



**CONCRETE PAVEMENT  
RESTORATION / PRESERVATION**

Caltrans Workshop Dec 2011

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Penhall Company

*making life a little smoother*

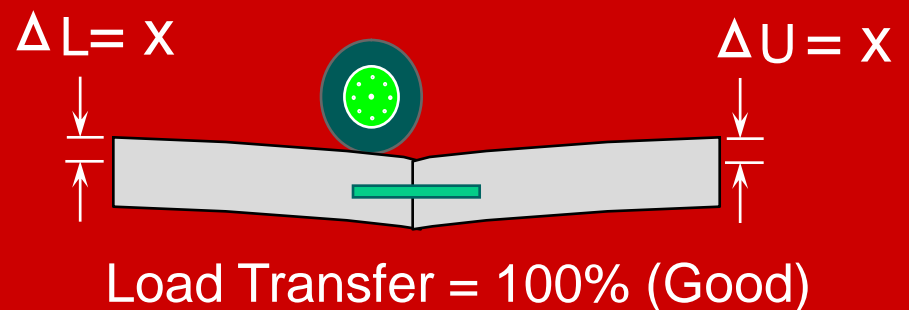
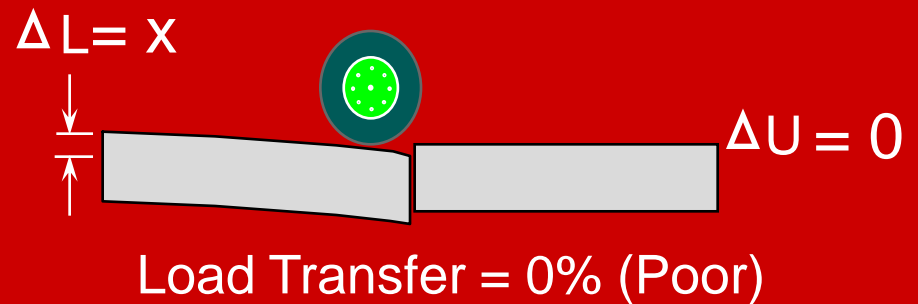
# LOAD TRANSFER RESTORATION

*Using  
Dowel Bar Retrofit*



# Purpose of Dowel Bar Retrofit

- Reestablish load-transfer across joints or cracks
  - Load-transfer is a slab's ability to transfer part of its load to its neighboring slab
- Used in JRC and JPC pavements to limit future faulting



# Applications

- Joints exhibiting distresses due to poor load transfer ( $LTE < 50\%$ )
- Uniform cracks that have not opened or faulted
- More appropriate on pavements experiencing heavy truck traffic
- Pavements  $> 8$  in (200 mm) thick

# Dowel Bar Retrofitting

- Increasingly popular method
- Installation of dowels to transfer load
- Faulted transverse joints and cracks
- Reduces further deterioration
  - Pumping and faulting
  - Spalling
  - Corner breaks



# Proposed Trigger Values and Expected Life - MTAG

Treatment	Trigger (National)	Climate Region <sup>1</sup>				Traffic ADT			Life of Treatment (Year)	Estimated Cost (\$) <sup>2</sup>
		Desert	Valley	Coastal	Mountain	<5000	>5000, <30000	>30000		
Crack Resealing	>1/4 inch	>1/4	>1/4	>1/4	>1/4	>1/4	>1/4	>1/4	4 - 7	\$27.7k - 42.4k/ln mi
Diamond Grinding	Faulting > 1/4 inch; Ride 95 in/mile	>1/4 >190	>1/4 >95	>1/4 >95	>1/4 >190	>1/4 >190	>1/4 >125	>1/4 >95	10 - 18	\$30.0k - 80.1k/ln mi
Partial Slab Repair	Surface distress - Patches <1.2 yd <sup>2</sup>	<1.2	<1.2	<1.2	<2.4	<2.4	<1.2	<1.2	8 - 12	\$155 - 270/yd <sup>3</sup>
Isolated Slab Replacement	3rd stage cracking or unstable slabs	Same Trigger Value. For desert, mountain, or ADT <5000, District makes decision to repair.							8 - 12	\$4000 - \$8000/slab
Dowel Bar Retrofit	LTE <60%, Faulting >1/4 inch, Max 10% Cracking	<40 >1/4 20	<70 >1/4 10	<70 >1/4 10	<50 >1/4 20	<50 >1/4 20	<70 >1/4 10	<70 >1/4 10	8 - 17	\$141k - 177k/ln mi

# Dowel Bar Retrofit Operations

Consists of 4 main operations:

1. Cutting the slots
2. Preparing the slots
3. Preparing and placing the dowel bars
4. Backfilling the slots

# Cutting the Slots

- Slot sawing machines
  - Cut parallel to pavement centerline
  - Cut parallel to each other
  - Cut to uniform depth
- Standard saws
  - Multiple cuts
  - More difficult to control
  - Not for high-production

