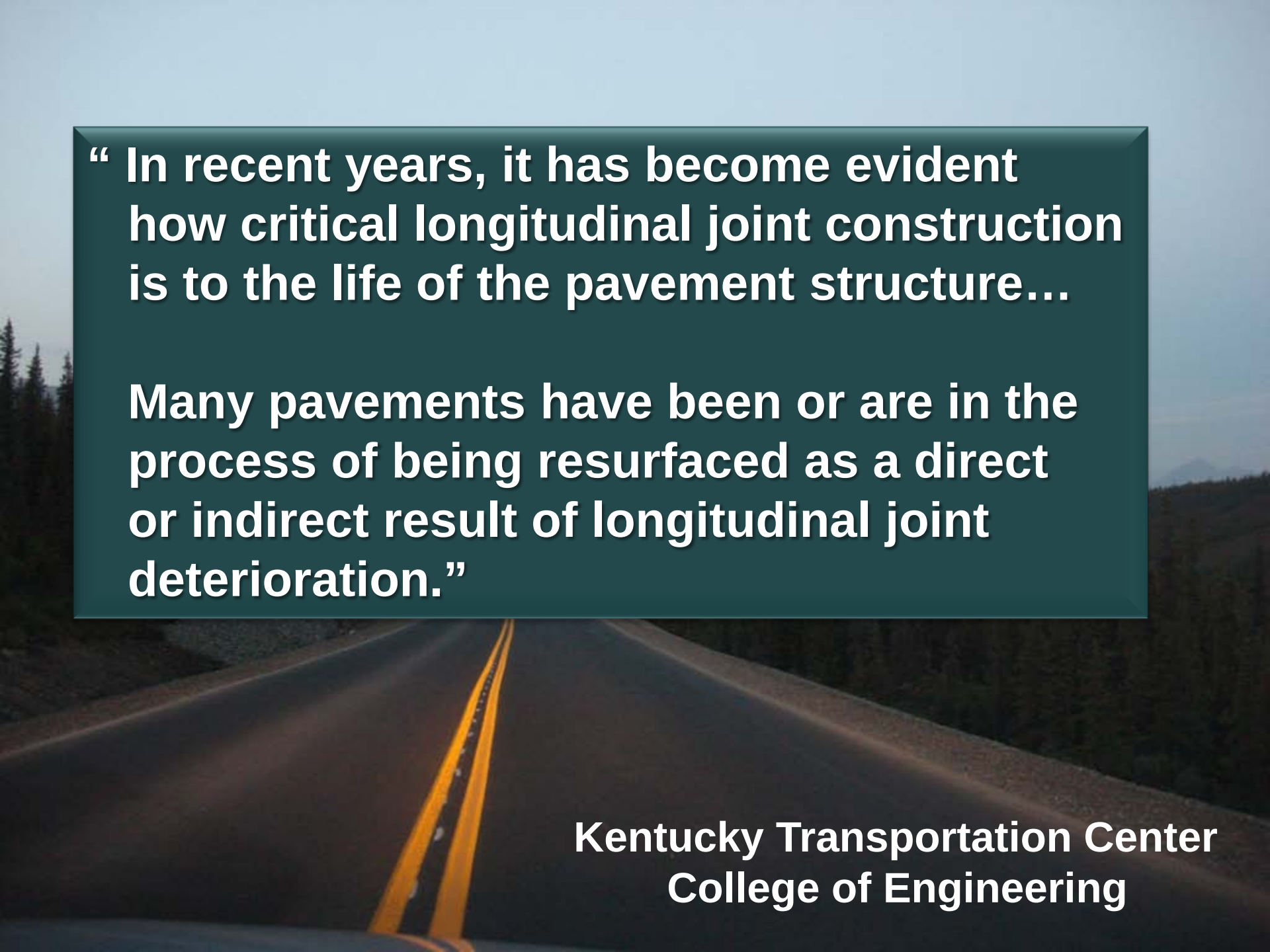
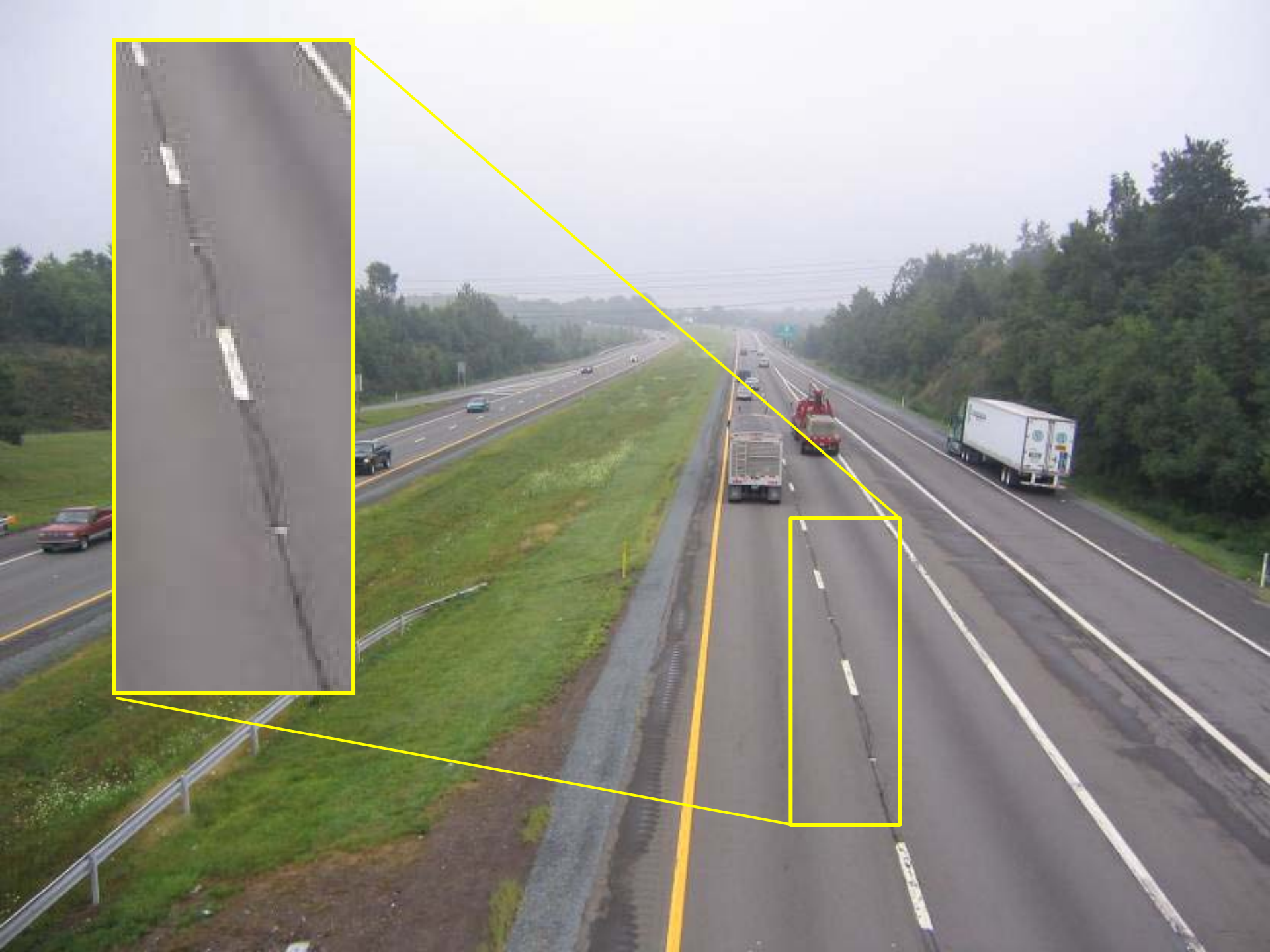
Best Practices for Constructing and Specifying HMA Longitudinal Joints

A Cooperative Effort between Asphalt Institute & FHWA

Bob Humer
Asphalt Institute


“ In recent years, it has become evident how critical longitudinal joint construction is to the life of the pavement structure…
Many pavements have been or are in the process of being resurfaced as a direct or indirect result of longitudinal joint deterioration.”
Kentucky Transportation Center
College of Engineering



Study Approach

1. Benchmark Survey – FHWA Divisions
2. Literature Review
3. Identify… What we know? Things we don't?
4. Interview the Experts (18)
5. Visit select State DOT's (5)
6. Report & Develop Training Tools…

Takeaways from FHWA Survey to 52 Division Offices

- ½ States are not satisfied with overall performance of L-Joints

- 2/3^{rds} of States have a “L-Joint spec”
  - Half of those (17) have a min. density
    - Range from 89% - 92% min G_{mm} *(Rice)*
  - Other half are method specs
    - From Joint Adhesive to very prescriptive

Experts Interviewed…

10 Consultants

- 52 FHWA Division offices
- 5 DOTs
- 10 Consultants
- 8 NAPA Sheldon D. Hayes award winning Contractors

Interview Questions

LONGITUDINAL JOINT CONSTRUCTION INTERVIEW

This survey is part of the Asphalt Institute's cooperative agreement, "Marketing of Hot Mix Asphalt (HMA) Joint Construction Best Practices".

1) First pass must be as straight as possible. How do you accomplish that?

2) Do you prefer a
   a) Notched wedge joint Do you compact the wedge? (yes) (no)
   b) Butt Joint

3) Do you use paver automation (yes) or (no), Your preference is
   a) Joint Matcher
   b) Ski

4) Do you roll the unsupported edges by:
   a) Staying back 6-inches from the edge
   b) Overhang the edge of the mat by 6-inches
   c) Other _____

5) When using a wedge joint do you tack the notch & wedge (yes) or (no) if yes, with
   a) Emulsion
   b) PG-grade Asphalt
   c) Other _____ If yes, complete wedge or portion. Any problems?

6) When using a butt joint do you tack the vertical face (yes) or (no) if yes, with
   a) Emulsion
   b) PG-grade Asphalt
   c) Other _____ If yes, complete wedge or portion. Any problems?

7) Have you ever used a proprietary joint adhesive, (yes) or (no), if yes
   a) Was it practical? (yes) or (no)
   b) Did it improve the performance of the joint? (yes) or no)

8) Have you ever cut the cold joint back prior to placing the adjacent lane? (yes) or (no)
   a) Was it practical? (yes) or (no)
   b) Did it improve the performance of the joint? (yes) or (no)

9) Have you ever used an infra-red heater on a longitudinal joint? (yes) or (no)
   a) Was it practical? (yes) or (no)
   b) Did it improve the performance of the joint? (yes) or (no)

10) How much do you overlap the hot material onto the cold material?
   a) _____

11) What do you do with the overlap material?
   a) Push it back to the joint
   b) Do nothing
   c) Other _____

12) Do you roll the second pass
   a) From the hot side overlapping onto the cold
   b) From the cold side overlapping onto the hot
   c) Make the first pass staying back from the joint and overlapping onto the cold with the second pass
   d) Start rolling on the outside edge and working into the joint
   e) Other _____

13) Do you monitor the longitudinal joint density (yes) or (no), if yes, how
   a) Nuclear gage or similar device
   b) Cores
   c) Other _____

14) Which type of specification offers the best chance to long term joint performance?
   a) Method
   b) Minimum percent density. What is the practical minimum? _____%
   c) No specification

15) Does a fine 9.5mm mix have a better chance for good performance than a 12.5mm
   a) Yes
   b) No

16) Does a 9.5mm mix with a design asphalt content of 6.2% asphalt have a better chance for good performance than that same mix at 5.7% asphalt?
   a) Yes
   b) No

17) Could I do anything additional in "late season" paving to improve joint performance?
   a) _____

18) Have you ever been required to seal the surface of a longitudinal joint as part of the contract? (yes) or (no). If yes, what did you use to seal the joint?
   a) The material was _____
   b) The width of the seal was _____ -inches

19) What are the other "Tips that make the difference"? List as many as you like.

