Dowel Bar Placement Methods, Issues, Verification



National Concrete Consortium

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Director of Technical Services

American Concrete Pavement Association



Dowel Bar Placement Methods,

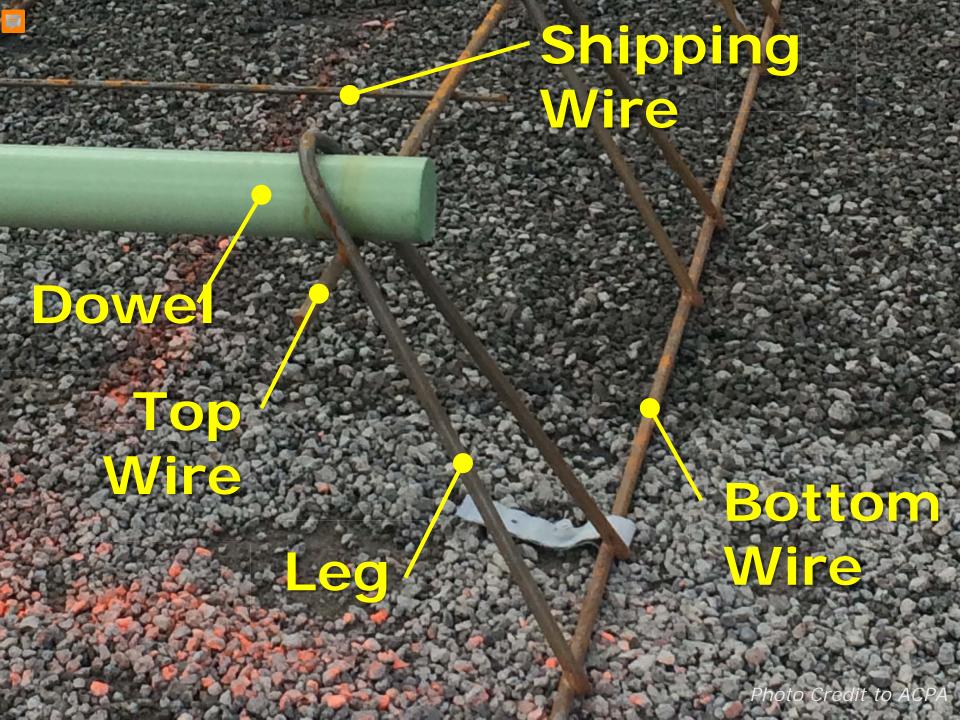
Issues, Verification

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





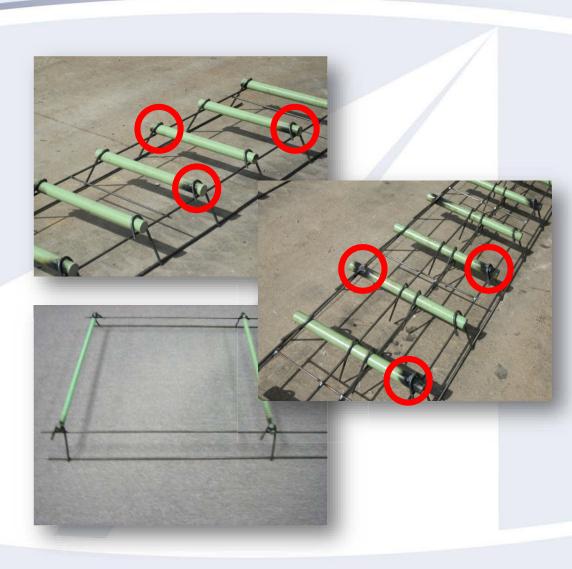






Types of Dowel Basket Assemblies

- 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.

ECH BRIE

Sentember 201

Recommendations for Standardized Dowel Load Transfer Systems for Jointed Concrete Roadway Pavements

Dowel Load Transfer



SEPTEMBER 2011

PRIMARY SOURCE
Guide to Dovel Load Transfer Systems
for Jointed Concrete Readway
Paraments
September 2011
Mark B. Snyder, P.E., Vico-President,
American Concrete Parament
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FHWA Pooled Fund TPF-5(159)

MORE INFORMATION Tom Cackler National Concrete Pavement Technolo Center, Iowa State University 515-234-5798

The National Concrete Consortium (NCC) is a national forum for concrete percenters research and technology transfer initiatives. NCC is sugported through the TechnologyTransfer Construct Consortium.

The goals of the NCC are to identify needed research proposts, develop pooled found isolatives, provide a forum for technology authorize between participants communicates state agencies' research needs to FHWA and industry, and provide assistance to the CP Book Map.

NSC participating states include Alabama California, Georgia, Sowa, Illinois, Indiana Kamasa, Louislana, Michigan, Minnesota, Missouri, North Carolina, North Dakota, New York, Ohio, Oklahorna, Pennsylvania

ntroduction

Round steel dowels are the devices most commonly used for transferring loads across transverse joints in concrete highway pavements. In new pavement construction, dowels are often installed in pre-assembled wire basket assemblies that are intended to support and hold dowels in the desired positions during paving operations (Figure 1).

