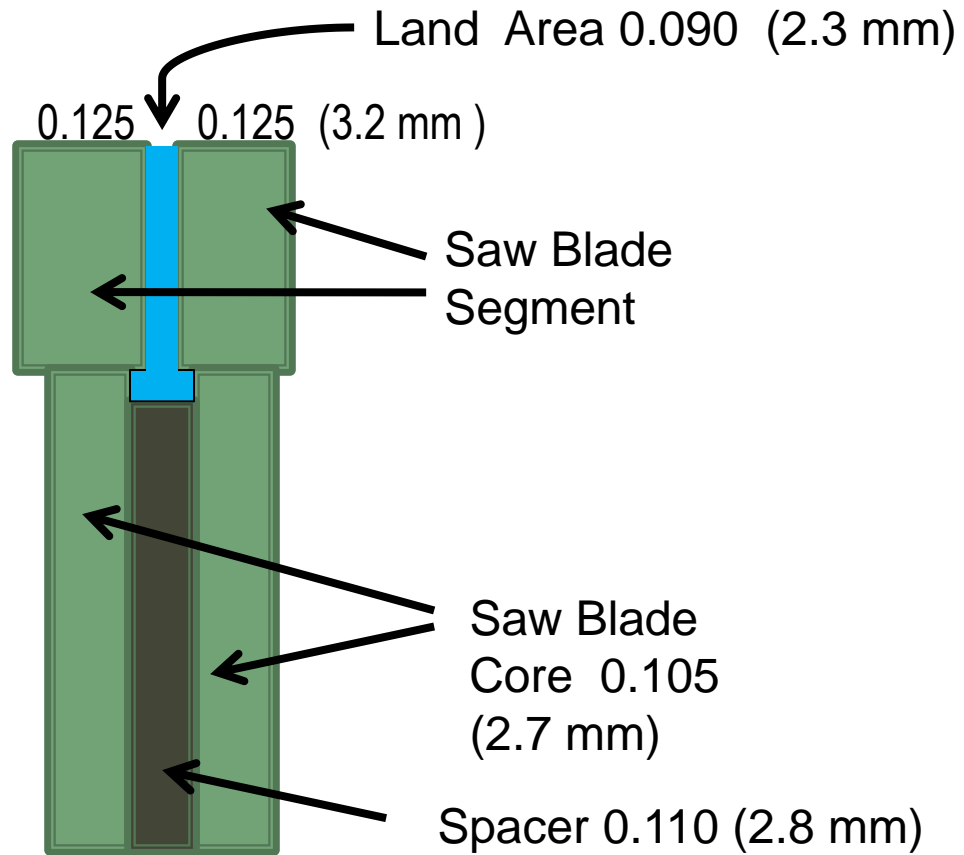
- Removes Faulting
- Improves Ride



# It all Starts with Blades and Spacers



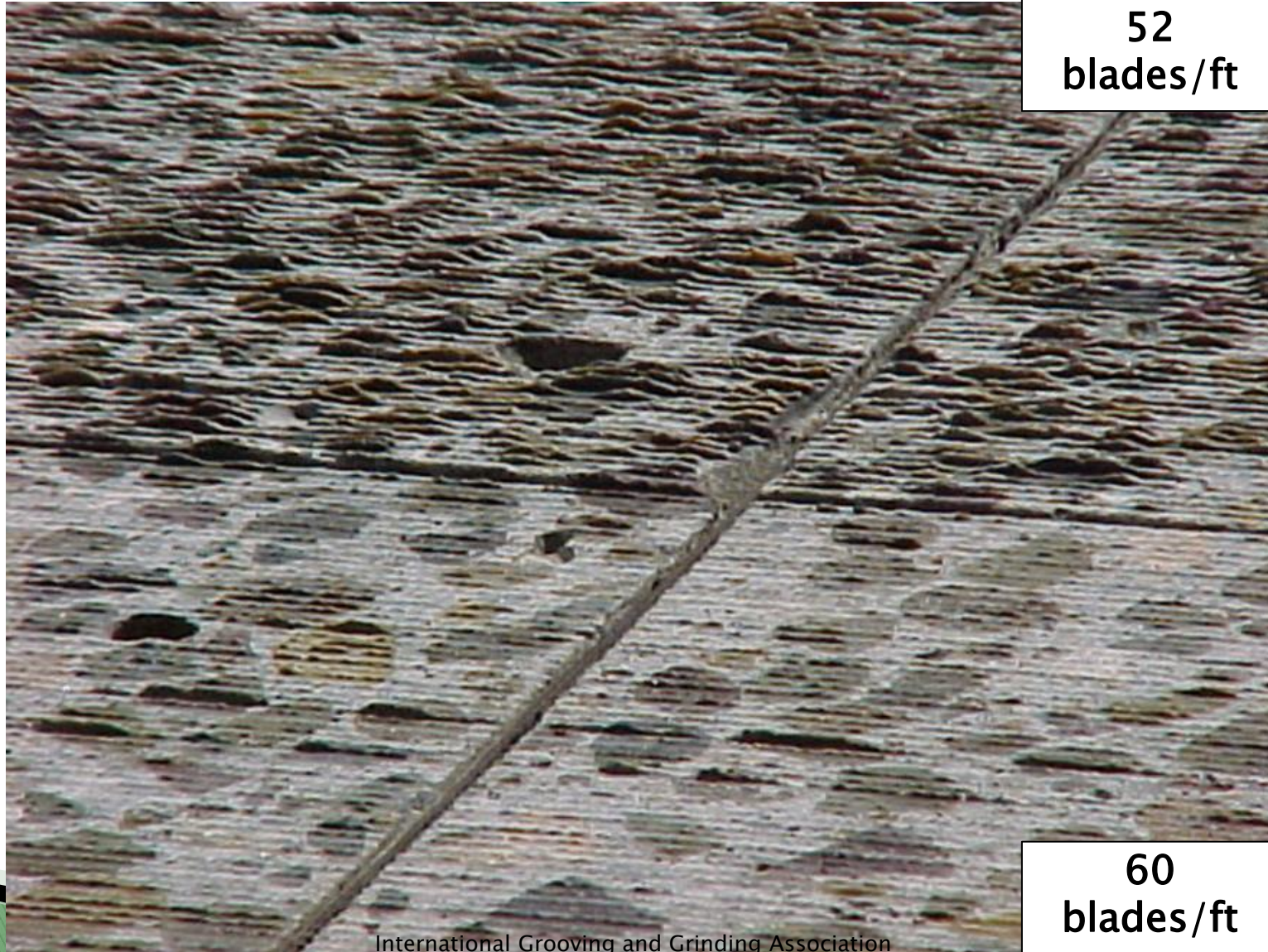
# Typical Conventional Diamond Grinding Blade Configuration



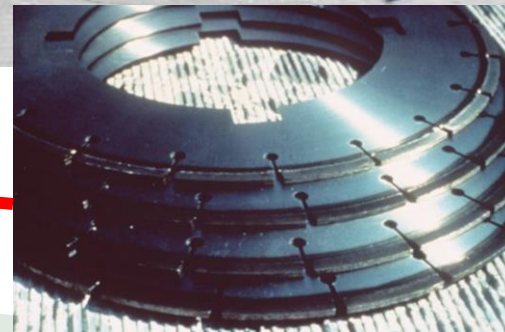
# The Spacers Create the Ridges (lands) in the Corduroy Texture



# Number of Blades Per Foot Matters!!!!



# Diamond Grinding Equipment

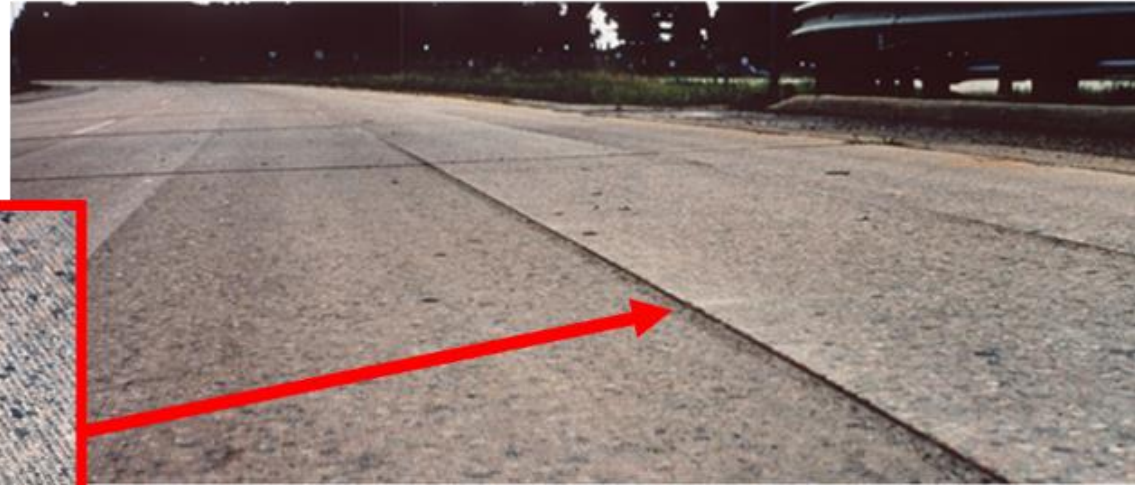
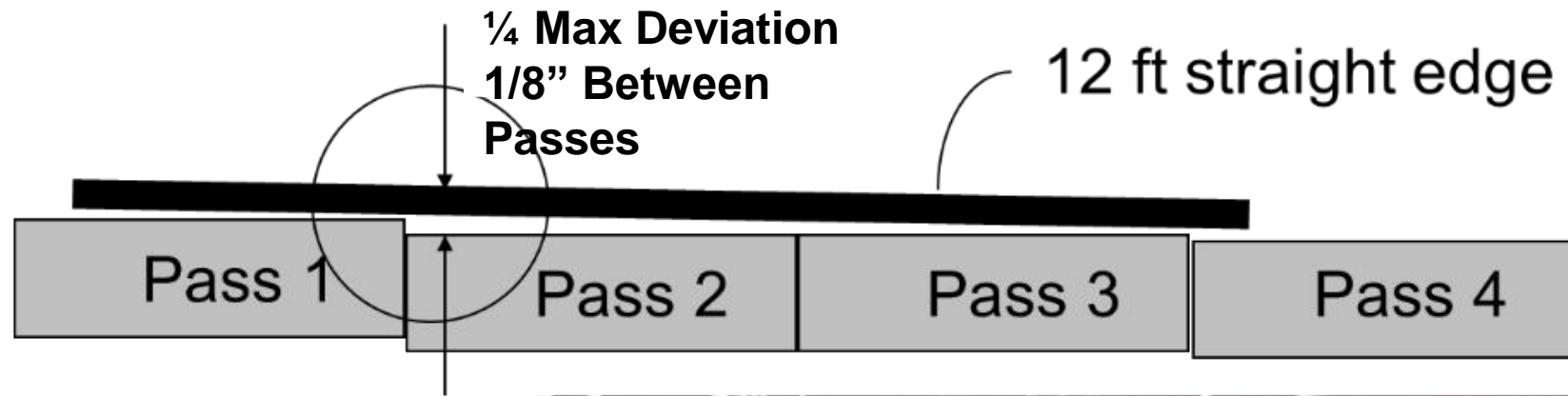