-
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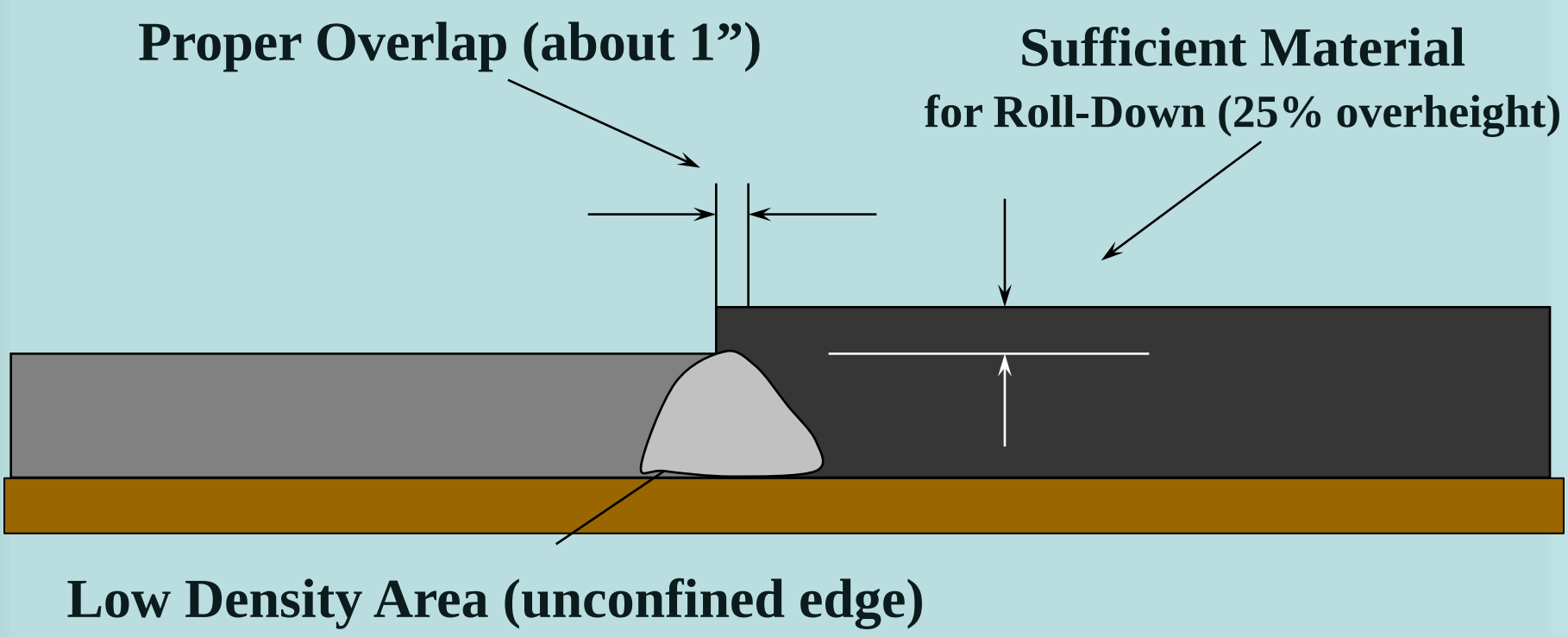
We sincerely appreciate you assistance in improving the performance of longitudinal joints. Thank You


Do the Experts Agree?
Not Always

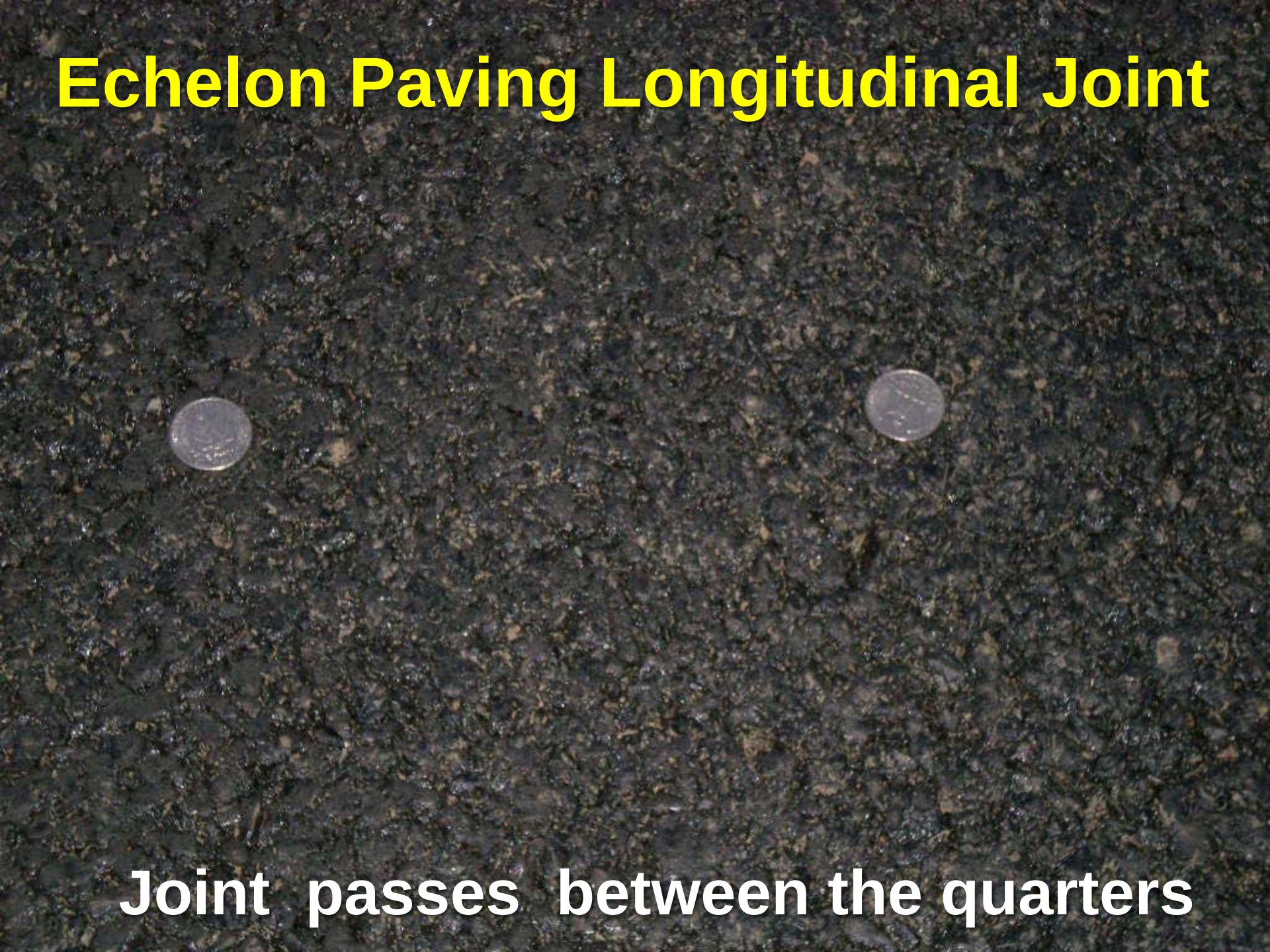
We Know Unsupported Edge Will Have Lower Density



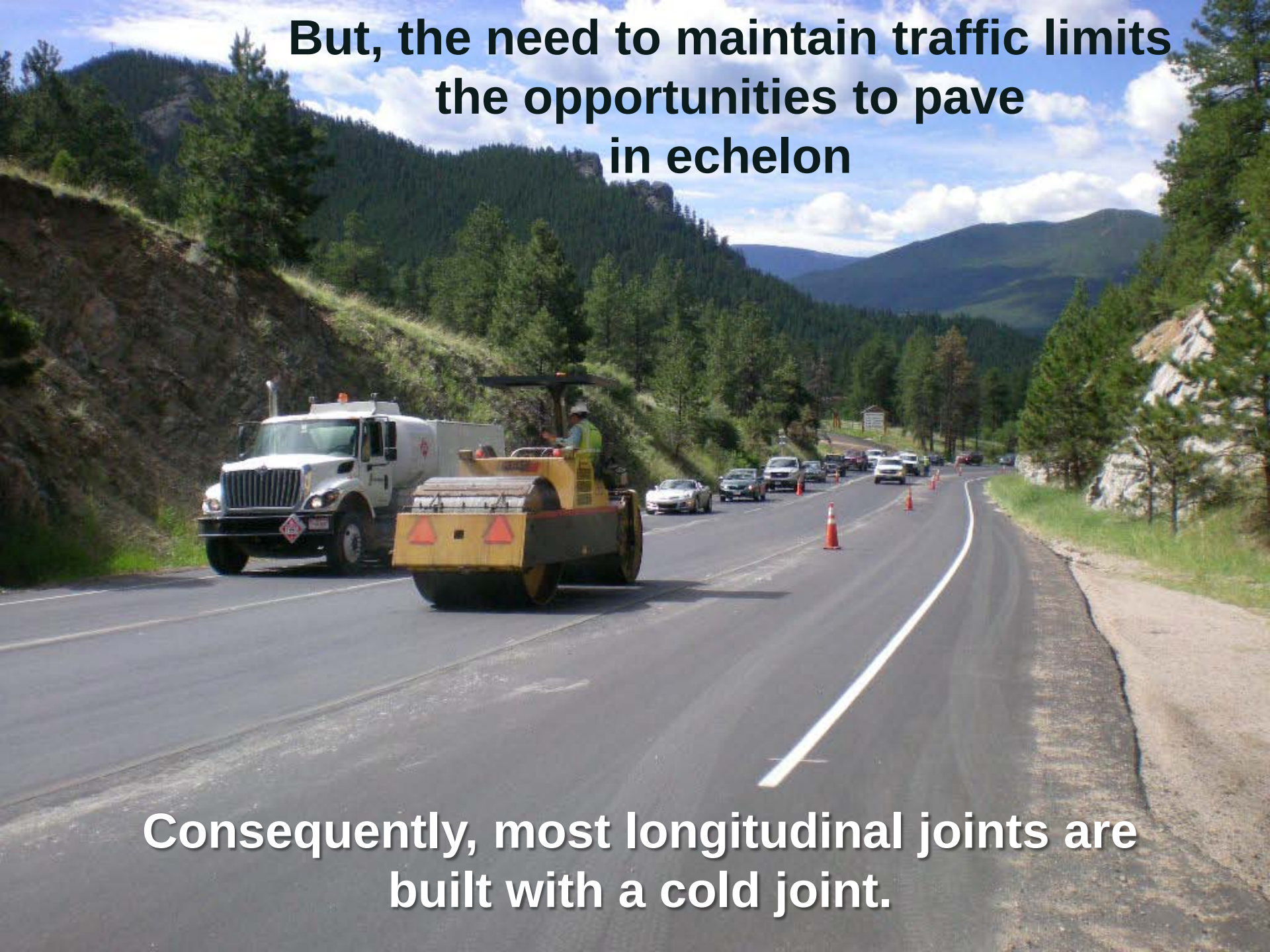

The Best Longitudinal Joint
Echelon Paving
INTERSTATE
295
New Jersey


BOMAG
HYPAC
HYPAC
Rolled Hot

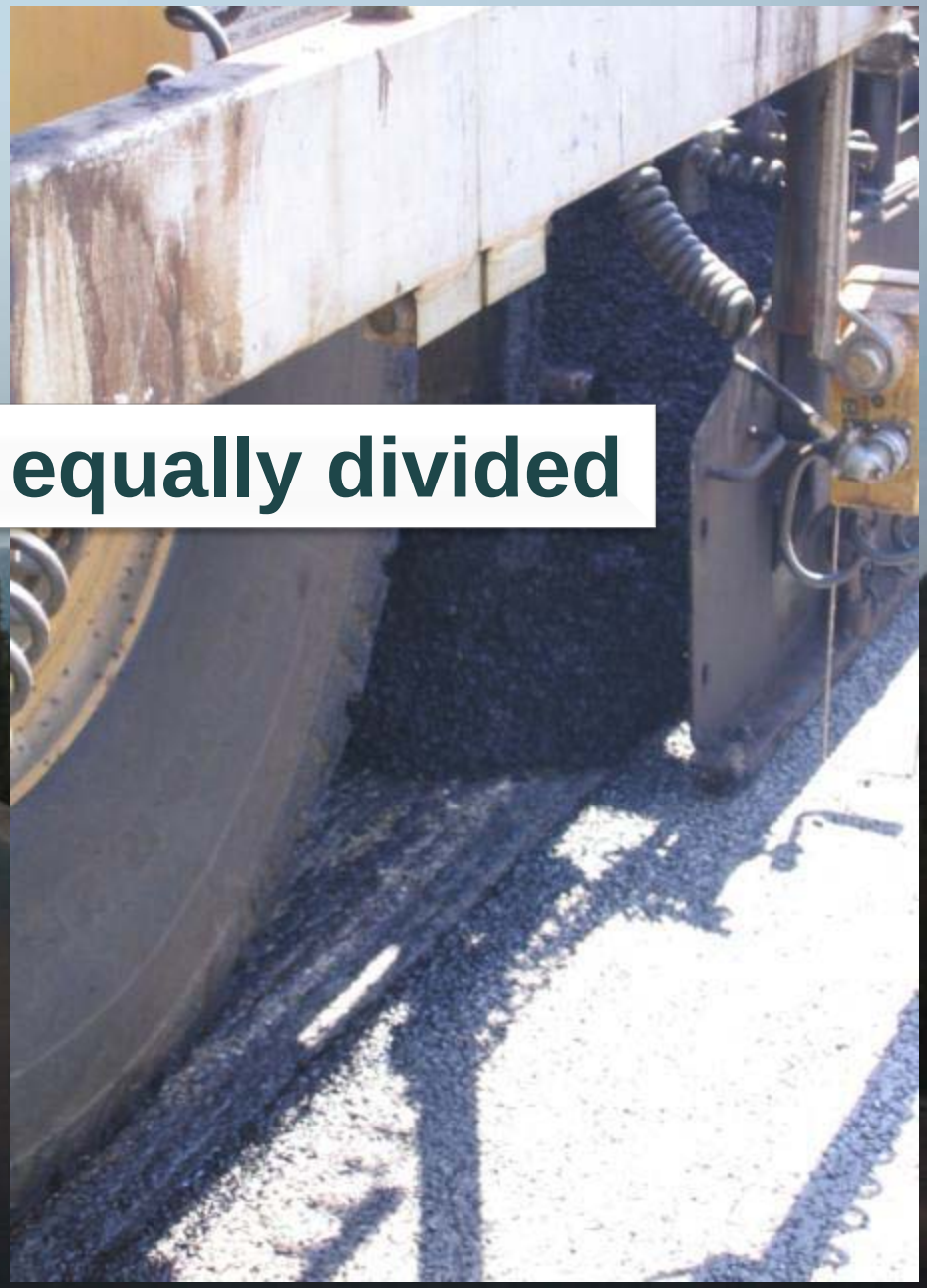
Echelon Paving Longitudinal Joint



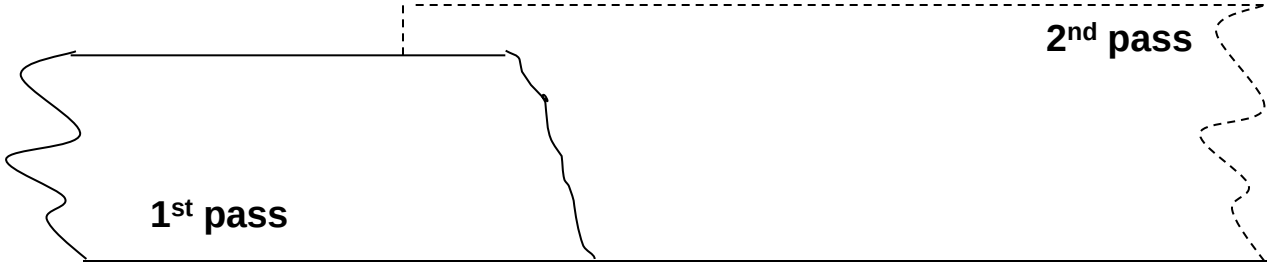
Joint passes between the quarters

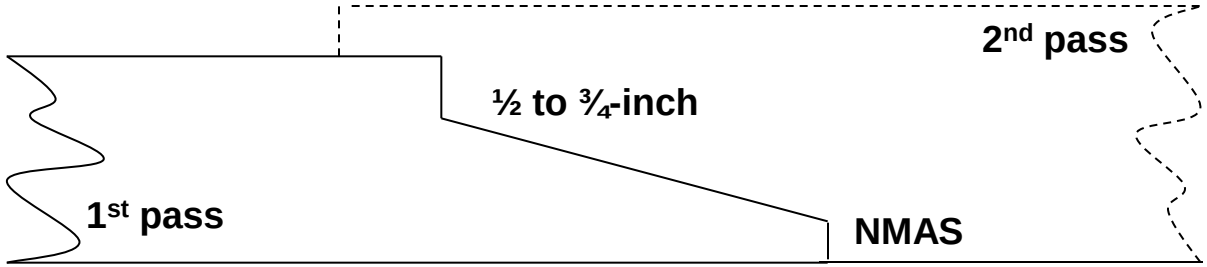

But, the need to maintain traffic limits
the opportunities to pave
in echelon
Consequently, most longitudinal joints are
built with a cold joint.