# Cutting the Slots

## Diamond saw slot cutter

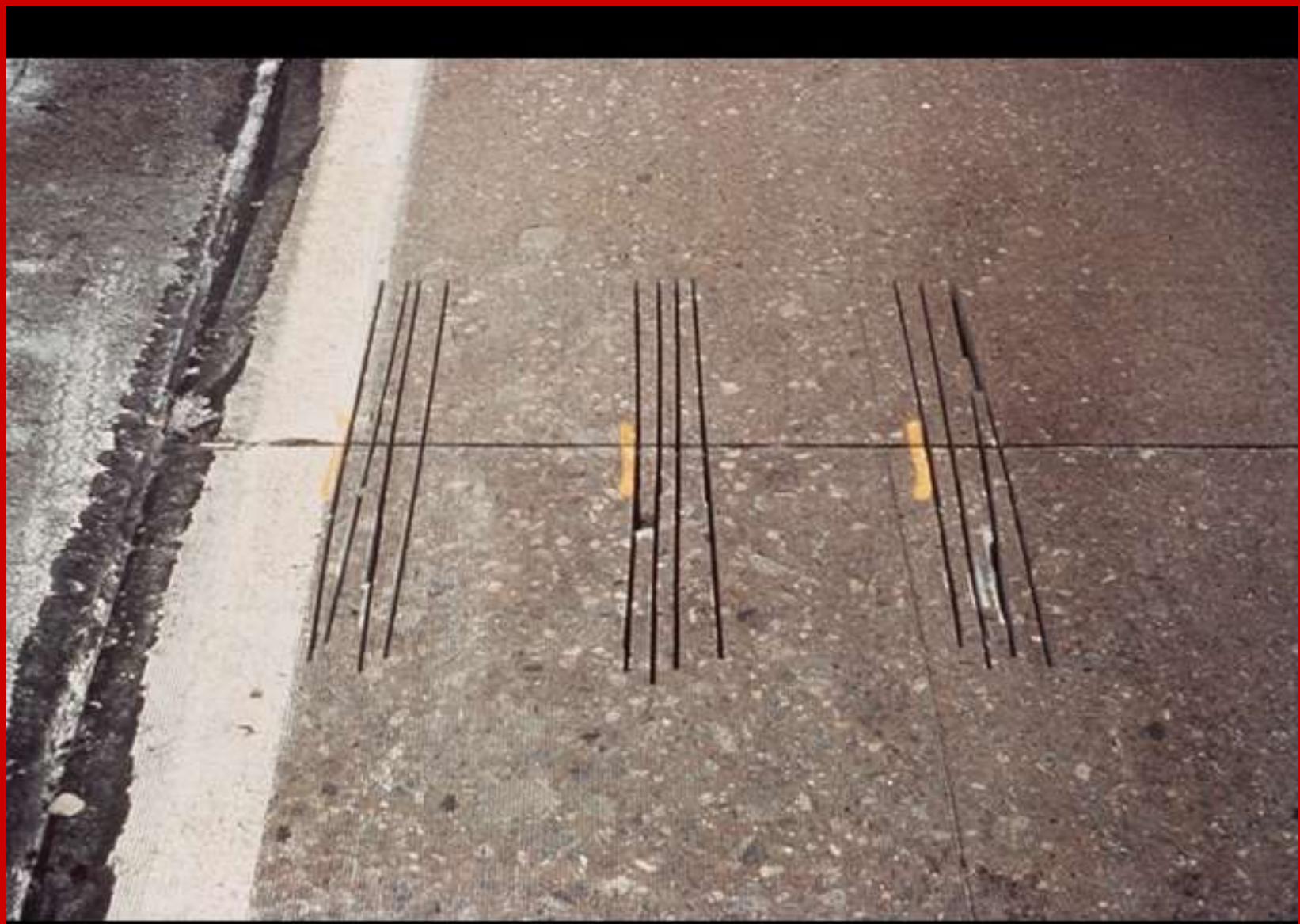
- Cuts multiple slots in a single pass
- Cuts form the edges of the slots
- Fins are removed later
- Can cut 3 or 6 slots in a single pass