# The Grinding Operation (Urban)



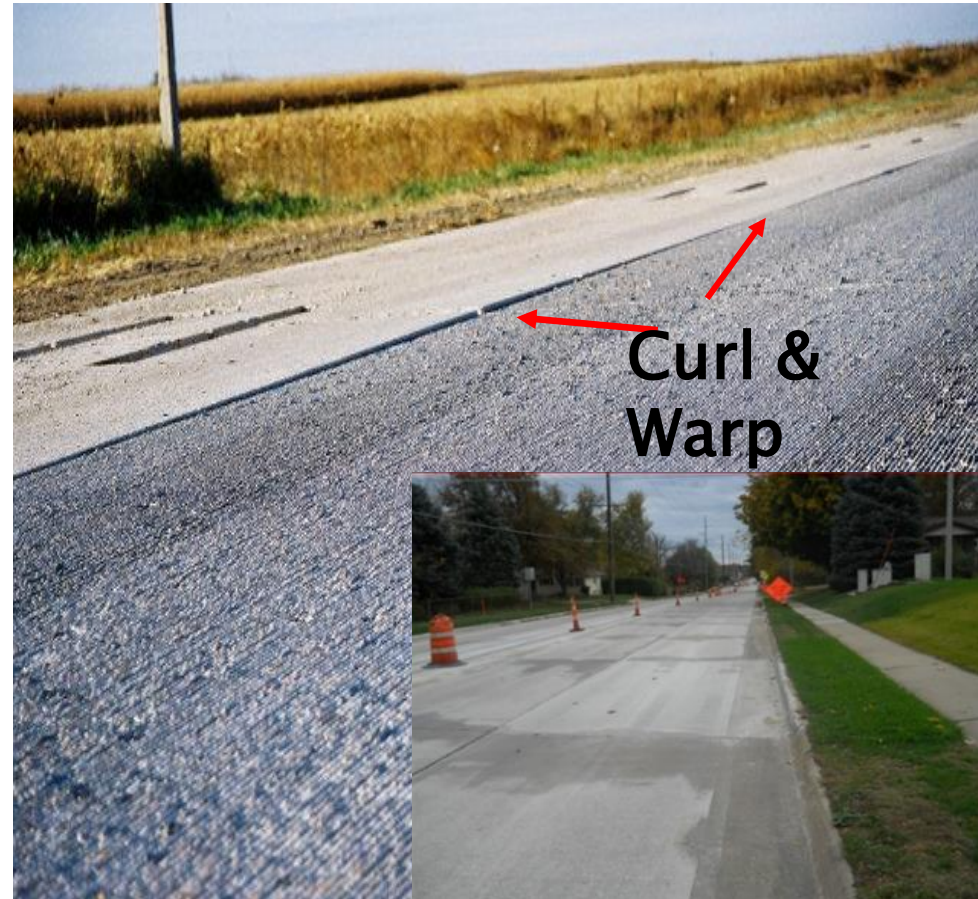
# Construction Inspection

## Poor Match Between Passes





# Percent Coverage (95%)



# Slurry Containment Vacuum

**Diamond Grinding Slurry**




**Slurry Recovery Failure**



**Proper Slurry Recovery System**

# Effectiveness of Diamond Grinding – CALTRANS





 **STATE OF CALIFORNIA**  
DEPARTMENT of TRANSPORTATION

**DIVISION OF  
ENGINEERING SERVICES**

**MATERIALS ENGINEERING  
AND TESTING SERVICES**

**OFFICE OF RIGID PAVEMENT  
AND STRUCTURAL CONCRETE**

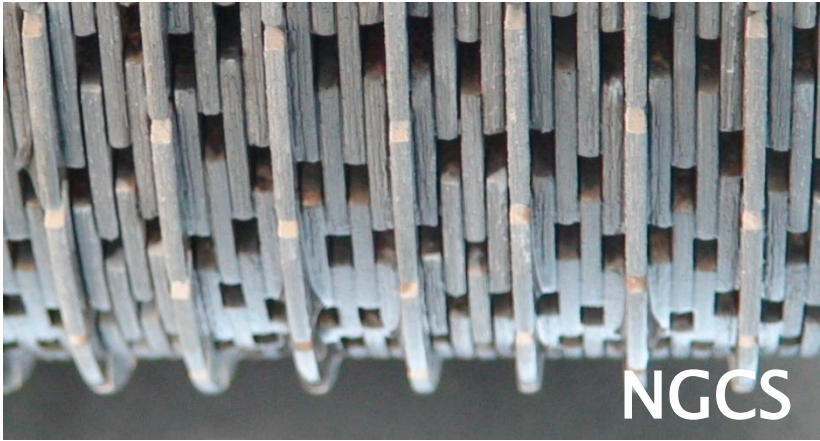
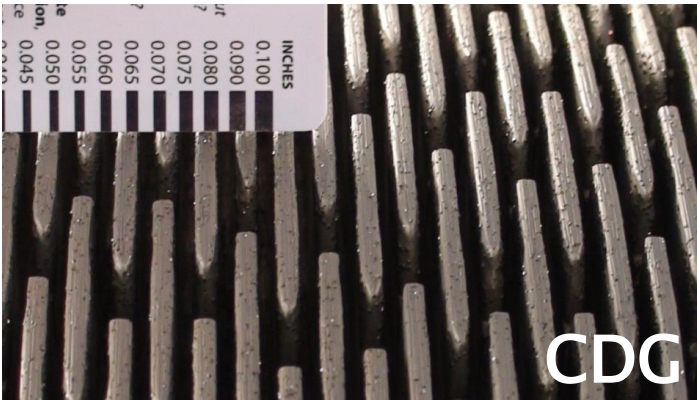
5900 Folsom Boulevard  
Sacramento, California 95819



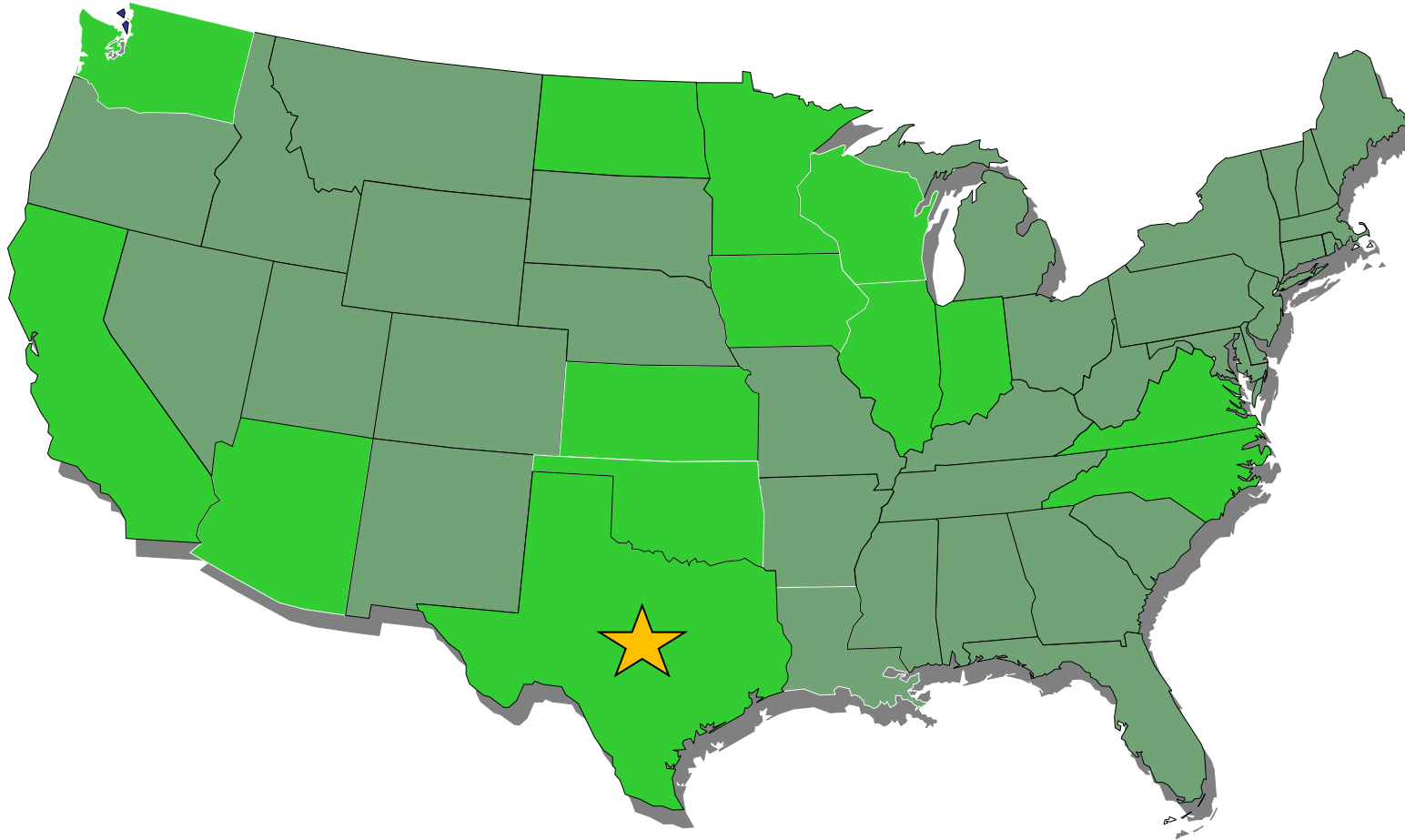
**THE EFFECTIVENESS OF DIAMOND GRINDING  
CONCRETE PAVEMENTS IN CALIFORNIA**

November 2004

# NGCS is a Diamond Grinding Procedure



# NGCS Site Locations in The USA



# Urban Areas Issues

## – Diamond Grinding –

Getting water and disposal of slurry

Difficulty in slurry disposal

Typically further Haul

May have to use treatment prior to disposal

Suburban level of expectation is more difficult-- grinding around manholes water valves Interchanges