Q. Prefer Notch-Wedge or Butt Joint?



The experts are equally divided



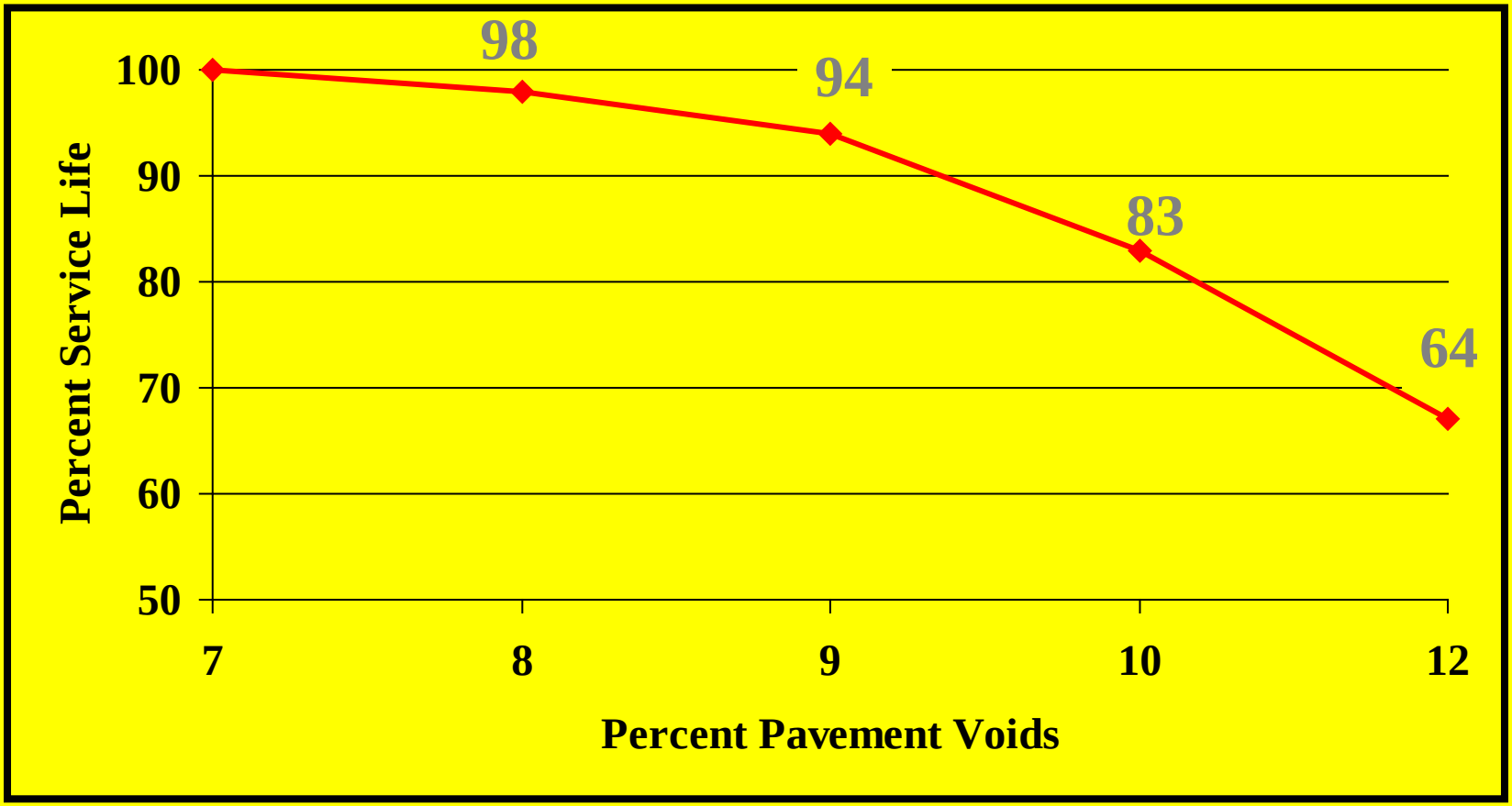


Wedge 3:1 to 12:1

What we do know!

- A pavement is permeable when the voids are interconnected.
- Coarse-graded 9.5mm and 12.5mm Superpave mixes become permeable at 7.7% voids.
- Coarse-graded 19mm mixes at 5.5%, and 25mm mixes at 4.4%. (ref: NCAT study)
- At what % the voids become interconnected depends on the type of mix.

Effect of Voids on Life



WA DOT Study

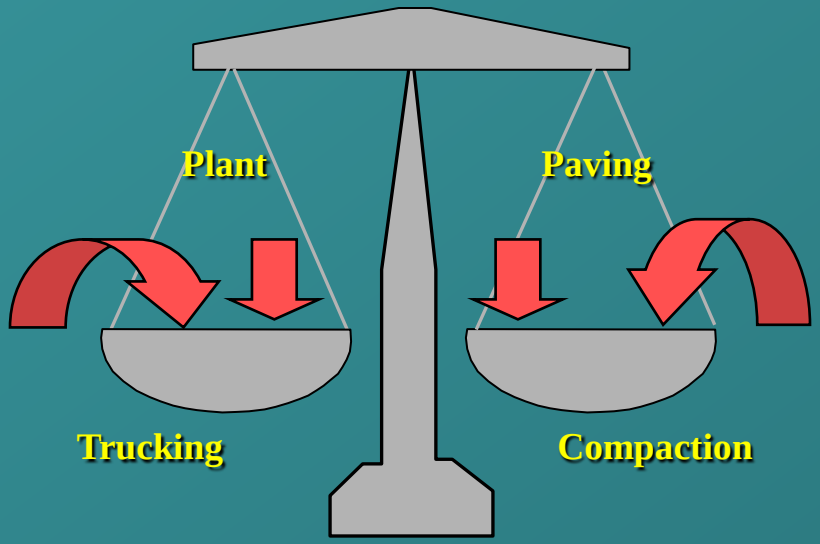
What we do know!

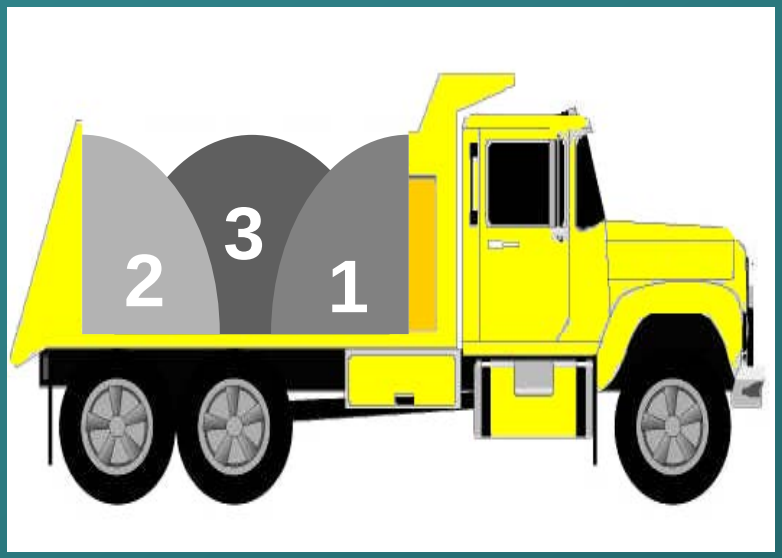
- A fine-graded 9.5mm mix with a 6.2% obc is less permeable than a coarse-graded 9.5mm mix with a 5.7% obc.
- On the other hand, small size finer graded mixes have more potential for rutting and bleeding.
- For dense-graded mixes, we should strive for the mat and joints to be impervious.
- As a “rule-of-thumb”, the % voids should not exceed 8%.

Prior Planning!

- Select joint (butt or wedge) best suited for that job
- Choose smallest NMAS that will do the job
- Consider using a “fine” gradation
- Lift thickness = NMAS x 4, exception “fine” gradation, NMAS x 3
- Longitudinal joint should be included in construction plan & sequence

GETTING STARTED OFF RIGHT





Dump Person

MTV; Keep paving moving

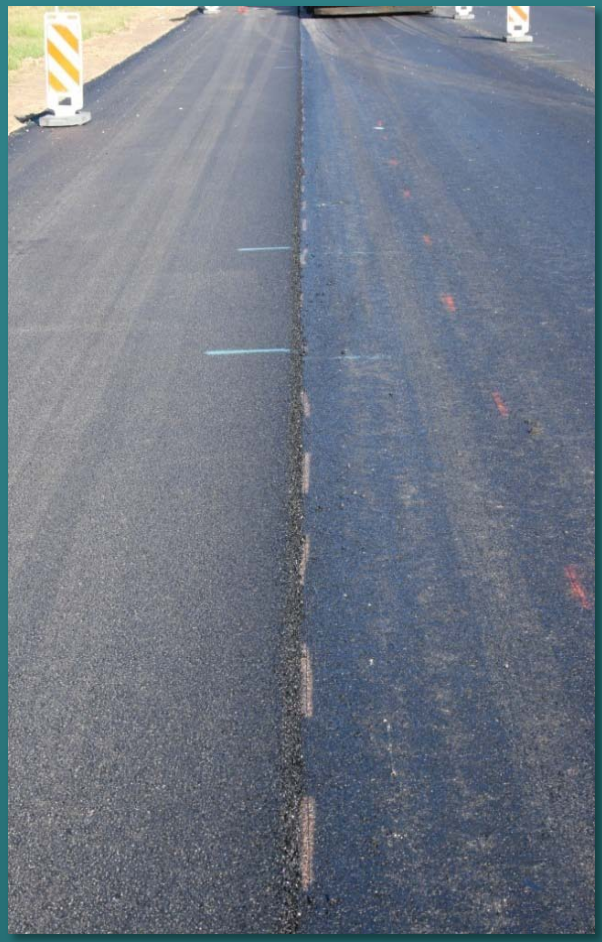
Tack Coat

Full width of mat to minimize movement of unsupported edge

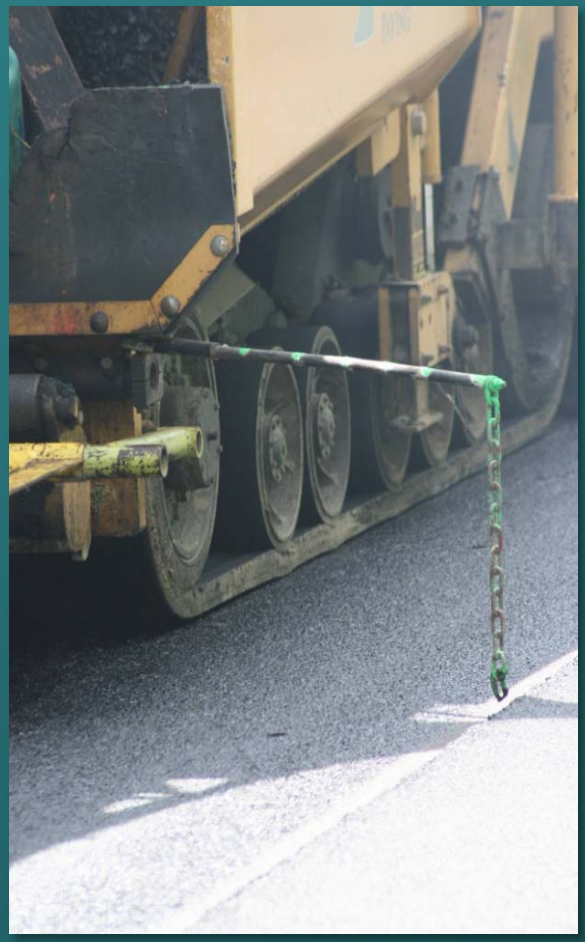
First Pass Must Be Straight!

Unanimous that a string-line should be used, to assure first pass is straight, to get a consistent 1” overlap with 2nd pass.