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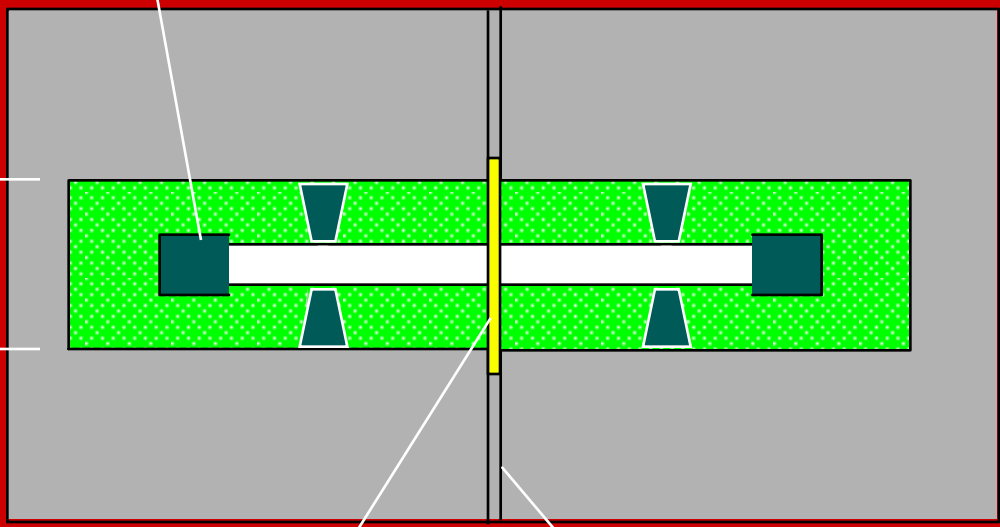




# Plan View of Slot

Endcaps placed  
on each end

2.5 to 3 in  
Slot Width  
(sized for  
chair size)



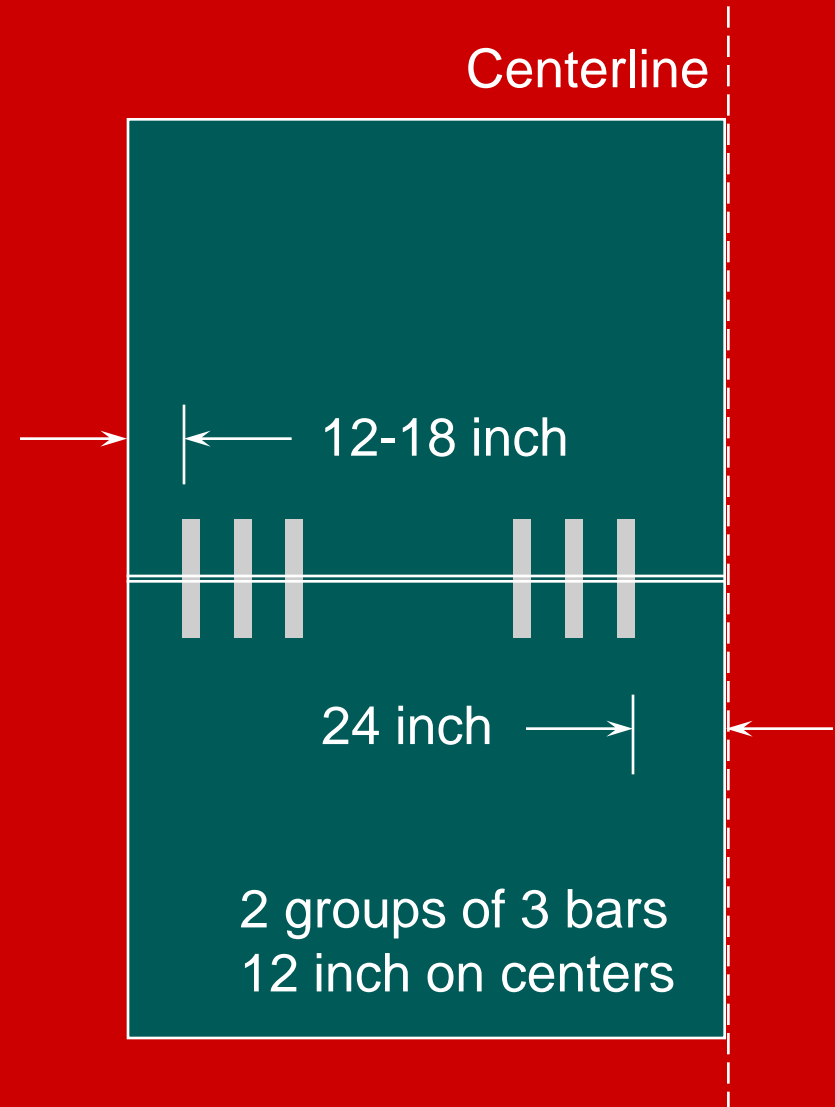
Joint Reformer

Joint/Crack

# Slot Locations in a Lane

- 3 slots per wheelpath
- Spaced 12 inch apart
- Outside dowels should be 12 –18 inch from edge
- Inside dowels should be 24 inch inside centerline

