Tack Coat and Thin Overlays

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Tack Coat Best Practices

4-Hour Alaska Workshop
Scheduled 4/12/16

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What do you think about this photo?

This one?
(Hint: you're not looking at sealed cracks.)

This one?

What about this one?

Successful Tack Coat

The Ultimate Goal:

Uniform, complete, and adequate coverage

Definition

Tack Coat:

A sprayed application of asphalt cement upon an existing asphalt or Portland cement concrete pavement which may or may not have been milled before an overlay, or between layers of fresh asphalt concrete.

What's wrong (if anything) with the following specification regarding application rate?:

"Apply the tack coat at a rate of 0.05 gallons/yd^2"

Everyone must be on the same page

Are we talking about:

- ***Original Emulsion***—an undiluted emulsion which consists of a paving grade binder, water, and an emulsifying agent.
- ***Diluted Emulsion***—an emulsion that has been diluted with additional water.
  - Critical to control
  - 1:1 typical (Original Emulsion:Added Water)
- ***Residual Asphalt***—the remaining asphalt after an emulsion has set, typically 57-70 percent.

What difference does it make?

If the example spec *intended* 0.05 gal/sy^2 of <u>residual</u> asphalt:

- ***Original emulsion*** *applied at 0.05 gal/sy^2 using an emulsion with 60% residual asphalt, leaves* ***0.03 gal/sy^2*** *on the roadway (40% less than intended).*
- ***Diluted Emulsion*** using the same emulsion diluted 1:1 with water and applied at *0.05 gal/sy^2* leaves ***0.015 gal/sy^2*** *on the roadway (70% less than intended).*
- *To receive* ***Residual Asphalt*** *at 0.05 gal/sy^2 using an emulsion with 60% residual asphalt, the contractor would need to apply* ***0.083 gal/sy^2*** *of* ***Original Emulsion*** *or* ***0.167 gal/sy^2*** *of* ***1:1 Diluted Emulsion***

More Terminology

- ***Tack Coat Break***—the moment when water separates enough from the asphalt, showing a color change from brown to black.
- ***Tack Coat Set***—when all the water has evaporated, leaving only the residual asphalt. Some refer to this as completely broke.

Importance of Tack Coats

- **To promote th[illegible]en pave[illegible]**
  - [illegible]
  - [illegible] pave[illegible]
  - All layers working together.
  - Apply along all transverse and longitudinal vertical surfaces.

Why do we use Tack Coats?