State highway agency requirements for downed baseket vany wordely. The adoption of a standard set of dowel basket designs will reduce manufacturer set-up and production costs and will allow manufacturers to more early maintain a larger inventory of lewer varieties of assembled dowel baskets, resulting in lower costs and fewer production delays.

This tech brief summarizes recommendations for standardization of dowel load transfer system design and basket assemblies. Details concerning the fac-



Figure 1. Typical slowel basket assembly

tors considered and the supporting design theories can be found in the Guide to Dowel Load Transfer Systems for Jointal Concrete Payments.

Dowel load transfer system design: current practice

Round steel dowels have, in recent years, become a standard component of the design of jointed connecte pravements in the United States. Dowel length and spacing are generally 18 in. and 12 in., respectively, though a few agencies have adopted shorter dowels and some powerments have been constructed with dowels concentrated only in the wheel paths.

The diameters of round steel dowels have historically (since about the 1950s) been 1/8 the slab thickness, but recent trends have been toward larger dowels to decrease dowel-cuncrete braring stresses and joint faulting. There has also been increased interest in the use of elliptical and flat plate dowels to reduce bearing stresses and provide a more efficient dowel cross-section.

Recommendations

Dowel bar material

Structural and behavioral considerations favor the continued use of metallic dowels that have engineering properties similar to those that have been in use for nearly 100 years—earbon steel conforming to AASHTO M27 Grade 70-80 (ASTM A 615 Grade 40 or 60). This includes the use of solid stuinless steel dowels, appropriately designed





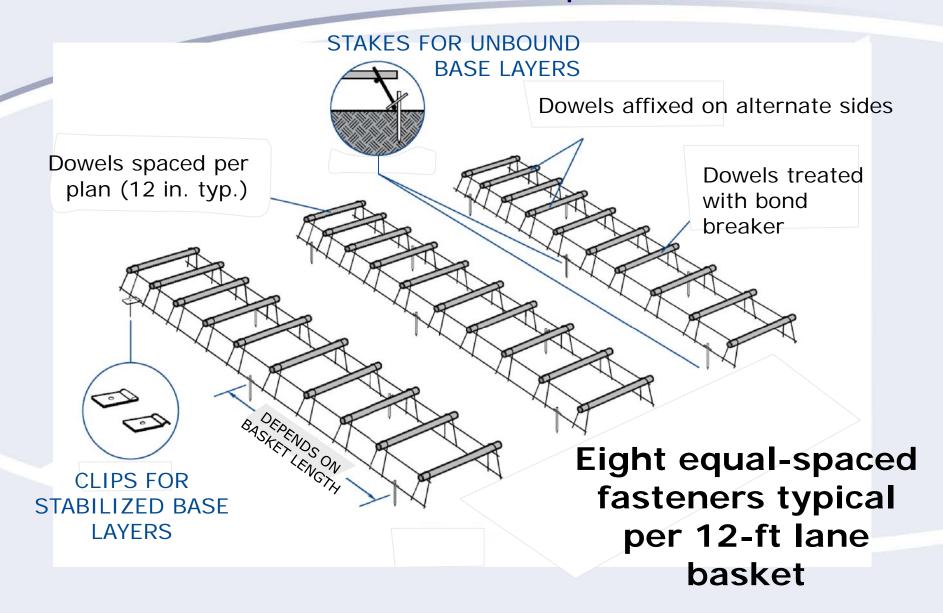
Types of Anchors

- 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

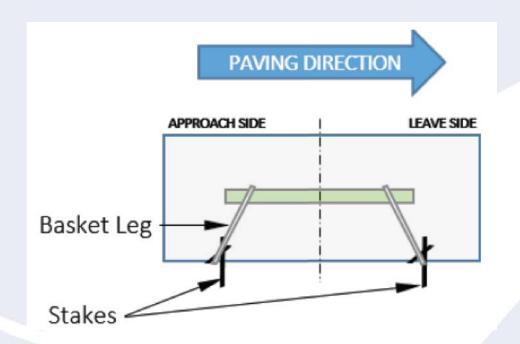
- Granular Base
 - ➤ Most states require minimum of 12 in. (300 mm)
- Dense-Graded Stabilized Base
 - ≥ 4 in. (100 mm) usually sufficient
- Open-Graded Stabilized Base
 - >6 in. (150 mm) depth to hold
- Make Adjustments as Needed!