Business entrances



Utility Adjustments  
are Optional

# Manholes Do Not Require Adjustment







# Rate of Sequestration Decreases With Time

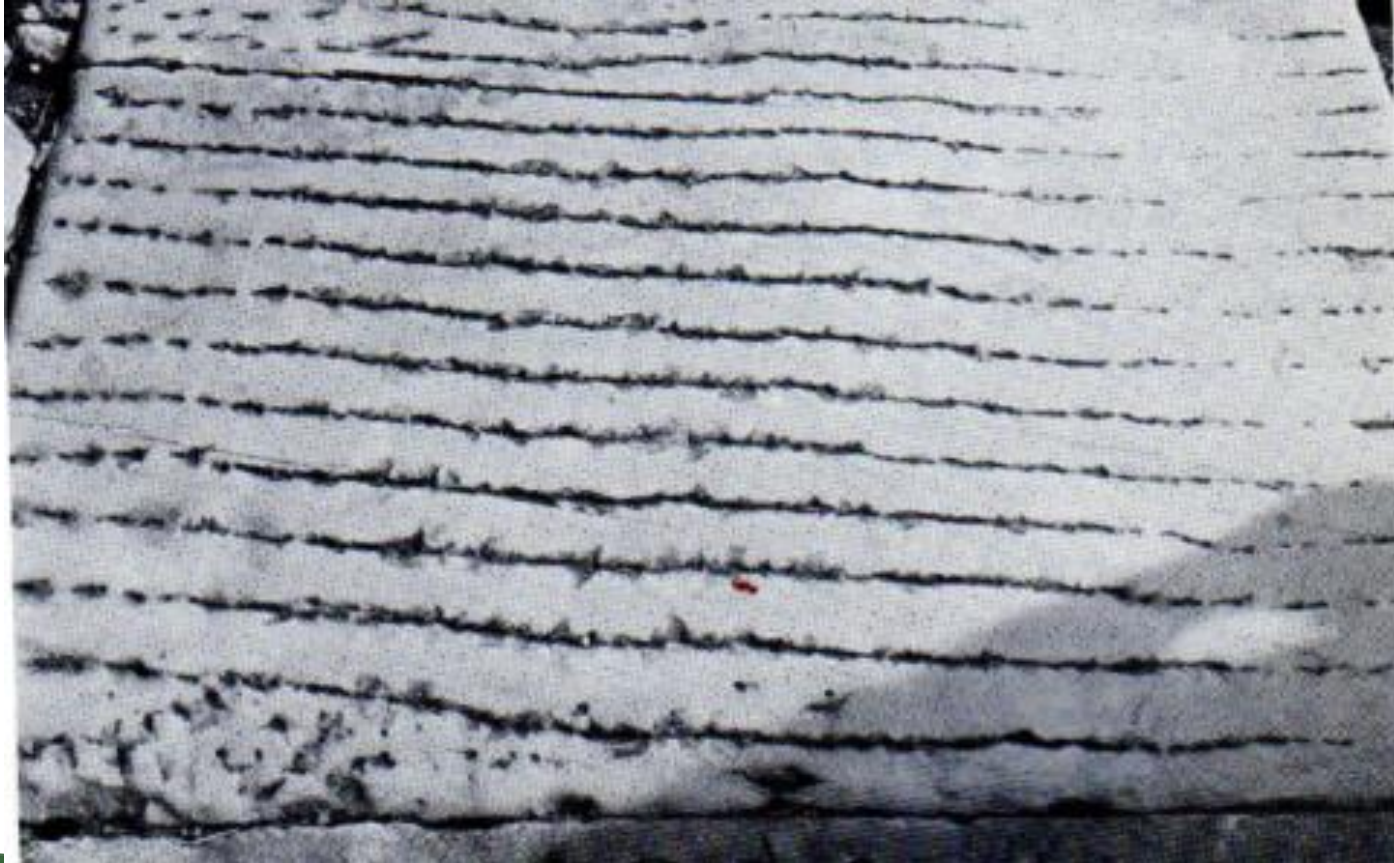
- Rate of carbonation related to the square root of time
- Roughly 45% of carbonation over 50 years occurs by Year 10
- Diamond grinding every 10 years will create a fresh surface for carbonation
  - Will more than double the amount of sequestered CO<sub>2</sub>
  - Accounting for GHG emissions associated with grinding, likely close to net zero
- Overlaying concrete with asphalt will shut out atmospheric CO<sub>2</sub> and terminate sequestration

Carbon sequestration is the removal or capture of carbon dioxide from the atmosphere to reduce atmospheric CO<sub>2</sub> pollution

Courtesy of  
Tom Van  
Dam

[www.ncenet.com](http://www.ncenet.com)

# Diamond Grooving!



**Grooves in Marble  
Streets in Asia Minor  
Settled by the Greeks  
in 8th Century BC.**

# Diamond Grooving

- Cutting parallel grooves into the pavement using diamond saw blades
- Longitudinal (more common) or transverse
- Benefits
  - Improved wet weather friction
  - Reduction in splash and spray



# Caltrans Early Report and Test Results

## Technical Report Documentation Page

1. REPORT No. 2. GOVERNMENT ACCESSION No. 3. RECIPIENT'S CATALOG No.

4. TITLE AND SUBTITLE  
Study Of The Effect Of Grooving On Motor Vehicle Accidents

5. REPORT DATE  
January 1972

6. PERFORMING ORGANIZATION

7. AUTHOR(S)  
Darryl R. White

8. PERFORMING ORGANIZATION REPORT No.

9. PERFORMING ORGANIZATION NAME AND ADDRESS  
State of California  
Business and Transportation Agency  
Department of Public Works

10. WORK UNIT No.

11. CONTRACT OR GRANT No.

12. SPONSORING AGENCY NAME AND ADDRESS

13. TYPE OF REPORT & PERIOD COVERED

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT  
Grooving has proved to be one of the most cost-effective safety programs of the Department of Public Works. Grooving has contributed greatly to savings in lives, injuries and dollars for the travelling public. Rainfall is comparatively moderate in California but the accident rate is four times greater on wet pavement than on dry pavement. This is one of the problem areas for which a positive solution has been found.

The Department of Public Works' accident experience reveals that grooving has yielded a:

- 1) 20 percent reduction in total accidents
- 2) 50 percent reduction in fatal accidents
- 3) 70 percent reduction in wet pavement accidents

Motorcycle accident reports were reviewed from both grooved and ungrooved sections. Abstracts of these reports are given in the following pages. They show little evidence that grooves constitute a hazard to

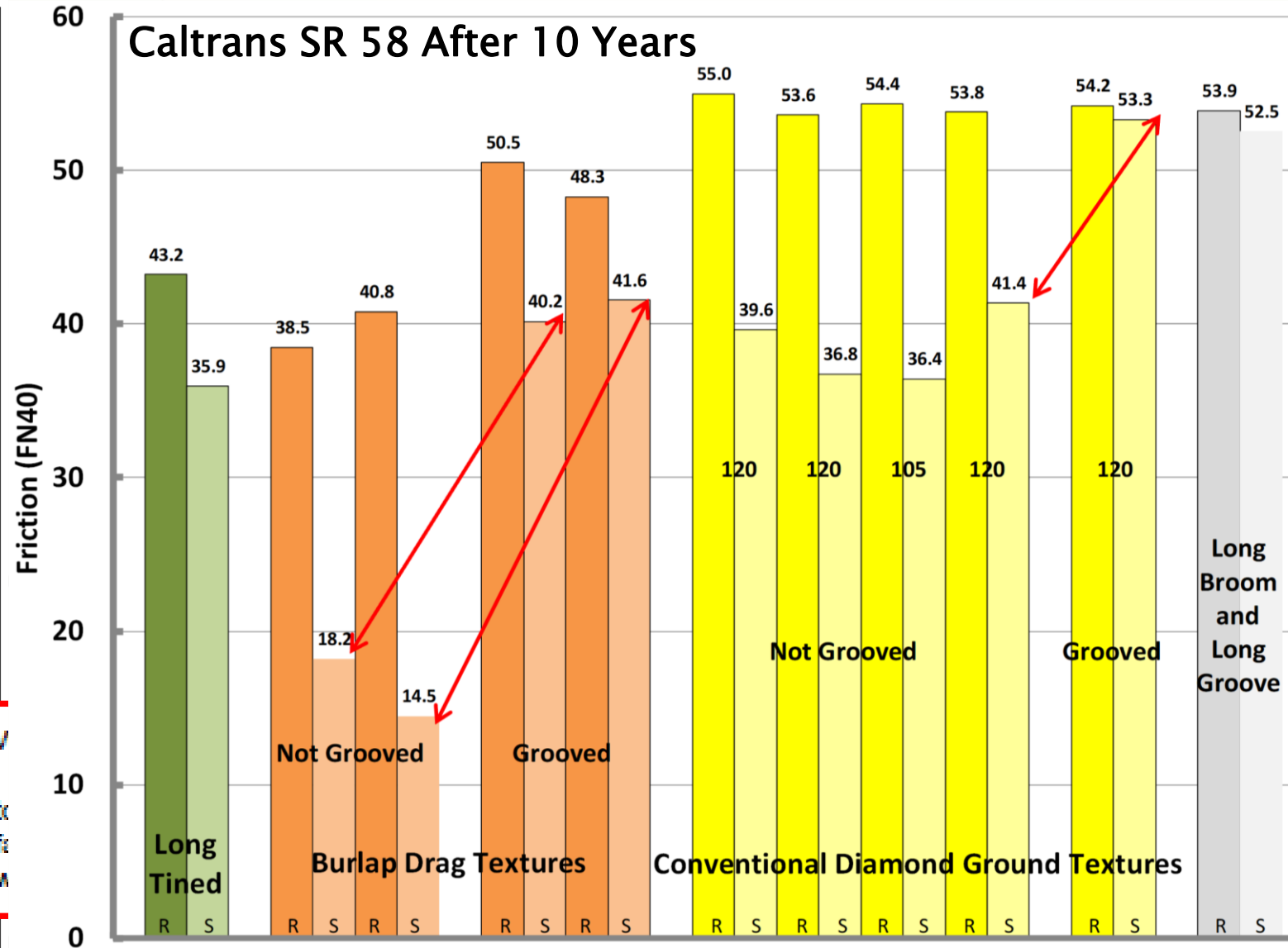
17. KEYWORDS

18. No. OF PAGES: 54 19. DRI WEBSITE LINK  
<http://www.dot.ca.gov/hq/research/researchreports/1>

20. FILE NAME  
72-69.pdf

This page was created to provide searchable keywords and abstract text for older scanned research reports.  
November 2005, Division of Research and Innovation

## Caltrans SR 58 After 10 Years



# Splash and Spray Durability

**ARFC**



**Longitudinally Grooved PCCP**



**March 2006 after 143 Days w/o  
Rain**



**Full Depth  
Repair**



# Full-Depth Repairs

- ▶ “Workhorse” treatment
- ▶ Removal/replacement of concrete pavement at deteriorated joints/cracks
- ▶ focus on workmanship
  - Dowel bar installation
- ▶ Need for rapid opening times
  - Accelerated materials
  - Precast repairs