Bonded Demonstration

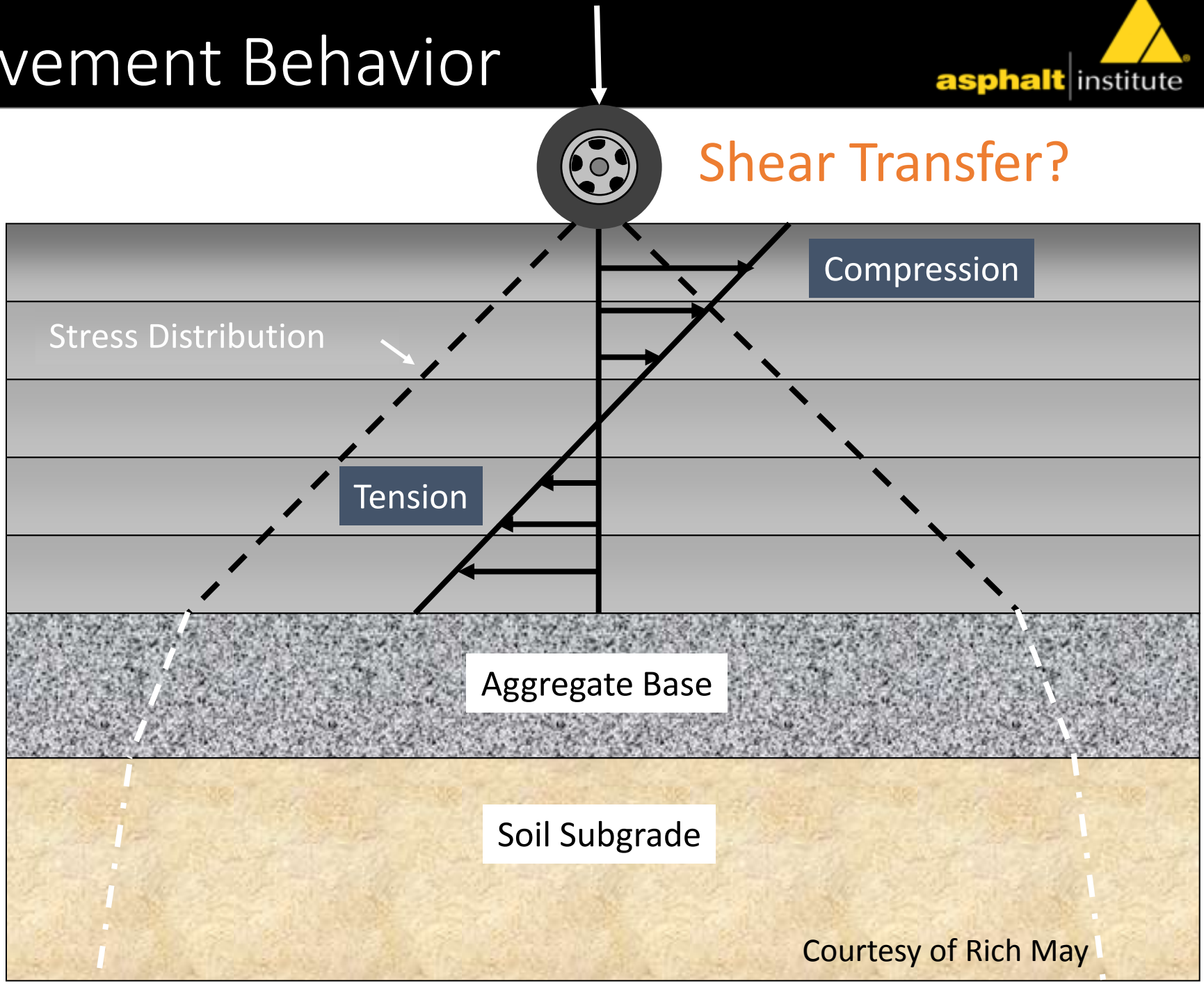
½” Deflection,
60# Load

¼” Deflection,
160# Load

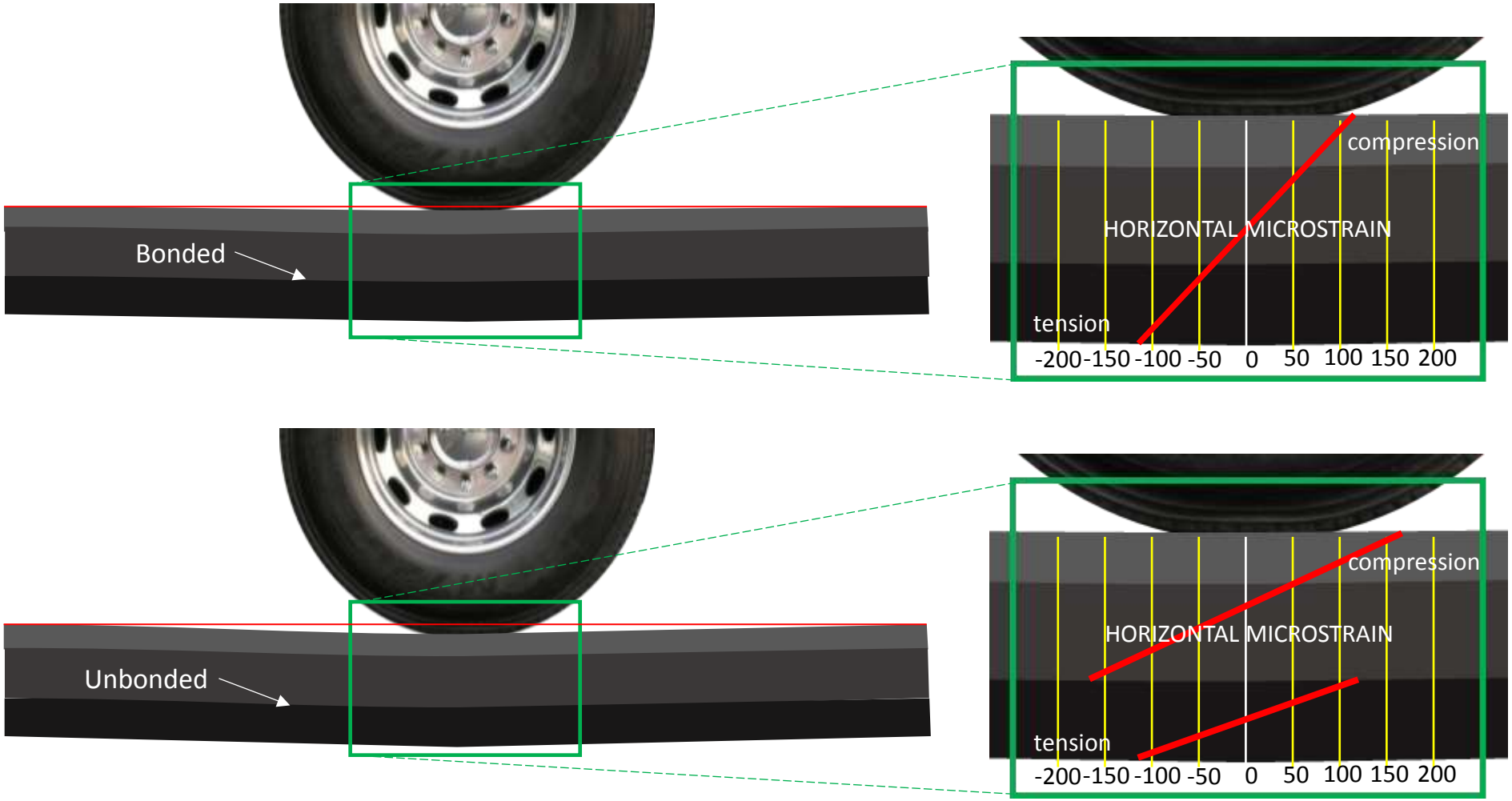
Unbonded

Fully Bonded

Pavement Behavior



Consequences of Debonding

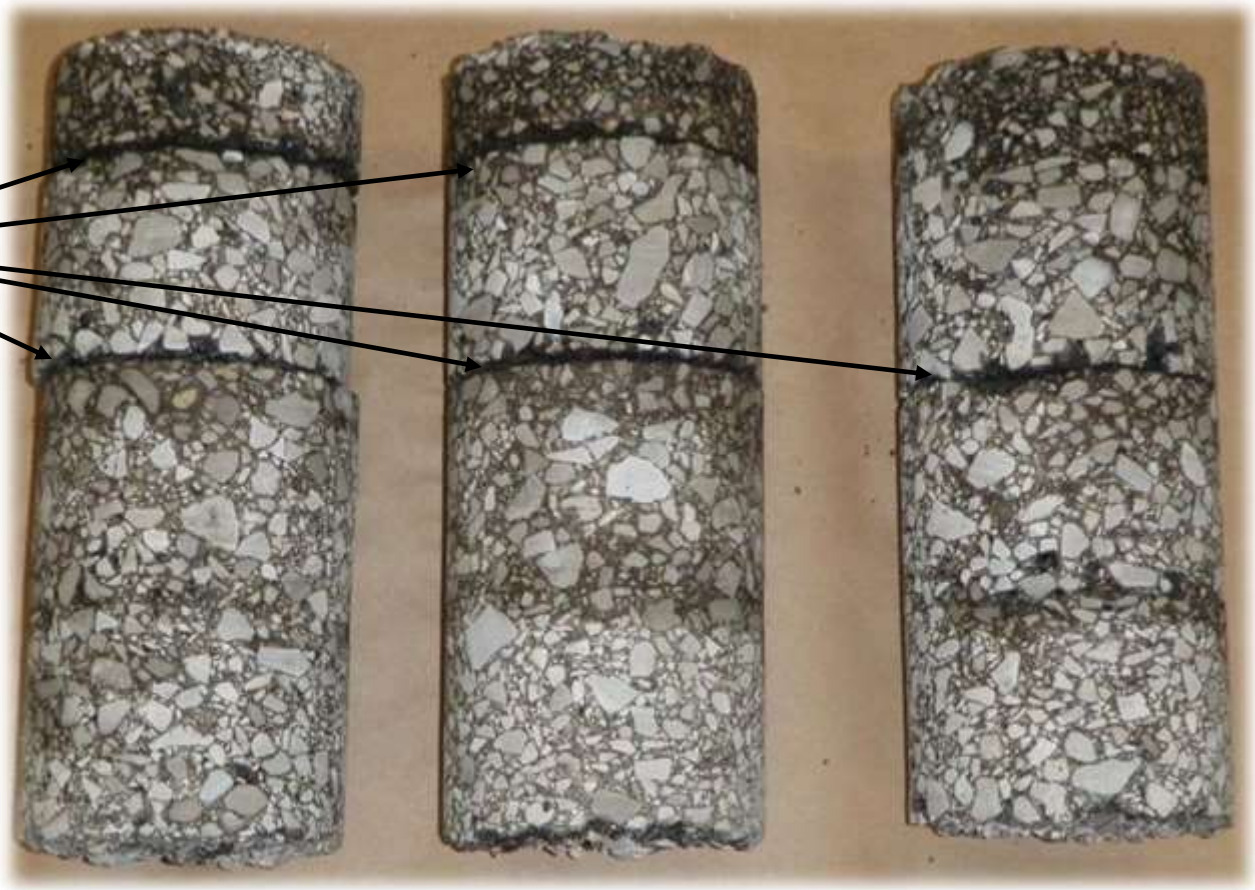


Courtesy of NCAT