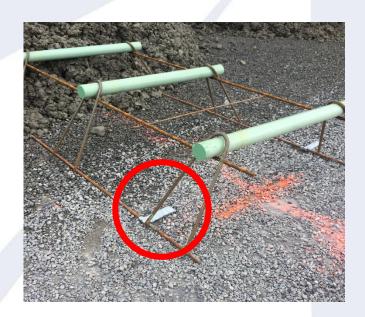






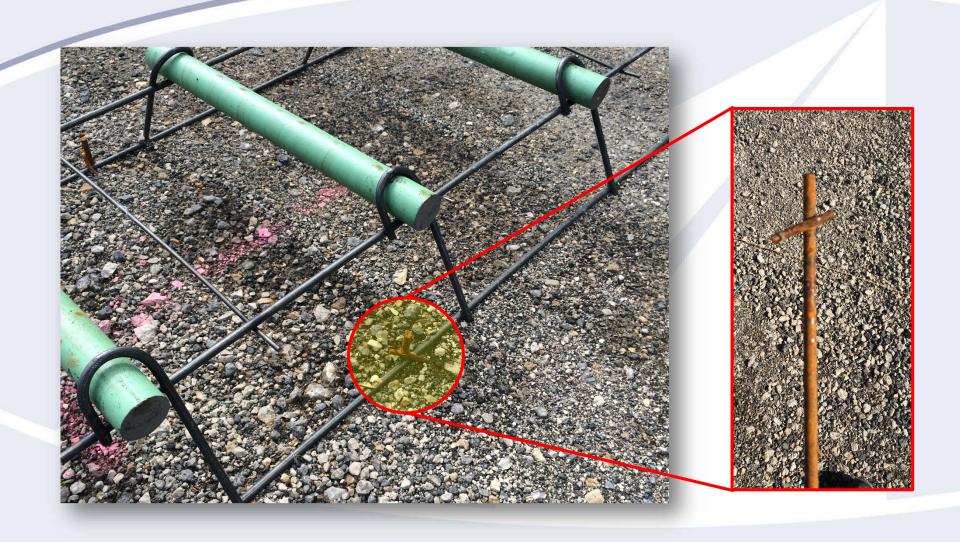
Anchoring on Leave Side of Joint





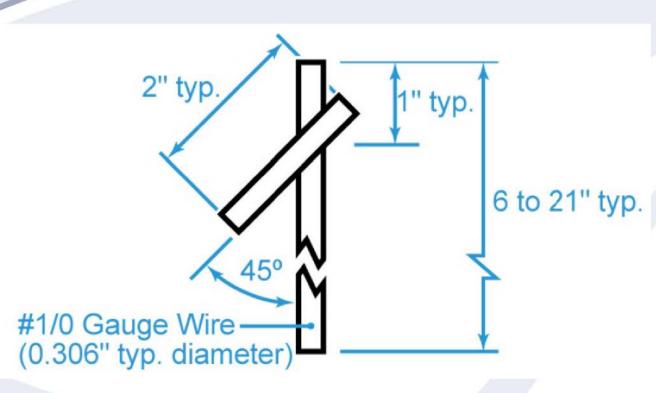


Anchoring Dowel Baskets - Basket Stakes





Baskets Stake - Typical Dimensions







Basket Stakes - Driving into Grade





Basket Clips - Wrap-Around Type





Basket Clips - Nail Down Type





Basket Clips - Nailing into Place





Anchoring Best Practices



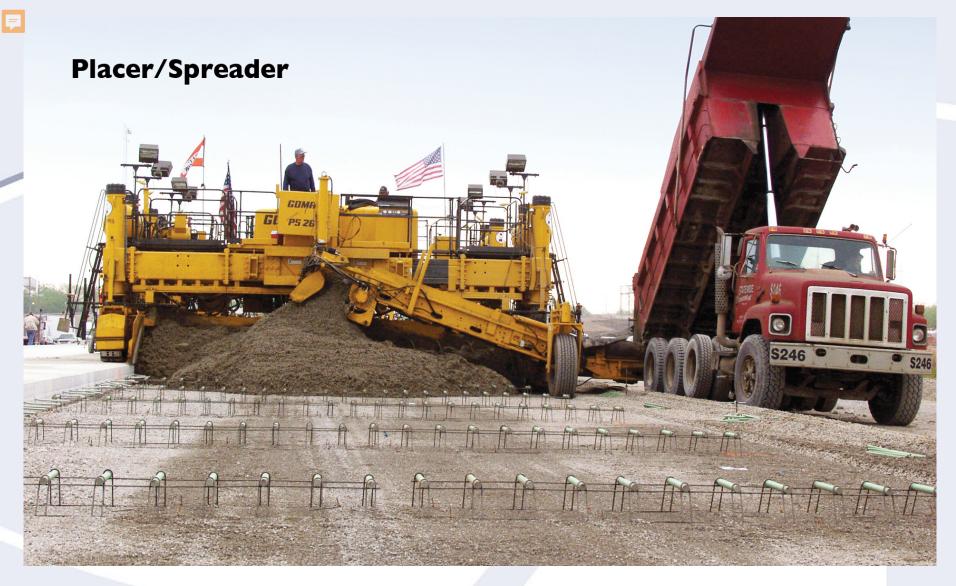






Anchoring Dowel Baskets - Installation





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



Anchoring Dowel Baskets





Anchoring Dowel Baskets



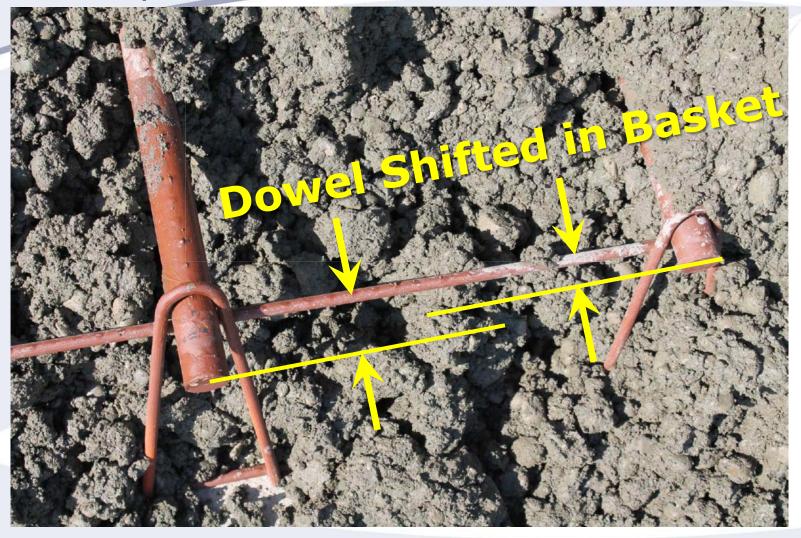


Basket Rigidity and Tie Wires

- 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.

F

Basket Rigidity Important to Avoid Collapse





Basket Rigidity Important to Avoid Collapse





