Best Practices For Full Depth Repair, Tack Coat, and Longitudinal Joint Construction

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NJ Asphalt Paving Conference
March 14, 2017

ASPHALT INSTITUTE

Surface Preparation

The performance of a hot mix asphalt pavement is strongly related to the condition of the surface on which it is constructed.

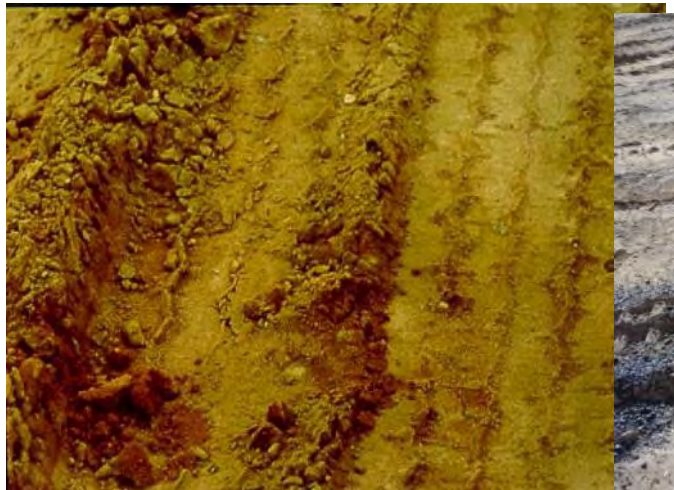
Surface Preparation

The most common surfaces overlaid with HMA or WMA include:

- Subgrade
- Granular Base Course (Aggregate Base)
- Existing Asphalt Pavement
- Existing PC Concrete Pavement

Subgrade & Base Support

- Good support critical to obtain proper density
- Spongy or unstable support
  - Provides little resistance to the rollers
  - Mixture not confined, energy dissipated
- Mixture moves and cracks rather than compacts



Subgrade Preparation

- The subgrade is the pavement foundation
- Must support the pavement and anticipated traffic
  - Soil type considered in thickness design
- Must be properly graded to provide drainage
  - Transverse and longitudinal grade
  - Smoothness and cross slope
- Must be uniformly compacted to required density

Proof Rolling

- Tire pressure at least 90% of maximum
- At least 6600 lb. per tire
- Roll full width using two complete passes
- If test rolling reveals soft, yielding, or unstable areas, remove
- Replace with approved material
- Test roll corrected area

Prime Coat

Why do we use Prime Coat?

- To seal in the subgrade at the proper moisture content
- To fill the surface voids and protect from the weather
- To stabilize the surface fines
- To promote bonding to the subsequent pavement layer

Prime Coat

Allow prime coat to cure 24 - 72 hours

- Often use MC-30 or MC-70
- Can use emulsion on non-cohesive soils or in areas where cutbacks banned, but are often not effective
- Remove loose material from roadway before application
- 0.2 to 0.5 gal/yd^2
- Blot excess prime with sand
- Broom off excess sand

Aggregate Base Preparation

- Mix to proper moisture content
- Best Practice - place using a laydown machine
- Place in 4” - 8” compacted lifts
- Stagger longitudinal and transverse joints at least 1’ in each succeeding layer
- Compact base to percentage of Proctor specified

Preparing to Overlay Existing HMA

Preparing an existing asphalt surface may be as simple as sweeping (*multiple passes may be necessary*) the existing surface and applying tack coat

Preparing to Overlay Existing HMA

Or it may involve one or more of the following:

- Patching
- Cleaning and filling cracks
- Placing a leveling course
- Milling the surface

Failed areas MUST be cleaned, repaired and brought into good structural condition before overlaying.

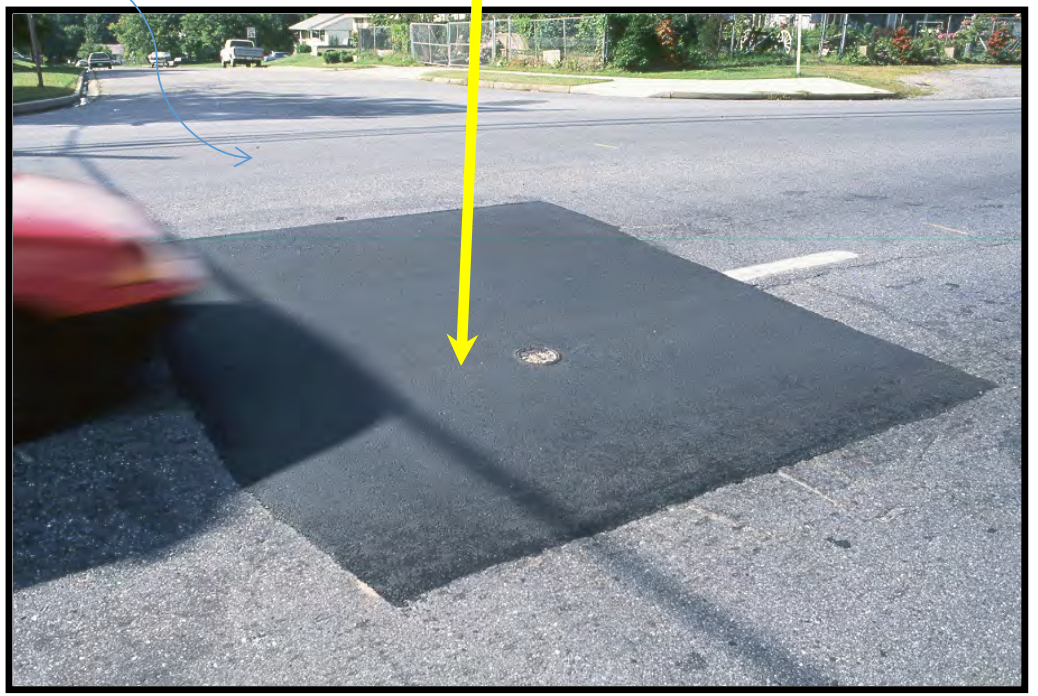
Patching

- Make sure to get at least 1 foot into the sound pavement when you mark the patch for removal
- Use good straight lines that are cut with vertical faces
- Remove all loose material
- Tack base and all vertical surfaces
- Patches must be strong enough to become a part of the permanent structure or they *will* be back!

Patching

Irregular patch - getting proper compaction is going to be difficult on this one.

Nice straight lines, no distress visible outside the patched area



Surface Preparation

- Rarely gets due consideration
- It is often time consuming and labor intensive
- Asphalt layers cover up the potential problems
- THE PROBLEMS WE DO NOT TAKE CARE OF TODAY WILL NOT GO AWAY
  - Often the problems get worse
  - They are more costly to fix the second time

Purpose of Tack Coats

- **To promote the bond between pavement layers.**
  - Prev
  - Fu of th
  - Wh
  - Critica uniformly at ap rate
  - Apply tack coat on all surfaces including vertical surfaces.

Why do we use Tack Coats?

Far too frequent practices

Consequences of Poor Bonding

- Poor pavement performance
  - Slippage cracks
  - Shoving
  - Early fatigue cracking
    - Bottom up
    - Top down
- Costly pavement repairs
  - Repair of isolated area relatively inexpensive
  - Removal and replacement of a portion or the entire pavement structure is very expensive
  - Shorter than expected pavement life can be devastating for agency budgets

Days later!

Courtesy of Road Science

Consequences of Poor Bonding

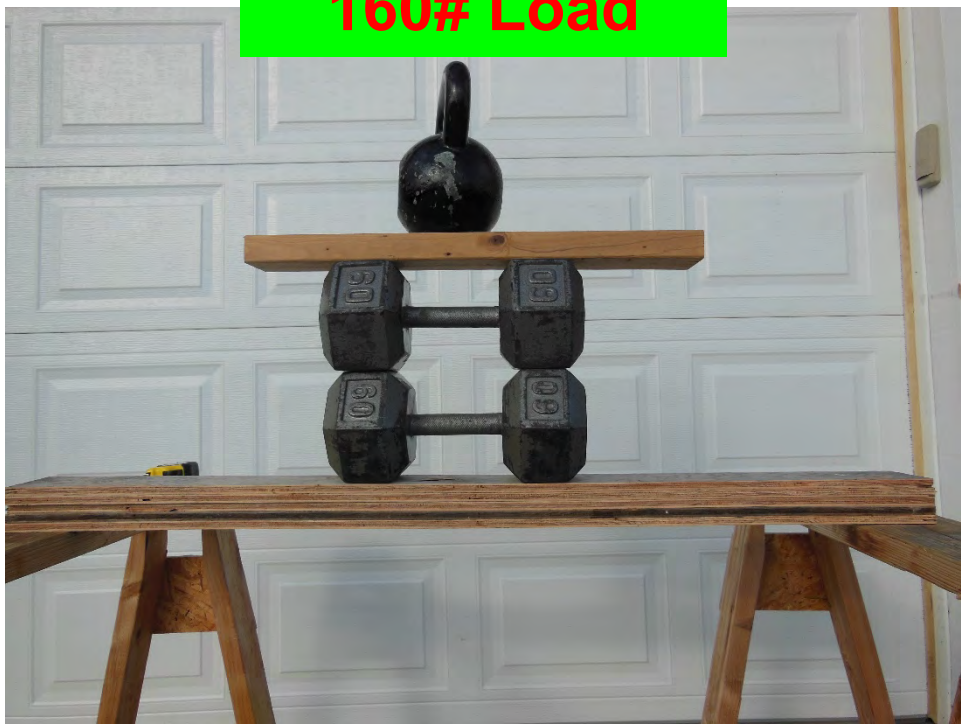
- Layer independence
  - Reduced fatigue life
  - Increased rutting
  - Slippage
  - Shoving
- Compaction difficulty

Direction of traffic?

