

# Dowel Bar Placement Methods, Issues, Verification



National Concrete Consortium

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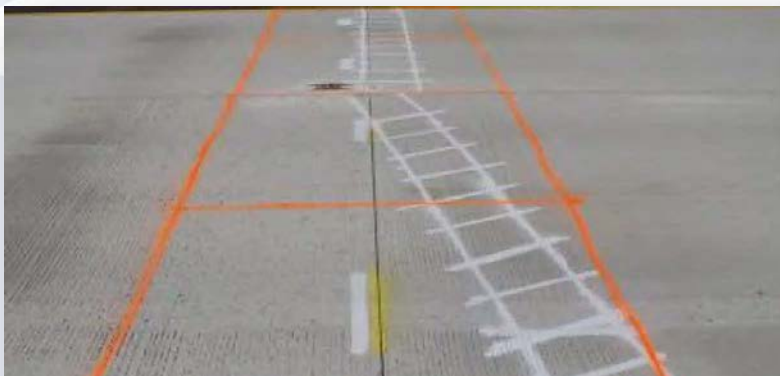




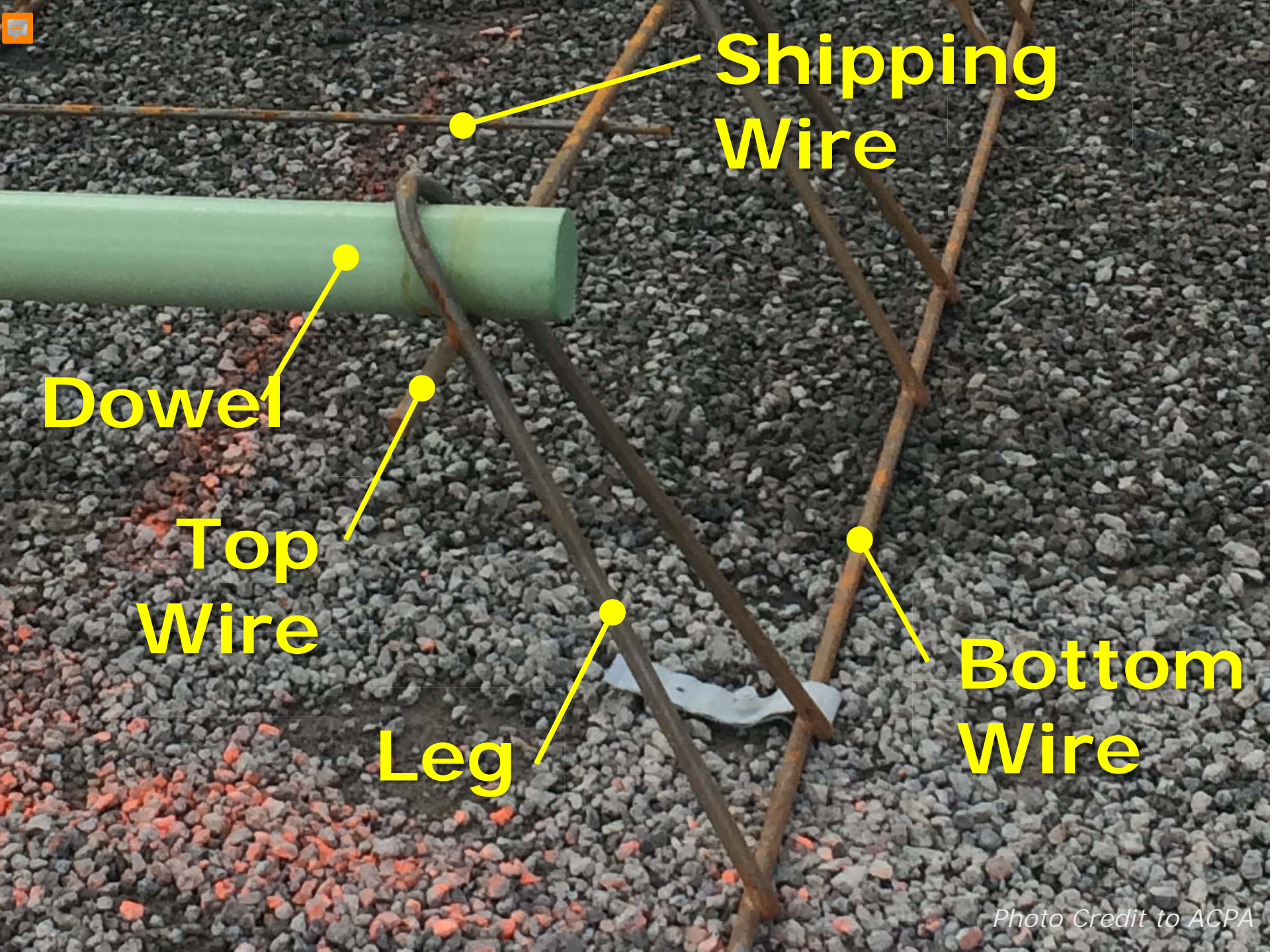


# Dowel Bar Placement Methods, Issues, Verification

- Dowel Placement
  - Dowel Baskets
    - Additional Bracing
  - Dowel Bar Insertion
- Issues
- Location Verification
- Resources







**Shipping  
Wire**

**Dowel**

**Top  
Wire**

**Leg**

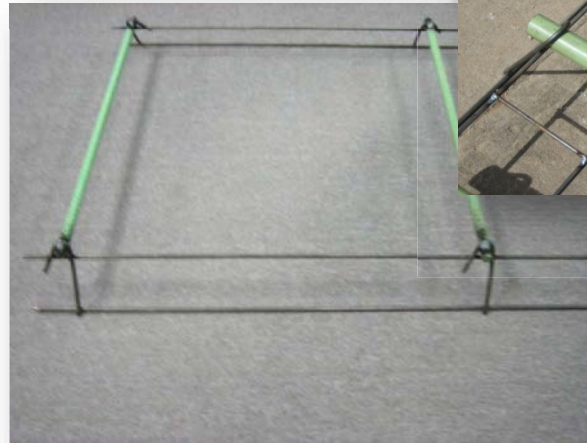
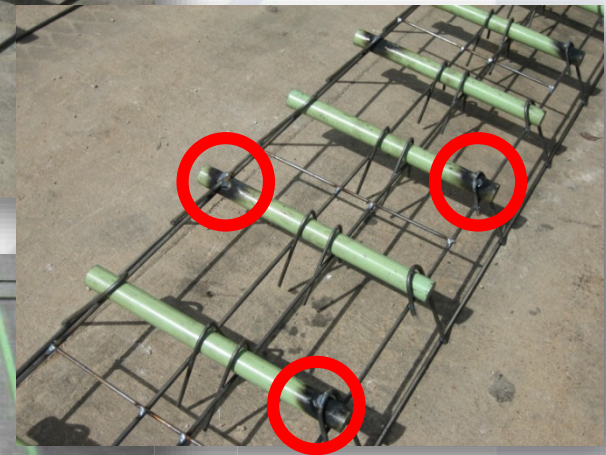
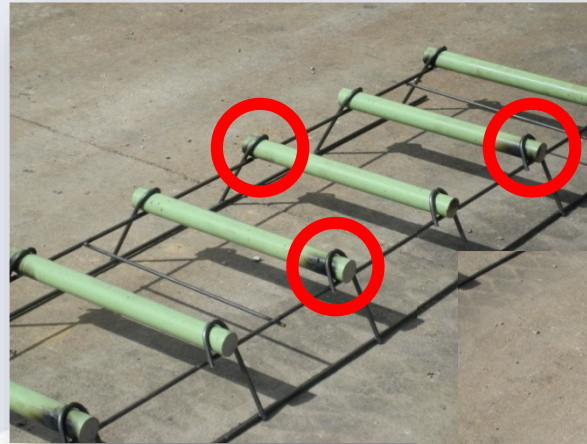
**Bottom  
Wire**





# Types of Dowel Basket Assemblies

- Contraction joint
  - Conventional
  - Half-width
  - Tapered baskets
  - Skewed baskets
  - Stepped baskets
- Expansion joint
- Rebar baskets
  - Tied joint
  - Hing-joint baskets

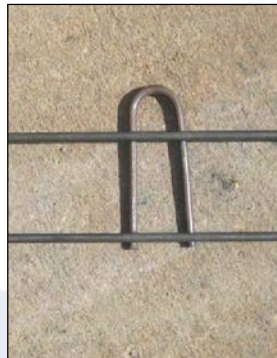






# Dowel Basket Assembly Variations

- Design of basket
- Wire gauges
- Number of shipping wires
- Number of dowels
- Spacing of dowels
- Dowel height
- Leg Style





# Dowel Basket Standardization Goal

- National Concrete Consortium goal for more than a decade.
- Among other recommendations:
  - Basket rail wire should be:
    - 0.306 in. min. diameter (1/0 gauge).
  - Loop wires should be:
    - "U" or "V" style.
    - 0.243 in. min. diameter (3 gauge).
  - Spacer or tie wires should be:
    - 0.177 in. dia. (7 gauge).
    - 4 used per standard-width basket.