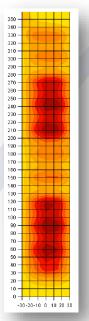


Basket Rigidity - Shipping Wires

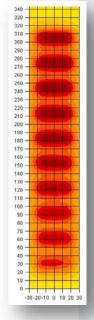




Cutting tie wires to facilitate MIT-Scan measurement can be counterproductive.







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

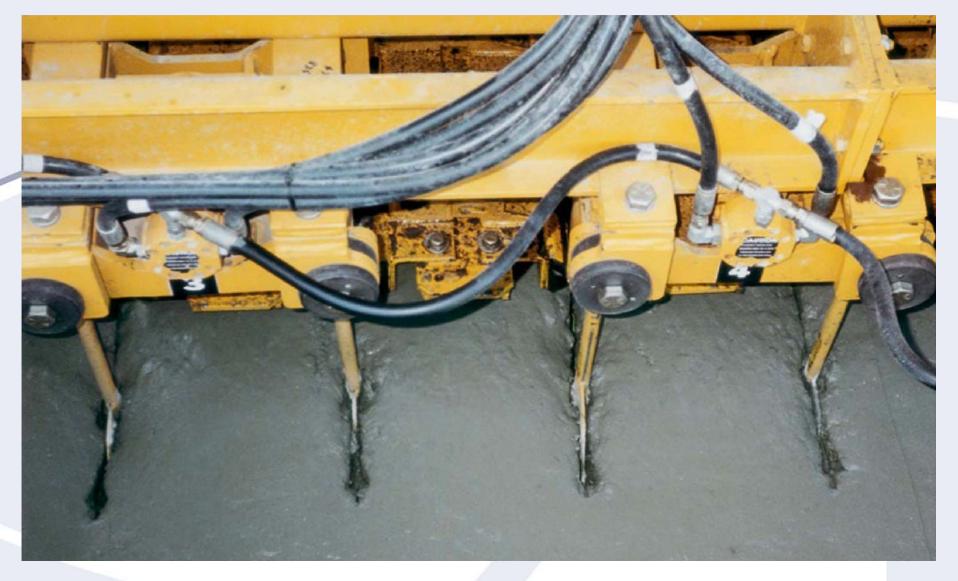


Height about at level of the vibrator support pipe or beam, or midlevel of the auger/plow

Capacity of the electrical & hydraulic systems.

Repeating bumps have been traced to surges in these systems.





<u>**Remember**</u>: Forks that push dowels into concrete <u>**do**</u> 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.

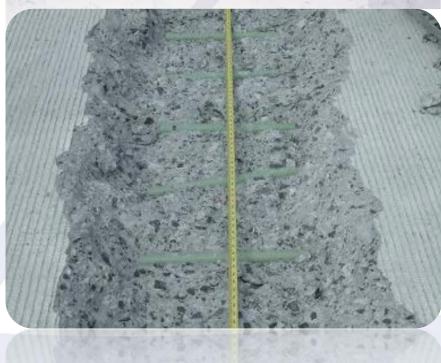


<u>Best Practice</u>: A basketball-sized roll in front of the correcting beam will address insertion scars and is a good indication the operation is well-tuned to the concrete. Slope sensors on pan allow for adjustments.