Bonding Demonstration

½” Deflection,
60# Load

¼” Deflection,
160# Load



Unbonded

Fully Bonded

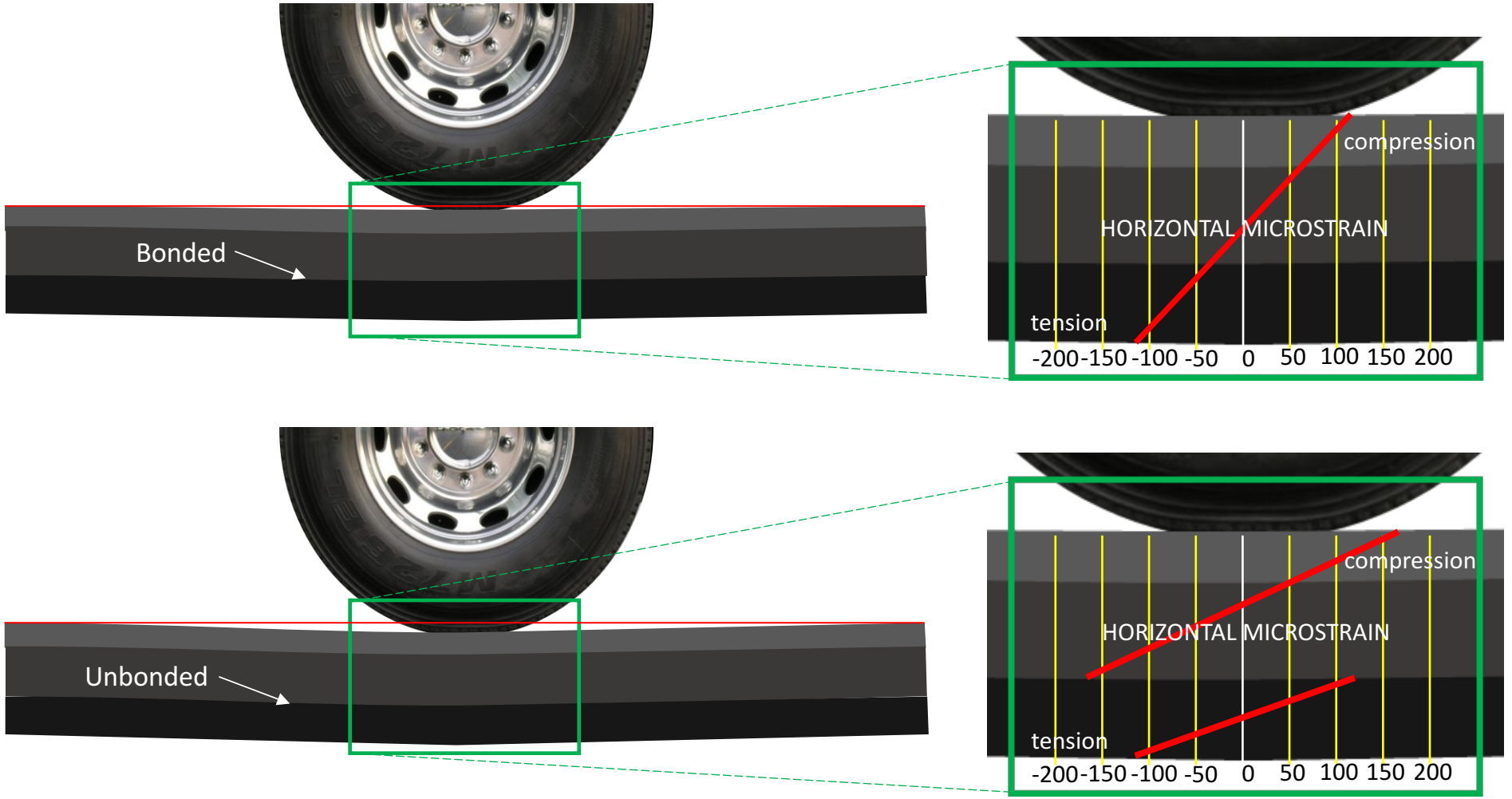
Bonding Demonstration Highlights

- 5 unbonded layers deflected 4x more than 5 bonded with the same loading.

- 2 bonded layers had less deflection than 5 unbonded with the same loading.

- ***5 bonded layers with over 2½x the load deflected half as much as 5 unbonded.***

Consequences of Debonding



Courtesy of NCAT

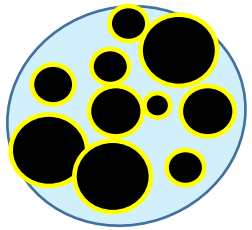
Loss of Fatigue Life Research

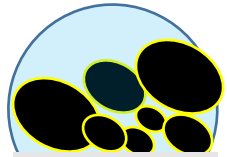
- May and King:
  - 10% bond loss = 50% less fatigue life
- Roffe and Chaignon
  - No bond = 60% loss of life
- Brown and Brunton
  - No Bond = 75% loss of life
  - 30% bond loss = 70% loss of life

Key Factors for Tack Coat Success

- Condition of Existing Pavement
- Tack Coat Application Rate
- Residual Binder Content
- Proper Distributor Operation
- Emulsion Break and Set Times

Emulsion Breaking & Setting





Emulsions are asphalt droplets suspended in water

- Breaking
  - Contact with surface changes pH; reducing charge
- Setting
  - Evaporation leads to coalescence
  - Original asphalt characteristics return

Tack Coat Application

Best Practices

- Surfaces need to be clean and dry.
- Uniform application.
- All surfaces are tacked.
- Tack should not be tracked off the road.

Best Practices

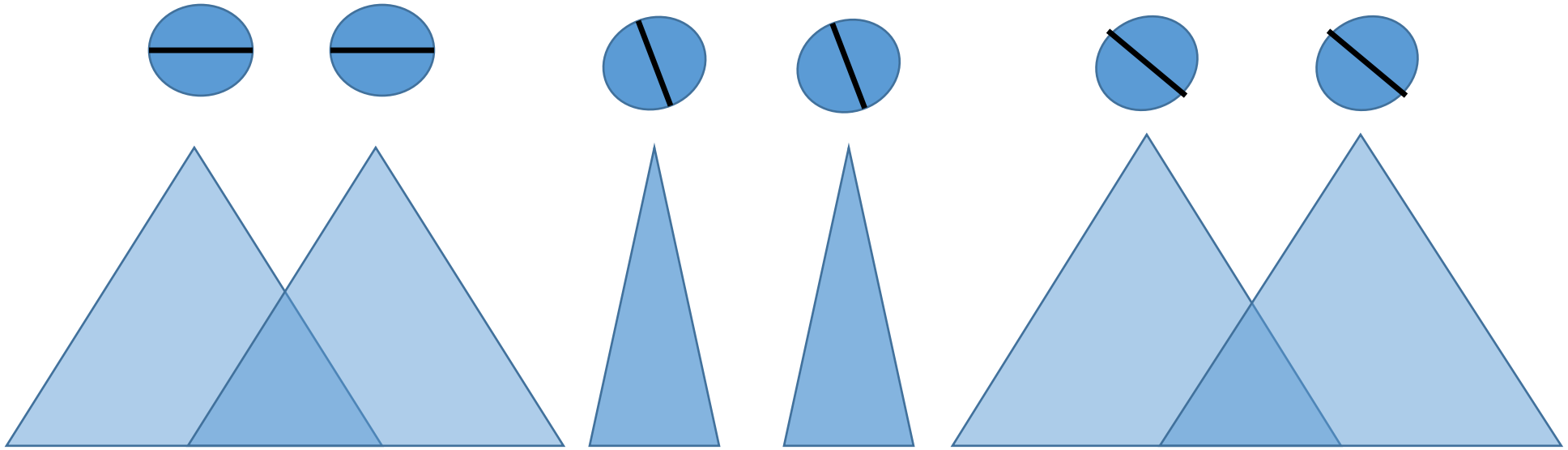
- Match application to conditions.
  - Materials
  - Residual rate
- Verify application rate.
- Resist tacking too far ahead of paver.