Must not come into contact with adjacent tiebars

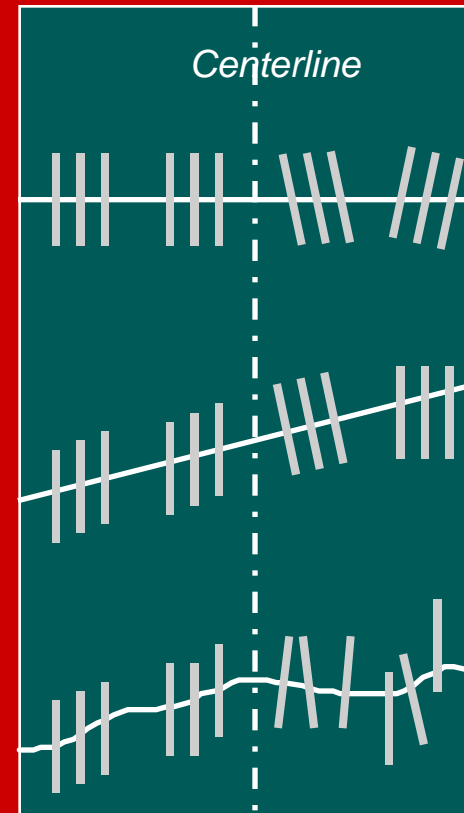


# Dowel Slot Alignment

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

**Correctly Aligned  
Dowel Slots**

**Incorrectly Aligned  
Dowel Slots**



# Preparing the Slots

Slot preparation consist of:

- Removing the concrete fins
- Flattening the bottom
- Cleaning the slots
- Caulking the joint or crack

# Removing the Concrete Fins

- Use 15-30 lb pneumatic hammers
- Chip out in large pieces
  - Pop with hammer at end of fin
  - Pop with hammer along saw cut





# Flattening the Slot Bottom

- Remove burrs and bumps from base with small brush hammerhead
- Allows the dowel to sit level and properly aligned