8 – 10 years (est.) Interstate Pavement

Cores Showing Debonding

Bonding Failures



Courtesy of MODOT

Consequences of Poor Bonding

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

Direction of traffic?

Loss of Fatigue Life Examples

- 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

So is it worth it to apply a tack coat?

Cost of Tack Coat

- New or Reconstruction
  - About **0.1-0.2%** of Project Total
  - About **1.0-1.5%** of Pavement Total Cost

- Mill and Overlay
  - About **1.0-2.0%** of Project Total
  - About **1.0-2.5%** of Pavement Total Cost

Estimated Cost of Bond Failure in Only the Top Lift

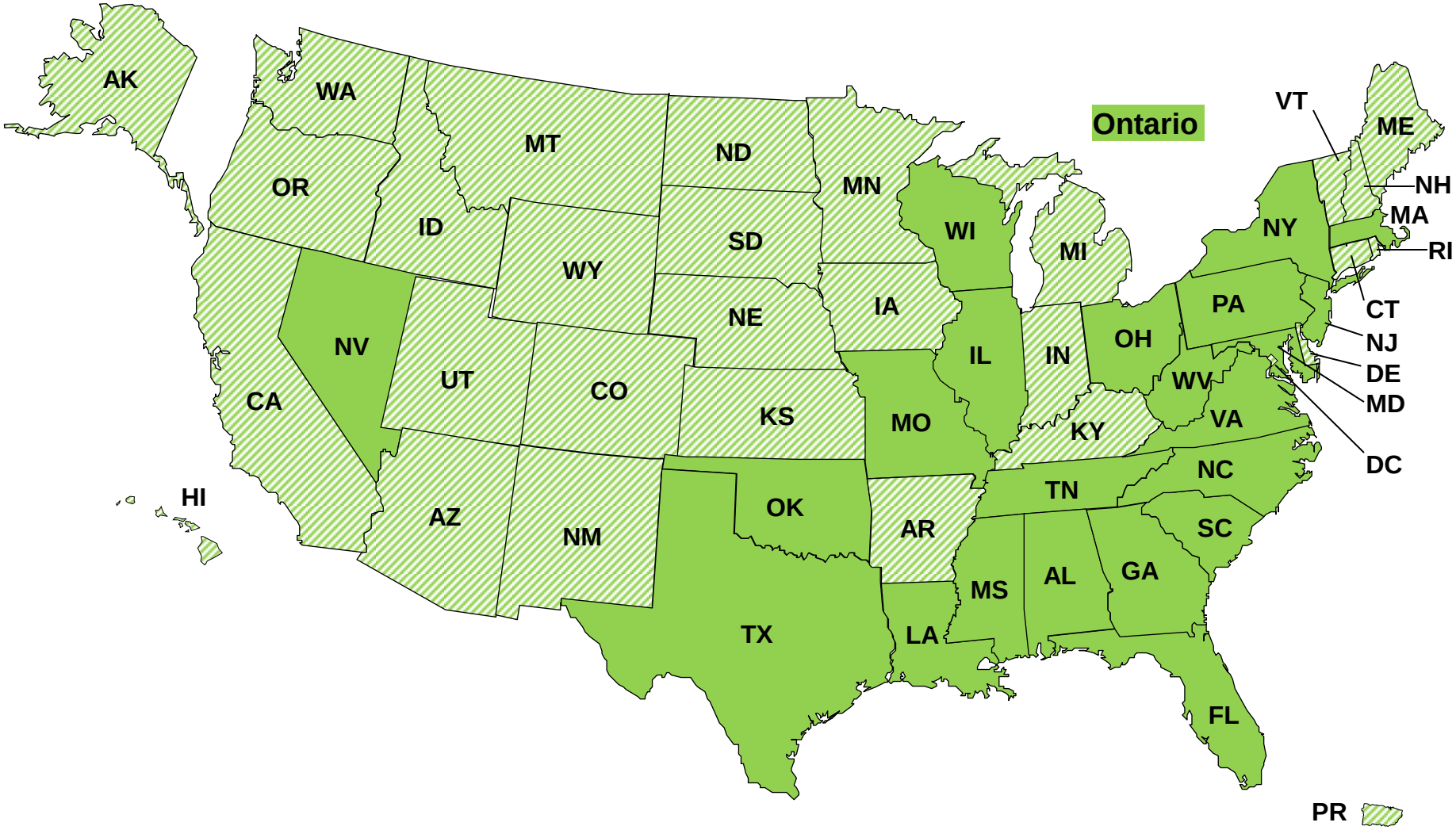
- Assume no inflation for materials
- Estimated traffic control
- Used project plans for thicknesses
- Used bid tabs for:
  - Milling
  - Material costs
  - Replaced pavement markings