Nozzle Selection

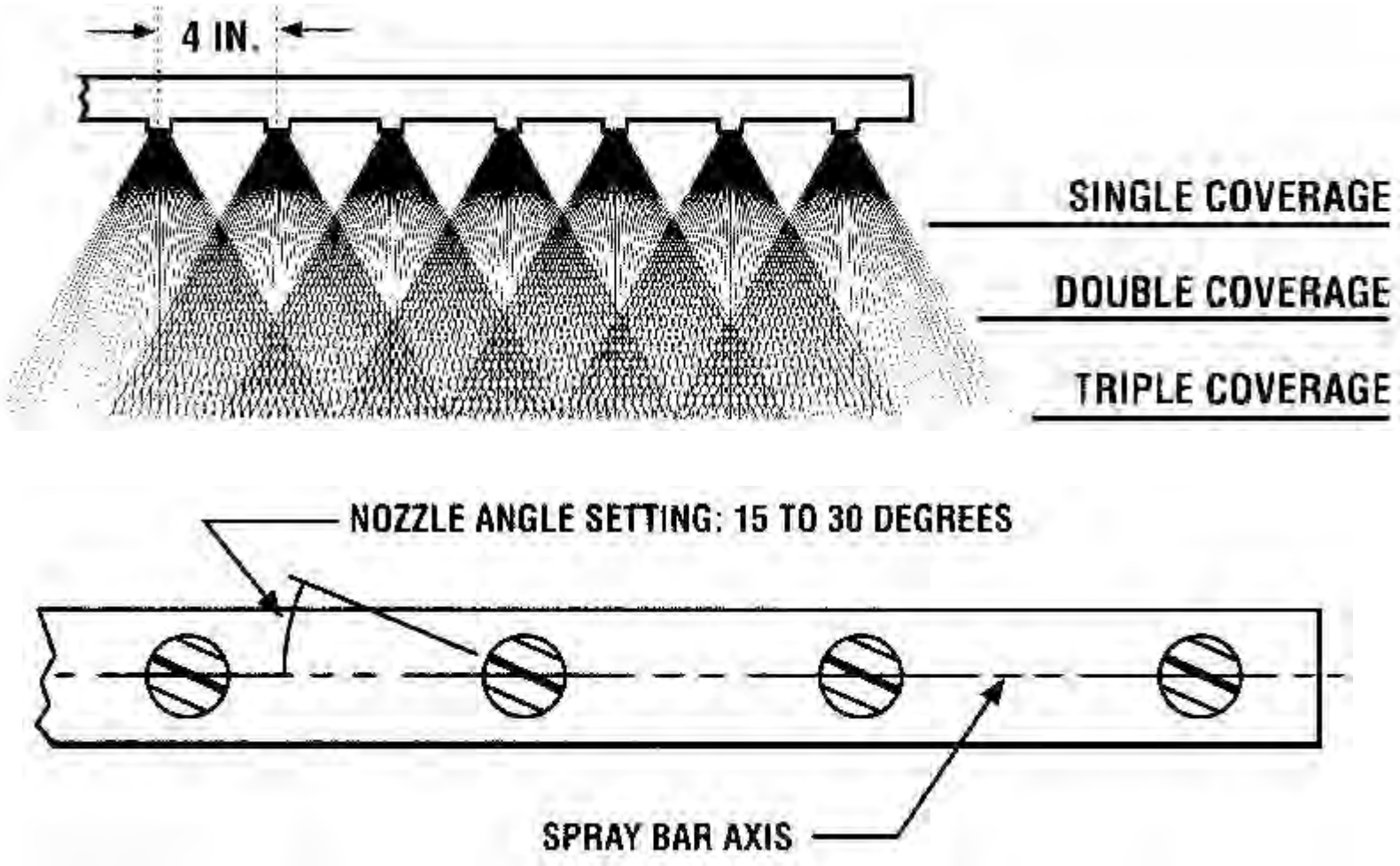
- Consult with distributor truck manufacturer to match the material to the nozzle.
- ONE SIZE DOES NOT FIT ALL

Effect of Nozzle Orientation

Proper nozzle angle of 15-30% assures proper overlap between nozzles without interference of tack streams.



Spray Bar/Nozzles



Tack Coat

Full width of mat to minimize movement of unsupported edge

Photo Courtesy of Jim Scherocman

Key Items for Inspectors

- Check truck setup.
  - Spray bar height (~12”)
  - Appropriate nozzles
  - Nozzle orientation (15-30°)
  - Check application rate gauge in truck
  - Check application temperature
- Collect samples.
- Know the desired application and residual rates.
- Visually inspect application
- Verify application.
  - Volume
  - Mass
  - ASTM D2995

Common Tack Coat Questions

- “When can I pave on the emulsion?”
  - Has emulsion broken?
  - Does it need to be set?
- Asphalt Institute recommends paving begin after the emulsion has broken.
- “How can I prevent tack pull-up/tracking?”
  - Make sure tack coat is broken
  - Use emulsions with hard base asphalt (CSS-1h)
  - Use a proprietary reduced-tracking emulsion
  - Use a spray paver

Common Tack Coat Questions

- What is the optimal application rate?
  - Surface type
  - Surface condition
- Asphalt Institute recommended ranges

Surface Type	Residual Application Rate (gsy)
New Asphalt	0.020 – 0.045
Existing Asphalt	0.040 - 0.070
Milled Surface	0.040 – 0.080
Portland Cement Concrete	0.030 – 0.050

Common Tack Coat Questions

- When to Re-Tack?
  - Tracking
  - Contamination

  Re-Tack when in doubt.
- Is Dilution okay?
  - Follow state specs
  - Verify dilution amount
  - Can not be used to "stretch" tack as residual value is key.

  Limit dilution to supplier.

Successful Tack Coat

The Ultimate Goal:

Uniform tack coat coverage

Longitudinal Joints are a Major Issue for Most Agencies.

Alaska


NEW YORK
THE EMPIRE STATE


Connecticut
644·ETS
Constitution State

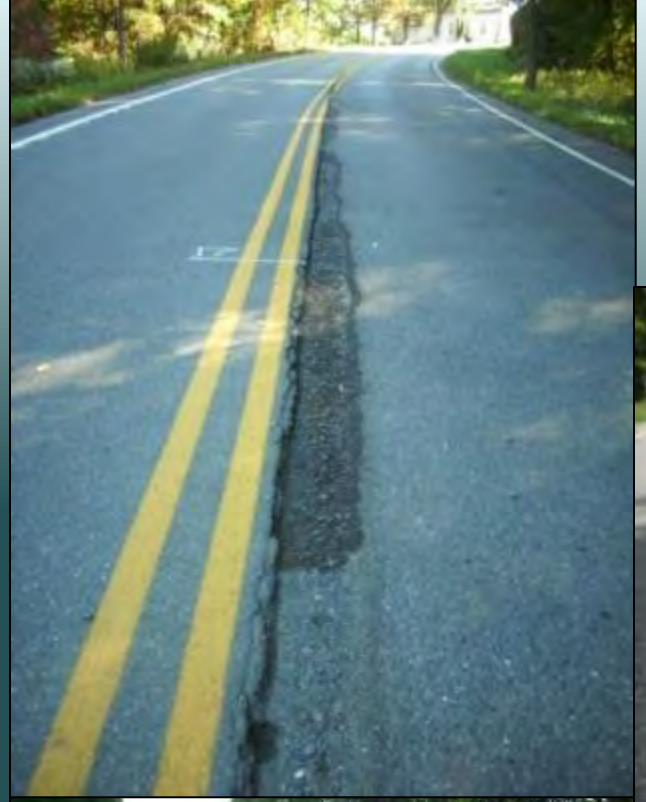
Some States have more challenges than others!

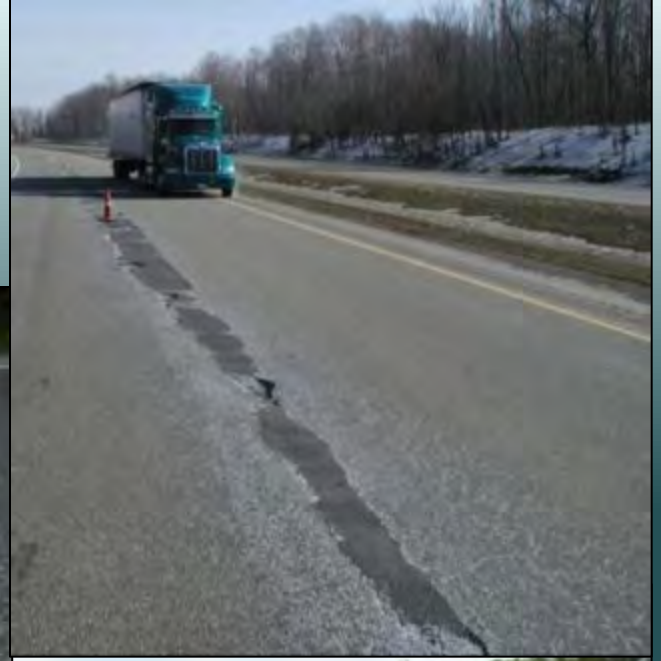
ALASKA

Too often longitudinal joints are the weak link in an otherwise durable long-lasting asphalt pavement.

- **Major concern for industry as well as agencies**
- **Offers greatest opportunity to improve overall life.**

Joint Issues In PA





LONGITUDINAL JOINT DENSITY SUMMARY

YEAR	DENSITY LOTS	AVG. JOINT DENSITY	AVG. MAT DENSITY
2007	18	87.8%	93.9%
2008	43	88.9%	94.1%
2009	29	89.2%	94.1%
2010	NO DATA, TRANSITION TO PWL SPEC.		
2011	137	91.1%	94.1%
2012	162	91.6%	94.0%
2013	167	91.4%	93.9%
2014	**316**	**92.3%**	**94.1%**

CT DOT Average In-Place Lot Density on Cores for Entire Year

Roadway (Non-Bridge)