# Cleaning and Caulking the Slots

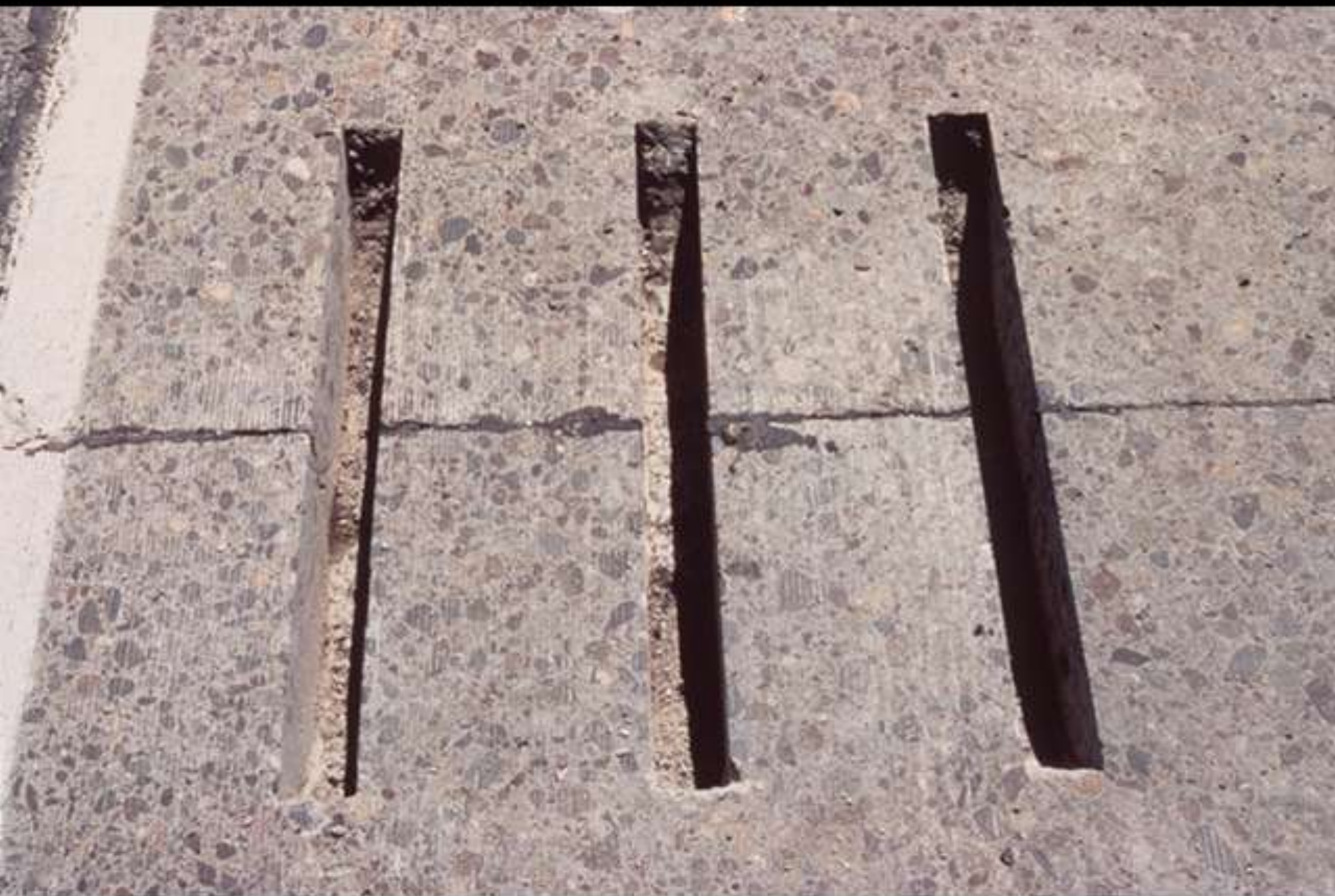
## Slot cleanliness is essential

- Sandblast first
- Airblow to remove debris
- Check for dust with hand

## Caulk the joint / crack within the slot

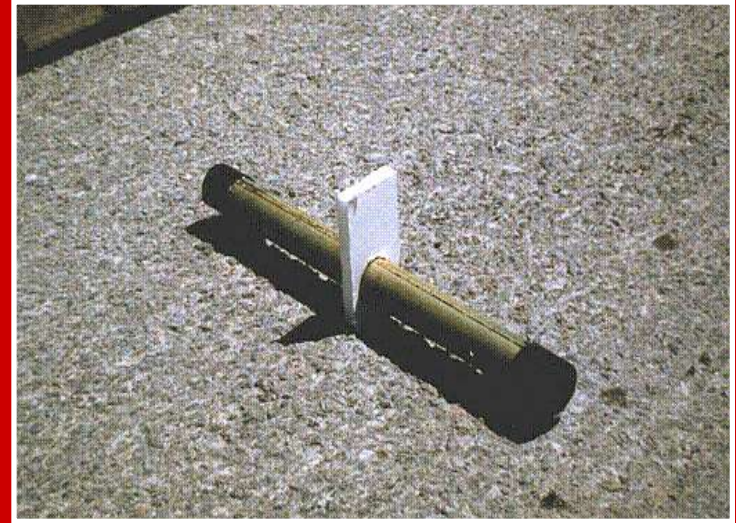
- Caulk bottom and sides
- Prevents patch material from entering joint or crack





# Preparing the Dowels

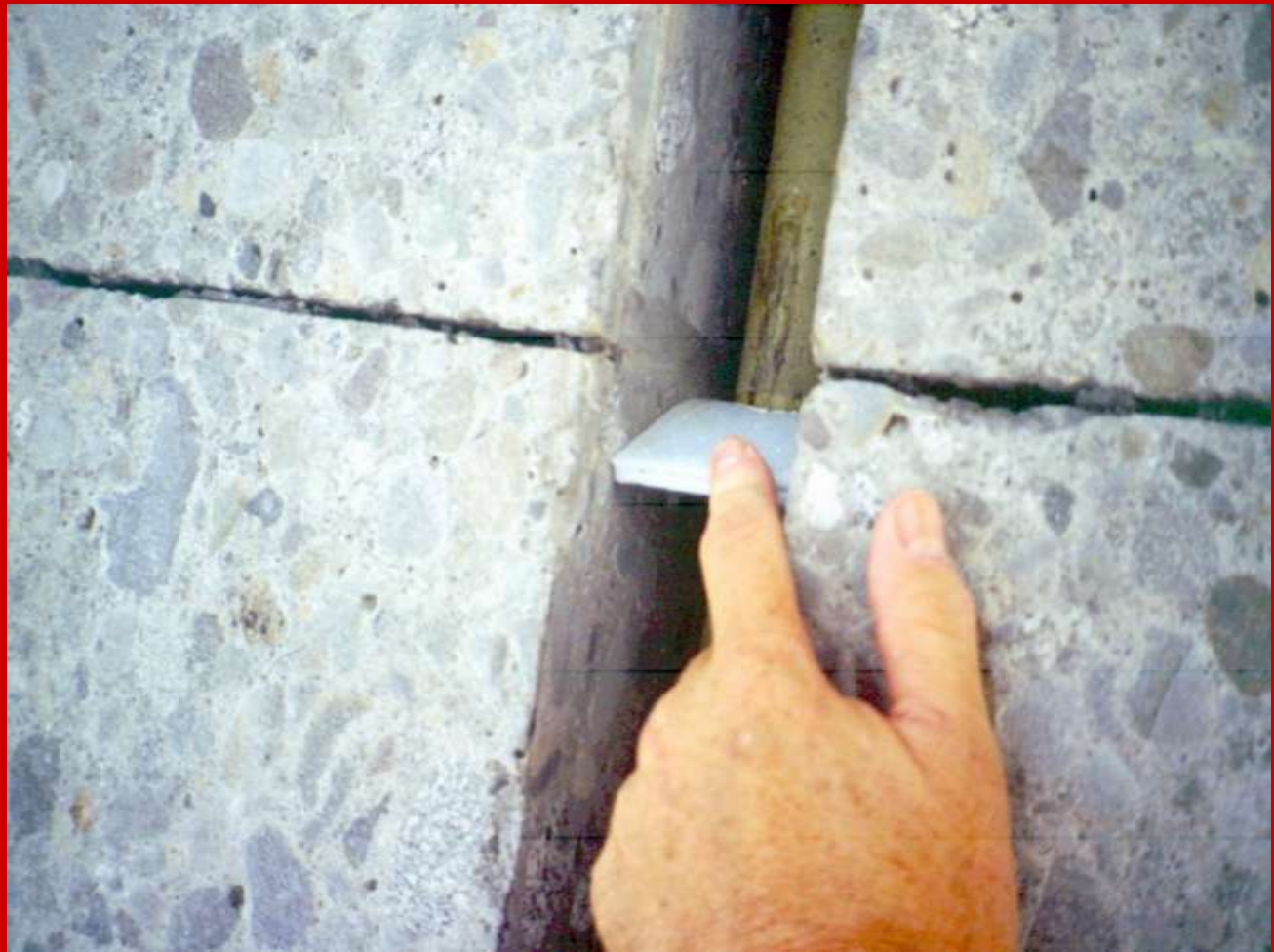
- Add joint former
  - Styrofoam
  - Fiber board
- Attach non-metallic expansion cap to one end
- Attach non-metallic chairs (sized for slot)