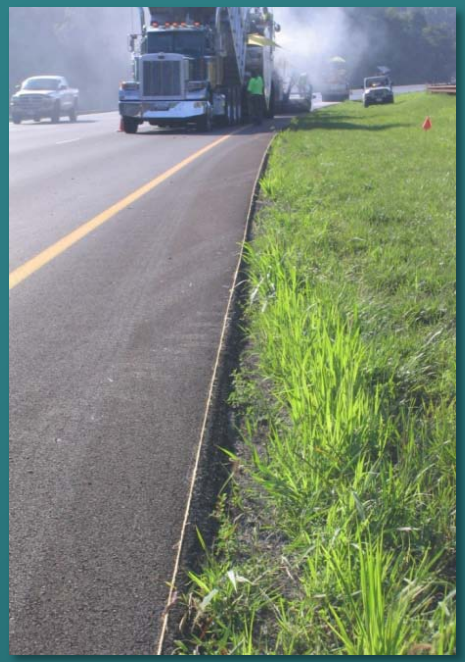
String-line



Skip Paint



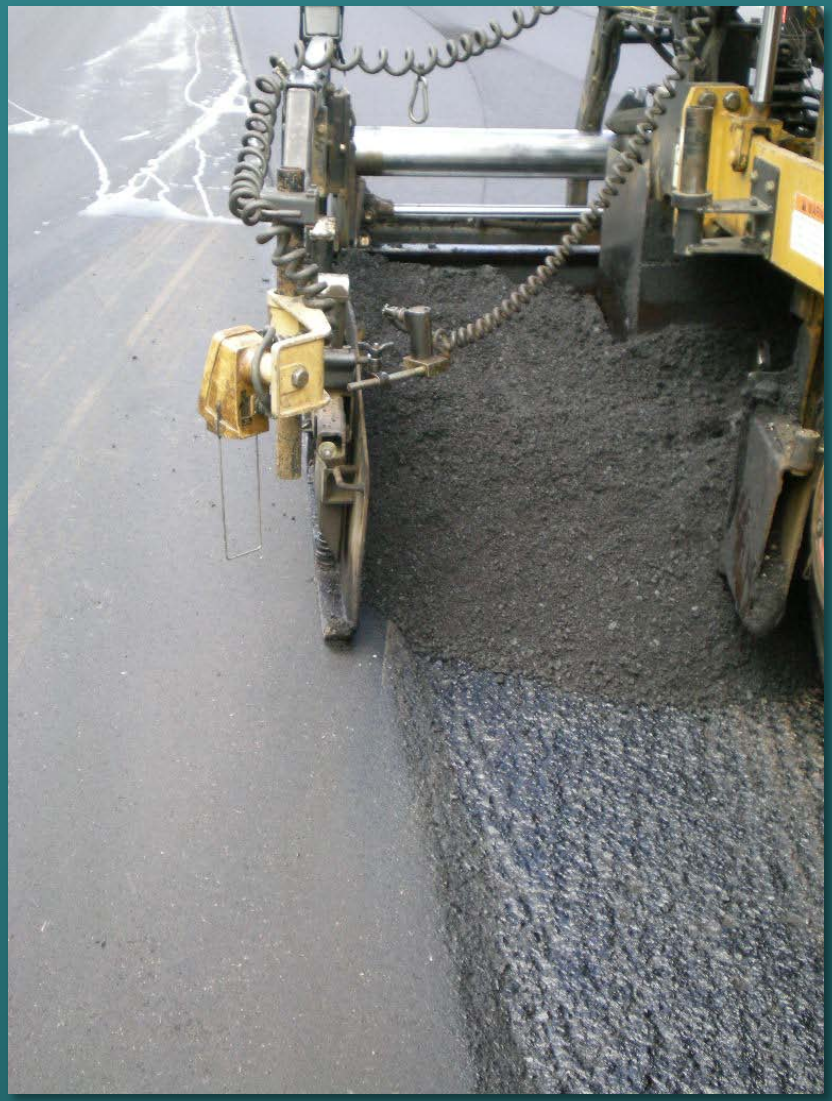
Reference

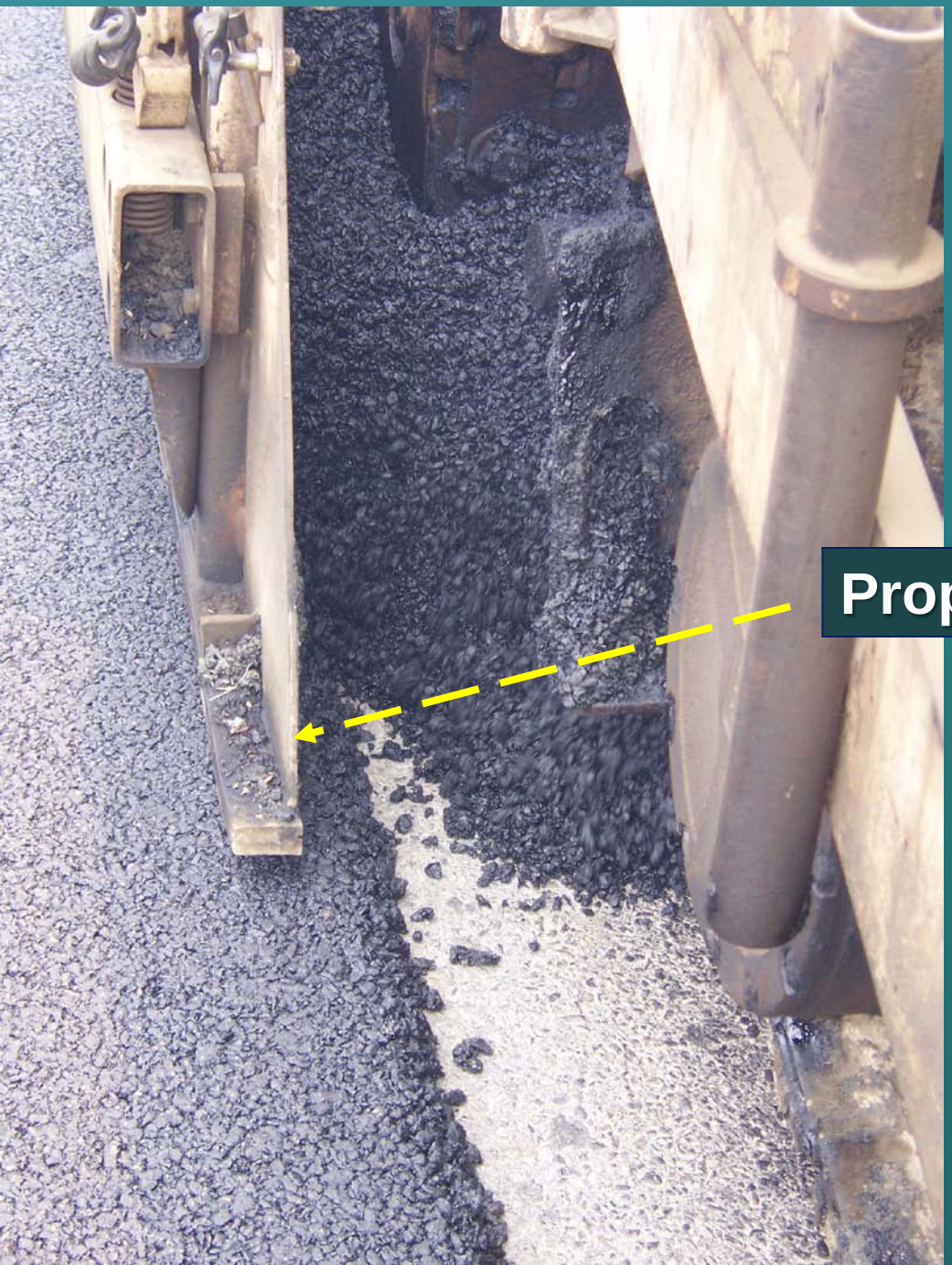


Great Results

Tough to get proper overlap (1”) with next pass

Paver on Automatic with Joint Matcher





Matching Joint

Proper Overlap: 1.0 ± 0.5 inches

Sufficient Depth of HMA to avoid “starving” joint and “bridging” with roller

After all rolling, desired height diff. about 0.1”

Set Material Depth to Fill the Joint Completely When Compacted

If the joint is starved of material the roller will simply bridge onto the cold mat and joint density will be poor.

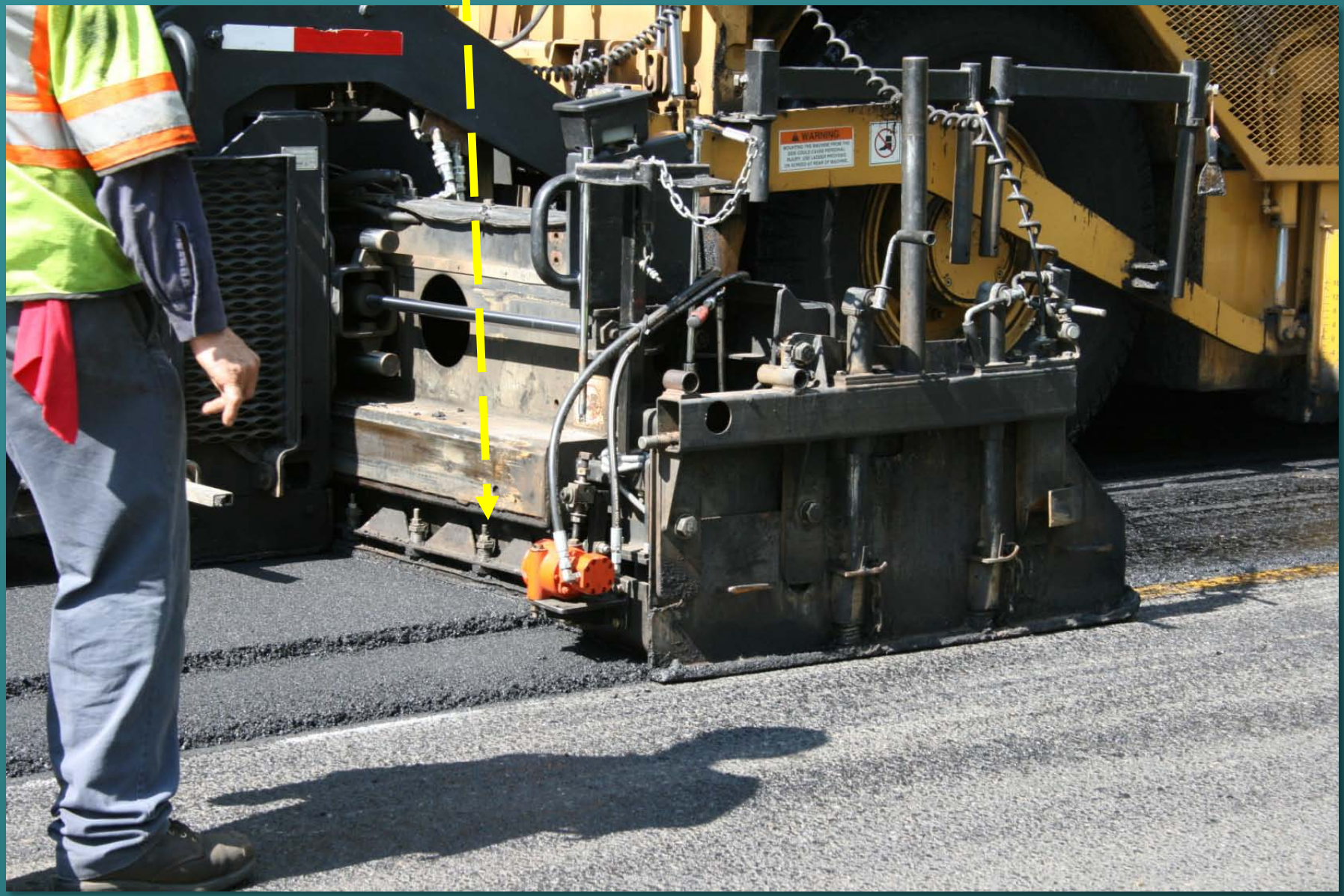
To avoid this, where practical set automated controls to function as joint matchers when paving between traveled lanes.

Frank Colella slide

Bumping Joint Properly

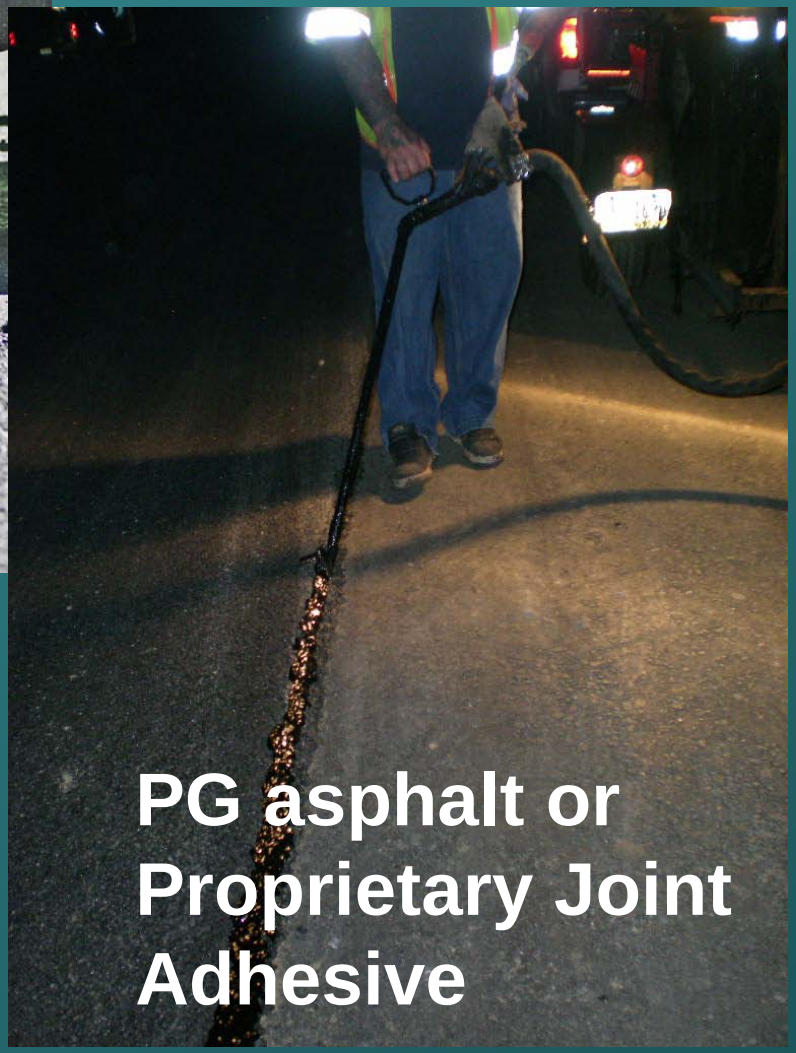
Don’t push across!