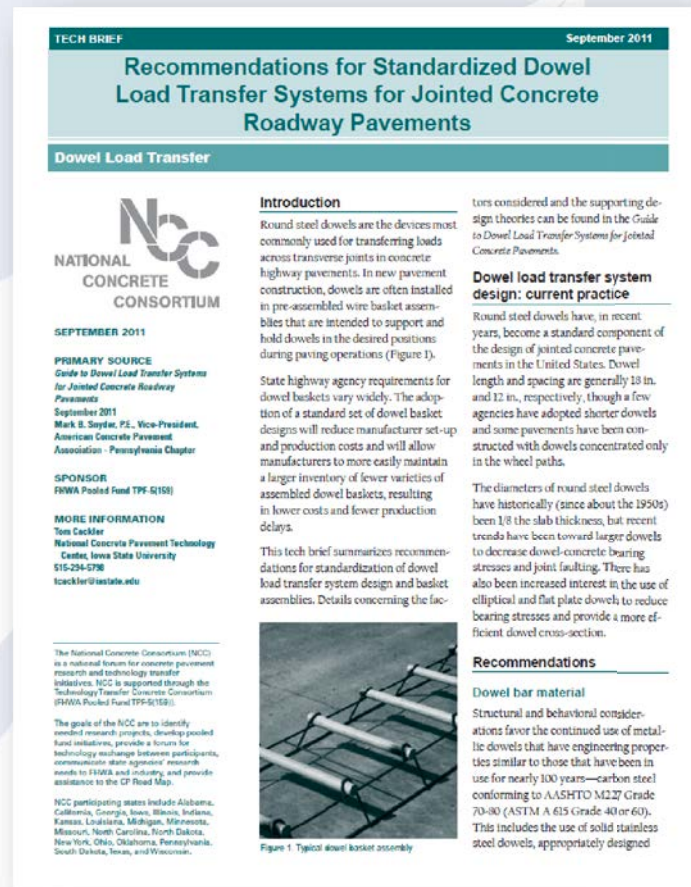






Photo Credit to ACPA





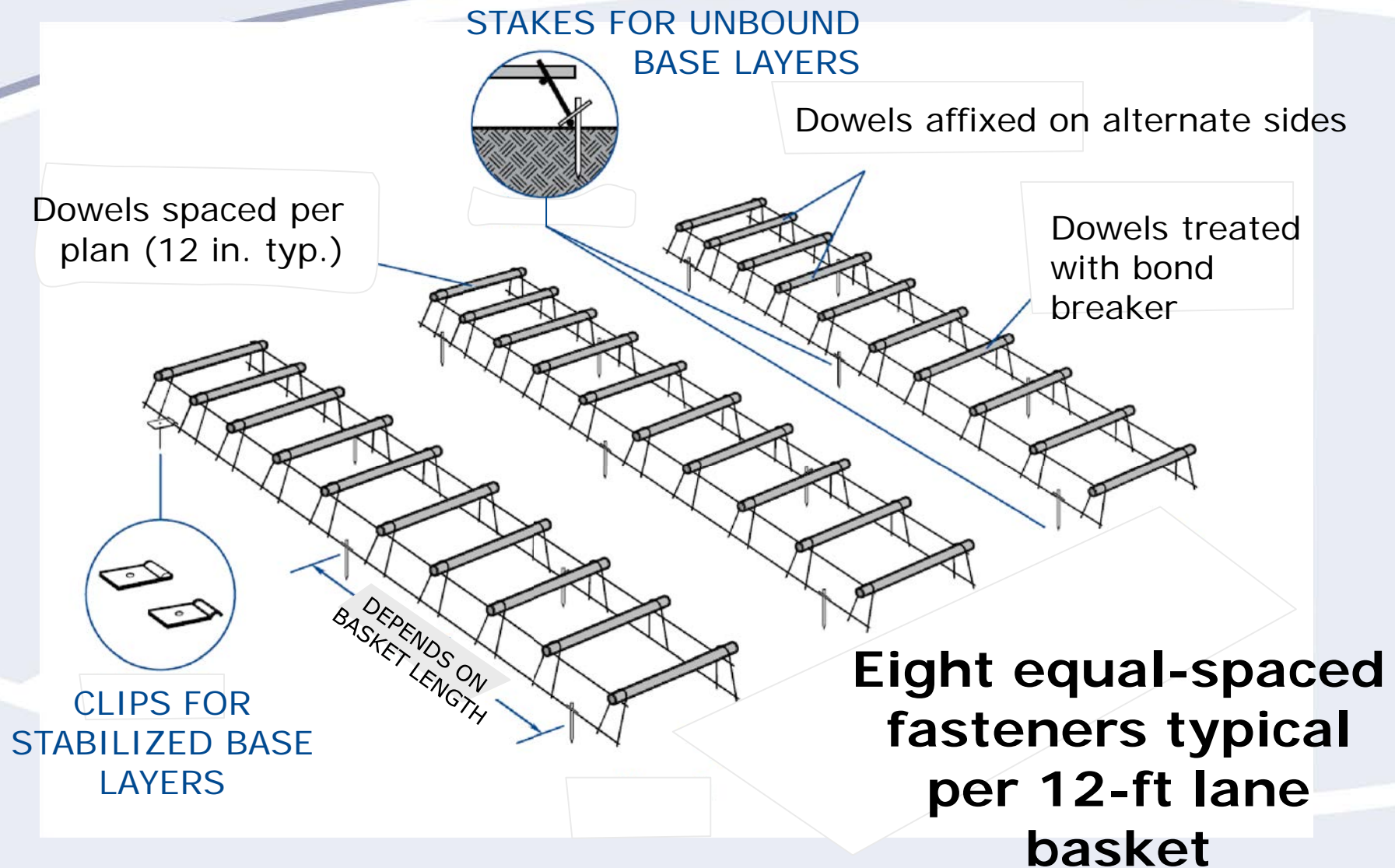
# Types of Anchors

- Pins
- Stakes
- Spikes
- Clips





# Number of Anchors per Basket





# Number of Anchors

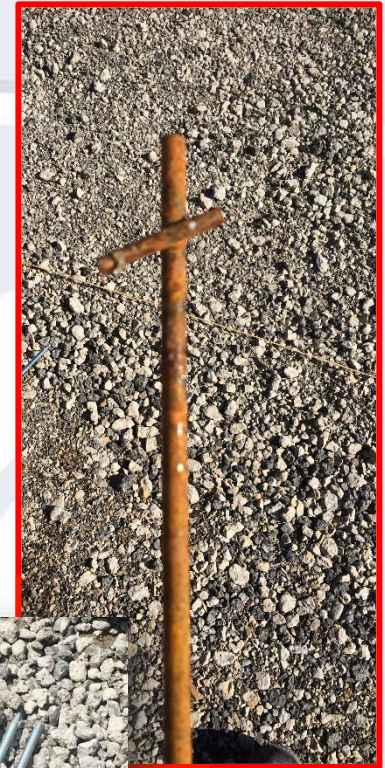
- Practice varies by:
  - Specification requirement (sometimes)
  - Contractor experience
  - Base type
- Recommended minimums:
  - 8 per basket (12-ft lane)
  - 10 per basket (14-15 ft. lane)
  - Same number on each side
- Make Adjustments as Needed!





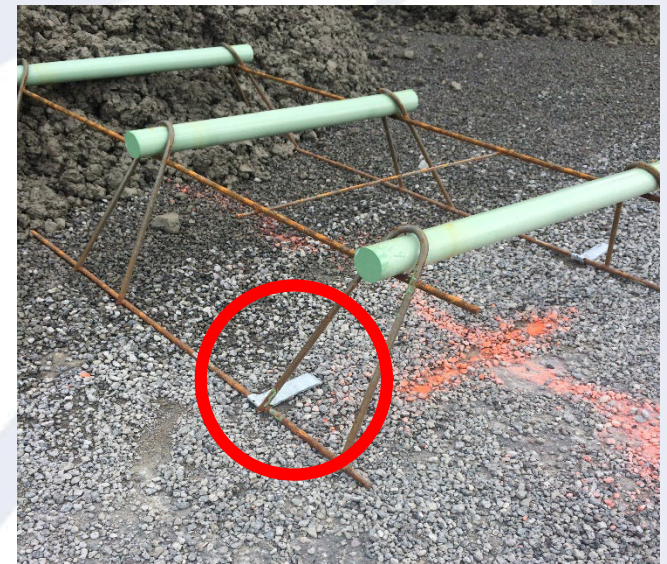
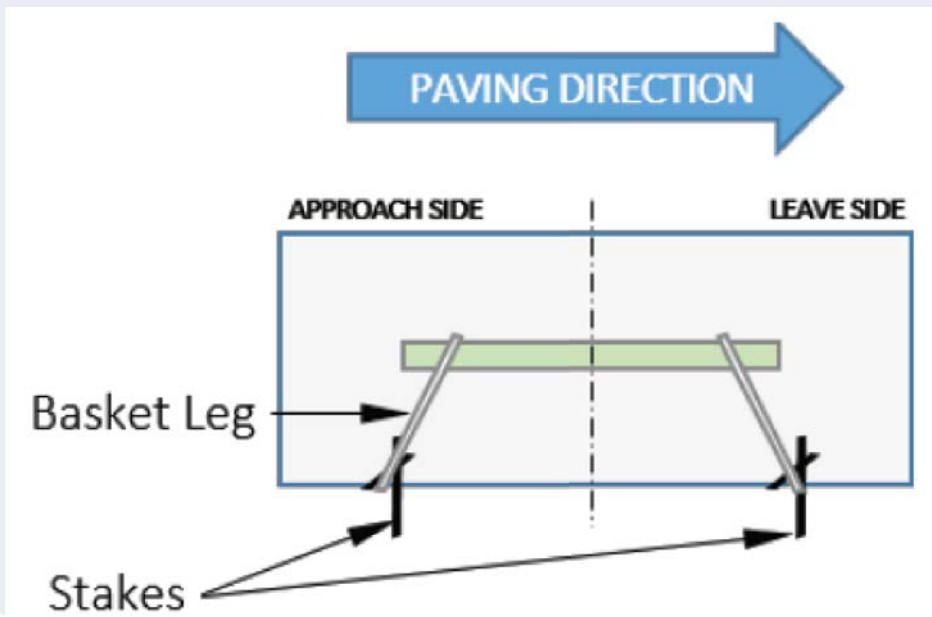
# Anchoring Depth

- Granular Base
  - Most states require minimum of 12 in. (300 mm)
- Dense-Graded Stabilized Base
  - 4 in. (100 mm) usually sufficient
- Open-Graded Stabilized Base
  - 6 in. (150 mm) depth to hold
- Make Adjustments as Needed!