19 12:12 PM

# Joint Sealed with Caulk





# Joint Reformer & Dowel Bar Endcaps

Allows movement for the slab to expand into without bearing on the patch or bar

– Joint Reformer

- Maintains Joint
- Prevents patch material from entering the joint

– Endcaps

- Minimum space is 1/4 inch
- Must be plastic
- Do not force – extra space for expansion



# Dowel Bar Chairs

- Should have a minimum height of 1/2 inch
  - Support dowels in base of slot
  - Allows backfill material to surround bar
  - Should fit snugly in slot to keep dowels properly aligned
- Should be non-metallic
  - Metallic chairs can cause dowel corrosion

# Placing the Dowels

- Ensure that legs of chairs fit tightly against slot walls
- Push assembly to base of slot
- Center reformer on the joint or crack

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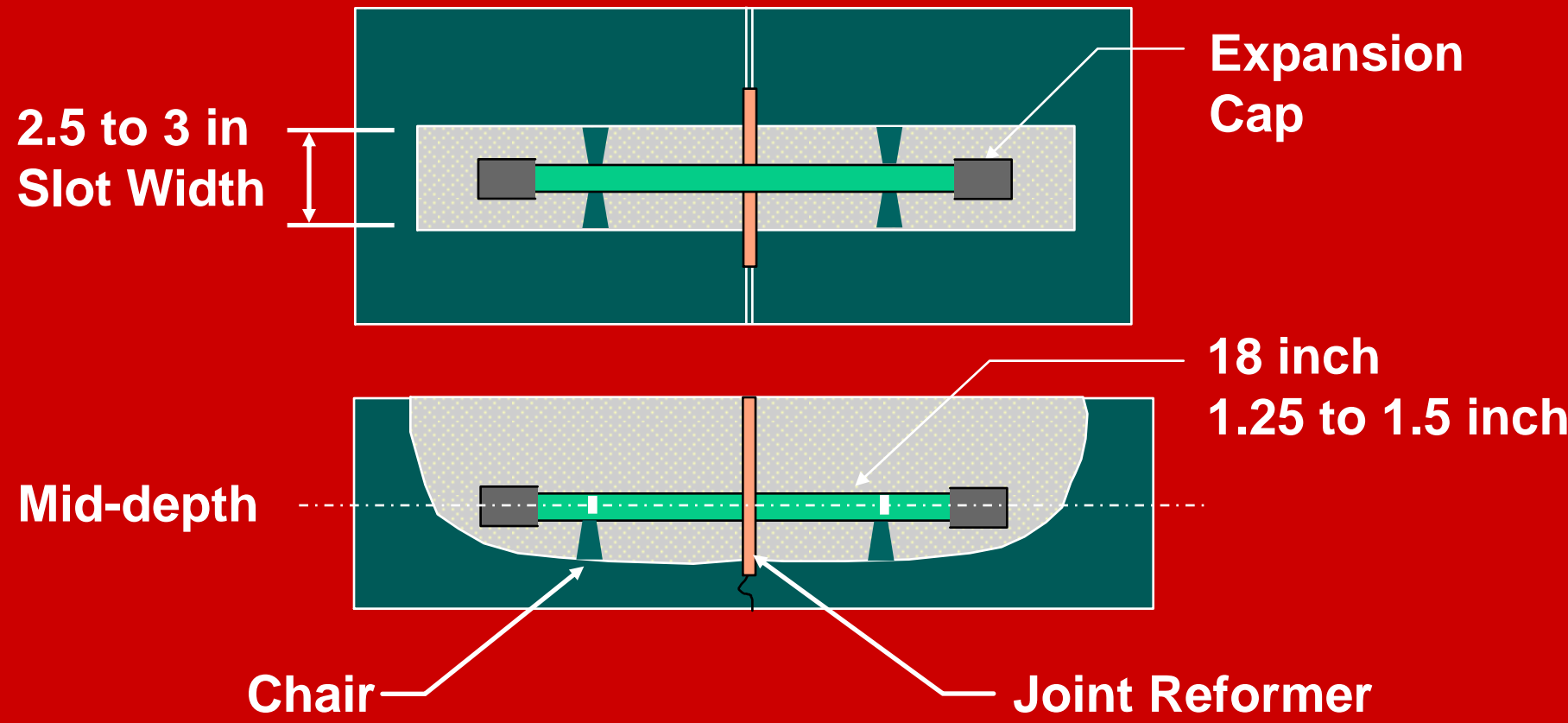
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# Plan and side view of inserted dowel