Vibratory Screed should always be On

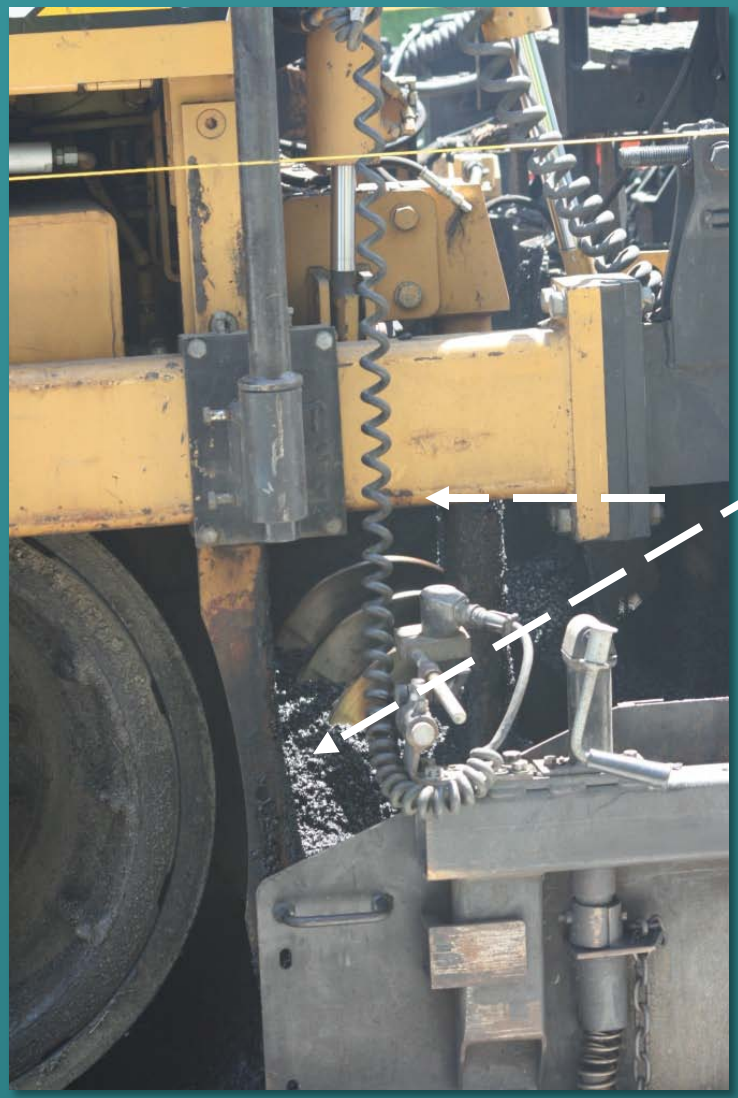


Tack the Joint! (Butt or Wedge)

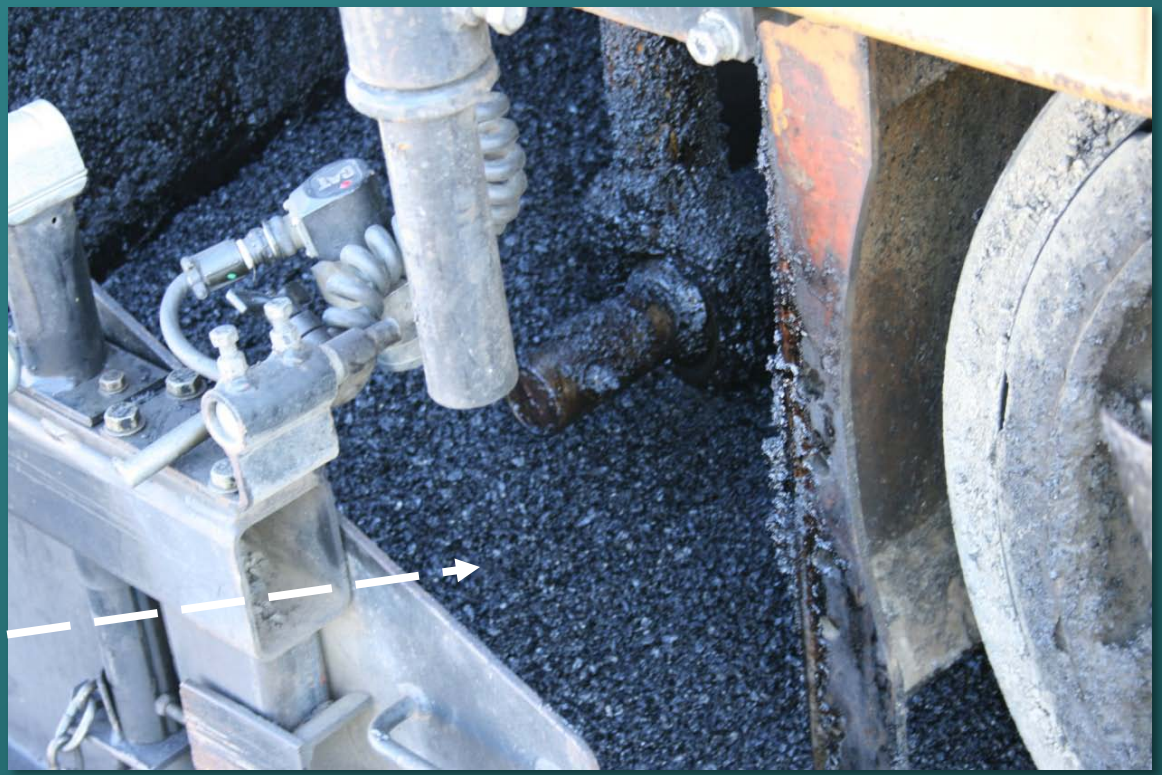
Emulsion, or



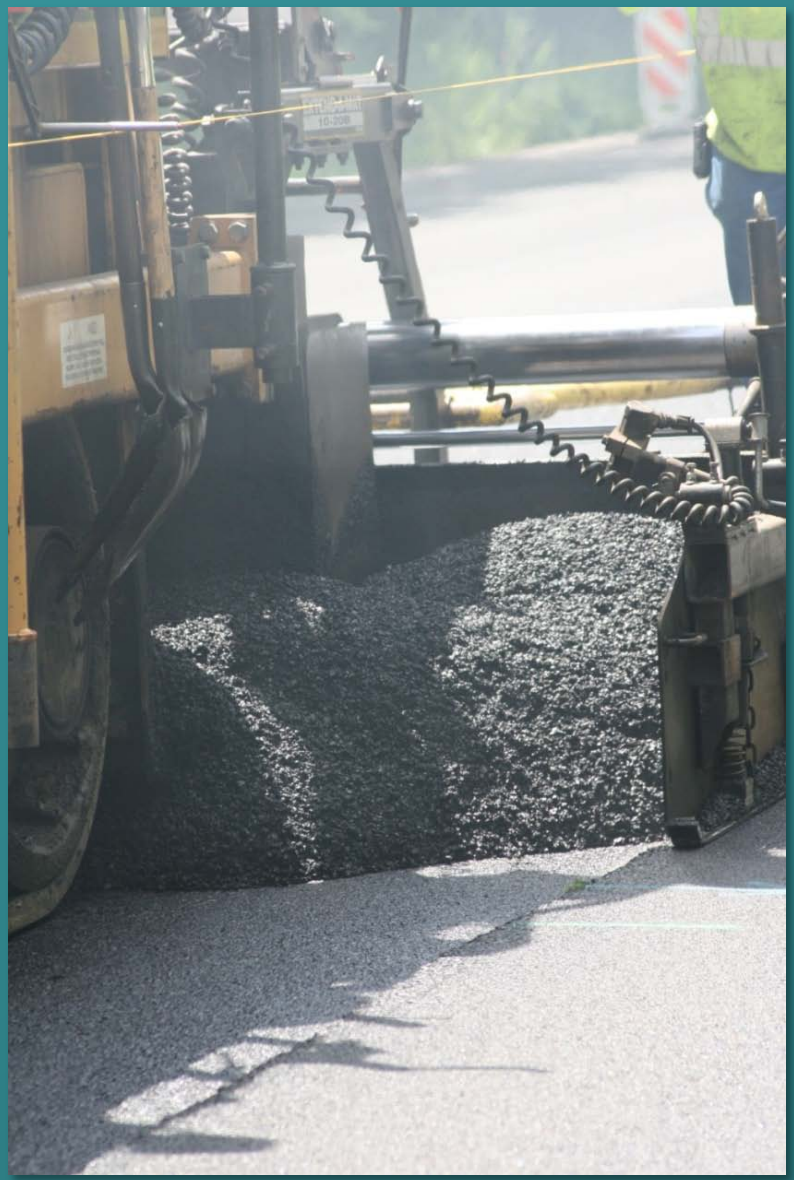
Auger



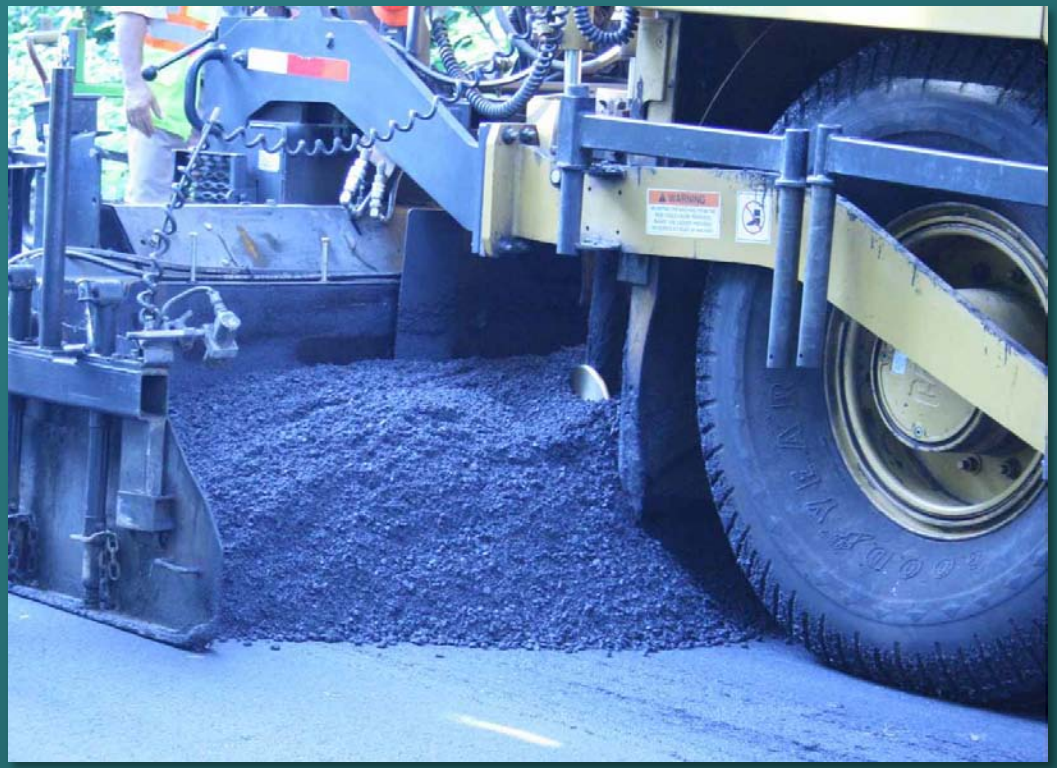
Uniform Head of Material
Across the Entire Screed



Carry Material Within
12 – 18-inches of
the End Gate



Carrying the mix out this far is unacceptable

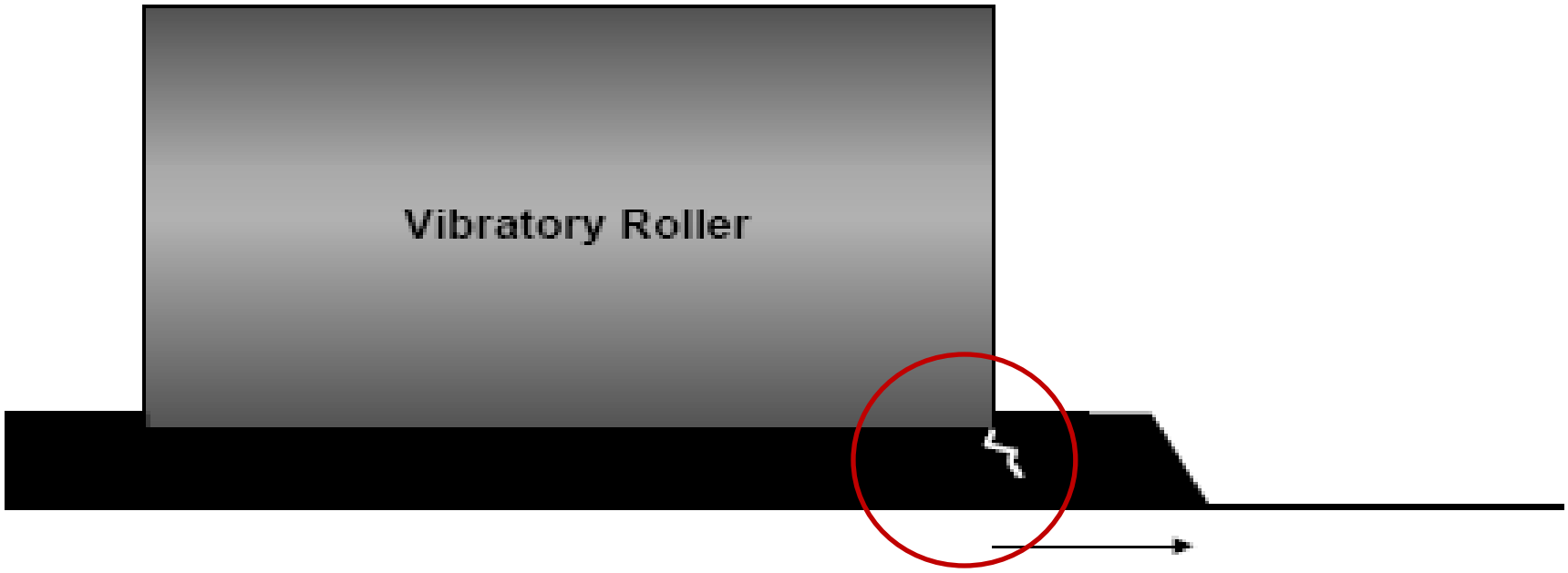



Auger not extended to within 12 to 18-inches of the end gate.
The result -
SEGREGATION at joint

1st Roller Pass on Unsupported Edge
50/50 opinion: Overhang vs. Stay Back 4-6”

- Roll When HOT!