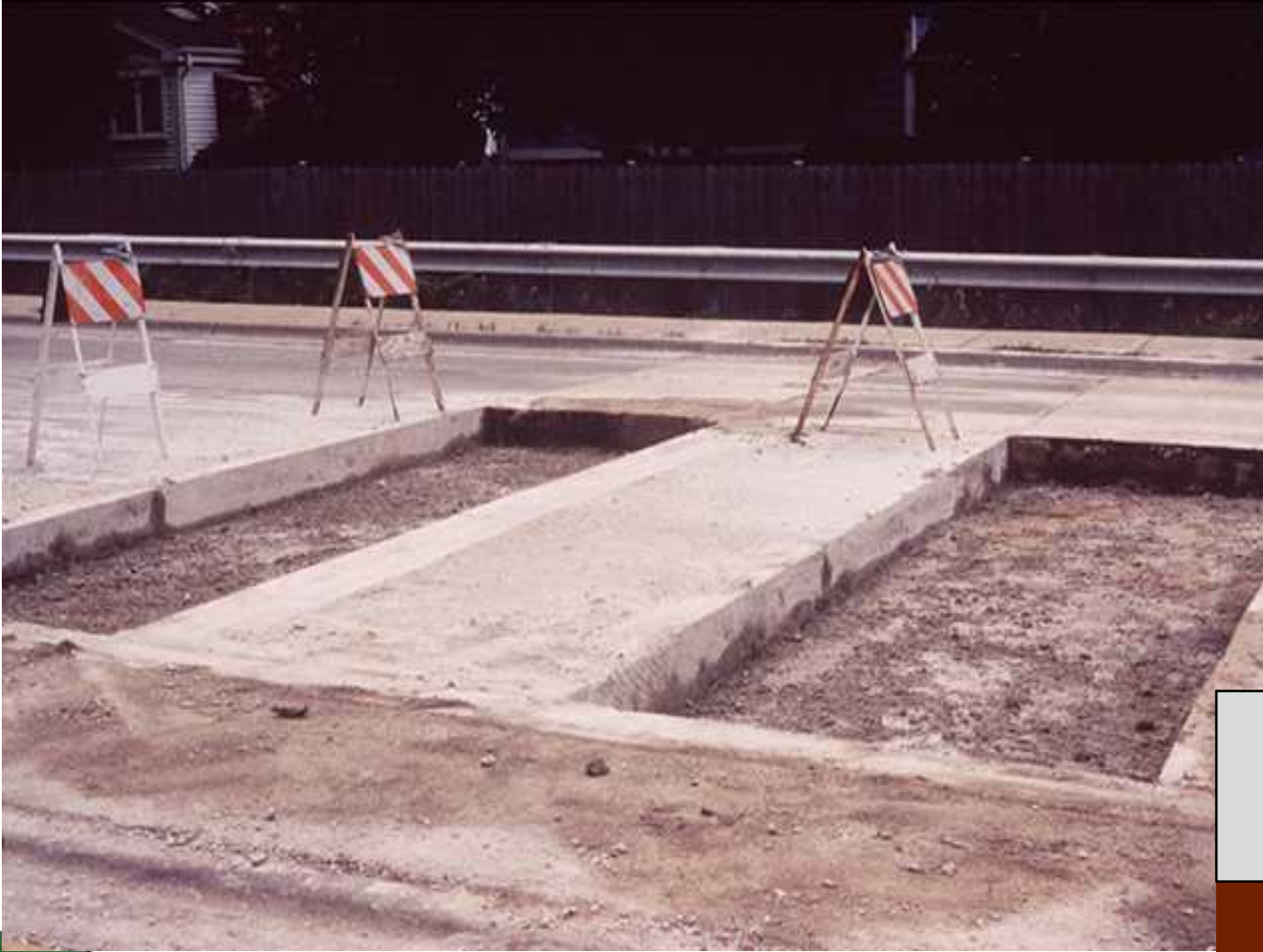




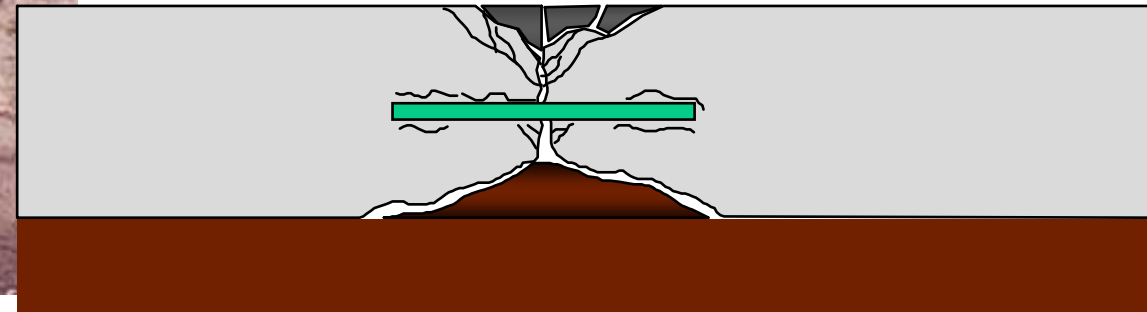
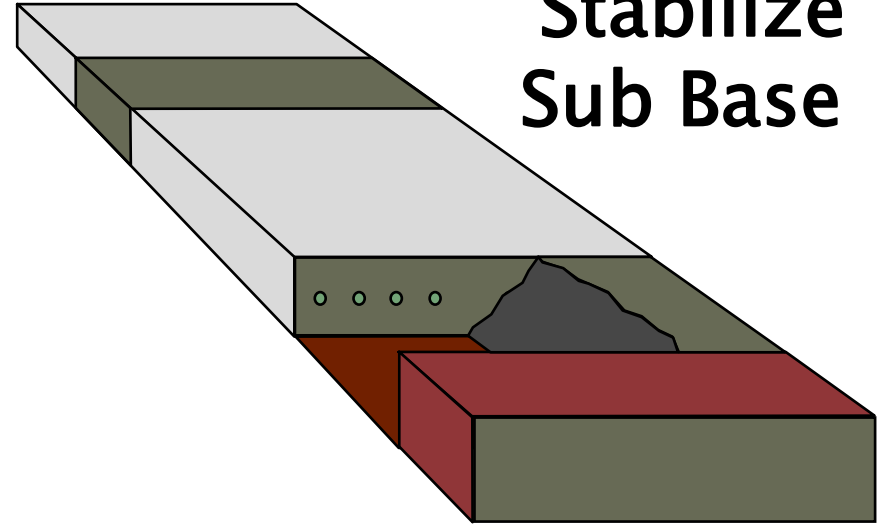
# Full Depth Repair