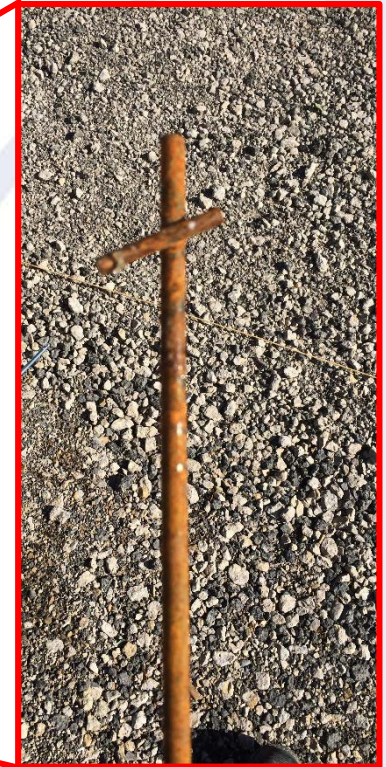
# Anchoring on Leave Side of Joint







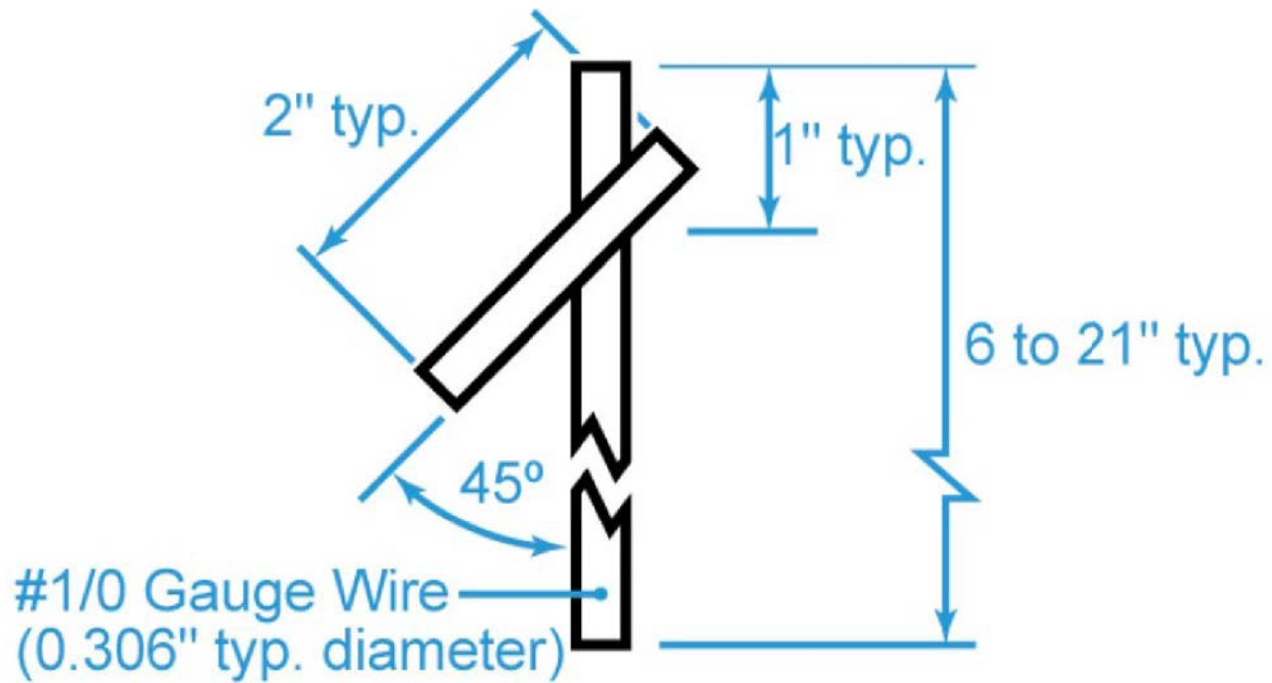
# Anchoring Dowel Baskets – Basket Stakes







# Baskets Stake - Typical Dimensions







# Basket Stakes – Driving into Grade



*Photo Credits to Hilti North America (L) and ACPA (R)*



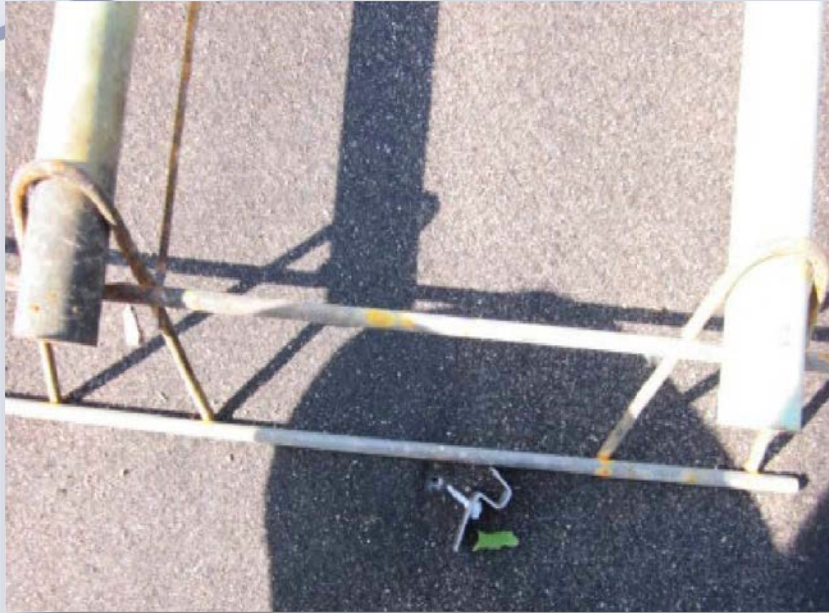
# Basket Clips – Wrap-Around Type







# Basket Clips – Nail Down Type



*Photo Credits to MnDOT (top L), Hilti North America (top R), and Dayton Superior*





# Basket Clips – Nailing into Place



*Photo Credits to Hilti North America (L), Duit Construction Company (C), and ACPA*



# Anchoring Best Practices







# Anchoring Dowel Baskets – Installation





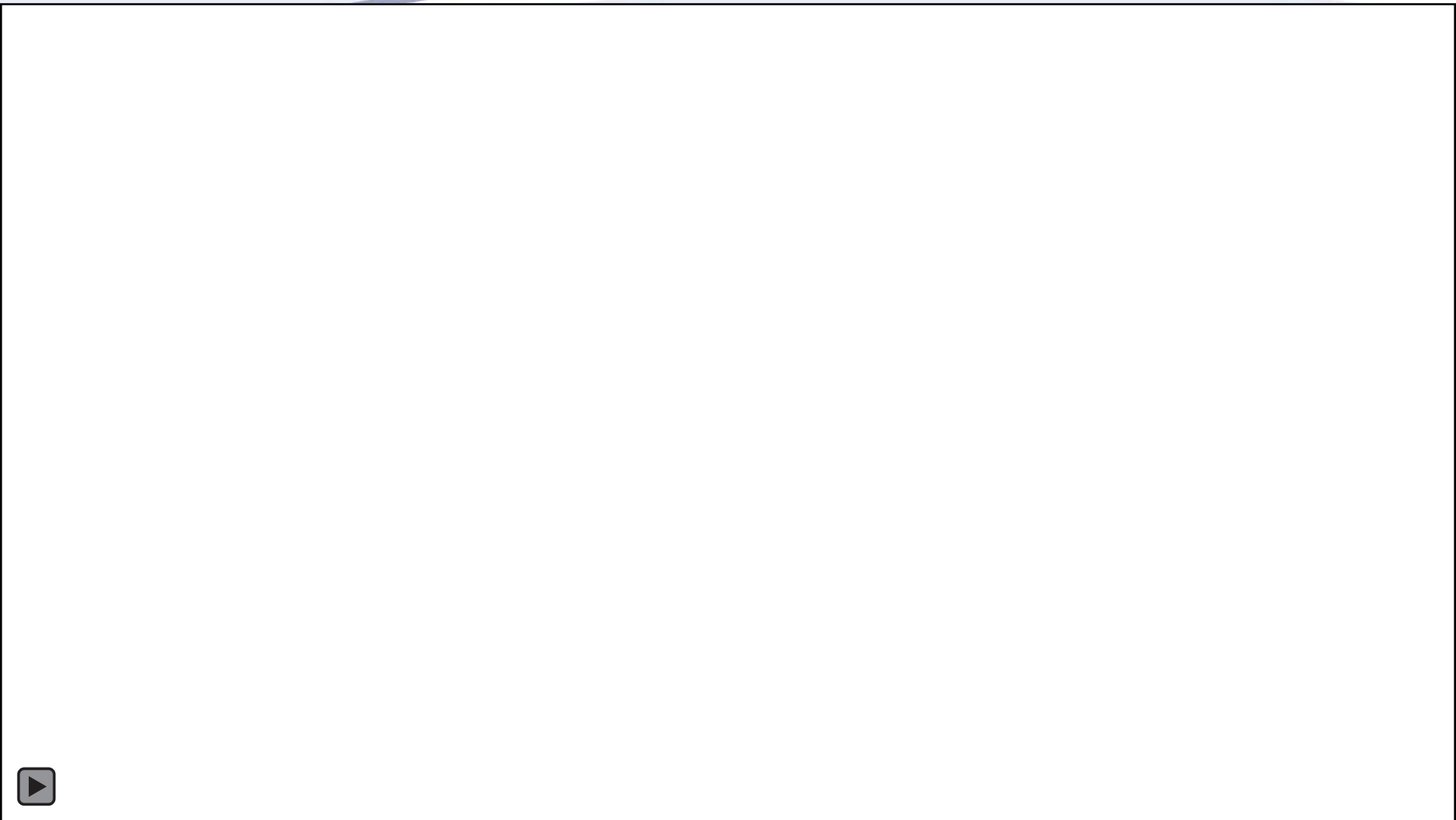
## Placer/Spreader



Placer/spreader with side belt to receive and distribute concrete from haul trucks.



# Anchoring Dowel Baskets







# Anchoring Dowel Baskets





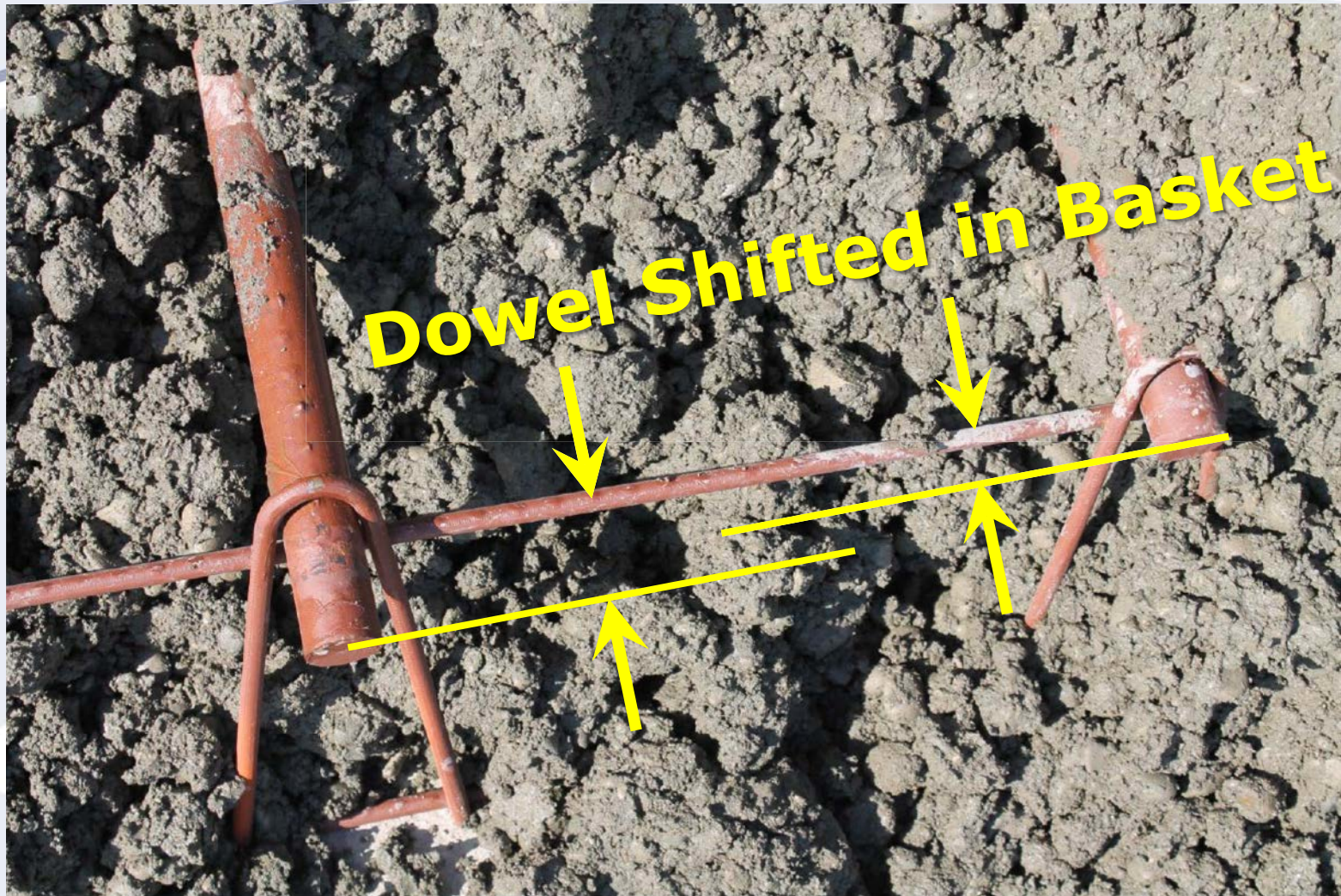
# Basket Rigidity and Tie Wires

- With well-made and properly anchored baskets:
  - Dowel bars should not skew, tilt or translate
- Cutting basket tie wires reduces basket rigidity.
- ACPA recommends against this practice:
  - No proof of problems in field.
  - Engineering analysis indicates tie-wire welds will yield far before joint is restrained.