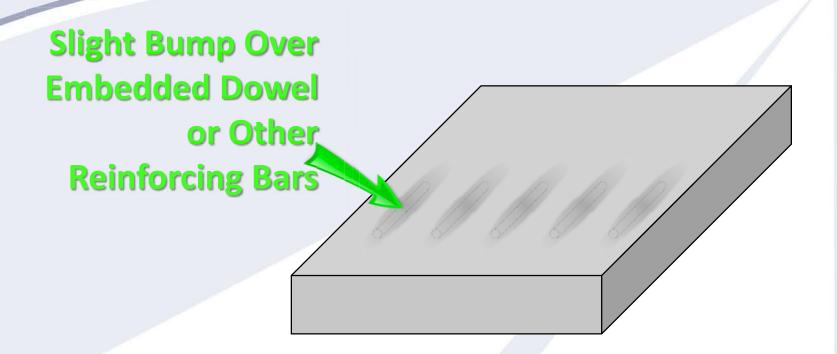


DOWEL PLACEMENT ISSUES





Reinforcement Ripple Over Embedded Steel



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

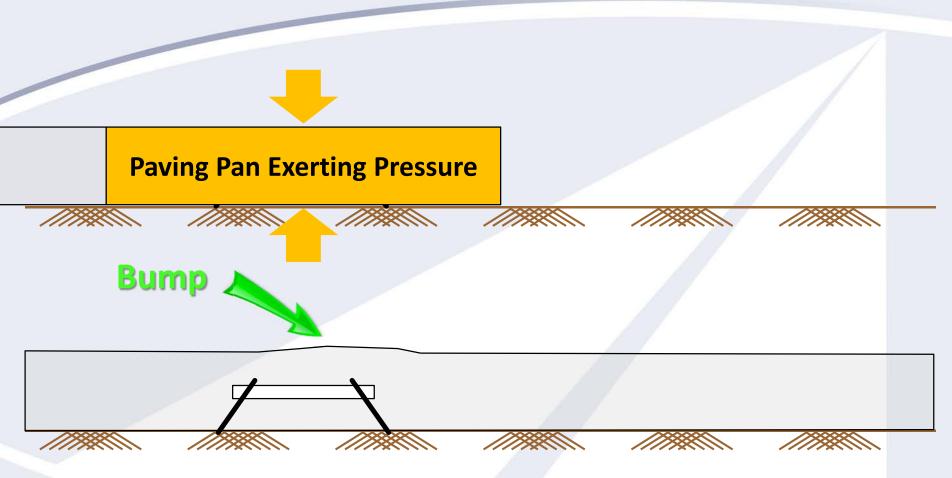
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Lack of Consolidation Over Dowel Basket

Slight Dip Over
Embedded
Dowel Basket

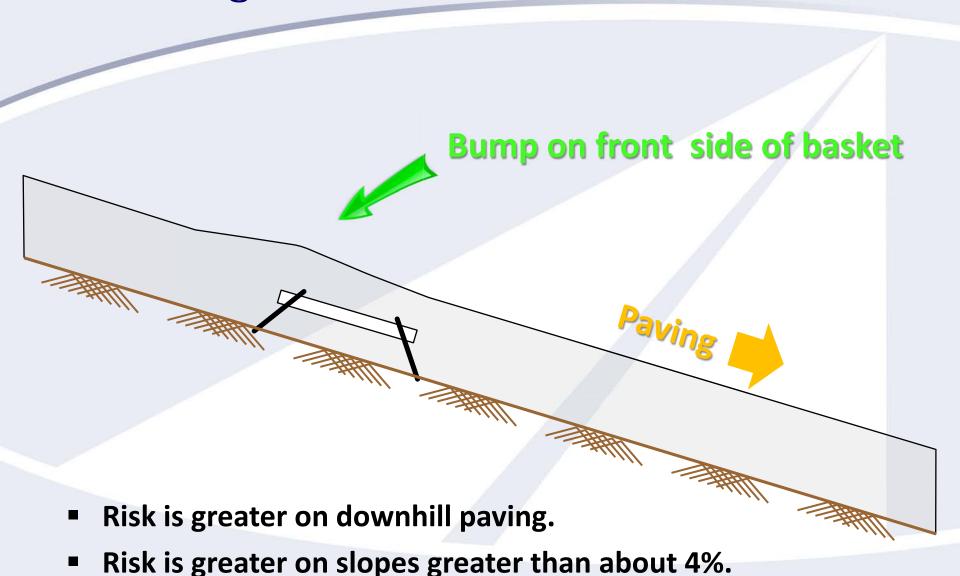
- Improper positioning of vibrators on paving machine.
- Malfunctioning or operating frequency of vibrator(s).
- Risk is greater on <u>thicker</u> pavements.