# Full Depth Repair



May also need to:  
Stabilize  
Sub Base



# Full Depth Repair



# Installing Steel Dowels



# Placing and Completing a Full Depth Repair

■ **Step 1:  
Place Concrete**



■ **Step 2:  
Finish & Texture**

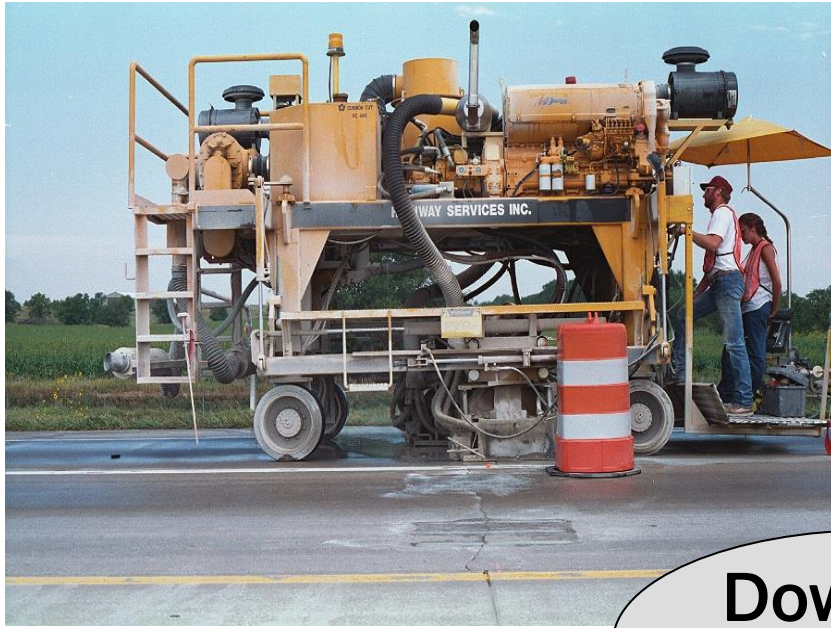


■ **Step 3:  
Cure Concrete**

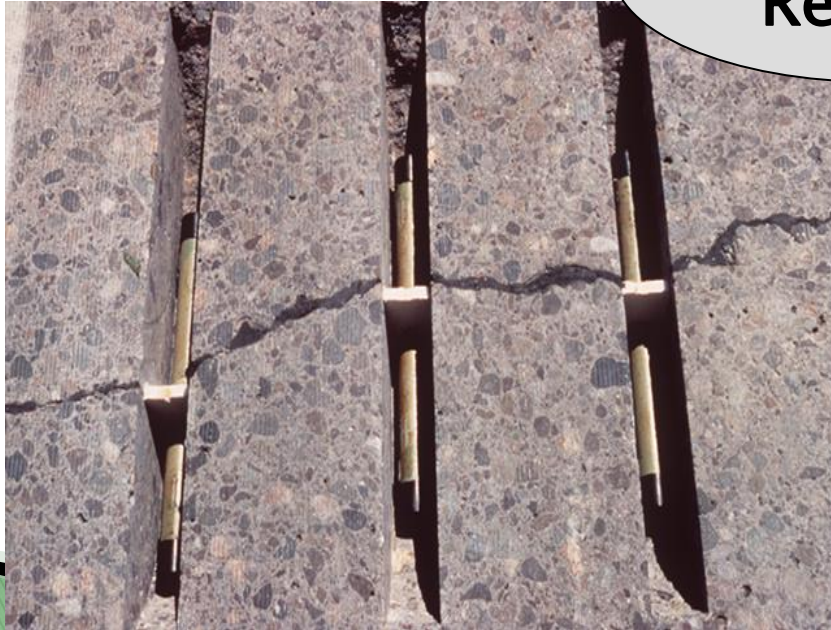


■ **Step 4:  
Saw & Seal**

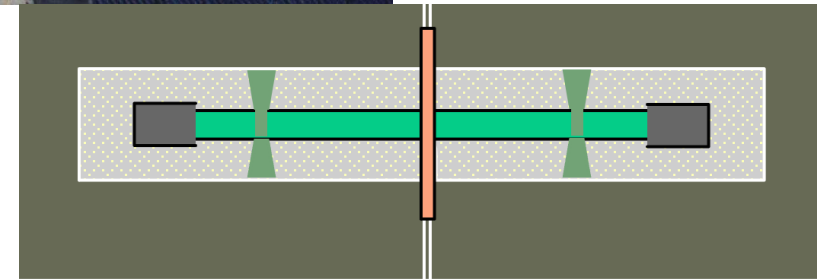
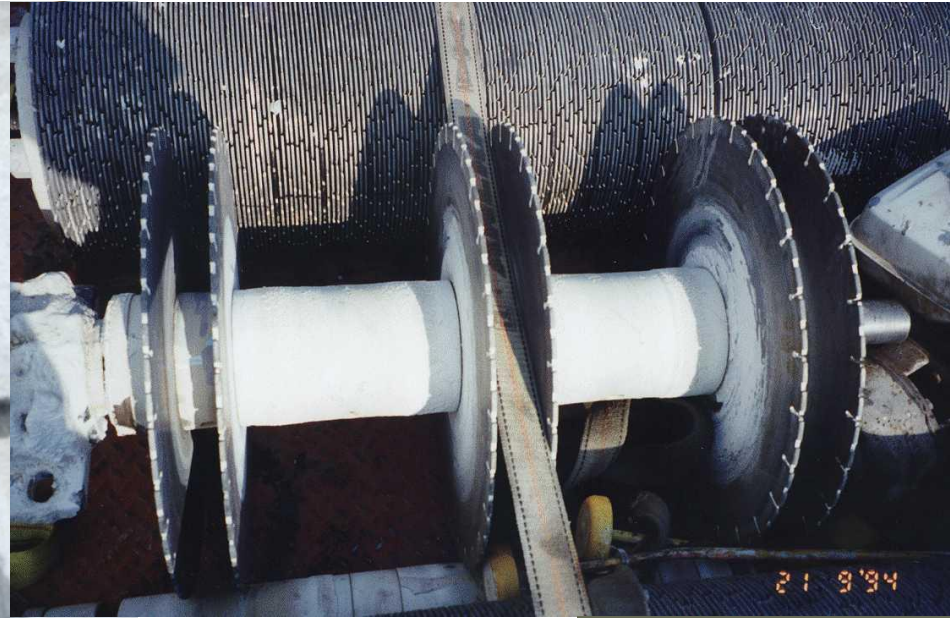




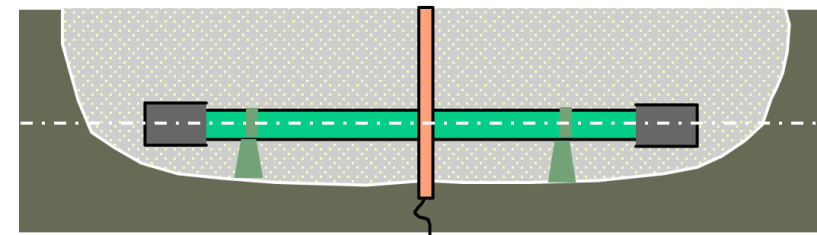
## Dowel Bar Retrofit



# Dowel Bar Retrofit

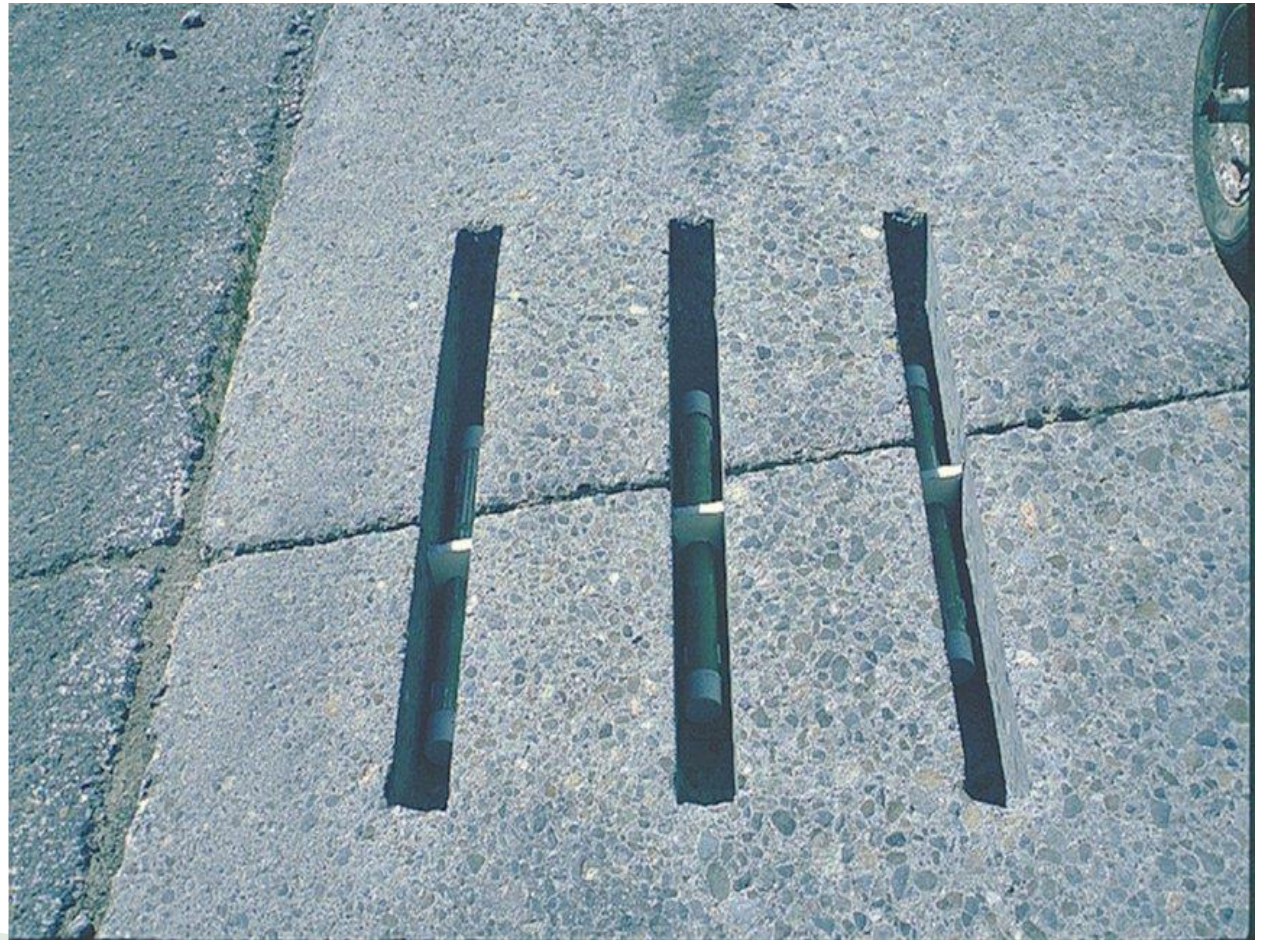


Also need to:  
Reseal Joints



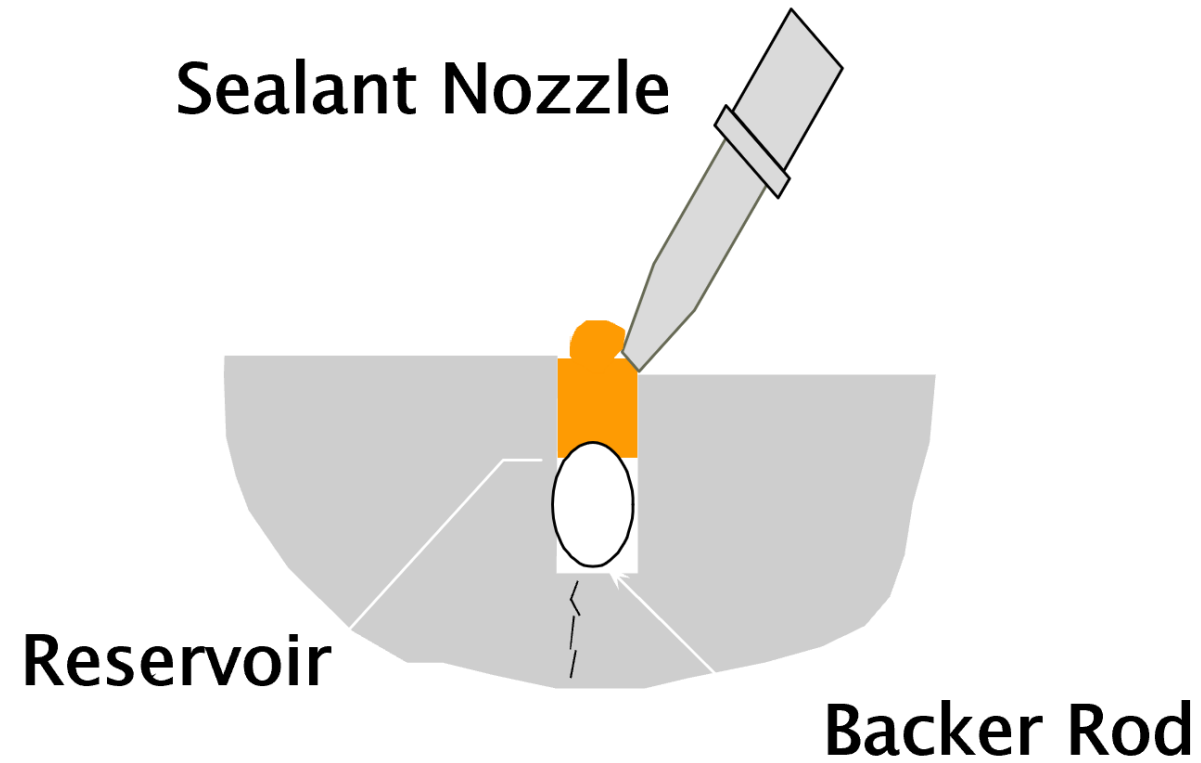
# Load Transfer Restoration

- Placement of load transfer devices across joints or cracks of existing pavements
- Candidate projects
  - Poor load transfer (< 60 %)
  - Pumping
  - Faulting
  - Corner breaks





# Sealing and Resealing



# Incompressibles!



# Base Erosion



# Long Term Performance of Sealants

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

PUBLICATION NO. FHWA-RD-99-142

SEPTEMBER 1999

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

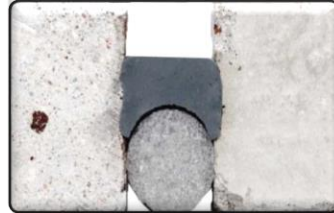
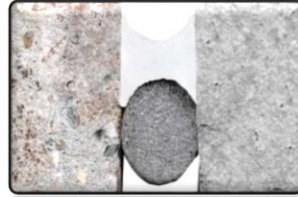


Sealant Material	Config-uration	Time at Which 75% Effectiveness Level Was Reached, months *					
		Arizona	Colorado	Iowa	Kentucky	South Carolina	Average
Koch 9005	1	116	66	94	156	63	99
	2	112	66	91	191	90	110
	3			148	182	49	126
	4	105	61				83
Crafco RS 231	1	52	80	76	86	92	77
	2	135	69	118	108	138	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.