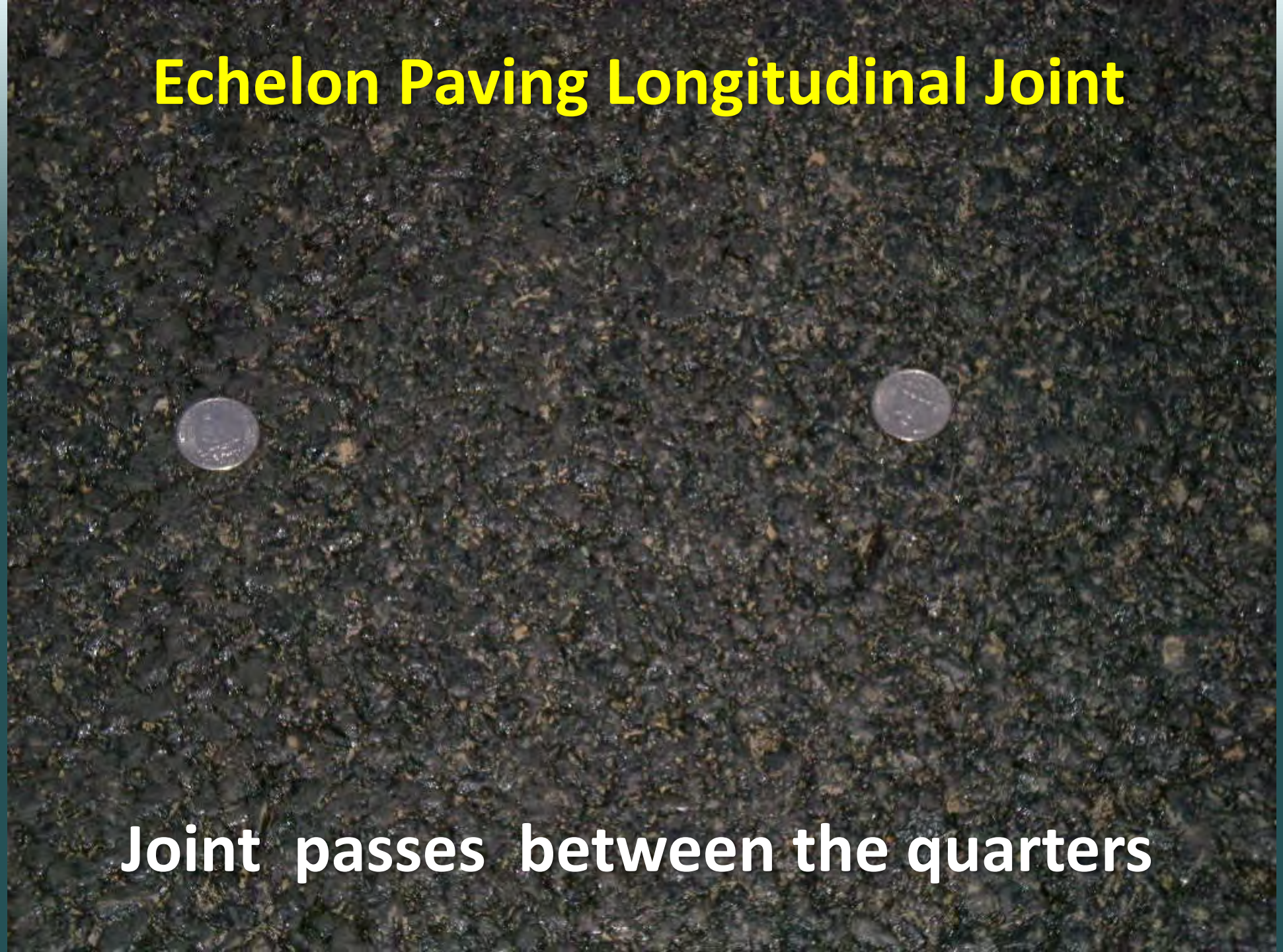
Year	Mat (Rqd. Min. of 92%)	Joint (Rqd. Min. of 91%)
Prior to 2010: Acceptance from gauges		
2011	**92.6%**	**91.6%**
2012	**93.0%**	**91.4%**
Std. Dev.	2.07 (on 2082 measurements)	2.40 (on 1863 measurements)
2013	**93.1%**	**91.8%**