Spring Back of Dowel Baskets



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

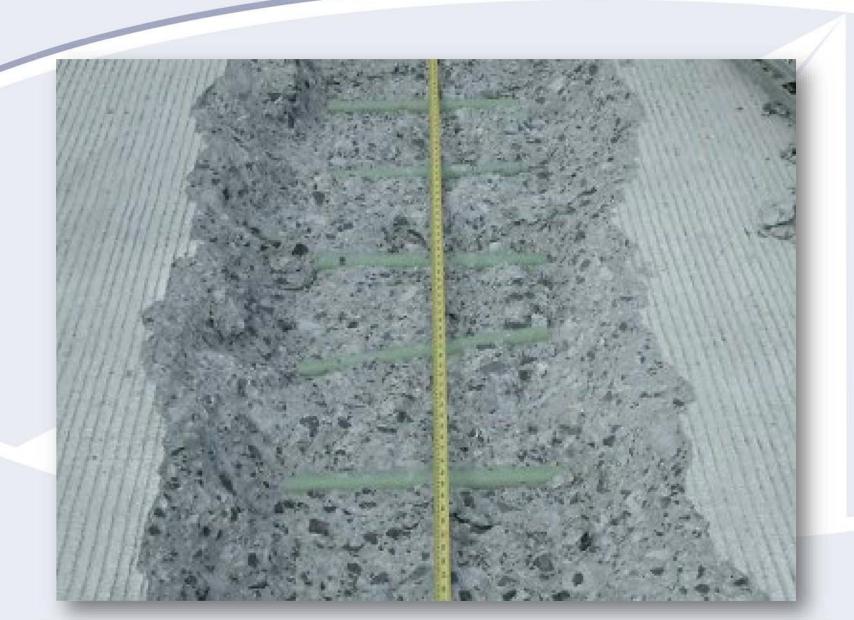
Damming from Embedded Steel





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

Misalignment



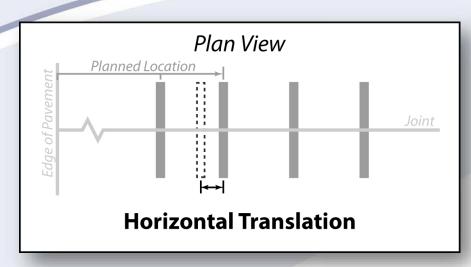
Finishing and Consolidation

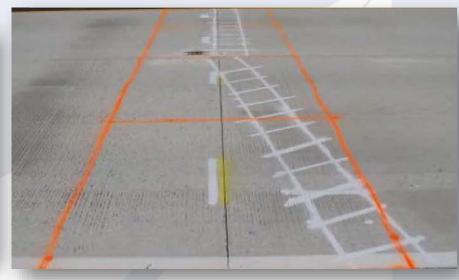








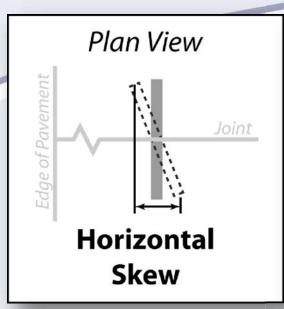


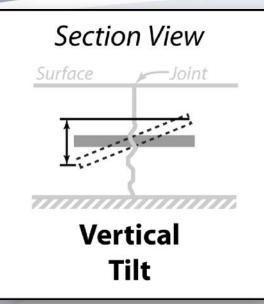


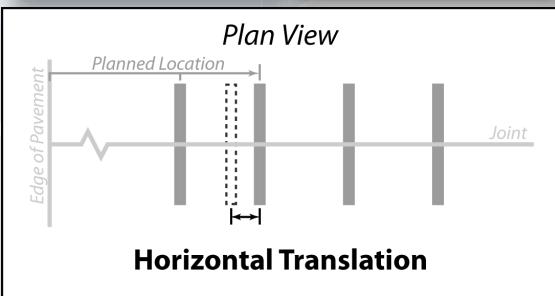
IMPORTANCE OF LOCATION AND ALIGNMENT

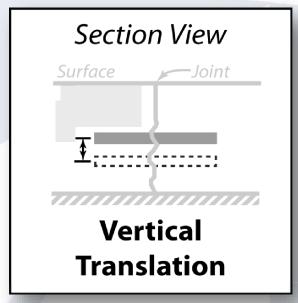


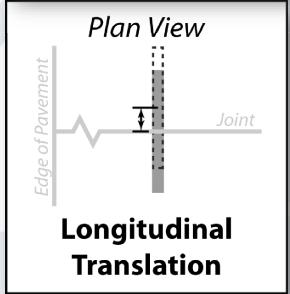
Dowel Alignment





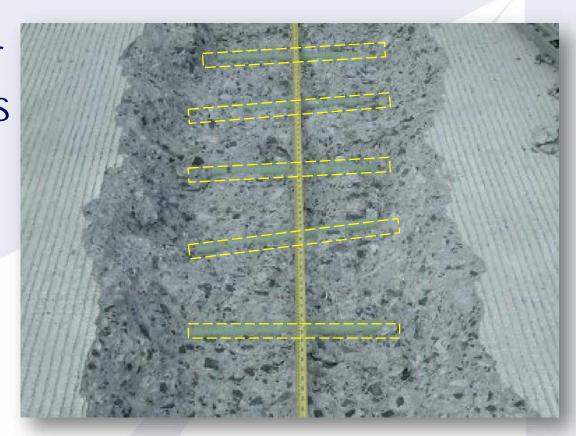








- Typical dowel bar installation results in a combination of skew, tilt and translation of some bars.
- The key is keeping the bars within reasonable tolerances.