30-100% of Original Pavement Costs

Common Tack Coat Materials

- Emulsified Asphalt
  - Most common option
    - SS-1, SS-1H
    - CSS-1, CSS-1H
    - RS-1, RS-1H, RS-2
    - CRS-1, CRS-2
    - PMAE
- PG Graded Binders
  - Neat Binders
    - PG 58-28
    - PG 64-22
    - PG 67-22
  - Polymer Modified
- Reduced or Non-tracking Emulsions

22 States Known to Allow Reduced Tracking Tack Materials



Tack Coat Challenges

- **Contractor**
  - Application Rate
  - Consistency of Application
  - Tack Coat Pickup or Tracking By Vehicles
  - Traction for Construction Equipment
  - Breaking/Setting Time
- **Agency**
  - Acceptance
  - Dilution?
  - Application Measurement
  - Bond Quality

Best Application Practices

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

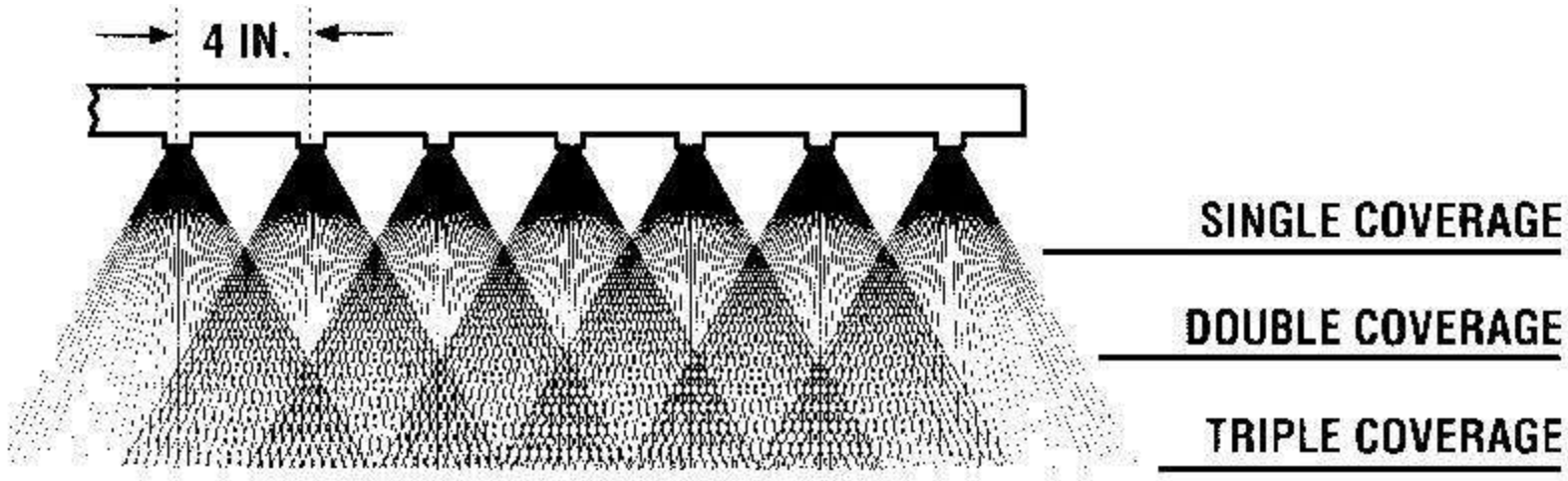
Best Practices

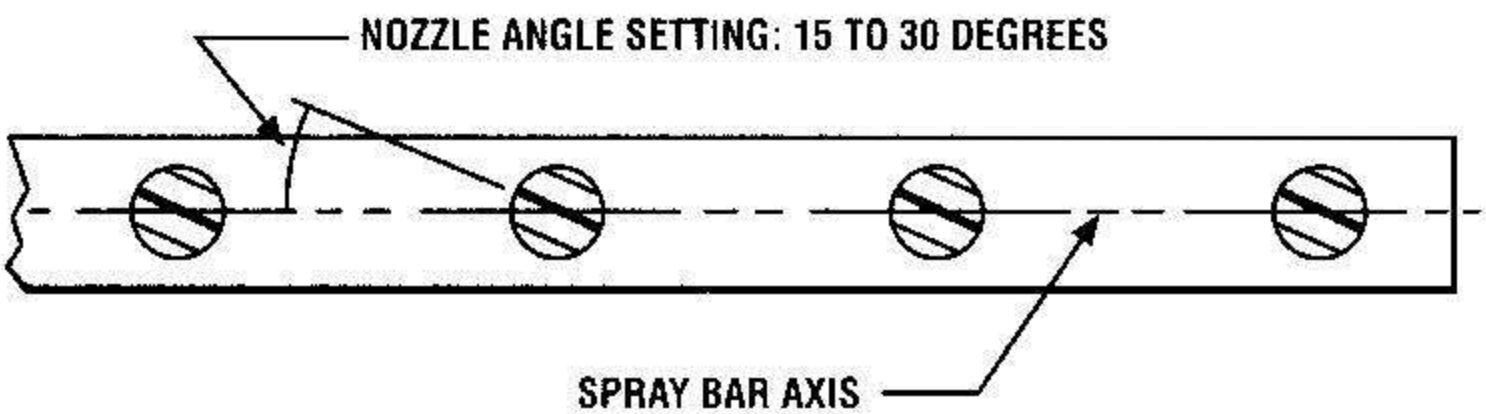
- Match application to conditions.
  - Materials
  - Residual rate
- Verify application rate.
- Resist tacking too far ahead of paver.

Distributor Truck Setup

- Liquid temperature
  - Monitor and match to material
- Calibrate distributor truck
  - Spray bar height
  - Spray bar pressure
  - Nozzle angle
  - Nozzle selection
  - Thermometers
  - Volumeter

Spray Bar/Nozzles





Nozzle Selection

Areas of Known Agreement

- Layer Bonding is Vital
- Surface Preparation
  - Clean
  - Dry
- Milling Improves Field Performance
  - Shear
  - Cleaning

Areas of Known Agreement

- Application Quality Vital
  - Proper Rate
  - Consistency
- Distributor Truck
  - Setup
  - Calibration/Verification
  - Maintenance
- Tacking of Longitudinal Joints
  - Bonding
  - Confinement
- Excessive Tack is Bad
- Thicker/Stiffer Lifts Less Prone to Slippage