# Basket Rigidity Important to Avoid Collapse







# Basket Rigidity Important to Avoid Collapse



*Photo Credits to MnDOT (L) and ACPA*

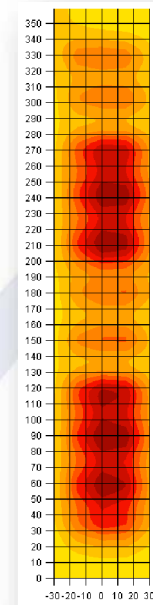




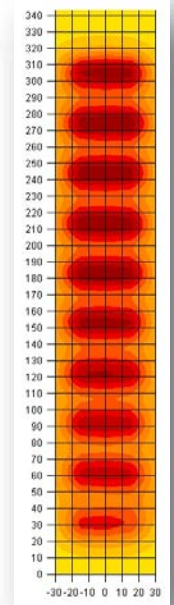
# Basket Rigidity – Shipping Wires



Cutting tie wires to facilitate MIT-Scan measurement can be counterproductive.



Erroneous Scan  
with Wires Intact



Better Scan with  
Wires Cut





# Basket Rigidity – KY Brace

- Provides additional leg stability
- Manufactured as part of the basket frame.
- Tool is used to rotate into position.





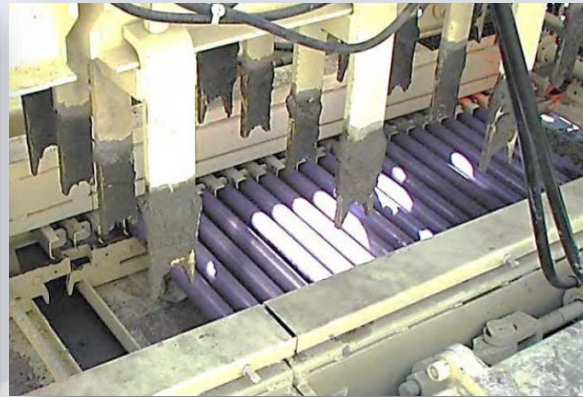


# Basket Rigidity – KY Brace





# Dowel Bar Insertion





# Smoothness Considerations with Dowel Bar Insertion

- DBI does not introduce embedded basket.
- But... inserted dowels do displace concrete upon insertion.
- The key to controlling dowel position and preventing bumps is the concrete mixture.
- Well-graded mixtures provide reliable and excellent results:
  - Accuracy.
  - Less indentation at surface.
- Gap-graded mixtures are prone to:
  - Dowel mislocation, translation, skewing.
  - Deeper indentations at surface.
  - Bumps or dips from displaced material.





# Additional Paver Set-Up with Dowel Bar Insertion

## Calibration of the machine for the configuration:

- Insertion depth for pavement thickness and cross-slope

- Hydraulic system

- Crane for lifting and loading dowel bundles



## Vibrator set-up:

- Height about at level of the vibrator support pipe or beam, or midlevel of the auger/plow

## Capacity of the electrical & hydraulic systems.

- Repeating bumps have been traced to surges in these systems.





Remember: Forks that push dowels into concrete do scar the surface. Scarring is addressed by a secondary process, including the paving pan.



For smoothness, it is best to follow insertion with a screed and paving pan to shape the surface and repair scarring.





Best Practice: A basketball-sized roll in front of the correcting beam will address insertion scars and is a good indication the operation is well-tuned to the concrete. Slope sensors on pan allow for adjustments.





# DOWEL PLACEMENT ISSUES

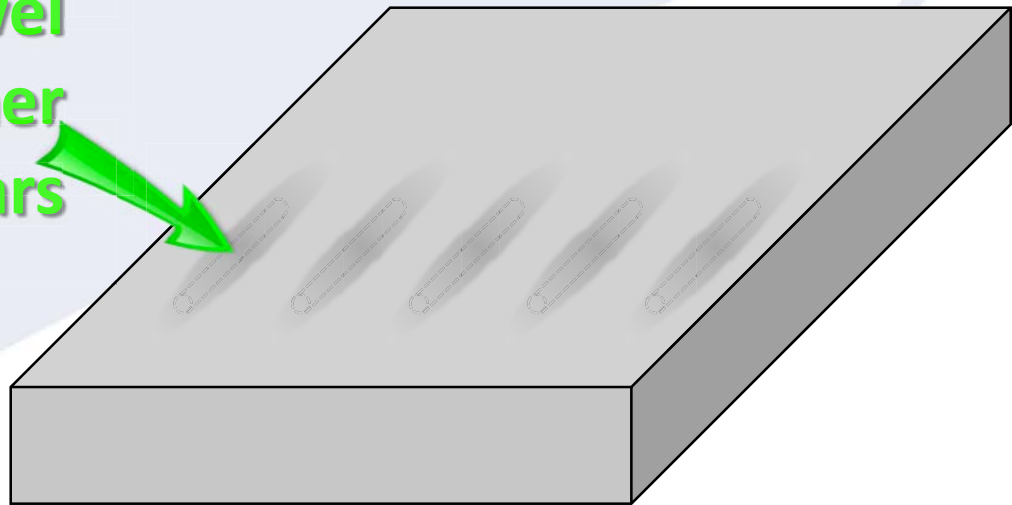






# Reinforcement Ripple Over Embedded Steel

**Slight Bump Over  
Embedded Dowel  
or Other  
Reinforcing Bars**

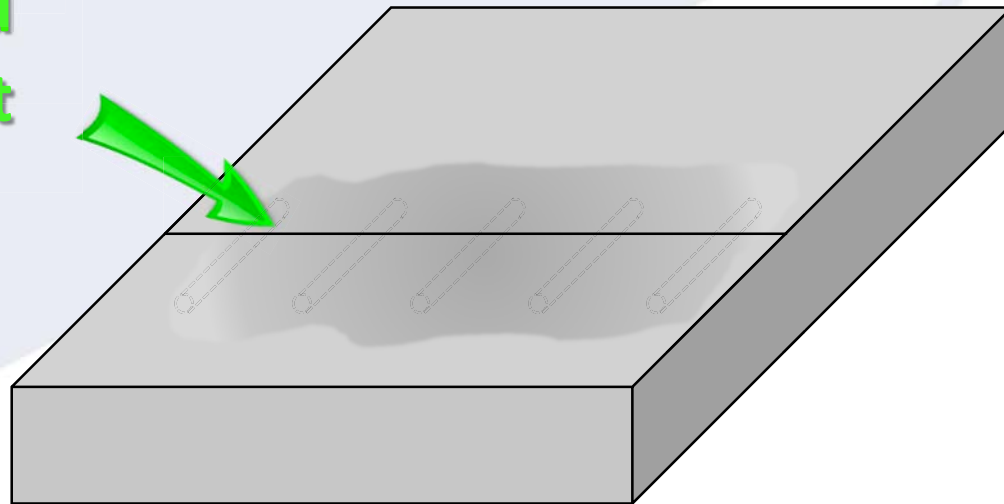


- Improper positioning of vibrators on paving machine.
- Malfunctioning or operating frequency of vibrator(s).
- Risk is greater on thinner pavements.