The Best Longitudinal Joint:
Echelon Paving

New Jersey

Rolled Hot

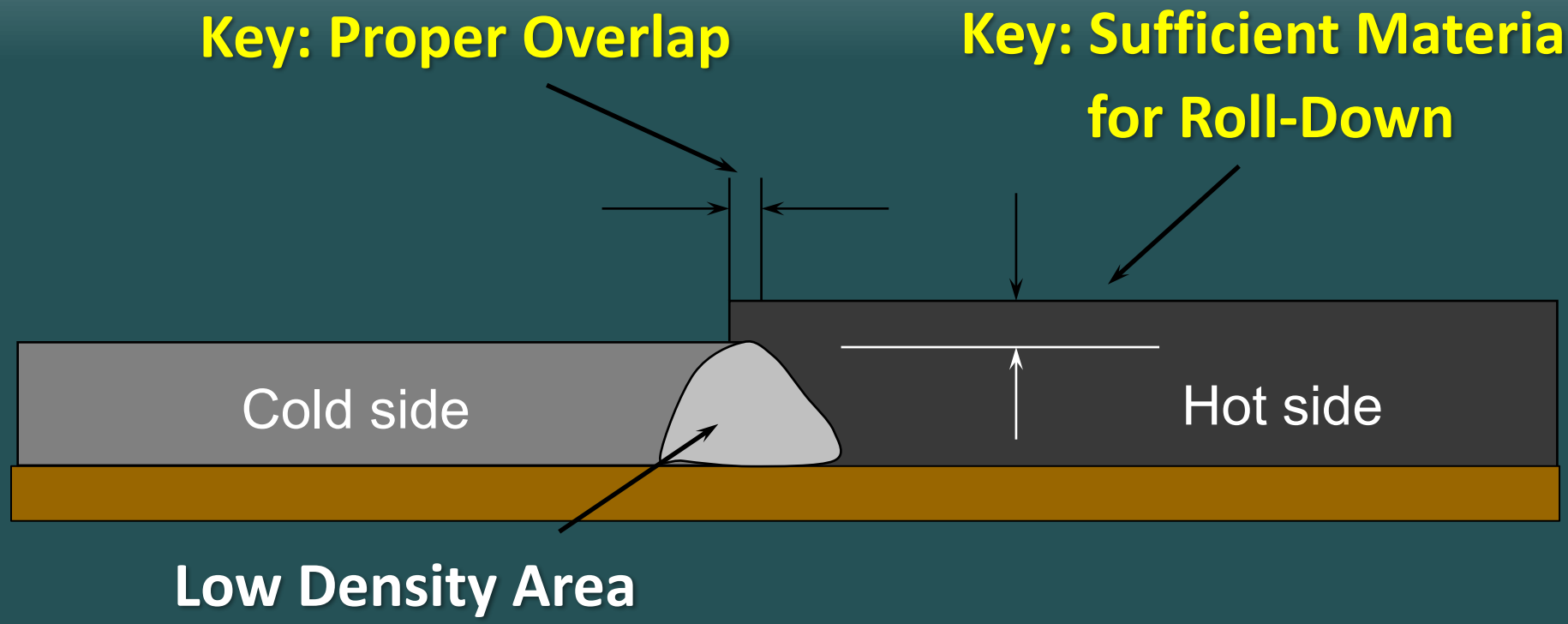
Echelon Paving Longitudinal Joint



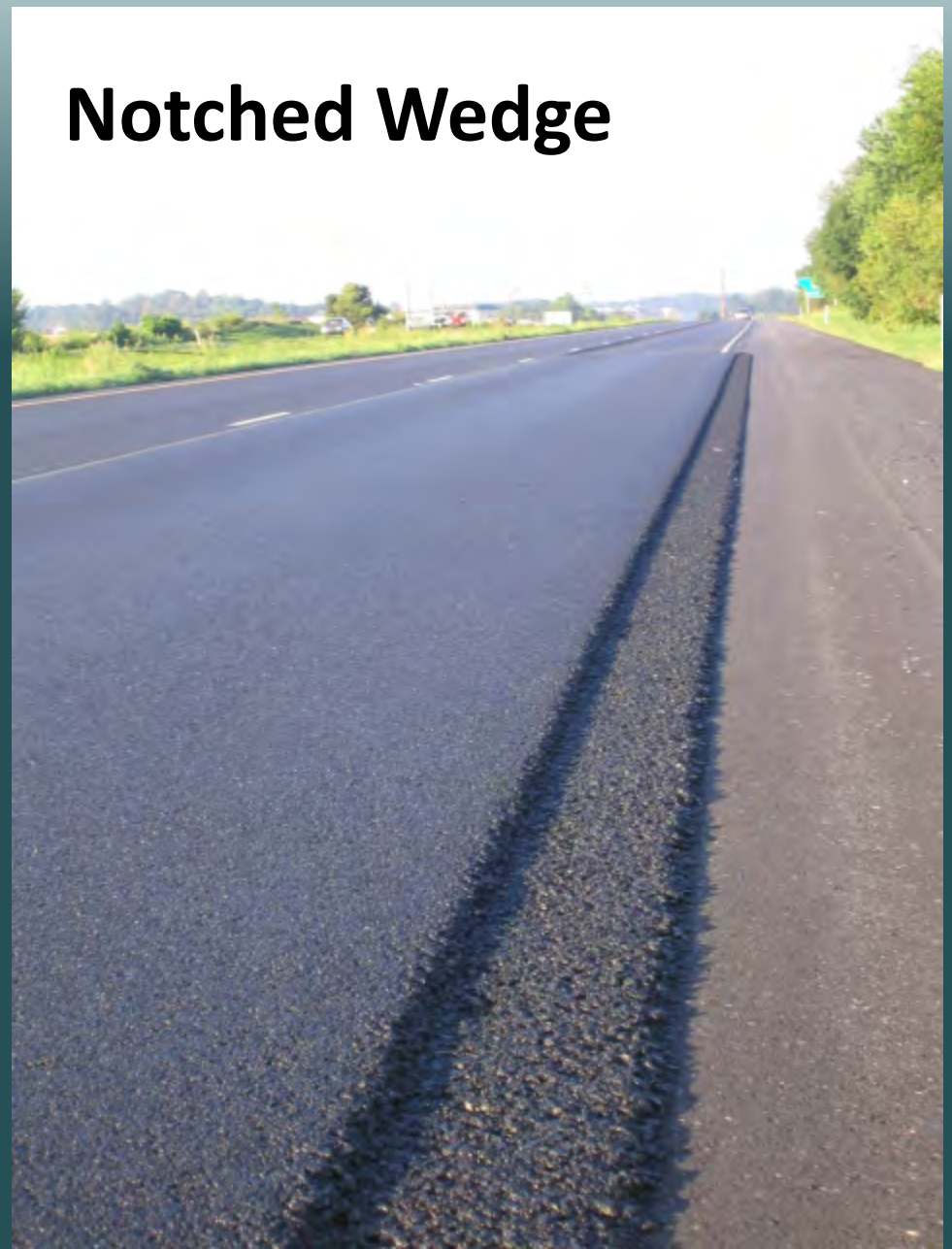
Joint passes between the quarters


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

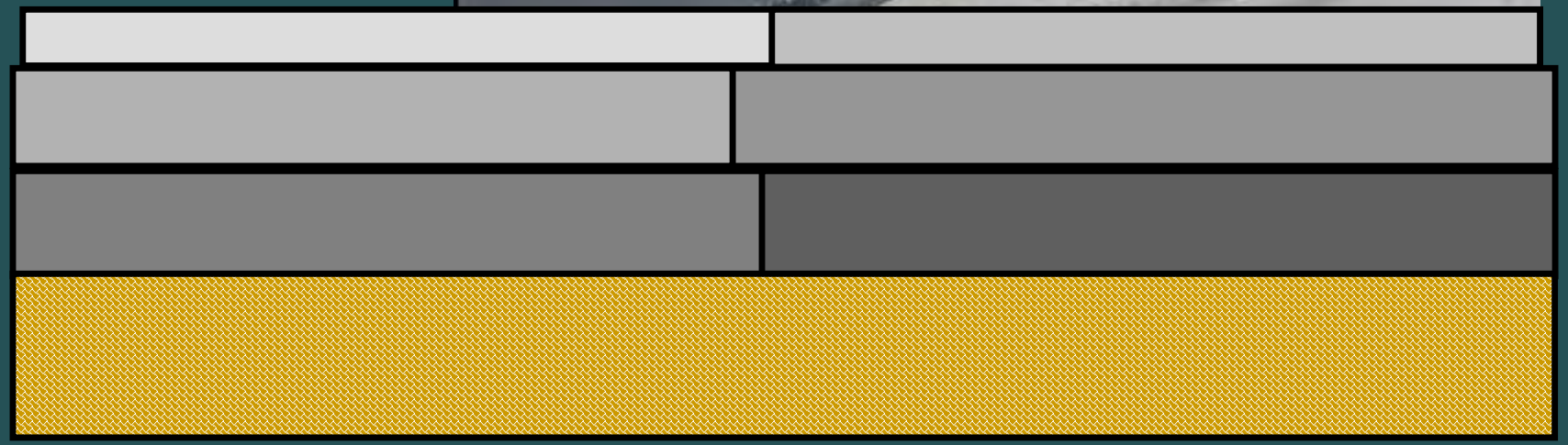
Unsupported Edge Will Have Lower Density



Experts Evenly Divided on Preferred Joint Type



Offset joints between layers by at least 6-inches; surface joint should be near centerline (not in wheelpath)



Plan to Avoid Placing Joint Where Striping Will Go

DELDOT

If Not, Can Eventually Result In This

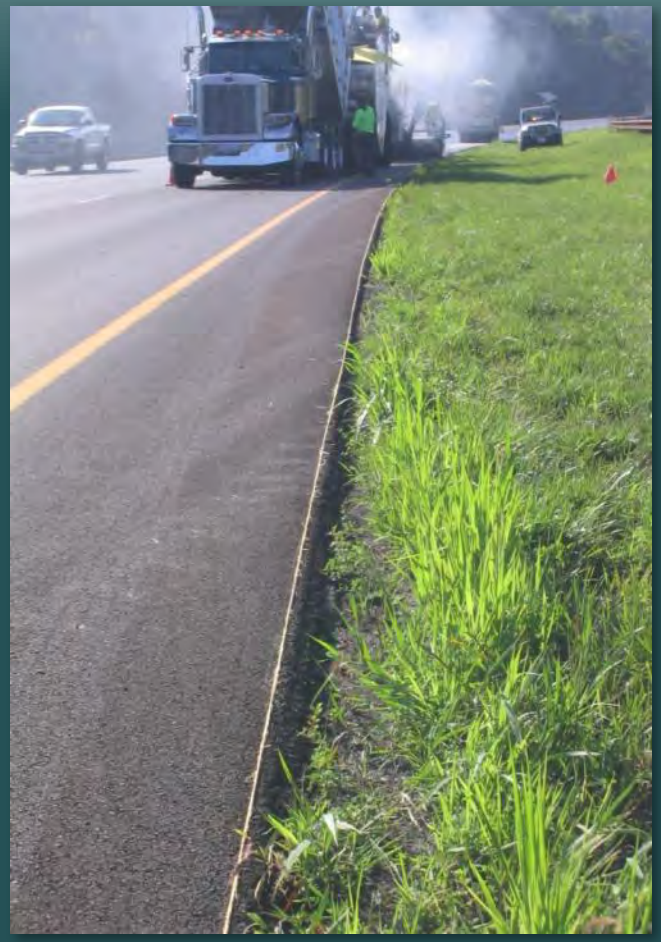
DELDOT

Tack Coat

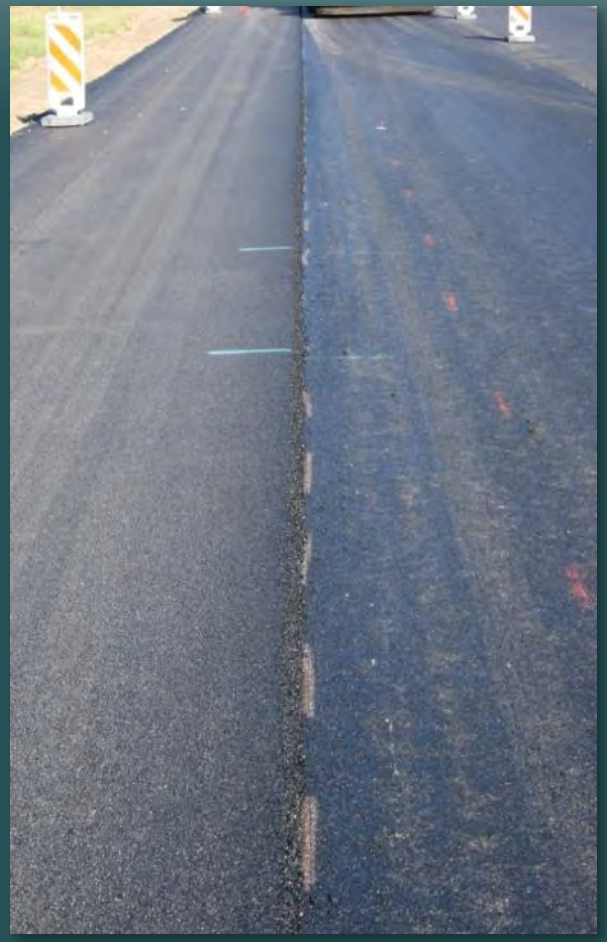
Full width of mat to minimize movement of unsupported edge

First Pass Must Be Straight!

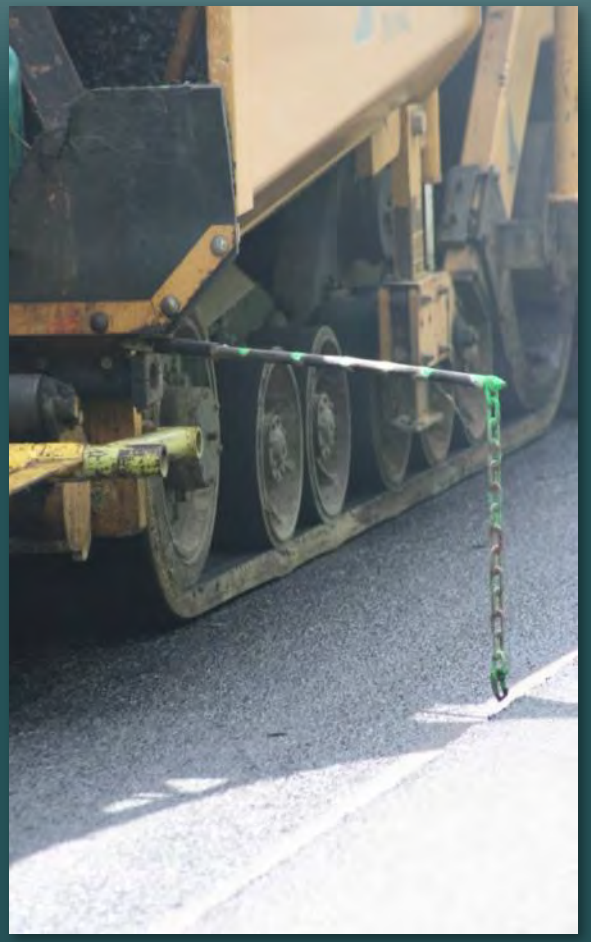
Unanimous that a string-line should be used to assure first pass is straight