# Sealant Types

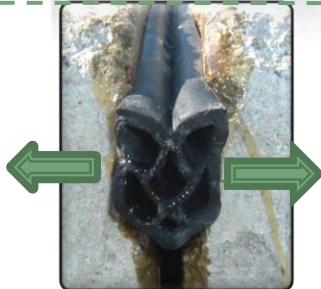
- ▶ **Silicone**
  - ▶ Non Sag
  - ▶ Self Leveling
  - ▶ Rapid Cure



- ▶ **Hot Pour**
  - ▶ Standard Modulus
  - ▶ Low Modulus



- ▶ **Compression Seal**



# Joint Sawing Equipment

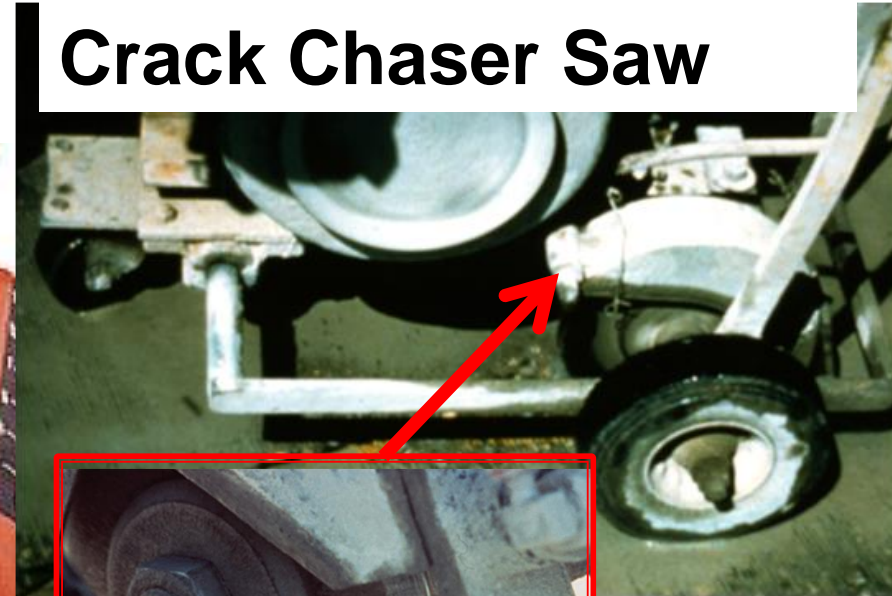
- ▶ **Early Entry Sawing**
  - Walk Behind
- ▶ **Wet Sawing**
  - Walk Behind
  - Rider/Span Saws
- ▶ **Dry Sawing**
  - Conventional Saws
  - Crack Chasing Saws



# Crack Chaser Saw



**Router**



**Crack Chaser Saw**



# Sealant Removal Equipment





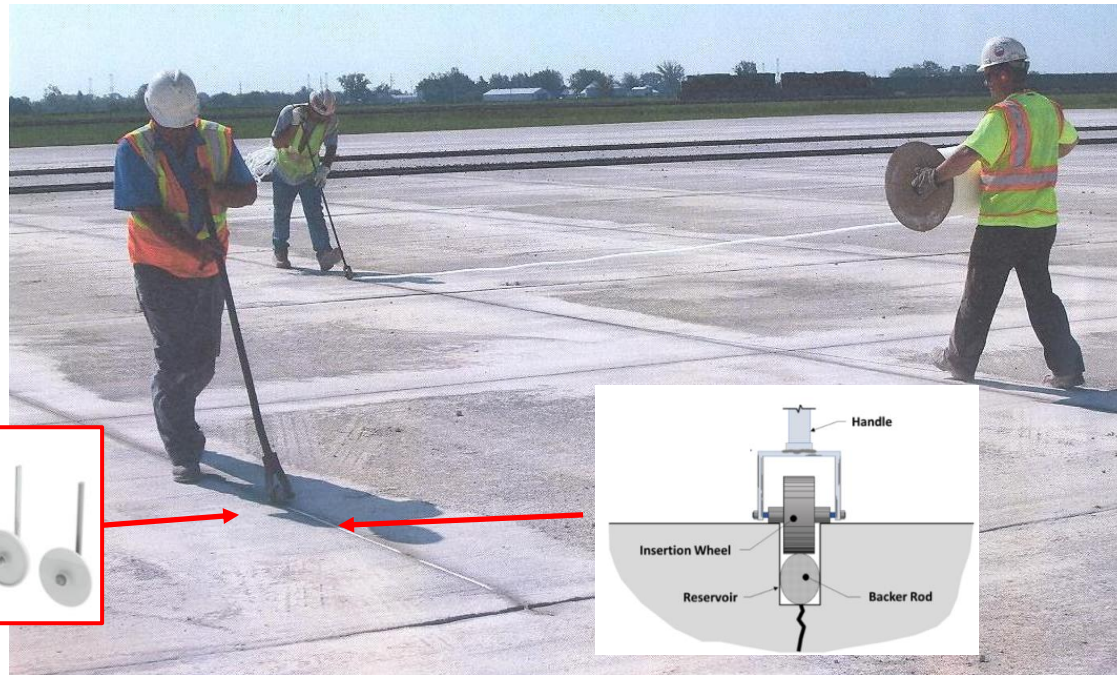
# Cleaning & Preparation Equipment

- ▶ Air Compressors
- ▶ Abrasive Blast Equipment
- ▶ Water Blast Equipment
- ▶ Air Blasting



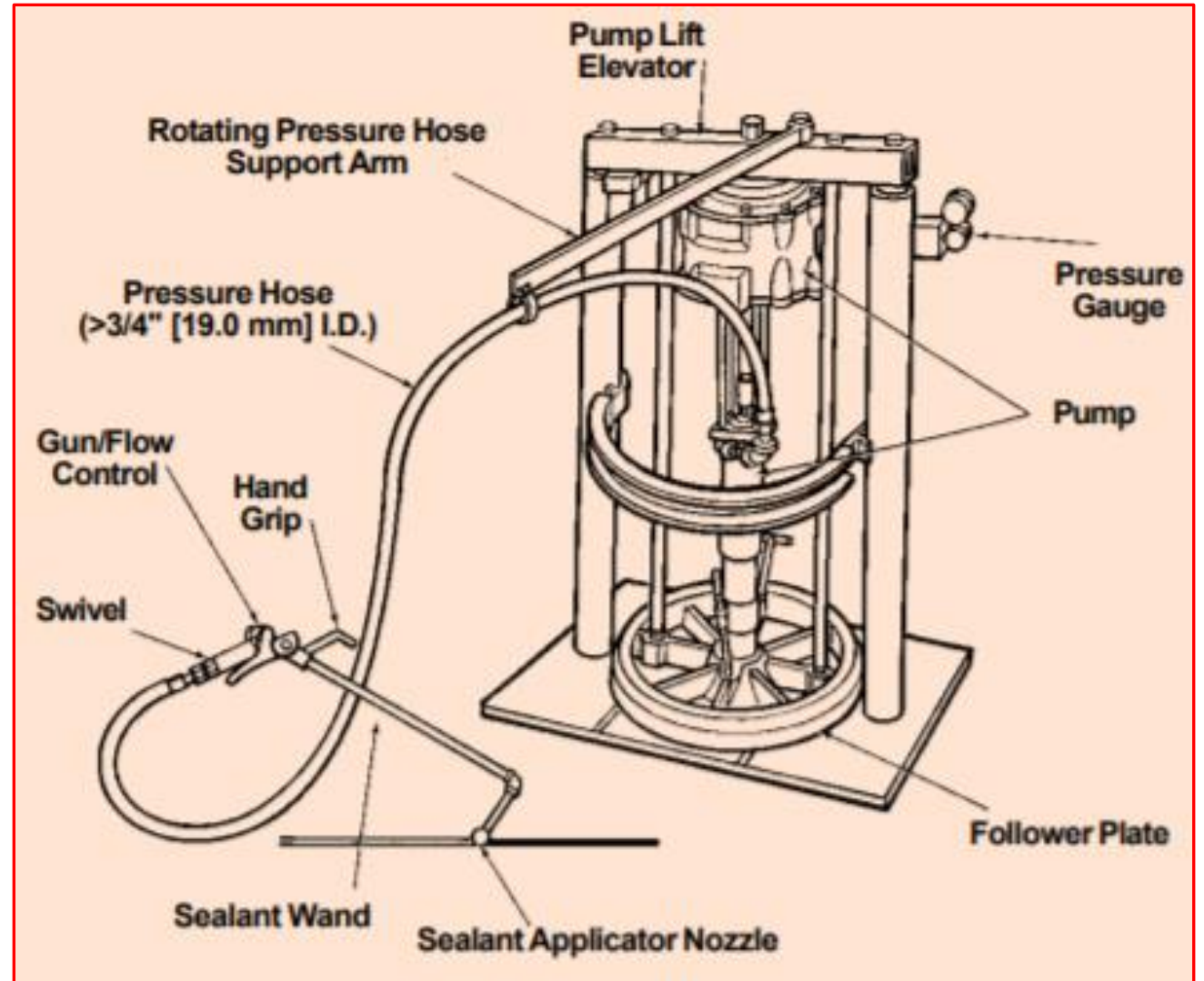
# Backer Rod Installation Equipment

- ▶ Backer rods are manually installed using simple tools. They typically consist of person or a cart that is used to roll the rod out in front of the manual insertion tool.