# Lack of Consolidation Over Dowel Basket

**Slight Dip Over  
Embedded  
Dowel Basket**

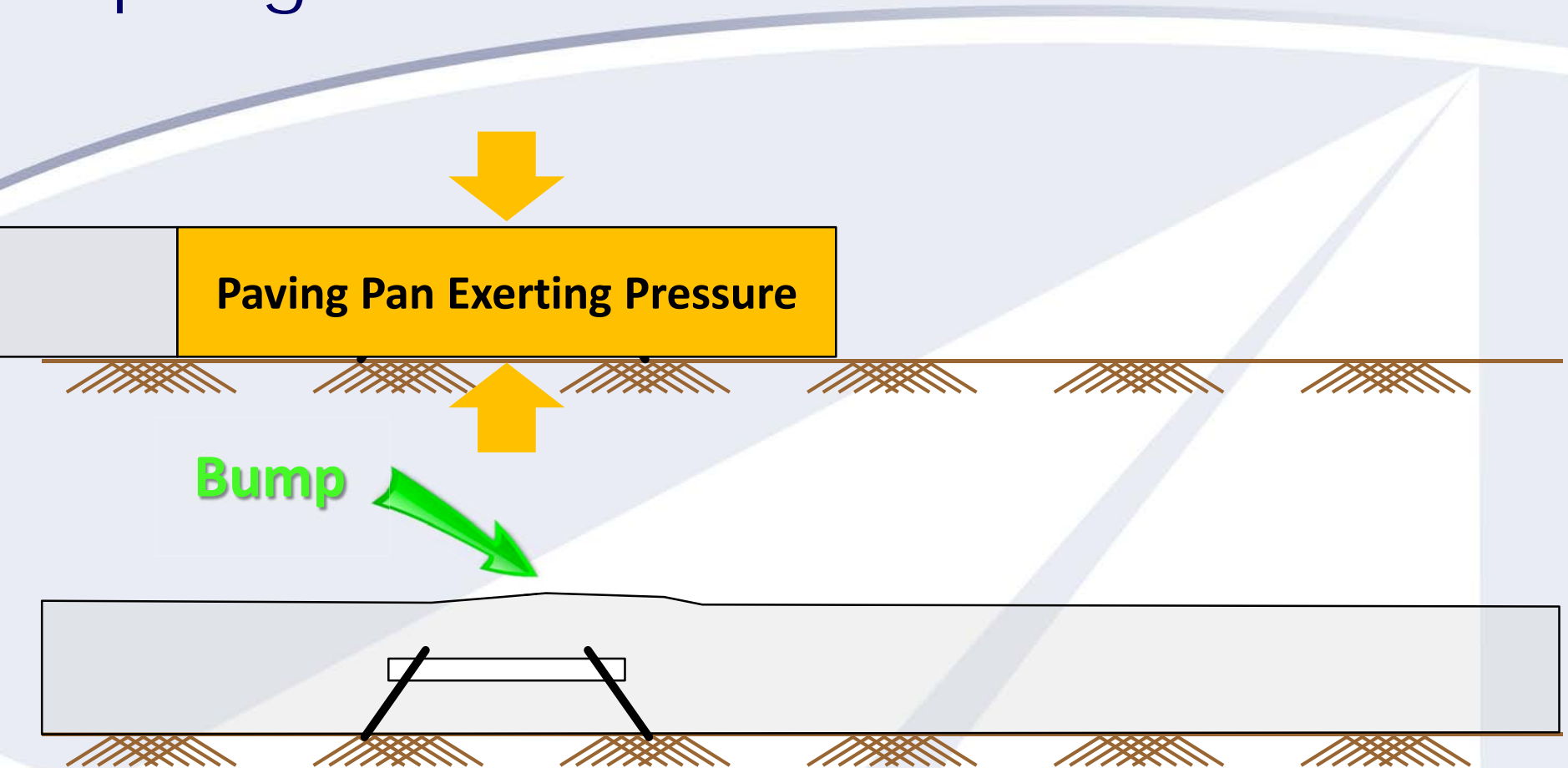


- Improper positioning of vibrators on paving machine.
- Malfunctioning or operating frequency of vibrator(s).
- Risk is greater on thicker pavements.





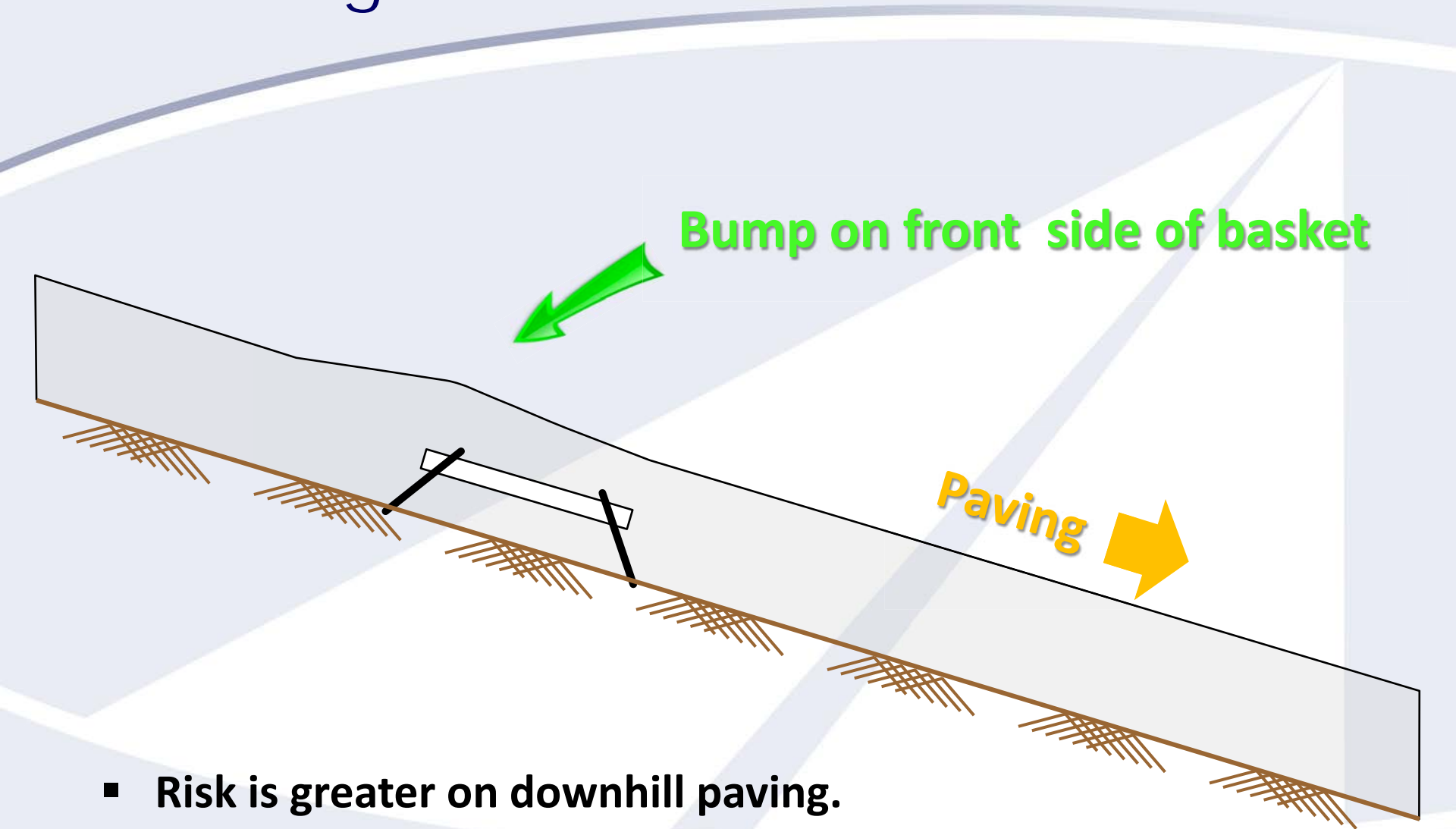
# Spring Back of Dowel Baskets



- Cutting shipping wires can increase risk of spring-back.
- Risk is greater on thinner pavements.

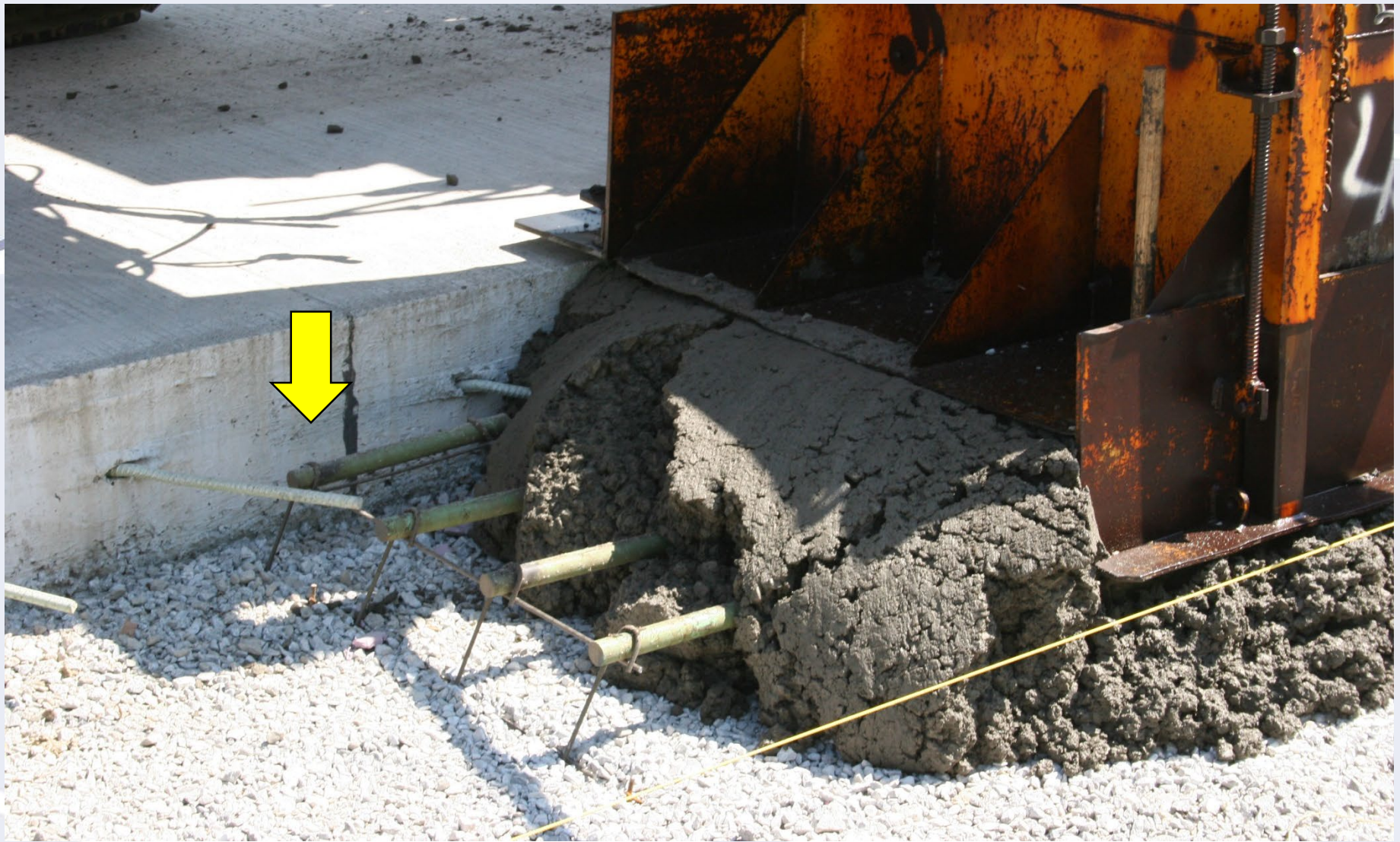


# Damming from Embedded Steel



- Risk is greater on downhill paving.
- Risk is greater on slopes greater than about 4%.





It may be difficult to consolidate the concrete around bars that are too close to the pavement edge.