String-line



Skip Paint



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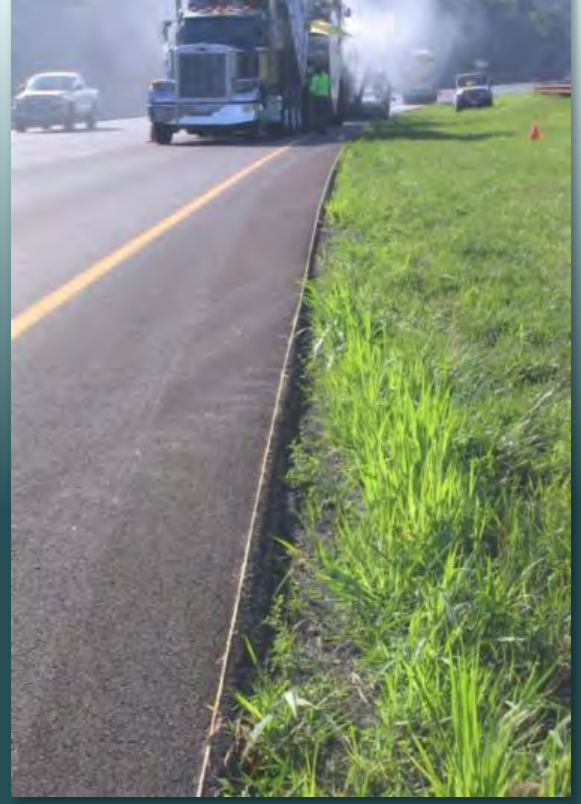
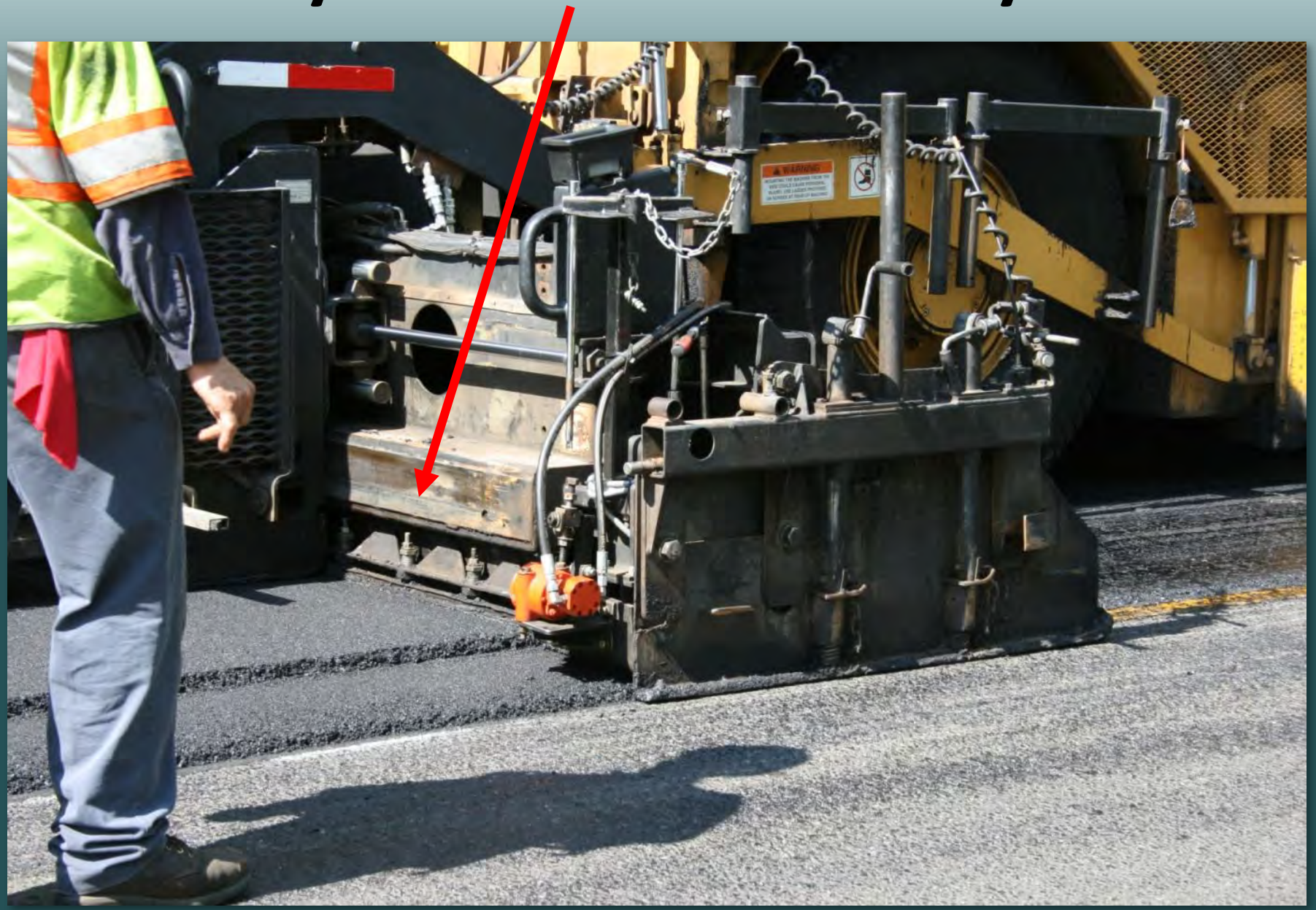