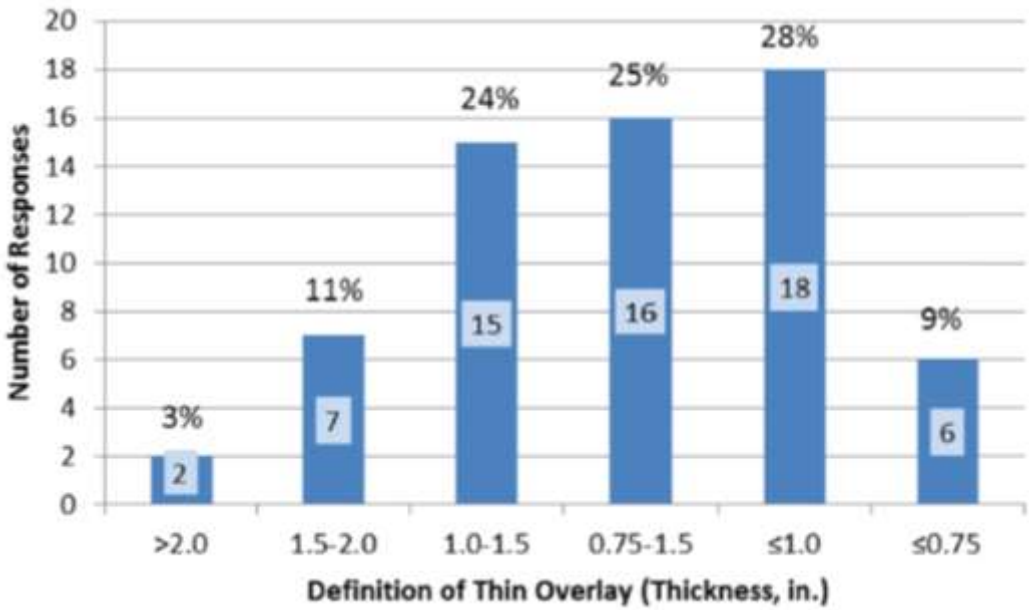
Areas of Known Agreement

- Tack Coat Rate Depends on Surface Condition
  - Fresh
  - Weathered
  - Raveled
  - Milled
- Need for Research
  - Field Performance
  - Field Testing
    - Bond strength
    - Application amount
- Treat Tack as **Separate Pay Item** vs. Incidental Item

Thin Lift Asphalt Overlays

How is “thin lift” asphalt defined?

- Thin Lift Overlays have been defined as surface mixes ranging from ≤ 3/4” to < 2.0” compacted thickness.
- They are not typically intended to strengthen the pavement structure, but instead to address functional problems as part of Pavement Preservation
- Typically dense-graded mixtures, but can be gap-graded or open-graded



State survey responses - **NCHRP Synthesis 464: Thin Asphalt Concrete Overlays**

There is not a nationally-accepted definition of thin lift asphalt. The concept varies from state to state.

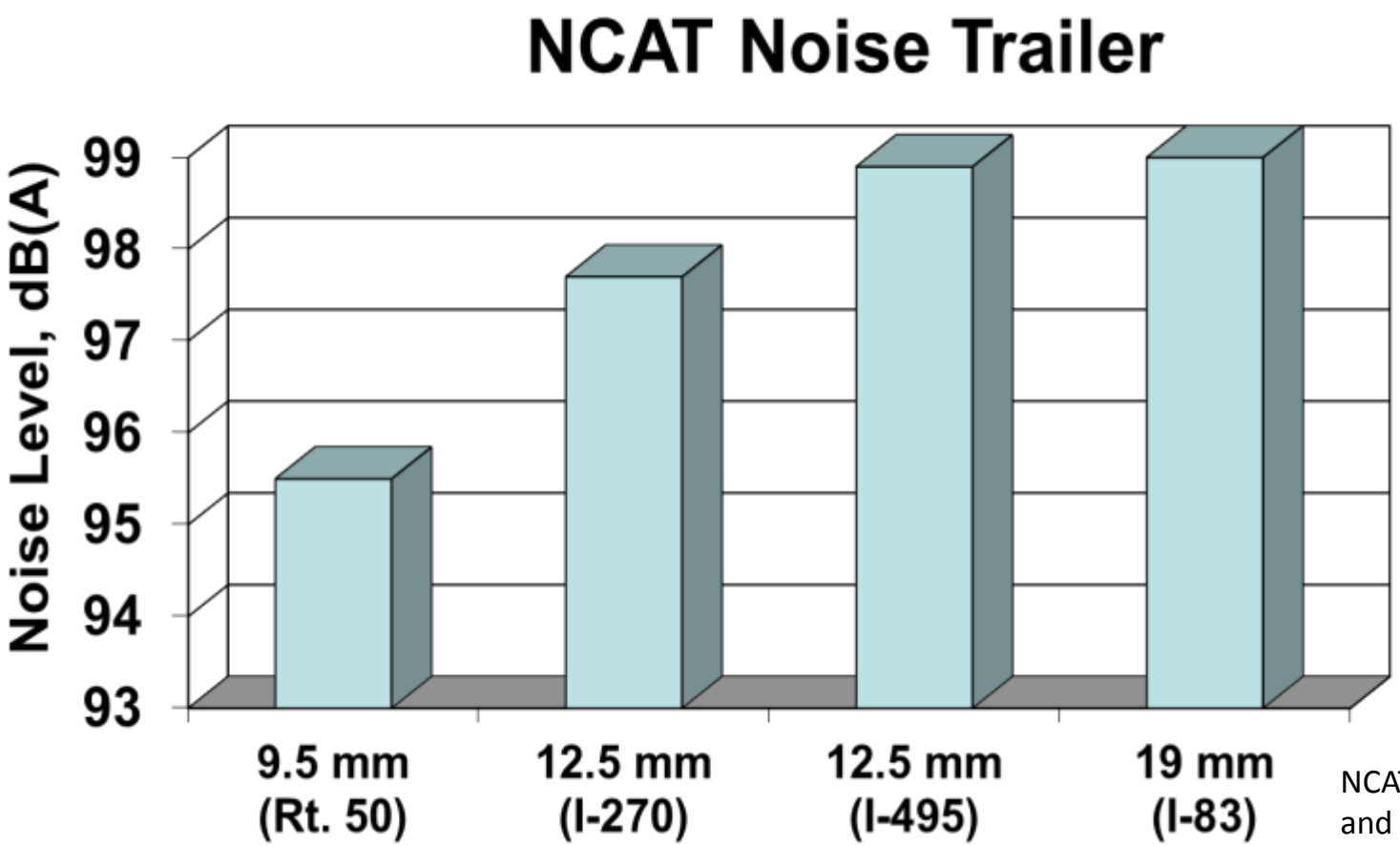
How is “thin lift” asphalt used?