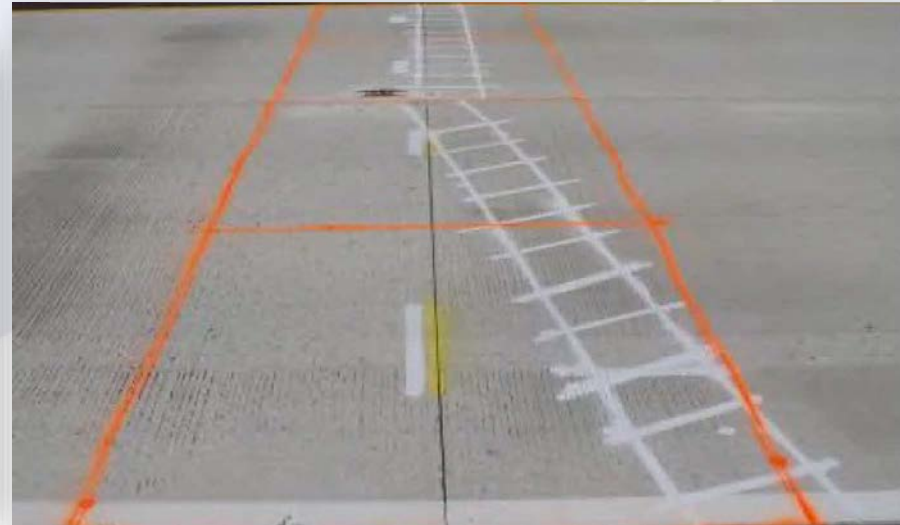
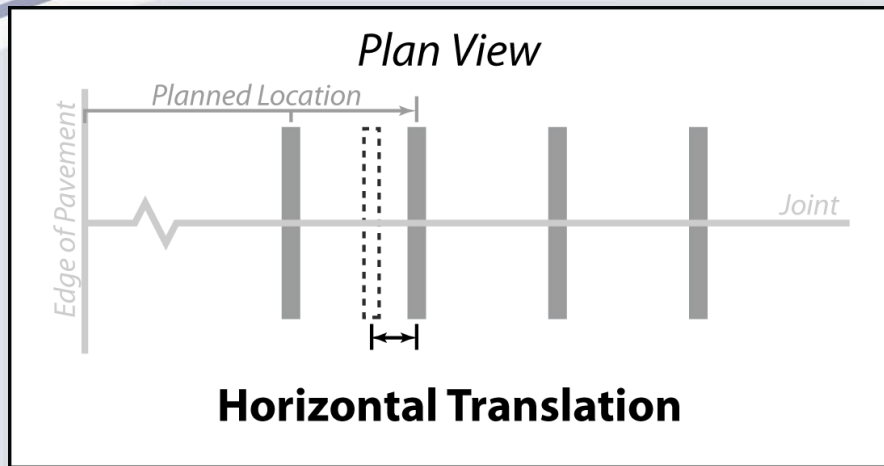
# Misalignment





# Finishing and Consolidation





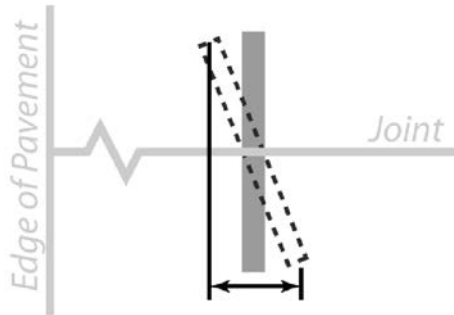
# IMPORTANCE OF LOCATION AND ALIGNMENT





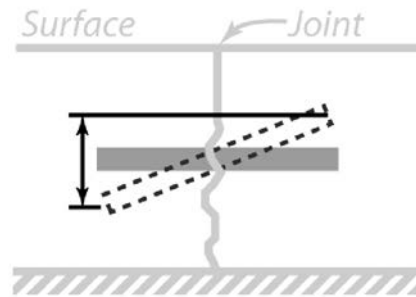
# Dowel Alignment

*Plan View*



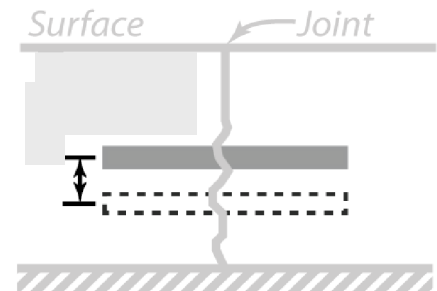
**Horizontal Skew**

*Section View*



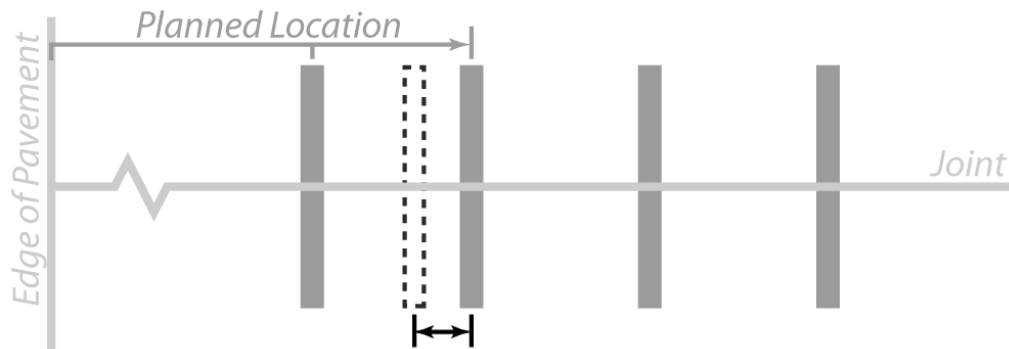
**Vertical Tilt**

*Section View*



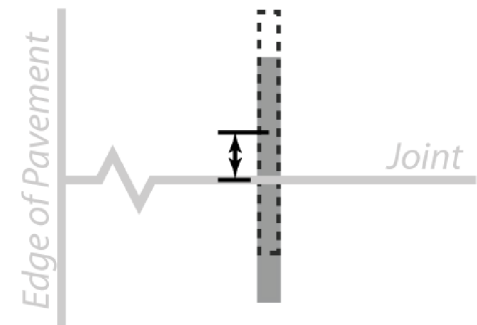
**Vertical Translation**

*Plan View*



**Horizontal Translation**

*Plan View*

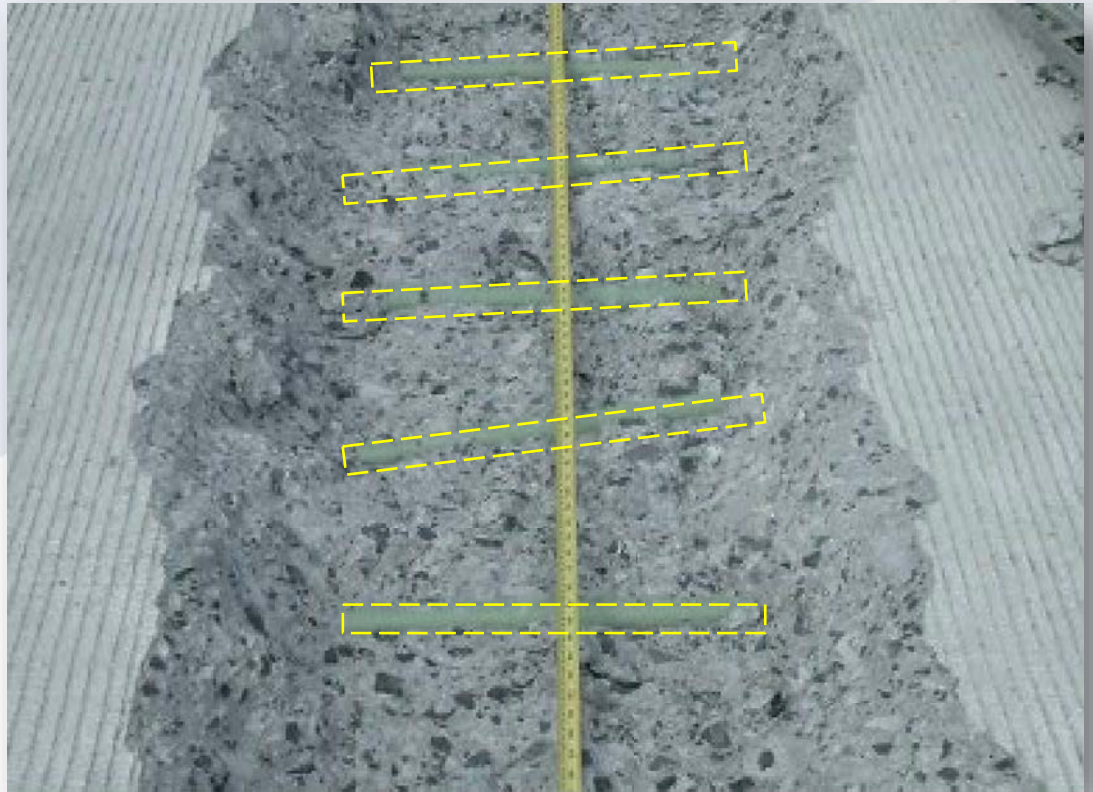


**Longitudinal Translation**



# Dowels & Dowel Alignment

- Typical dowel bar installation results in a combination of skew, tilt and translation of some bars.
- The key is keeping the bars within reasonable tolerances.







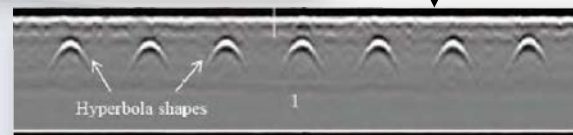
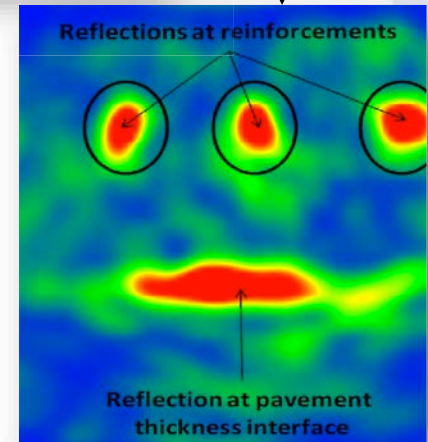
*Photo Credit to ACPA*





# Dowels & Dowel Alignment

- Dowel bar imaging has provided a method to detect bar location and alignment without damaging the slab