Joint/Crack



# Backfill Materials

- Basic requirement
  - Thermal properties be similar to concrete
  - Must bond to the existing concrete
  - Should be fast setting
  - Should have little or no shrinkage
  - Must develop enough strength to allow traffic on it in a short time

# Backfill Materials

Both fast-track concrete and proprietary mixes have been used successfully

- Fast track concrete mixes usually contain type III cement, accelerators, and aluminum powder
- Accelerators and aluminum powder improve set times and reduce shrinkage

# Backfill Materials

- Mix backfill in small quantities
  - Avoid aggregate larger than 3/8 inch
    - This ensures dowel is completely encased in patch material
- Vibrate with small spud vibrator
  - 1 inch diameter
  - Avoid touching dowel
    - Touching dowel knocks it out of alignment

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# Final Steps

- Finish flush (or slightly humped) with surrounding surface
- Apply curing compound
- Saw over joint reformer
- Diamond grind entire project
- Re-seal joints & cracks





Note good consolidation of backfill material around bar



# Cross-stitching longitudinal cracks/joints

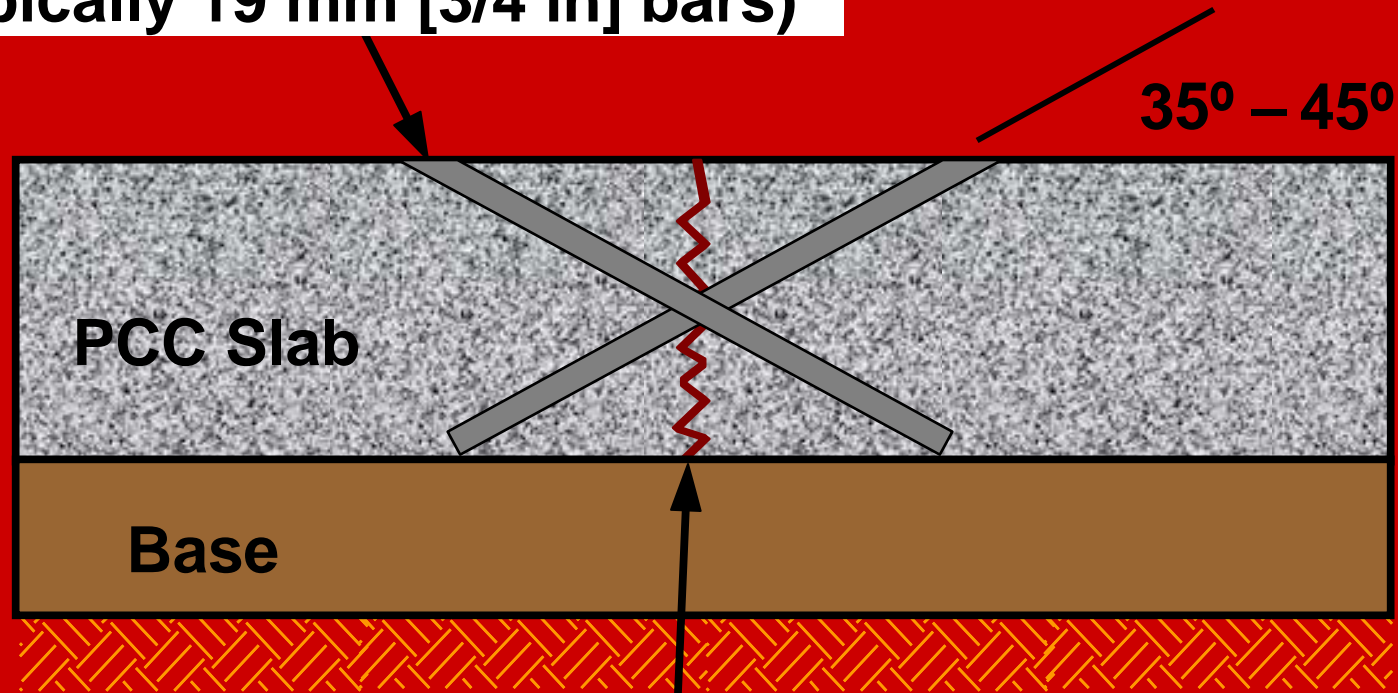


# Cross-Stitching

- Grouting of tiebars in holes drilled across nonworking longitudinal cracks at an angle to the pavement surface
- Prevents horizontal and vertical crack movements