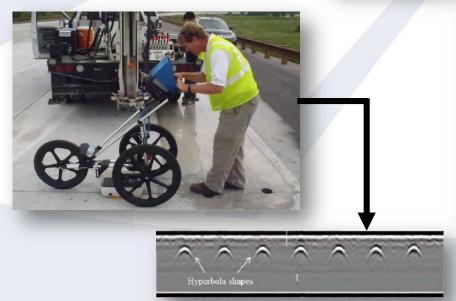


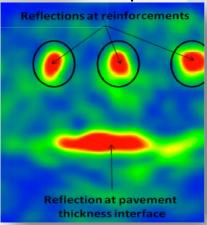




 Dowel bar imaging has provided a method to detect bar location and alignment without damaging the slab



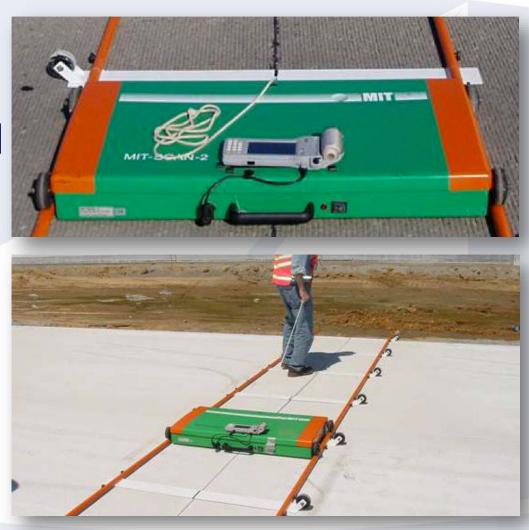






- MIT Scan2 B
- MIT-DOWEL-SCAN



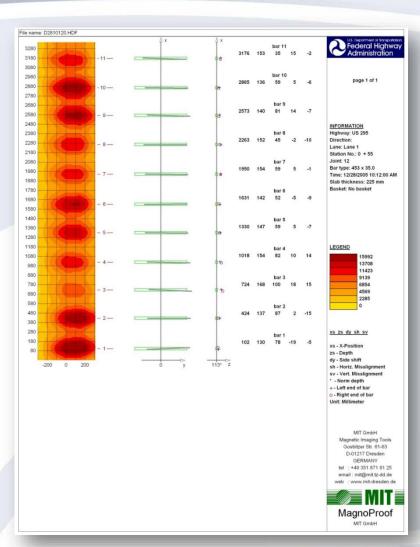




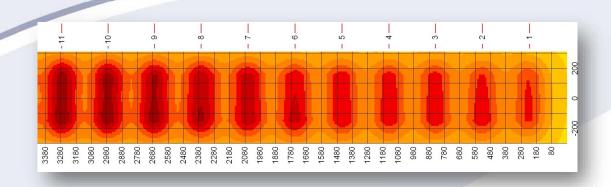
- MIT-SCAN2 typical output provides:
 - Graphical presentations
 - Numerical data

Each bar included.

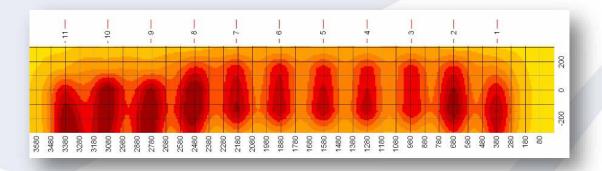
Easy to interpret.