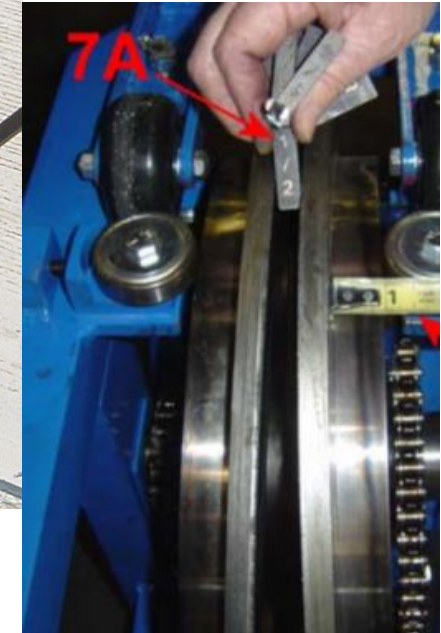
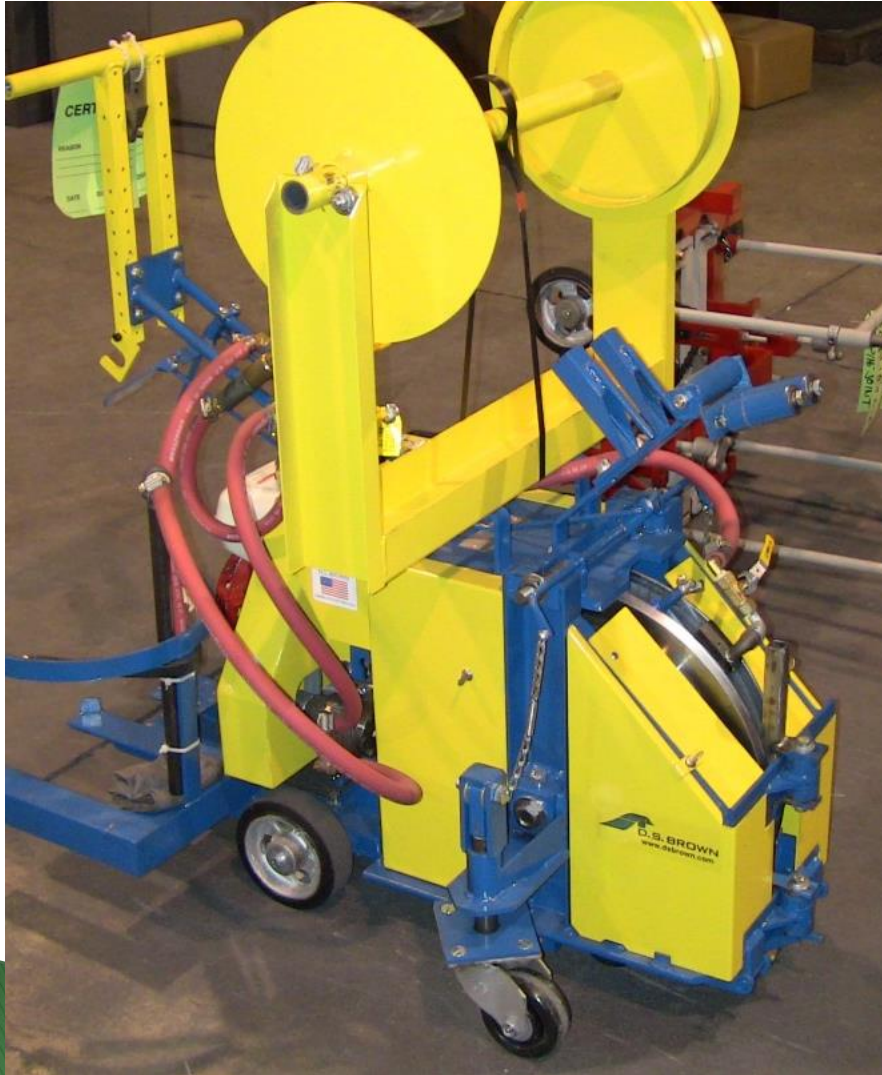


# Silicone Sealant Installation Equipment

- ▶ Installation equipment consists of an extrusion pump that sets in a pail or drum. The material is then pumped through a high pressure hose to the sealant wand and application nozzle.



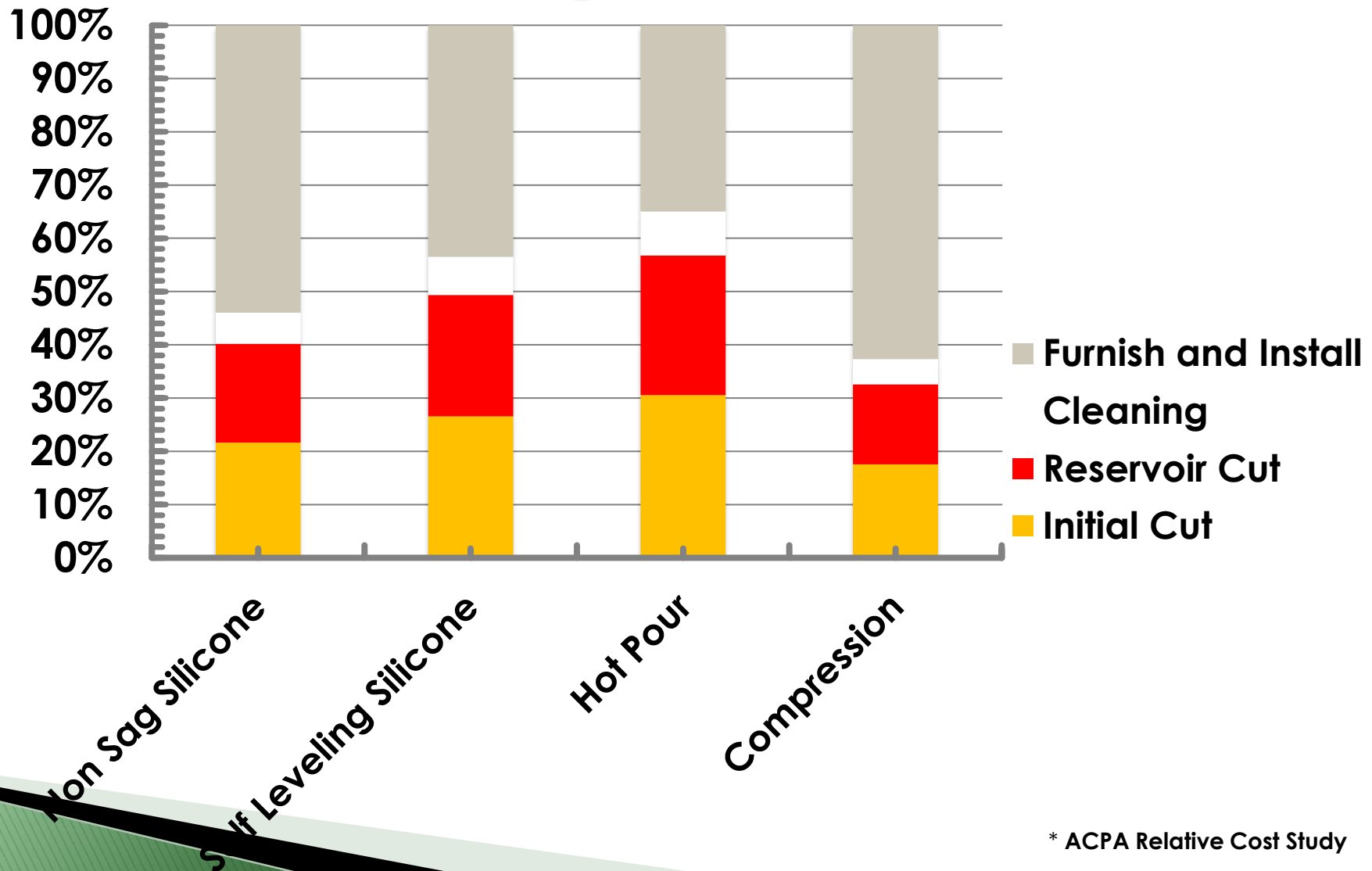
# Compression Seal Installation Equipment