# Cross-Stitching Schematic

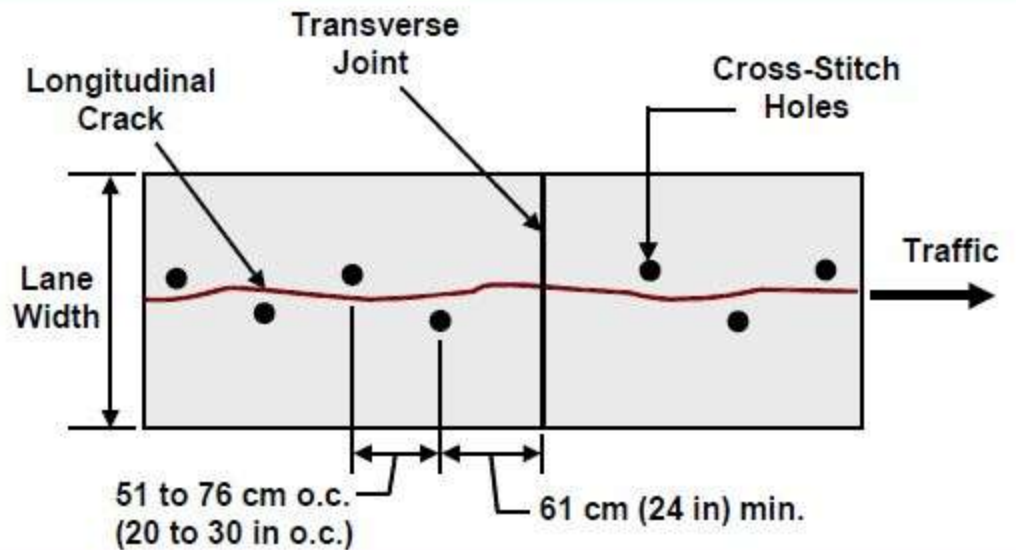
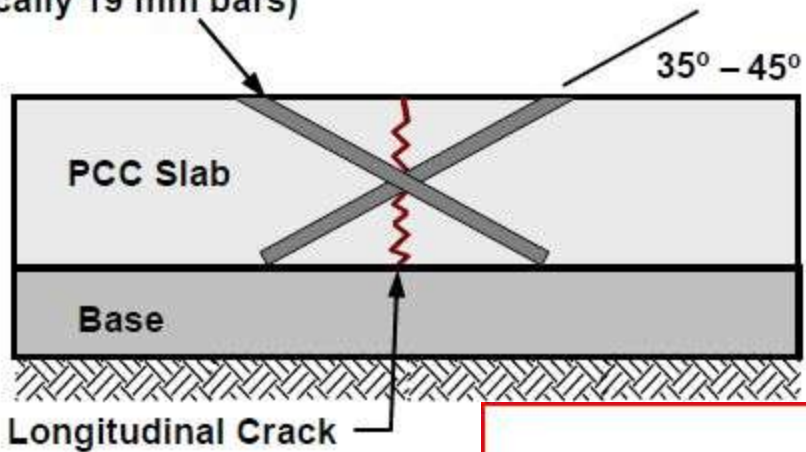
**Deformed Tiebars Inserted and Grouted Into Drilled Holes (typically 19 mm [3/4 in] bars)**



**Longitudinal Crack**

Fig. 8.5 on p. 8.14

Deformed Tiebars Inserted and Grouted Into Drilled Holes (typically 19 mm bars)



Angle	Slab Thickness, in (mm)							
	7 (175)	8 (200)	9 (225)	10 (250)	11 (275)	12 (300)	13 (325)	14 (350)
	Distance from Crack to Hole, in (mm)							
35°	5.00 (125)	5.75 (145)	6.50 (165)	7.25 (180)	7.75 (195)	8.50 (210)	—	—
40°	—	—	—	—	6.50 (165)	7.25 (180)	7.75 (195)	8.25 (205)
45°	—	—	—	—	—	6.00 (150)	6.50 (165)	7.00 (175)
	Length of Bar, in (mm)							
35°	8.00 (200)	9.50 (240)	11.00 (275)	12.50 (315)	14.50 (365)	16.00 (400)	—	—
40°	—	—	—	—	12.50 (315)	14.00 (350)	16.00 (400)	18.50 (465)
45°	—	—	—	—	—	12.00 (300)	14.00 (350)	16.50 (415)
	Diameter of Bar, in (mm)							
	0.50 (13)	0.75 (19)	0.75 (19)	0.75 (19)	0.75 (19)	0.75 (19)	1.0 (25)	1.0 (25)



# Cross-Stitching

## Grout Insertion



# Cross-Stitching

## Bar Insertion





# Cross-Stitching

## Final Grouting





# Questions?



International Grooving and Grinding Association  
[IGGA.net](http://IGGA.net)



American Concrete Pavement Association Southwest Chapter  
[ACPA-Southwest.org](http://ACPA-Southwest.org)



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