# Dowels & Dowel Alignment

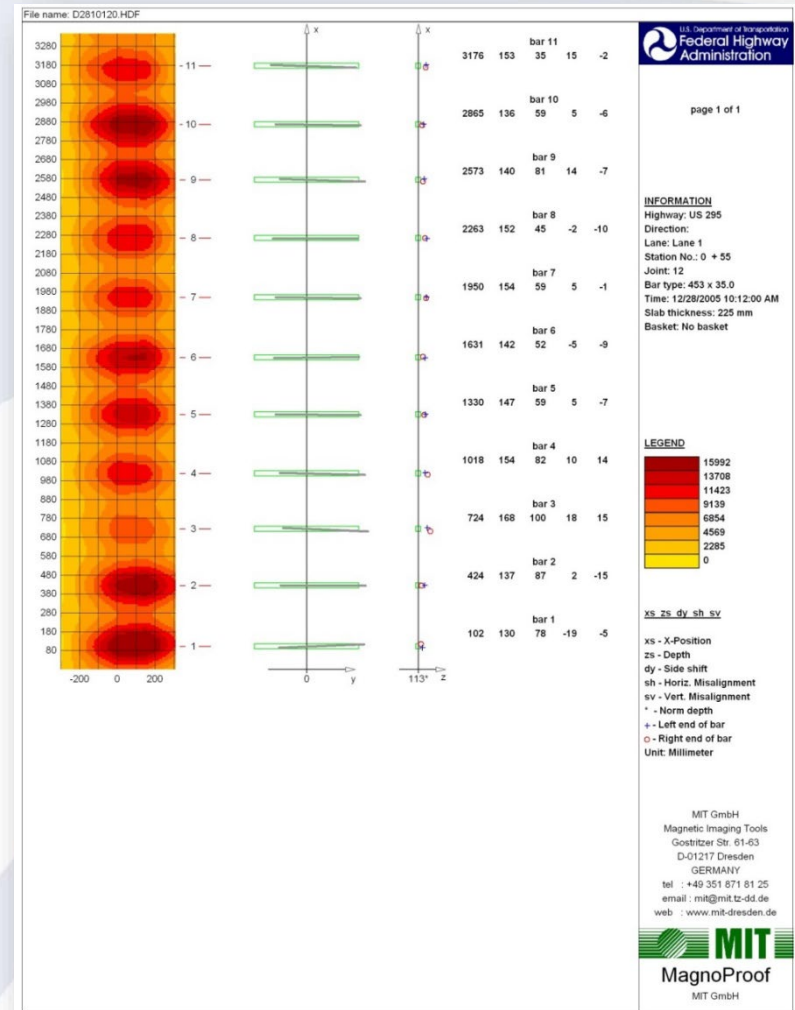
- MIT Scan2 B
- MIT-DOWEL-SCAN



*Photo Credits to KSE Testing Equipment*

# Dowels & Dowel Alignment

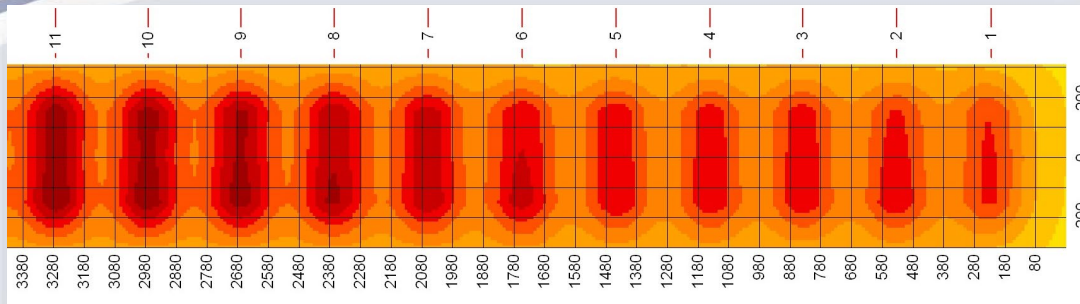
- MIT-SCAN2 typical output provides:
  - Graphical presentations
  - Numerical data
- Each bar included.
- Easy to interpret.



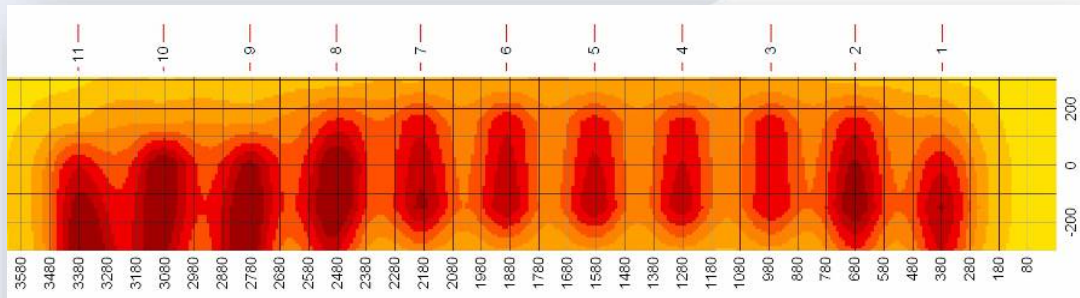




# Dowels & Dowel Alignment



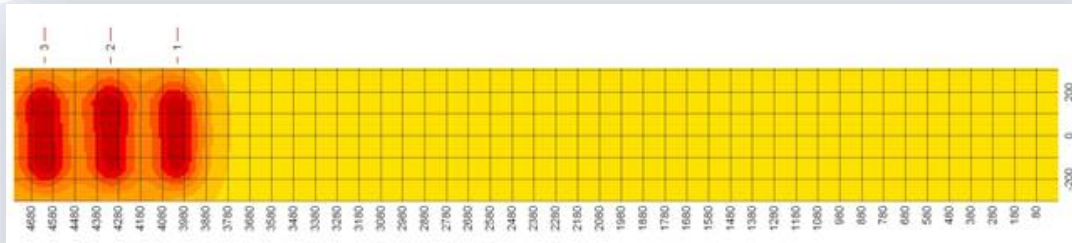
Scan from typical joint  
showing bars in good  
position



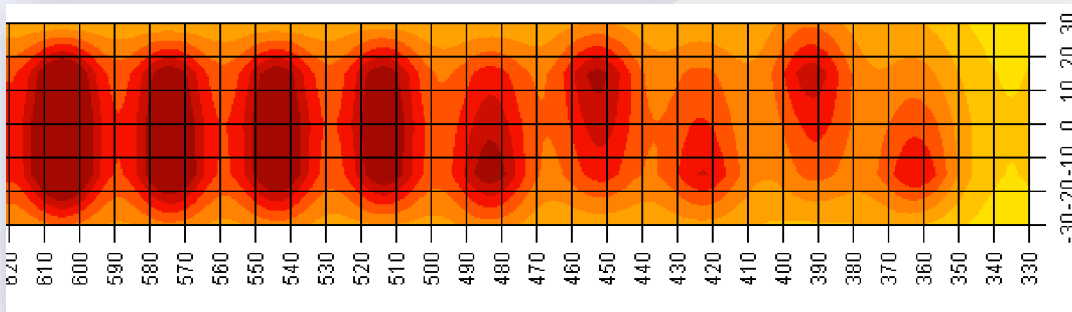
Scan from joint  
indicating an  
anchoring issue



# Dowels & Dowel Alignment



Scan from joint with missing dowel bars



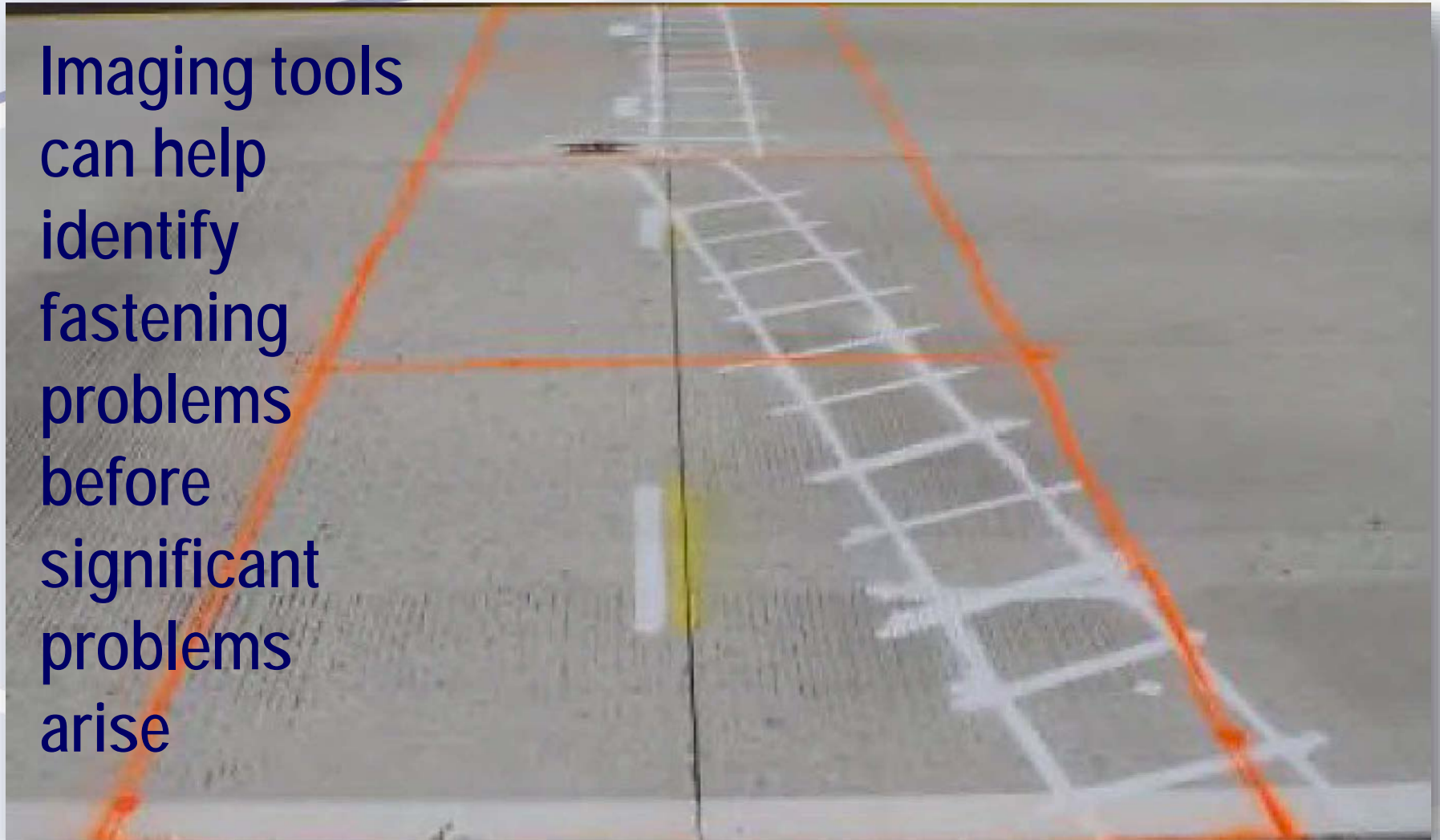
Scan from joint where the basket opened & dowels tilted





# Dowels & Dowel Alignment

Imaging tools  
can help  
identify  
fastening  
problems  
before  
significant  
problems  
arise