Great Results

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

Vibratory Screed Should Always Be On



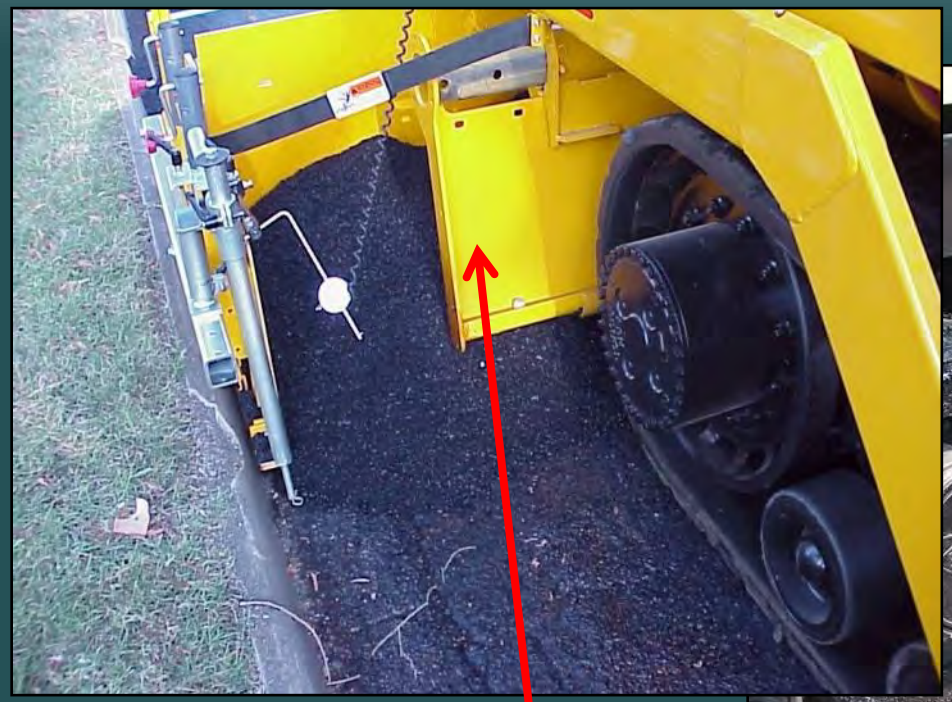
Uniform Head of Material

Maintained Across Width of Auger

Extend Augers to Within 12-18 inches of End Gate

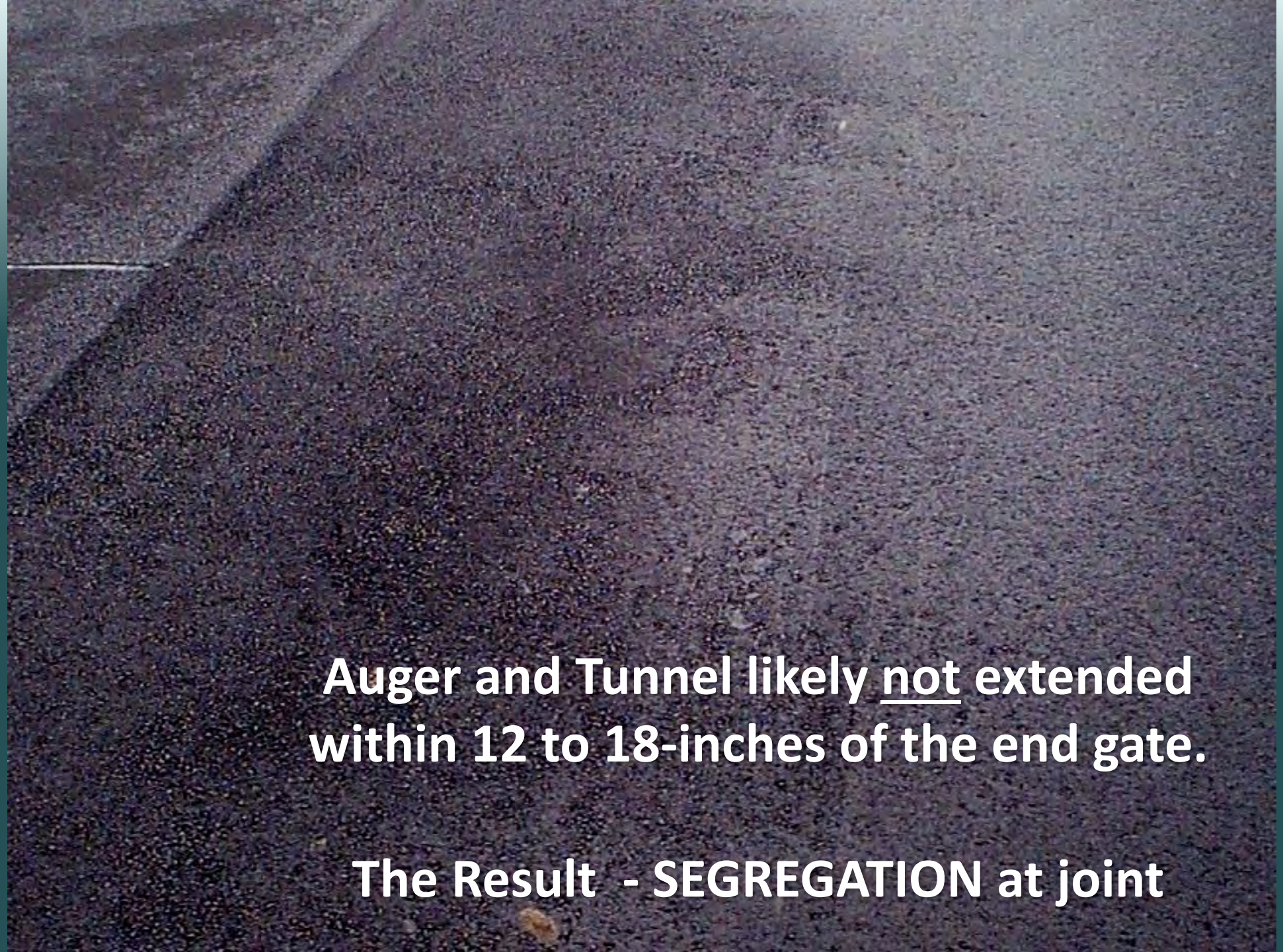
Extend Tunnels the Same Distance

To control material flow at outer edges of screed and deliver homogenous HMA at joint



Tunnels

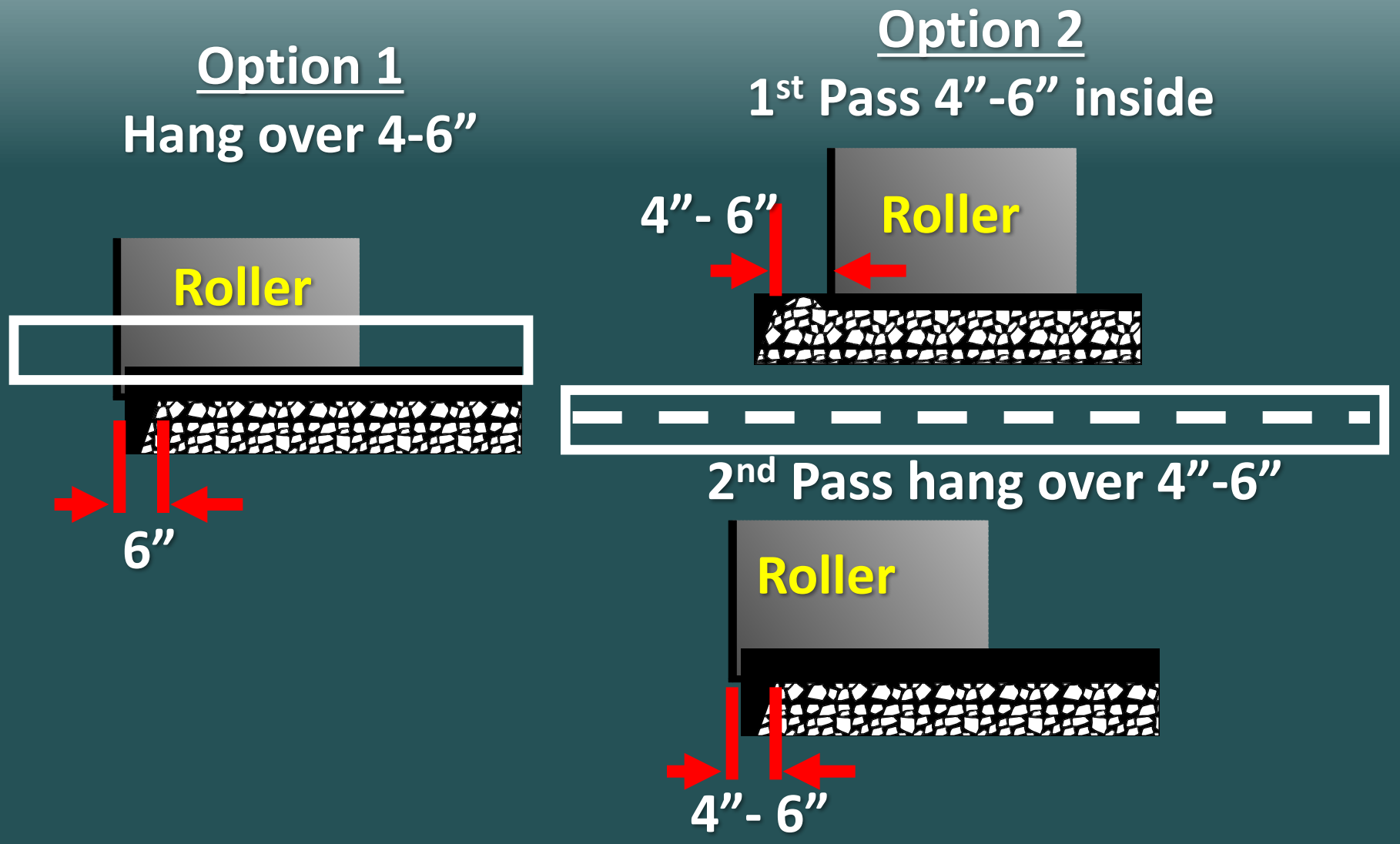
Examples of Auger Overload… Likely to Segregate


Auger and Tunnel likely not extended
within 12 to 18-inches of the end gate.
The Result - SEGREGATION at joint

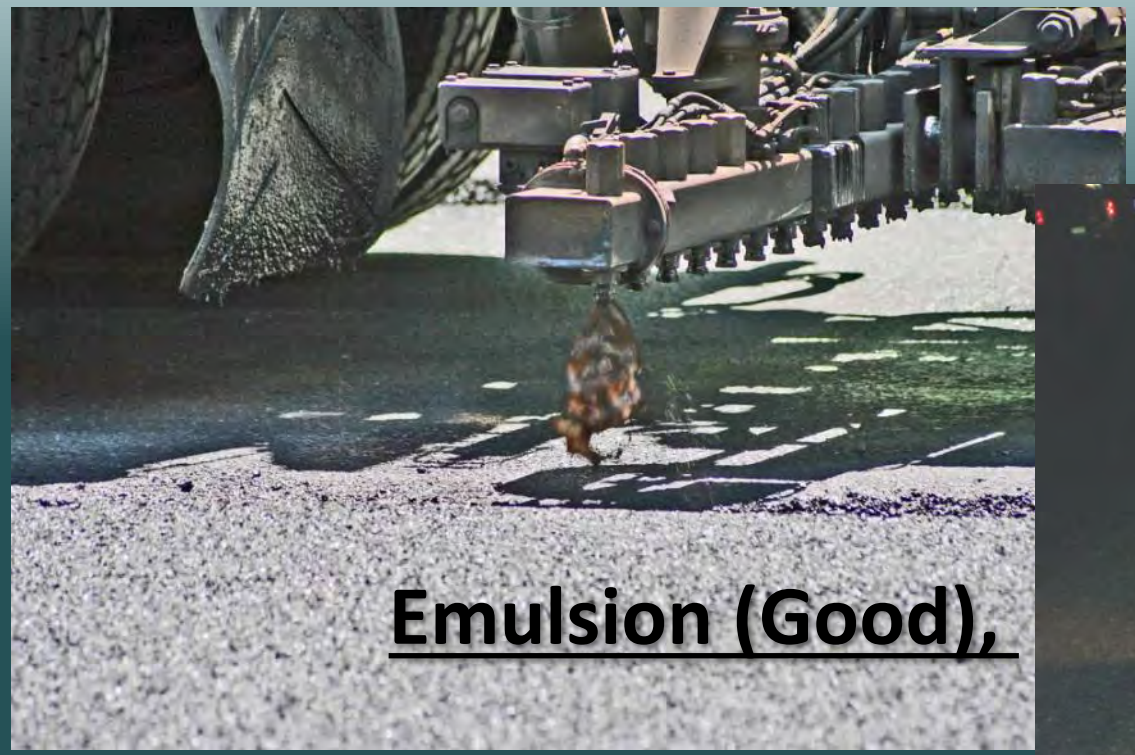
Rollers Need to Be Kept Close to the Paver