If staying back 6”, Watch for lateral movement and stress crack



Edge of drum inside unsupported edge

Can cause cracking near the edge and lateral mix movement at the unsupported edge

Rolling the Supported Edge
(many different opinions and approaches)

Staying off the Joint by 6”
with 1st Pass Avoids Bridging

but, watch for stress cracks along the edge of the drum. May be more of a concern with rolling unsupported edge

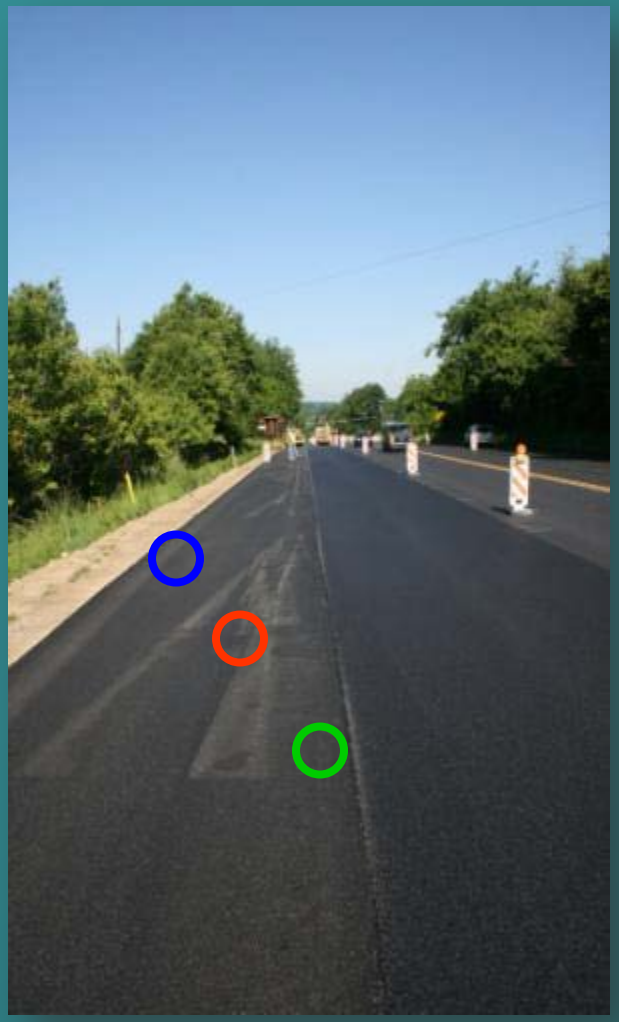

Permeability at the
Longitudinal joint
Photo: Wes McNett

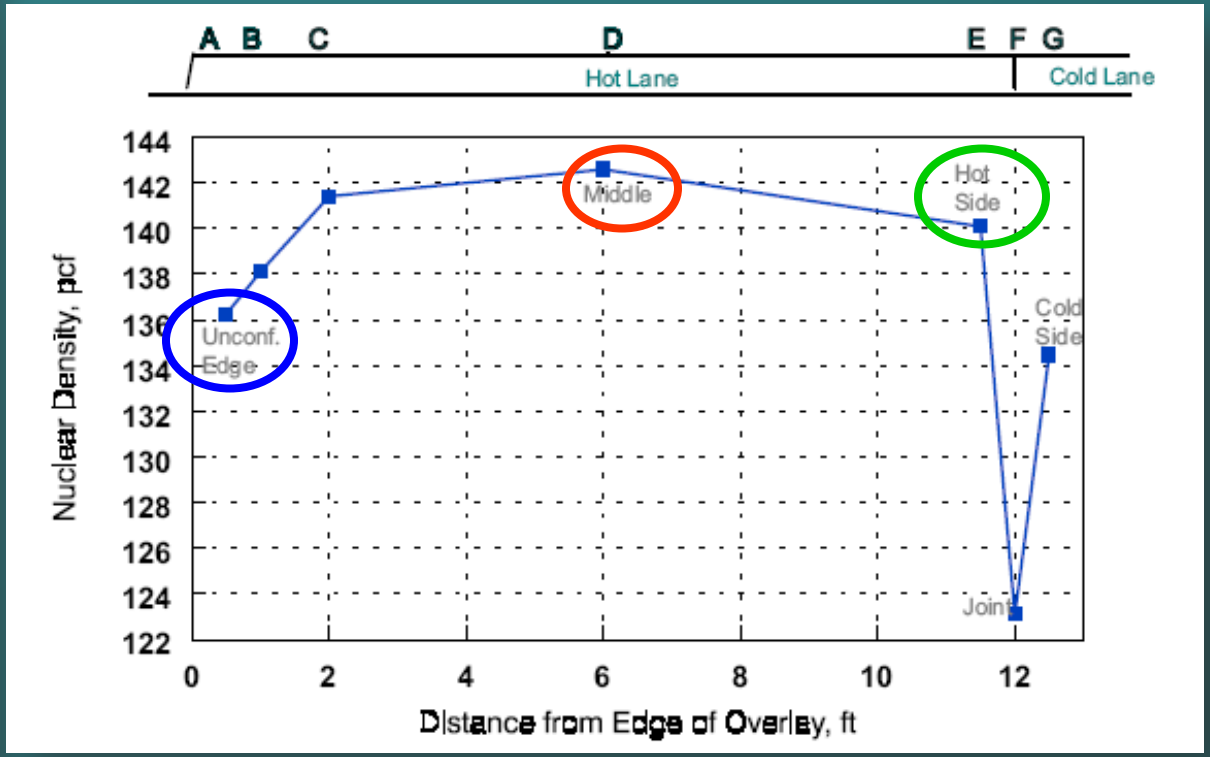

Destined for Failure

Longitudinal Joint Specification

Nuclear Density Profile

Texas Transportations Institute Study





Unconf.	Middle	Hot Side
88.5 %	93.0%	91.0%

Longitudinal Asphalt Pavement Joint Construction ……Performance

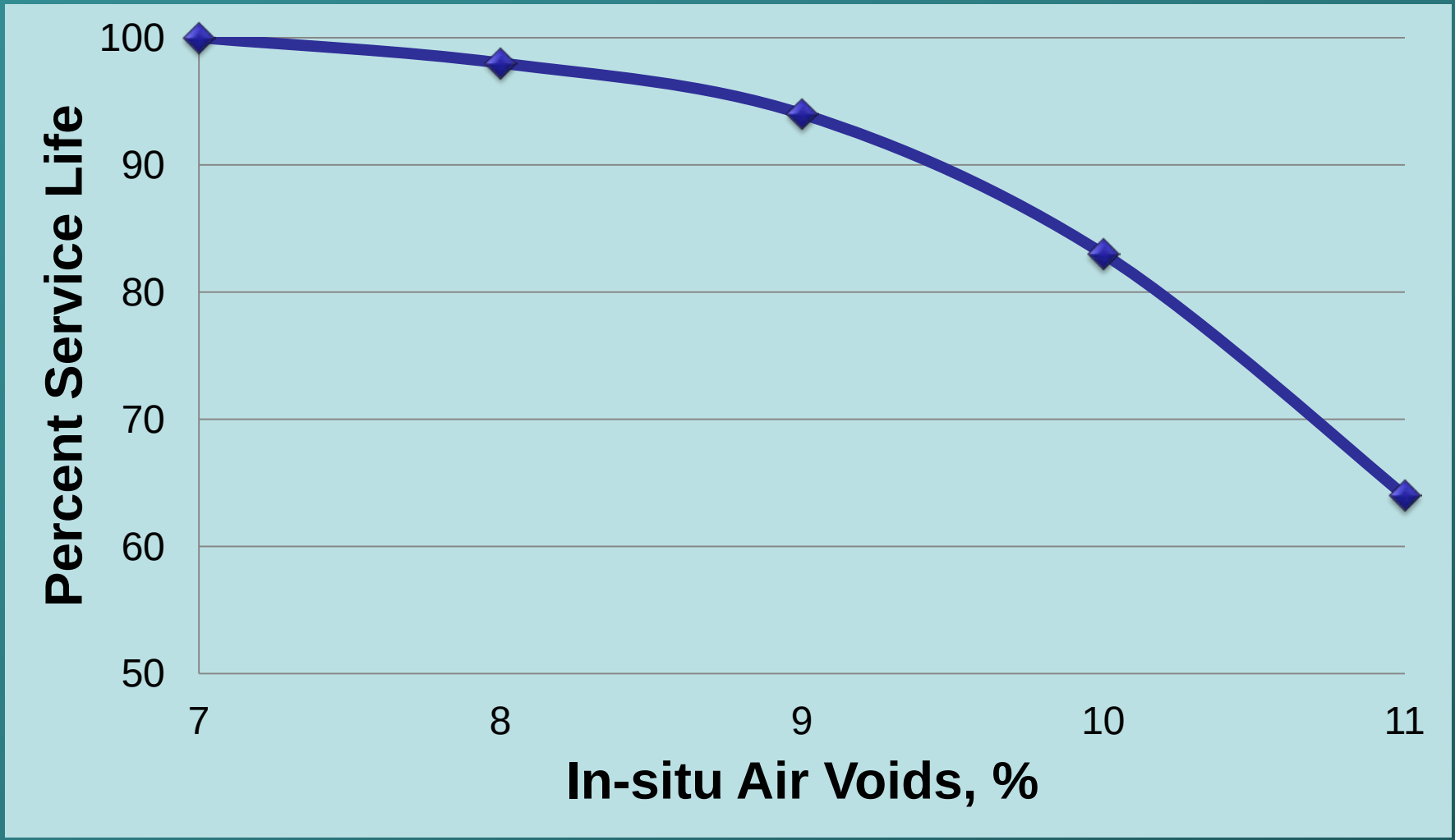
- D. Morian, et al. Quality Engineering Solutions, NV

Significantly better performance		98% of the Mat	12 years
	vs	95% of the Mat	8 years

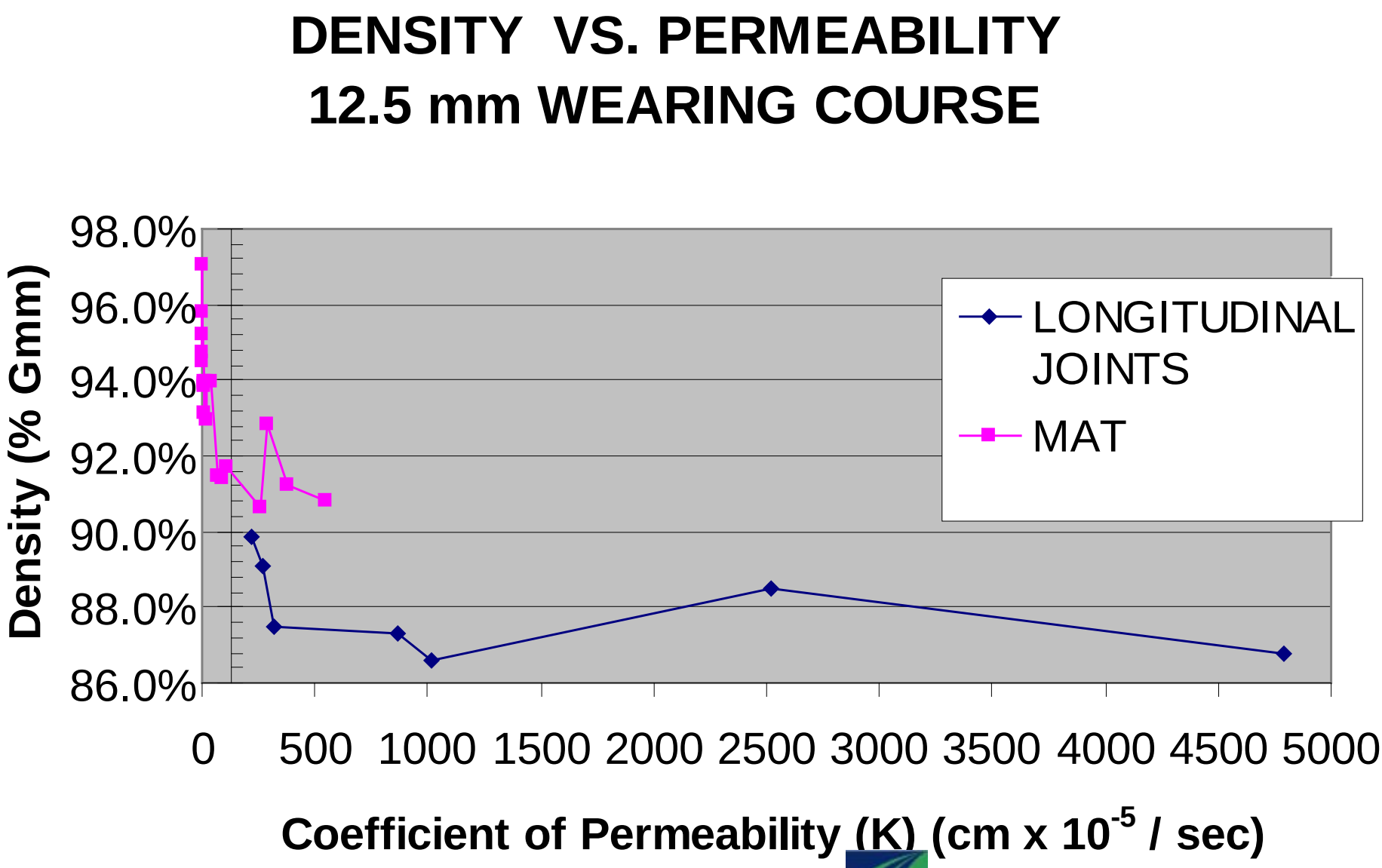
Assume mat is 94% of G_{mm},	then 98% of 94% is 92%	(8% V_a)
	then 95% is 89%	(11% V_a)
	then 93% is 87%	(13% V_a)