# Hot Pour Sealant Installation Equipment



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



\* ACPA Relative Cost Study

# Clean Isn't an Option



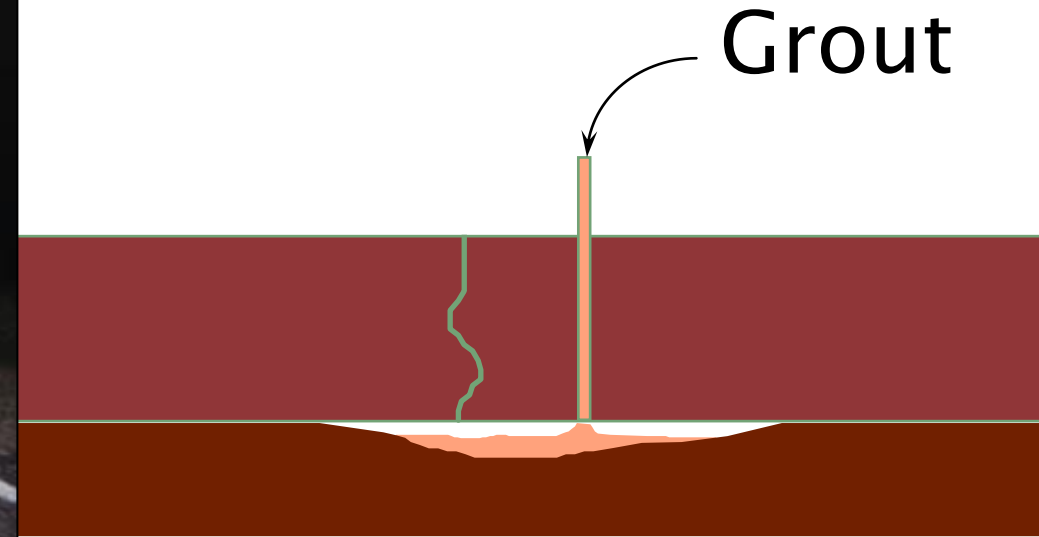


**Slab  
Stabilization/  
Jacking**





# Slab Stabilization



Fill Void or Level Slab

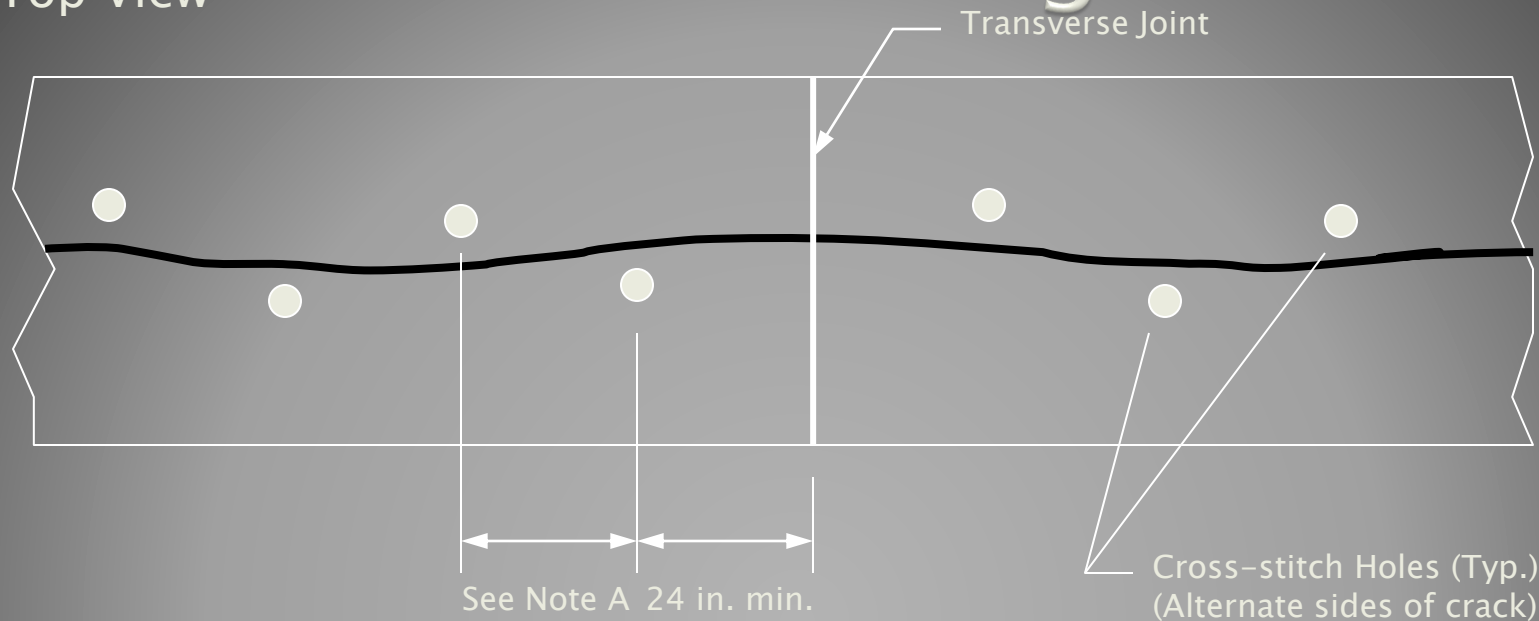


## Cross Stitching

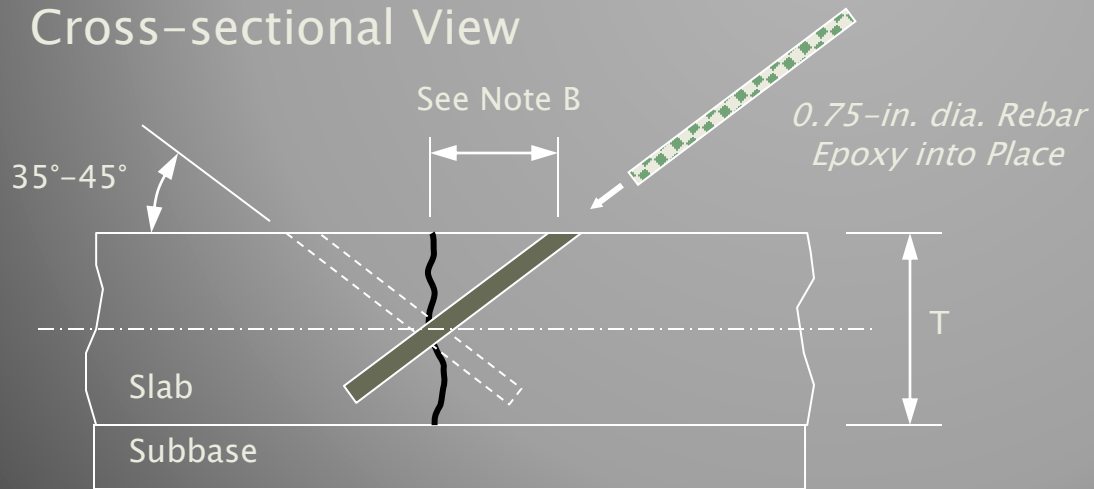


# Cross Stitching

Top View



Cross-sectional View

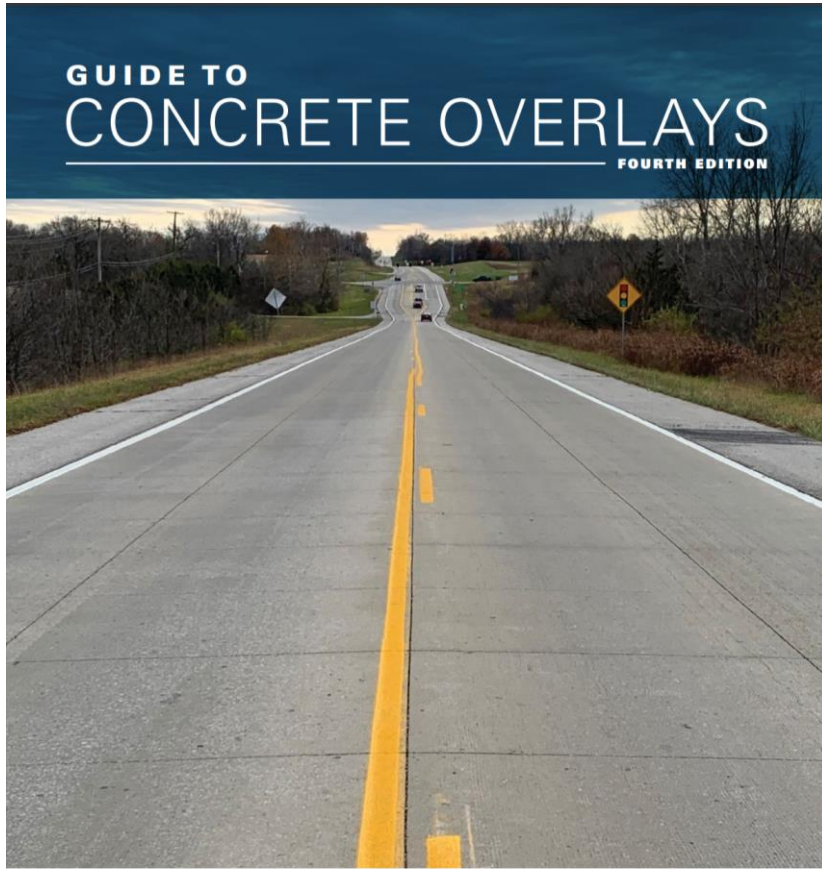


**Note A:** Distance between holes is 24 in. for heavy traffic; 36 in. for light traffic  
**Note B:** Determine distance from longitudinal crack to hole based on slab thickness  $T$  and drill angle. Slabs less than 12 inches thick require a 35° insertion angle.

# Summary

- **Concrete pavement preservation works in all environments**
  - **Based on traffic and schedule the appropriate techniques and products need to be selected**
- 

# Concrete Pavement Preservation Tools



**GUIDE TO  
CONCRETE OVERLAYS**  
FOURTH EDITION

IOWA STATE UNIVERSITY  
Institute for Transportation

NOVEMBER 2021

National Concrete Pavement  
Technology Center



## Pavement Preservation Checklist Series

17 Joint and Crack Sealing of Portland Cement Concrete Pavements

## Pavement Preservation Checklist Series

18 Diamond Grinding of Portland Cement Concrete Pavements

## Pavement Preservation Checklist Series

19 Dowel-Bar Retrofit for Portland Cement Concrete Pavements

## Pavement Preservation Checklist Series

20 Partial-Depth Repair of Portland Cement Concrete Pavements



## Tech Brief

U.S. Department of Transportation  
Federal Highway Administration

### PAVEMENT PRESERVATION HOW:

**ARIZONA, TEXAS, UTAH, AND NEW MEXICO**  
EDC-4 PEER-TO-PEER EXCHANGES

### INTRODUCTION

On May 2nd and 3rd, 2019, an FHWA-sponsored EDC-4 "How" Pavement Preservation State Peer-to-Peer Exchange was conducted in Phoenix, Arizona. State department of transportation (DOT) participants included 38 DOT representatives from Arizona, 1 from Texas, 2



## Tech Brief

U.S. Department of Transportation  
Federal Highway Administration

### PAVEMENT PRESERVATION HOW:

**DELAWARE, MARYLAND, NEW JERSEY, AND PENNSYLVANIA**  
EDC-4 PEER-TO-PEER EXCHANGES

### INTRODUCTION

On November 19th, 2018, an FHWA-sponsored EDC-4 "How" Pavement Preservation State Peer-to-Peer Exchange was conducted in Dover, Delaware, with one FHWA representative and six department of transportation (DOT) representatives from Delaware, one from Maryland, two from New Jersey, and two from Pennsylvania. Larry Galbraith with the National Center for Pavement Preservation and Larry Scofield with the International Grooving & Grinding Association and American Concrete Pavement Association facilitated the day-and-a-half long meeting. Delaware was the host state and provided meeting room facilities. Antonio Nieves of the FHWA provided the meeting background and kicked off the meeting.

The meeting format consisted of each of the states identifying their current procedures, issues, and successes for each of the topics discussed. Table 1 indicates the discussion topics.

Table 1. List of pavement preservation treatments discussed

Asphalt pavement preservation treatments	Concrete pavement preservation treatments
Chip seal	Hot-applied sealers
Micro-surfacing	Half-depth repair
Cold-in-place recycling (CIR)	—
Crack seal	—

## Tech Brief

U.S. Department of Transportation  
Federal Highway Administration

### PAVEMENT PRESERVATION HOW:

**GEORGIA, ALABAMA, AND SOUTH CAROLINA**  
EDC-4 PEER-TO-PEER EXCHANGES

### INTRODUCTION

On May 6th, 2019, an FHWA-sponsored EDC-4 "How" Pavement Preservation State Peer-to-Peer Exchange was conducted in Macon, Georgia, with 1 FHWA representative and 20 department of transportation (DOT) representatives from Georgia, 2 from Alabama, 2 from South Carolina, and 1 from Puerto Rico. Larry Galbraith with the National Center for Pavement Preservation and Larry Scofield with the International Grooving & Grinding Association and American Concrete Pavement Association facilitated the day-and-a-half long meeting. Georgia was the host state and provided meeting room facilities. Louis Rodriguez of the FHWA provided the meeting background and kicked off the meeting.

The meeting format consisted of each of the states identifying their current procedures, issues, and successes for each of the topics discussed. Table 1 indicates the discussion topics.

Table 1. List of pavement preservation treatments discussed

Asphalt pavement preservation treatments	Concrete pavement preservation treatments
Ultra-thin bonded wearing course	Dowel bar retrofit
Hot-in-place recycling (HIR)	Diamond grinding
Cold-in-place recycling (CIR)	—
Micro-surfacing	—
Crack seal	—
Chip seal	—
This hot mix asphalt (HMA) overlay	—
Seal seal	—
Crack seal	—

### SUMMARY OF IMPORTANT ISSUES OR SUCCESSSES

#### Asphalt Concrete Pavement Preservation

Ultra-thin bonded wearing course: This treatment is not commonly used in these three states, and experience with the treatment has been limited. With limestone aggregates, it was noted that stripping could be an issue, particularly under bridges where the limestone cannot dry out.

Hot in-place recycling (HIR): This treatment is not commonly used in these states, but all three states expressed interest in the treatment. A couple of the states have developed specifications, but the treatment is not yet in the preservation toolbox.

Cold in-place recycling (CIR): This treatment is not commonly used in these three states. Again, the states expressed interest, but nothing regarding this treatment is actively being developed.

## Pavement Preservation Checklist Series

21 Full-Depth Repair of Portland Cement Concrete Pavements

## Pavement Preservation Checklist Series

22 Cross-Stitching for Portland Cement Concrete Pavements

## Pavement Preservation Checklist Series

23 Longitudinal Diamond Grooving of Portland Cement Concrete Pavements





Questions?

Thank  
You!