Best Way to Roll a Joint

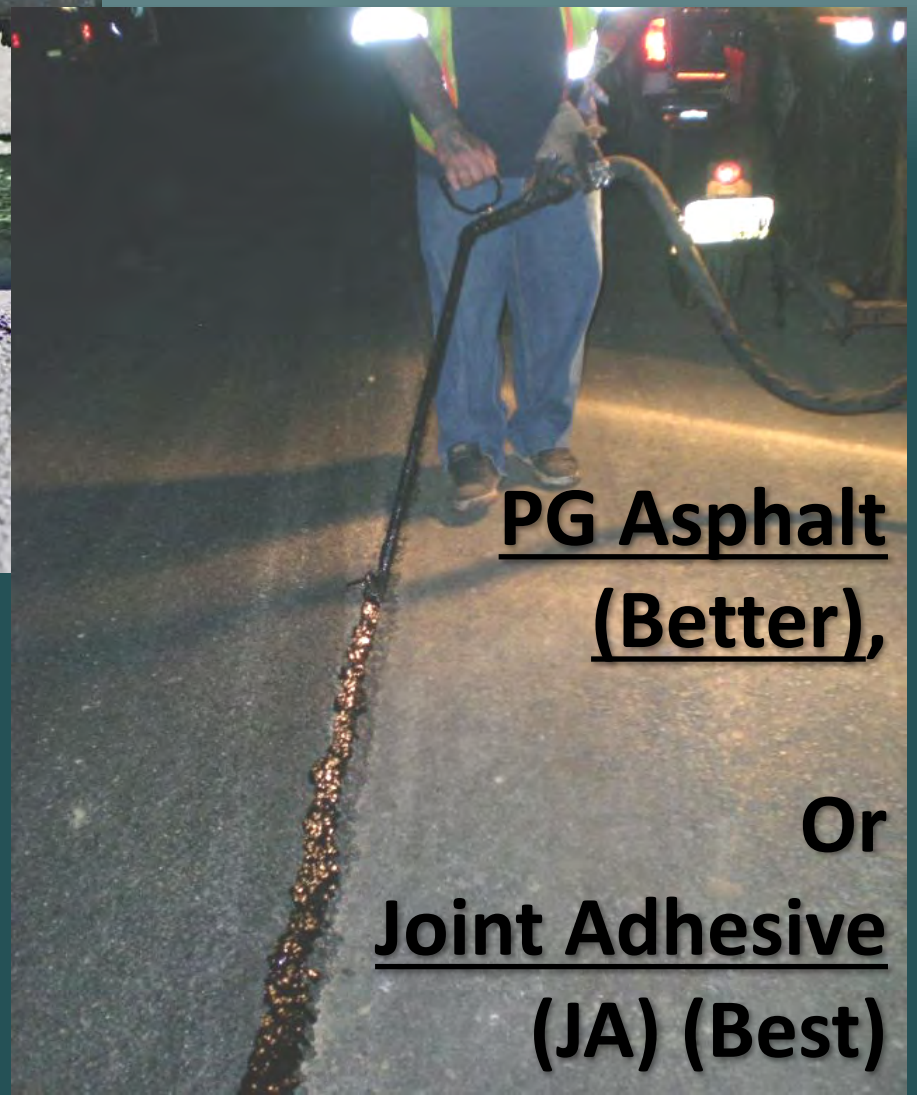
Rolling Unsupported Edge?
Experts 50-50 on Where to Put 1st Pass



Paint the Side of Joint (Butt or Wedge)



Emulsion (Good),



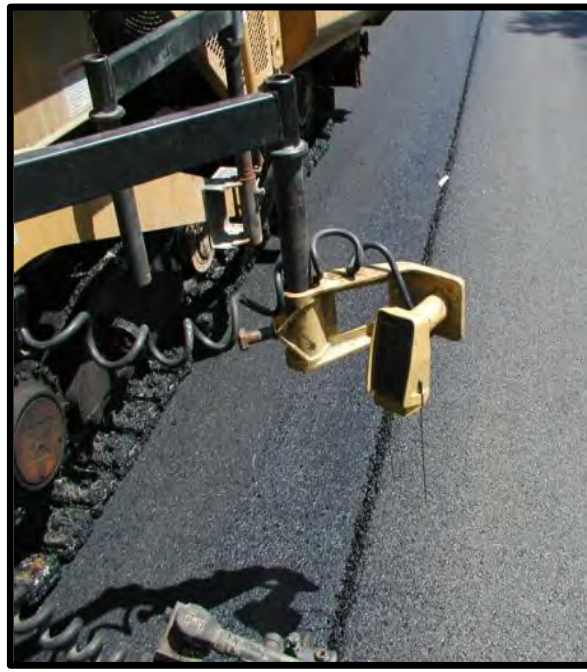
PG Asphalt (Better),

Or

Joint Adhesive (JA) (Best)

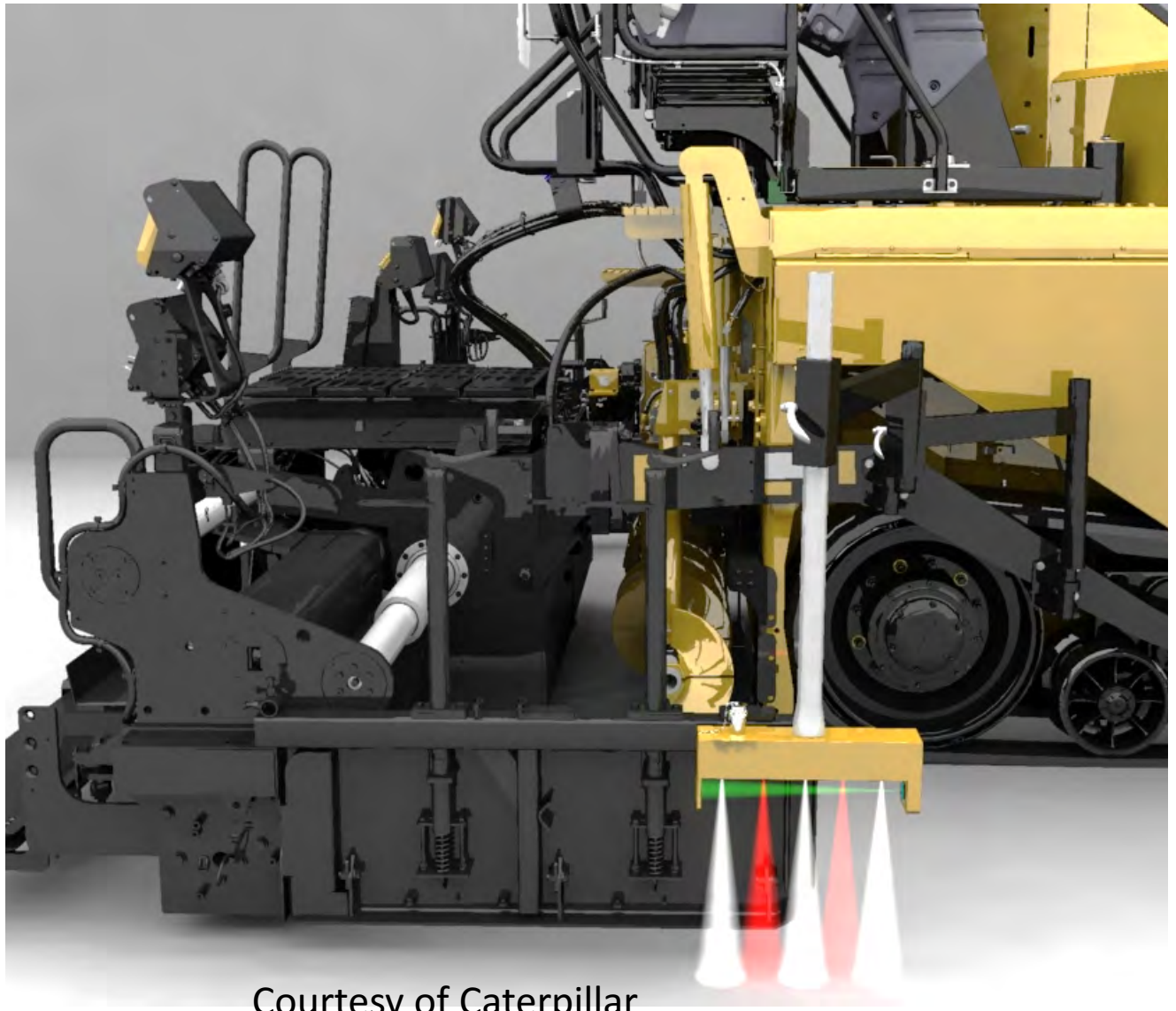
When Closing Joint, Set Paver Automation to Never Starve the Joint of Material

- Target final height difference of +0.1” on hot-side versus cold side
  - NH spec requires 1/8” higher
- Joint Matcher (versus Ski) is best option to ensure placing exact amount of material needed
- If hot-side is starved, roller drum will “bridge” onto cold mat and no further densification occurs at joint



Automatic Grade Control

Joint Match



Courtesy of Caterpillar


Destined for Failure
Hot side of joint starved of material at each end of load. Bridging occurs.

Proper Overlap:

- 1.0 ± 0.5 inches
- Exception: Milled or sawed joint should be 0.5 inches

Don't Rake Overlap Across the Joint! – Starves the Joint

Photo by
James Scherocman, P.E

Lute the Longitudinal Joint

This lute person is doing a great job

Rolling the Supported Edge

Our Recommendation to Minimize Bridging:

1st pass all on hot mat with roller edge off joint approx 6-12 inches

2nd pass overlaps on cold mat 3-6 inches

Pneumatic Rubber Tired Rollers

- Many experts believe kneading action helps in providing a tighter surface that is more dense and less permeable compared to drum rollers.
  - Research supports this
- But must keep these away from the unsupported edge to avoid excessive lateral movement of mat
- Use during intermediate rolling of the supported edge.
  - Not finish rolling.

Alternative Techniques / Products Not Mentioned Today

- Mill & Pave One Lane at a Time
- Cut Back Joint
- Joint Heaters
- Surface Sealers Over Joint

Commonly asked questions

- Does the first pass have to be straight?
  - Absolutely in order to match up
- When matching up, what is the proper overlap onto the cold side of the joint?
  - 1” +/- 0.5” (0.5” for milled or sawed joints)
- Is tack coat required?
  - Yes – on all surfaces including vertical faces – PG binder or joint adhesives may also used
- Which automation should used when matching up?
  - Joint matcher will insure the right amount of material to not starve the joint – account for rolldown and finish 0.1” higher (ski is for smoothness)

OUR GOAL: Joint Life = Mat Life

- 14 year old surface
- I-65 in IN: SR252 to US31

Questions?