Scan from typical **j**oint showing bars in good position

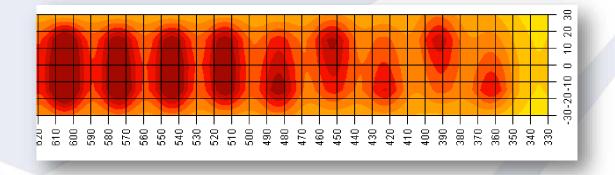


Scan from joint indicating an anchoring Issue



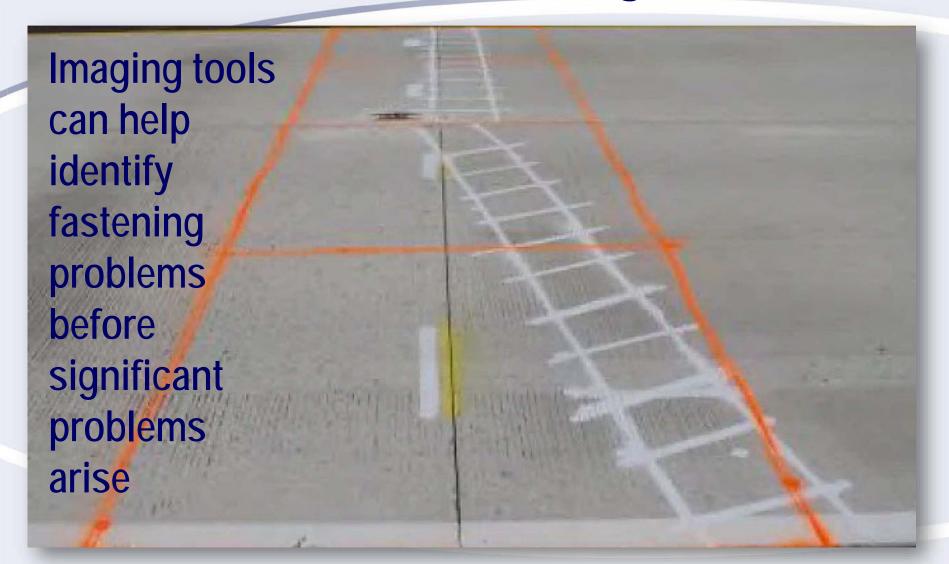


Scan from joint with missing dowel bars



Scan from joint where the basket opened & dowels tilted









Dowel too close to surface

Dowels tipped and too close to surface







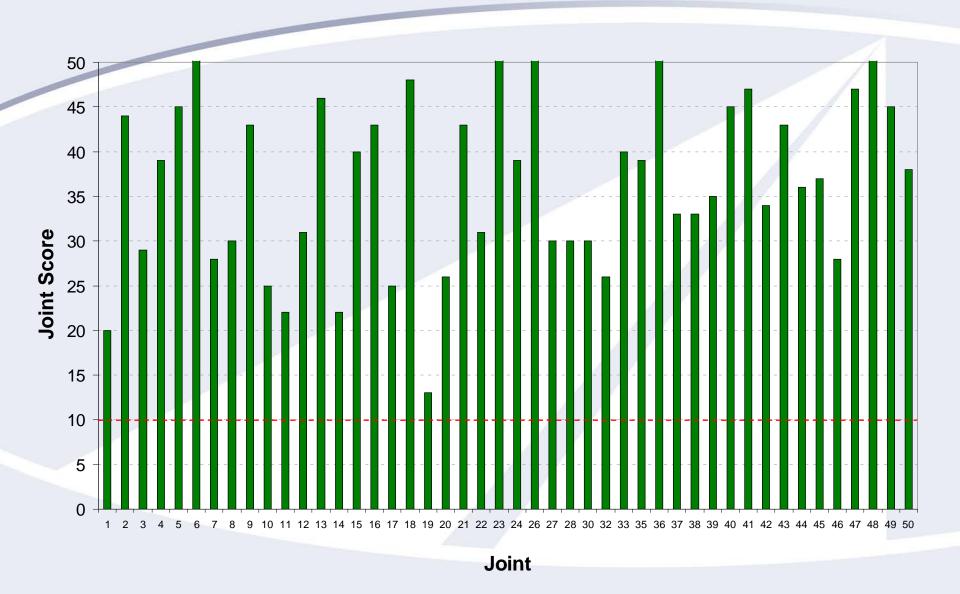
Dowel too close to corner.

Dowel tipped and too close to surface





Joint Score for a section in GA







Reference

MAY 201

FHWA-HIF-16-00

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 notfunction as intended and, if well out of tolerance, can cause detrimental pavement damage.

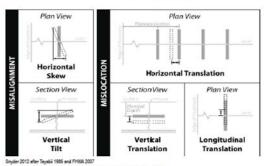




Figure 1. Five types of dowel bar misalignment and mislocation

http://www.fhwa.dot.gov/pavement/concrete/pubs/hif16021.pdf



Additional Resources



SEPTEMBER 2011

Guide to Dowel Load Transfer Systems for Jointed Concrete Roadway Pavements



National Concrete Pavement **Technology Center**

IOWA STATE UNIVERSITY Institute for Transportation

TECH BRIEF

Recommendations for Standardized Dowel Load Transfer Systems for Jointed Concrete **Roadway Pavements**

Dowel Load Transfer



SEPTEMBER 2011

PRIMARY SOURCE Guida to Down! Load Transfer System for Jointed Concrete Roadway September 2011

Mark B. Snyder, P.E., Vice-President Association - Pennsylvania Chapter

FHWA Pooled Fund TPF-5(158)

MORE INFORMATION

National Concrete Pavement Technology Center, Iowa State University tcackler@iastate.edu

The National Concrete Consortium INCCI

reded research projects, develop pooled and initiatives, provide a forum for

itomia, Georgia, Ipwa, Illinois, Indian saas, Louisiana, Michigan, Minnesota soun, North Carolina, North Dakota,

Introduction

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State highway agency requirements for dowel baskets vary widely. The adoption of a standard set of dowel basket designs will reduce manufacturer set-up and production costs and will allow manufacturers to more easily maintain a larger inventory of fewer varieties of assembled dowel baskets, resulting in lower costs and fewer production

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Recommendations

Dowel bar material

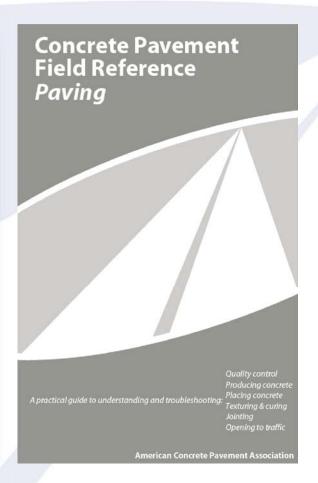
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Additional Resources





www.acpa.org

Thank You! Questions? Feedback?









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Desktop Software | software.acpa.org
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On-Demand Training | ondemand.acpa.org
Live Online Training | webinars.acpa.org
Your Local Contact | local.acpa.org