Effect of In-Place Voids on Life

Washington State DOT Study



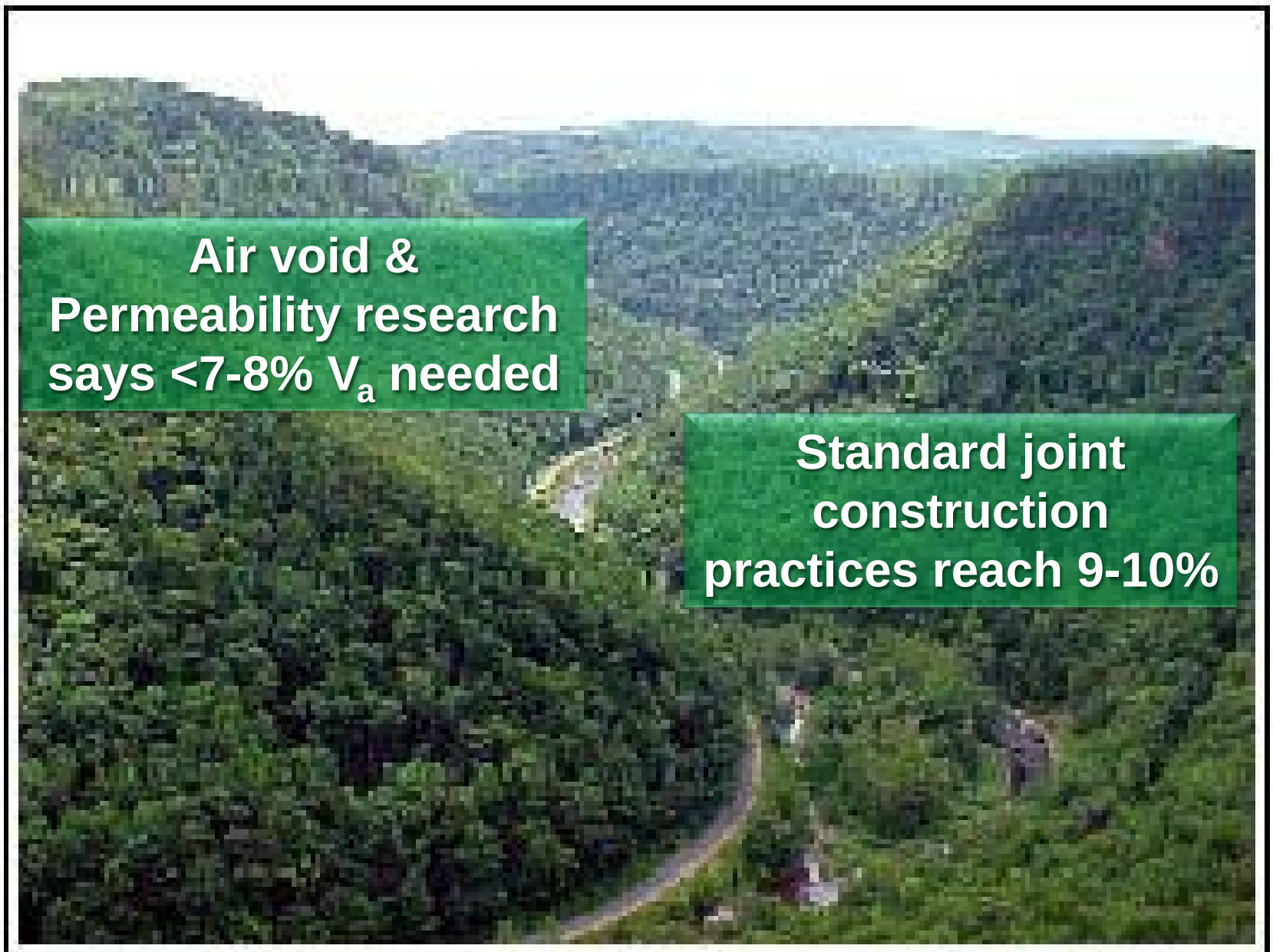
Permeable Below 92% Density



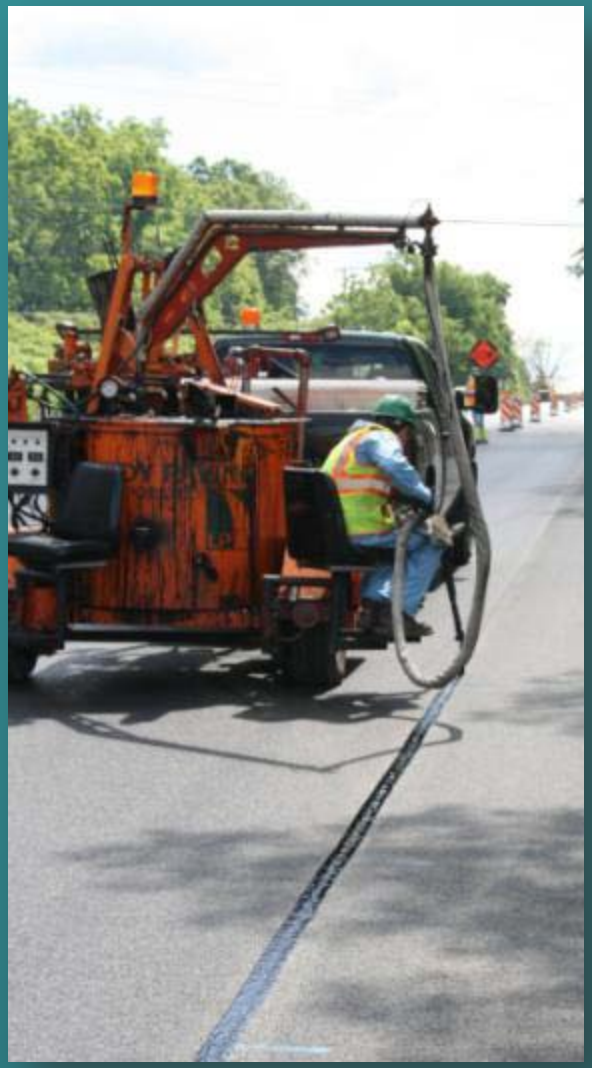
Various Research Reports on Critical Air Void Level for Permeability

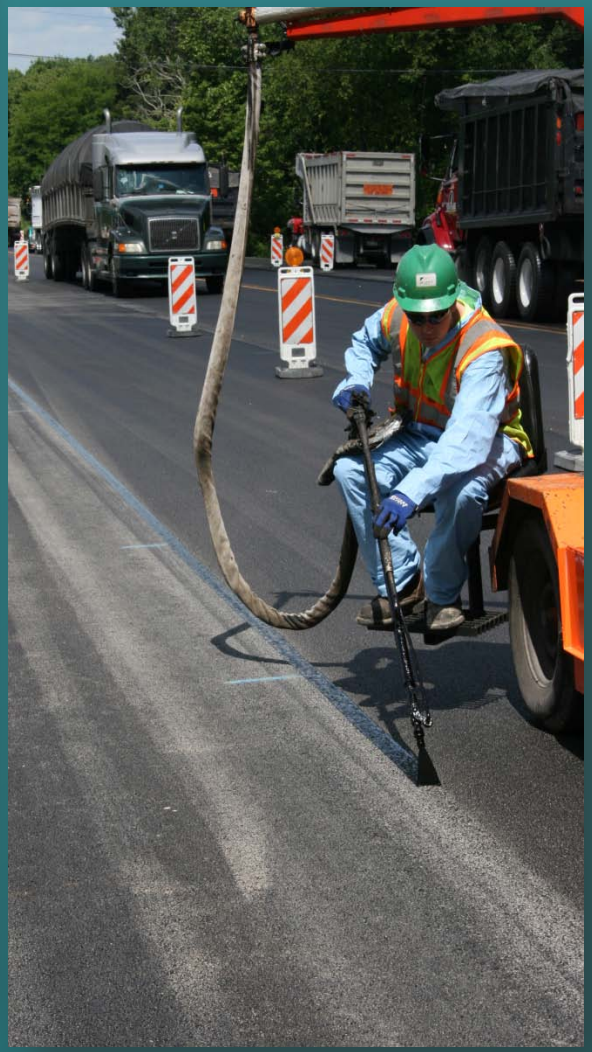
	Critical Voids where permeable
9.5 mm	
E. Zube - California Dept. of Highways - 1962	8
L. Cooley, B. Prowell, R. Brown – NCAT - 2002	7.7
R. Mallick, et al - (fine graded)	8.5
12.5 mm	
B. Choubane, et al – Florida DOT - 1998	7
J. Westerman – Arkansas HTD - 1998	6
NCAT 03-02 – (coarse graded) - 2003	7

Dilemma at the Joint



Option: Sealing the LJ





Overbanding is not Unusual

Many Agencies require for patching

Proposed "End-Game" Criteria for LJ Density Spec

Six-inch Cores -

Centered on butt joint, or middle of wedge

≥ 92% of G_{mm} : maximum bonus

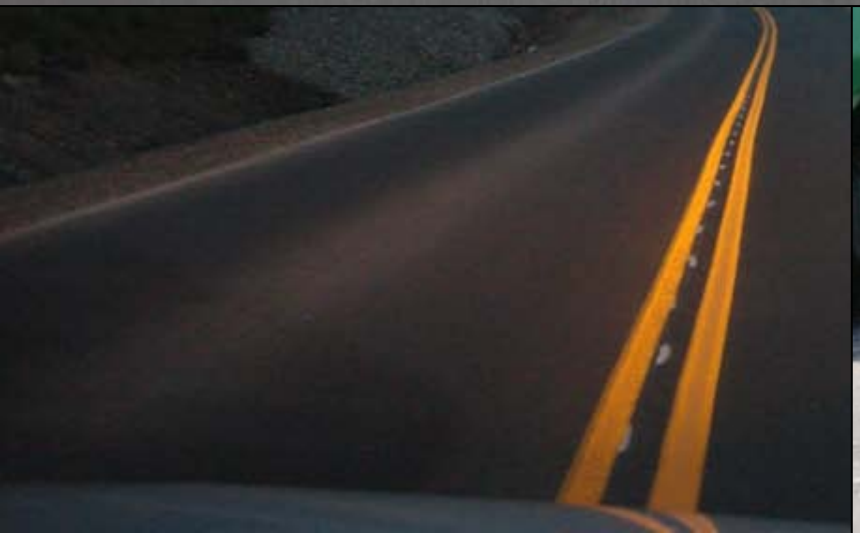
Between 92% and 90% of G_{mm}: pay 100%, possible pro-rated bonus, and overband joint

< 90% of G_{mm} : reduced payment, overband joint

Other Options / New Products

- Mill & Fill One Lane at a Time
- Joint Heaters
- Cut Back Joint
- Wedge Compactors
- Joint Adhesives (hot rubberized asphalt)
- Surface Sealers Over Joint

Joint Heaters



Cutting Back the Joint

B. Prowell photos

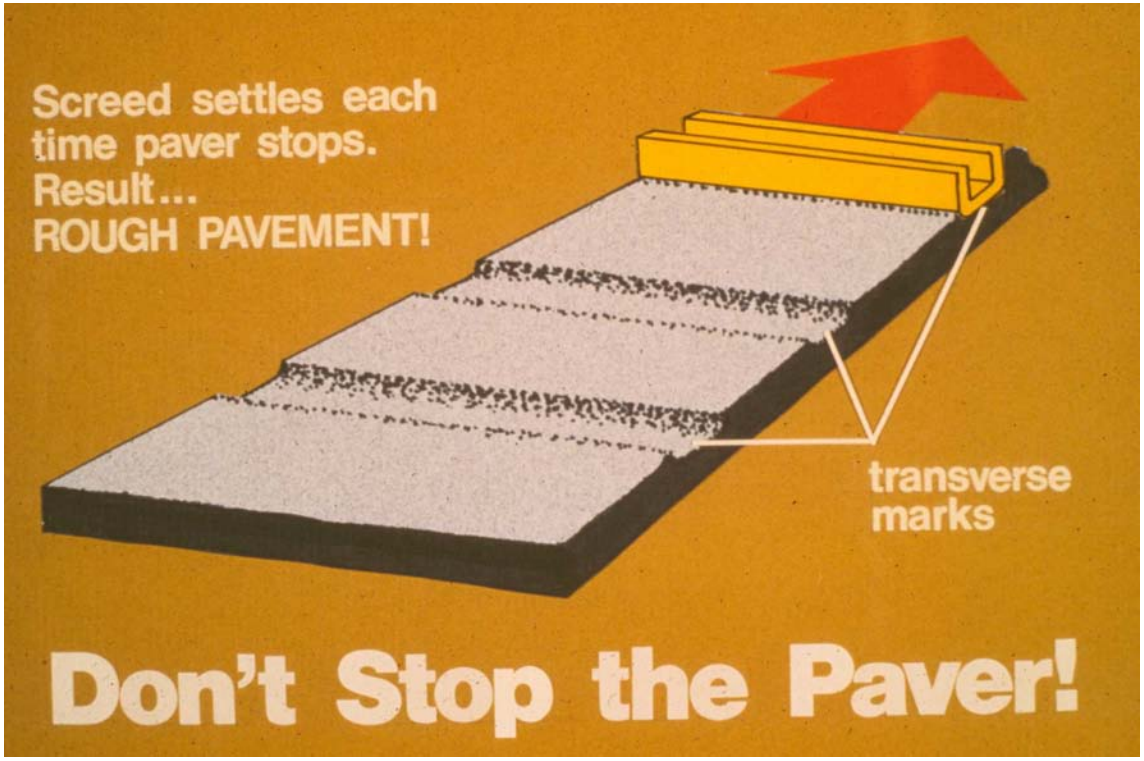
Cutting Wheel Fixed to Roller in Europe

- Best practice in Europe on Dense Graded mixes on large projects when traffic is managed.
- Cut when mix is warm and plastic.
- Watering of blade prevents tearing.
- Joint then painted with 50pen binder.
- Cutting and painting not done on open mixes.