*Photo Credit to Kentucky Transportation Center*



# Dowels & Dowel Alignment



▲ Dowel too close to surface

Dowels tipped and too close to surface ▶







# Dowels & Dowel Alignment



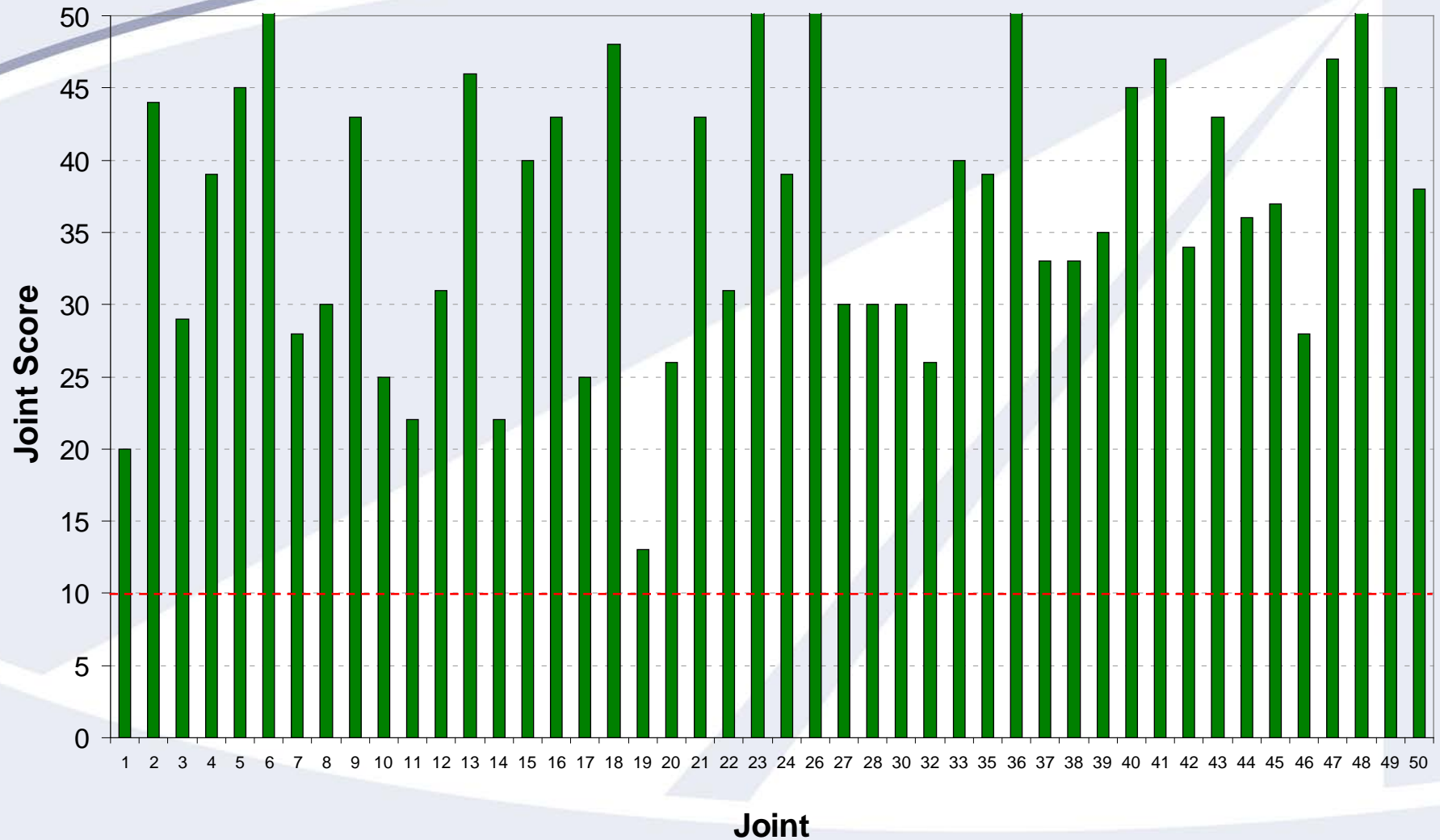
▲ Dowel too close to corner.

Dowel tipped  
and too close to  
surface





# Joint Score for a section in GA





A photograph of a two-lane asphalt road stretching into the distance. The road is flanked by dense green trees on both sides. On the right shoulder, a dark red SUV is parked. In the distance, several orange traffic cones are visible on the road, and a person can be seen walking on the right shoulder. The sky is clear and blue.

30-yr old pavement section with extremely poor  
dowel alignment

# Reference

## Tech Brief

### DOWEL BASKET ANCHORING METHODS Best Practices for Jointed Concrete Pavements

#### INTRODUCTION

Dowels are the most common form of load transfer in concrete pavements. They come in various sizes, shapes, and materials, but to perform optimally over the course of the pavement life, they need to be oriented appropriately and within tolerable location limits in the slab. Proper placement ensures optimal load transfer with minimal added stress to the pavement. For this reason, attention to dowel placement during paving is important, and ensuring that dowel placement accuracy is maintained through paving is a necessary quality control activity.

Dowel basket fasteners, such as basket clips and stakes, are commonly used to secure dowel baskets for the paving process. This tech brief summarizes the purpose and recommendations for ensuring that dowels placed using baskets maintain their position and elevation through the paving process. Additional details can be found in the *Guide to Dowel Load Transfer Systems for Jointed Concrete Roadway Pavements* (Snyder 2011).

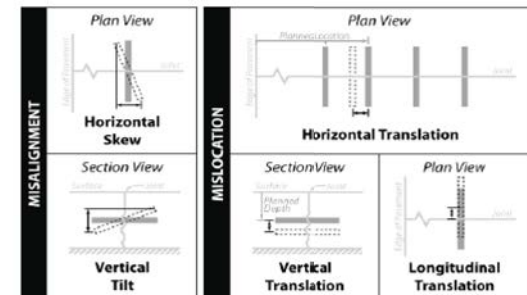
#### DOWEL ALIGNMENT AND PLACEMENT

The location and alignment of dowel bars is important to achieve intended performance. This is true regardless of whether dowels are placed using a mechanical dowel bar inserter (DBI) or placed before paving with baskets, which is the subject of this tech brief.

Pavement specifications typically include placement tolerances. These tolerances call for dowels to be placed reasonably close to parallel with the pavement centerline and the pavement surface. This also results in the dowels being parallel to each other. Specifications also require that dowels be located within mid-depth of the slab. Dowels that are significantly misaligned or mislocated (as illustrated in Figure 1) may not function as intended and, if well out of tolerance, can cause detrimental pavement damage.



U.S. Department  
of Transportation  
Federal Highway  
Administration

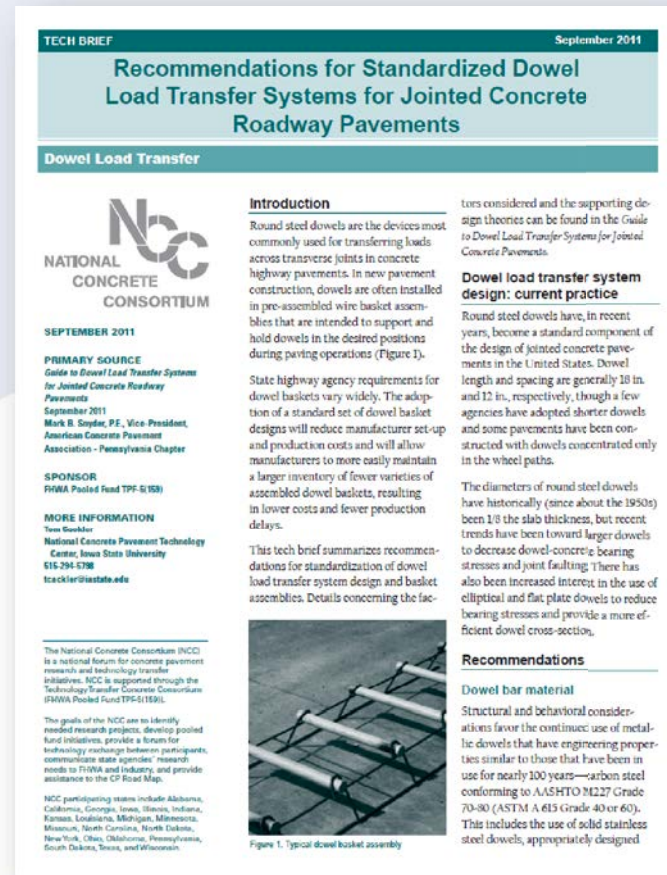
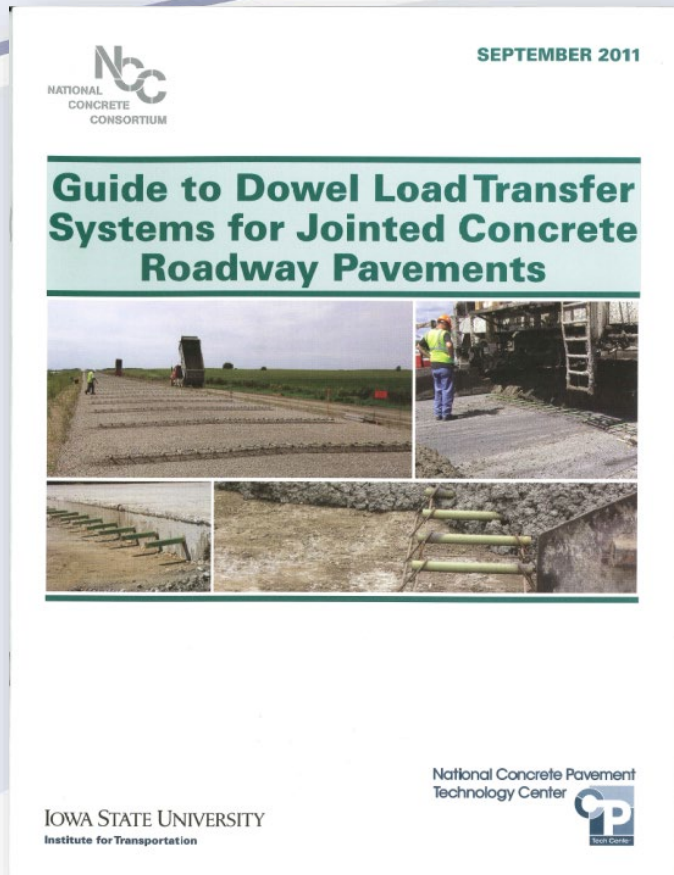


Snyder 2012 after Tayebli 1996 and FHWA 2007

Figure 1. Five types of dowel bar misalignment and mislocation



# Additional Resources



[www.cptechcenter.org](http://www.cptechcenter.org)



# Additional Resources



[www.acpa.org](http://www.acpa.org)



# Thank You!

## Questions? Feedback?



Main Website | [acpa.org](http://acpa.org)  
Concrete Wiki | [wikipave.org](http://wikipave.org)  
App Library | [apps.acpa.org](http://apps.acpa.org)  
Pavement Design | [PavementDesigner.org](http://PavementDesigner.org)  
Desktop Software | [software.acpa.org](http://software.acpa.org)  
Resources | [resources.acpa.org](http://resources.acpa.org)  
On-Demand Training | [ondemand.acpa.org](http://ondemand.acpa.org)  
Live Online Training | [webinars.acpa.org](http://webinars.acpa.org)  
Your Local Contact | [local.acpa.org](http://local.acpa.org)