http://www.highwaysmaintenance.com/kraktext.htm

Smoothness

Keep the Operation Moving

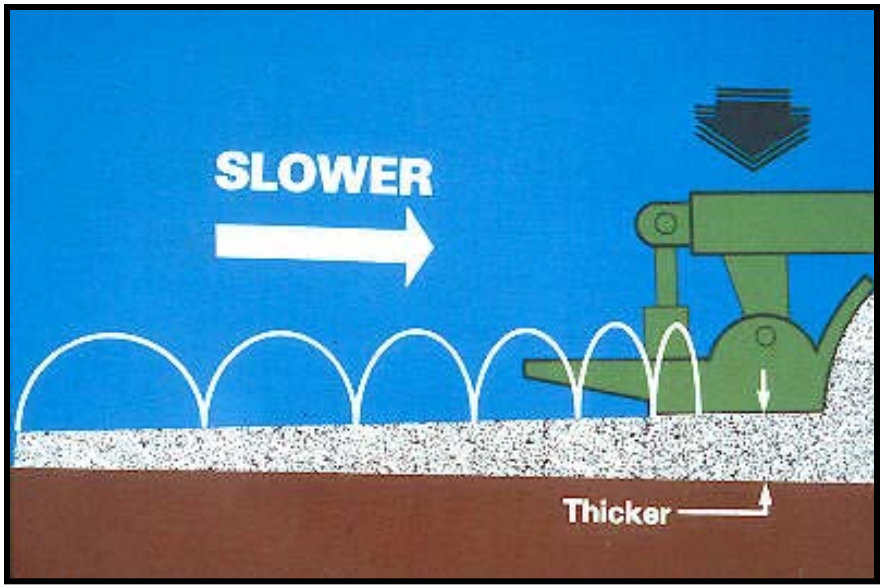


One of the essentials for a smooth riding asphalt pavement is to provide for a continuous operation!

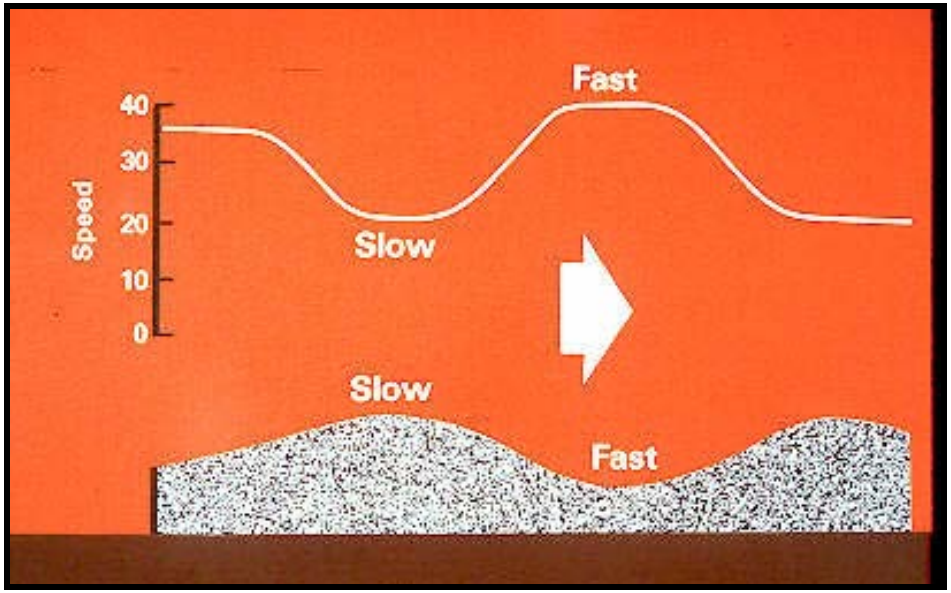
This requires planning!

Smoothness

The effects of changing the Paver Speed



Maintain Constant Paving Speed



Planning the Speed of Paving

asphalt institute

$S = (2{,}000 \times P) / (60 \times W \times H \times D)$ (in U.S. Customary Units)

S = Speed of the Paver (in feet / minute)

P = Production at the Plant (in Tons / hour)

W= Width of paving (in feet)

H = Lift thickness (in feet)

D = in-place Density (in pounds / ft^3)

$S = P / (60 \times W \times H \times D)$ (In metric units)

S = Speed of the Paver (in meter / minute)

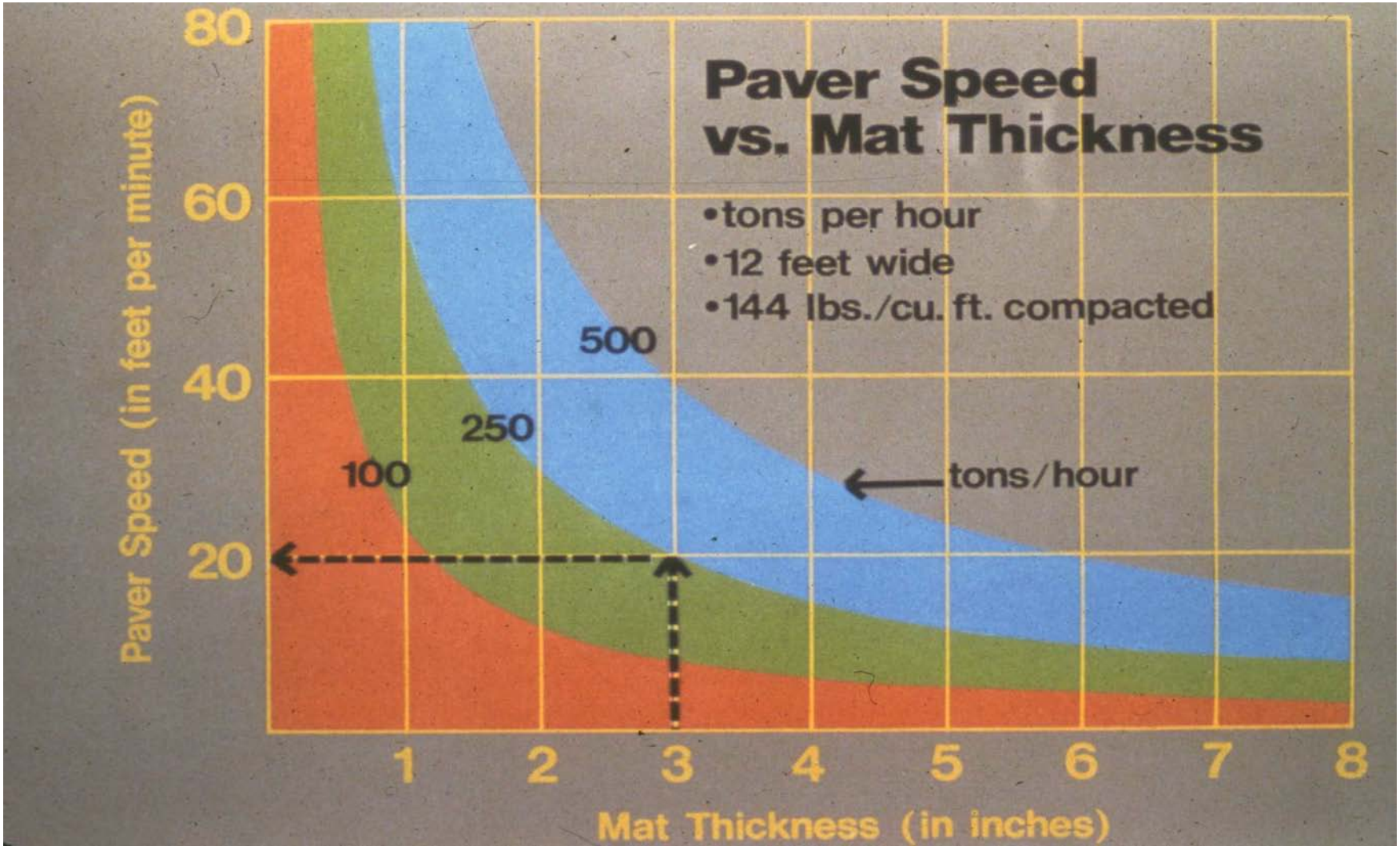
P = Production at the Plant (in Tonnes / hour)

W= Width of paving (in meter)

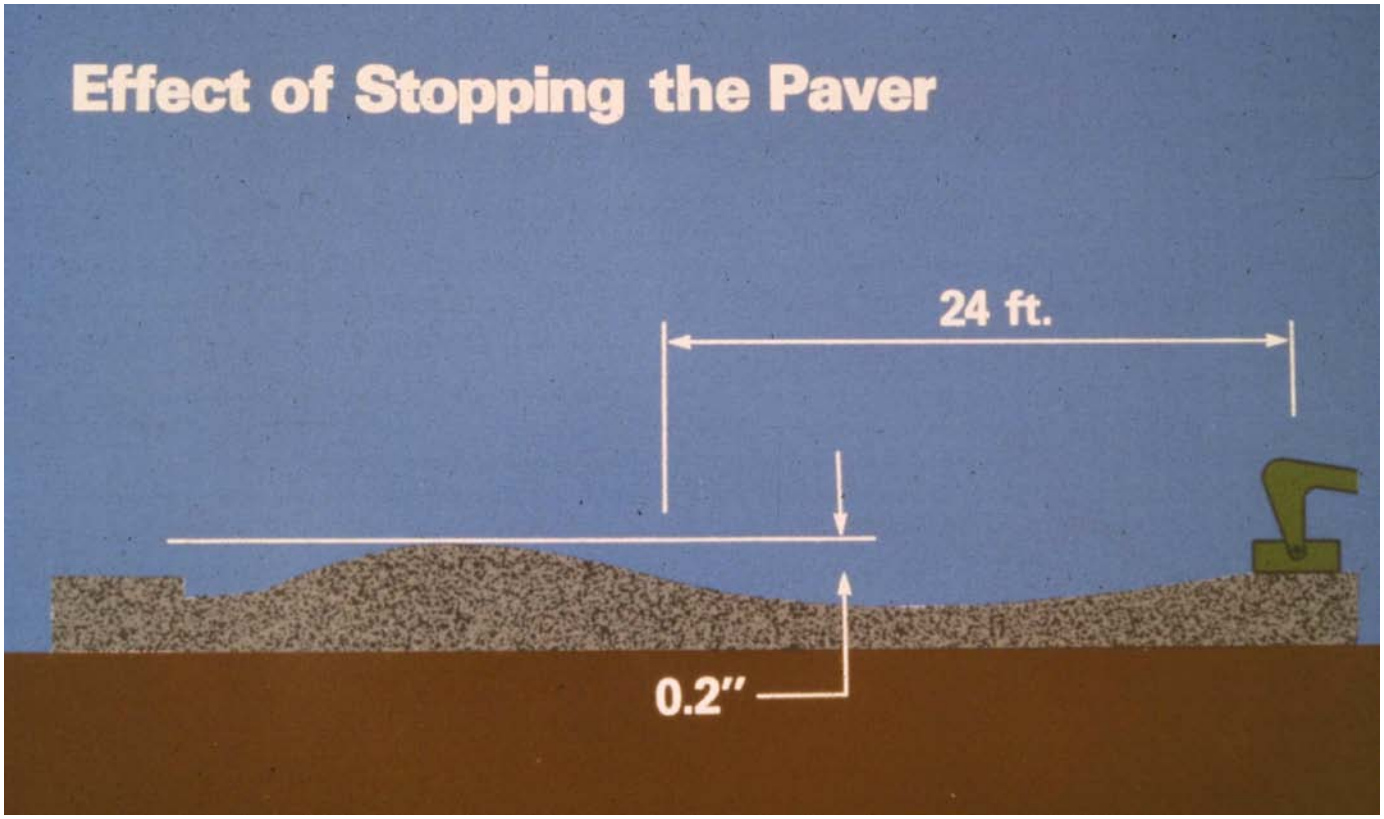
H = Lift thickness (in meter)

D = in-place Density (in grams / cm^3)

Planning the Speed of Paving



Avoid disruptions of the paving operation



An “over-active” screed operator will cause surface roughness.
You will not be able to roll this out.
<u>What the Paving Machine places is the final smoothness</u>.

Questions?

Robert (Bob) Humer, P.E.
Asphalt Institute Senior Regional Engineer
Westlake Village, CA