- Some use it as a pavement preservation tool, applying more frequent, thinner overlays in order to prevent a pavement from attaining a significant loss in serviceability.
- Some use thin, dense-graded or gap-graded asphalt lifts for pavement maintenance to seal pavements and restore a smooth riding surface.
- Some use thin open-graded asphalt lifts for safety to reduce potential for hydroplaning, wet-weather spray, and nighttime glare of headlights on wet pavement.

Benefits of Thin Asphalt Overlays

- Long service, low life-cycle cost
- Can handle heavy traffic
- Can be constructed quickly, minimizing traffic delays
- Protects existing pavement
- Seals the surface
- Reduces rate of pavement deterioration
- Corrects surface deficiencies
- Restores skid resistance
- Can be recycled
- Aesthetically pleasing
- Safe
- Quiet
- Smooth
- *Looks and feels new to the traveling public*

Noise Reduction

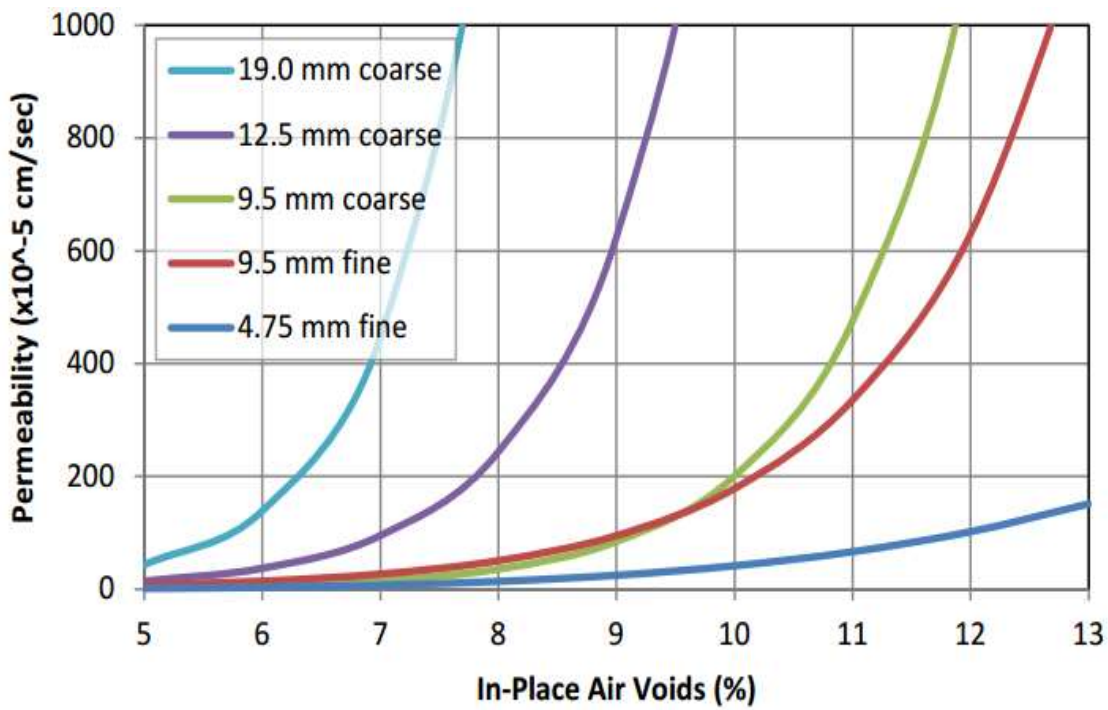


NCAT - Hanson, James and NeSmith 2002

Smaller Aggregate = Less Noise

Impermeability

As the Nominal Maximum Aggregate Size gets smaller, the size of the individual air void spaces decreases. Therefore, at the same percentage of in-place air voids, thin lift asphalt mixes are inherently less permeable.

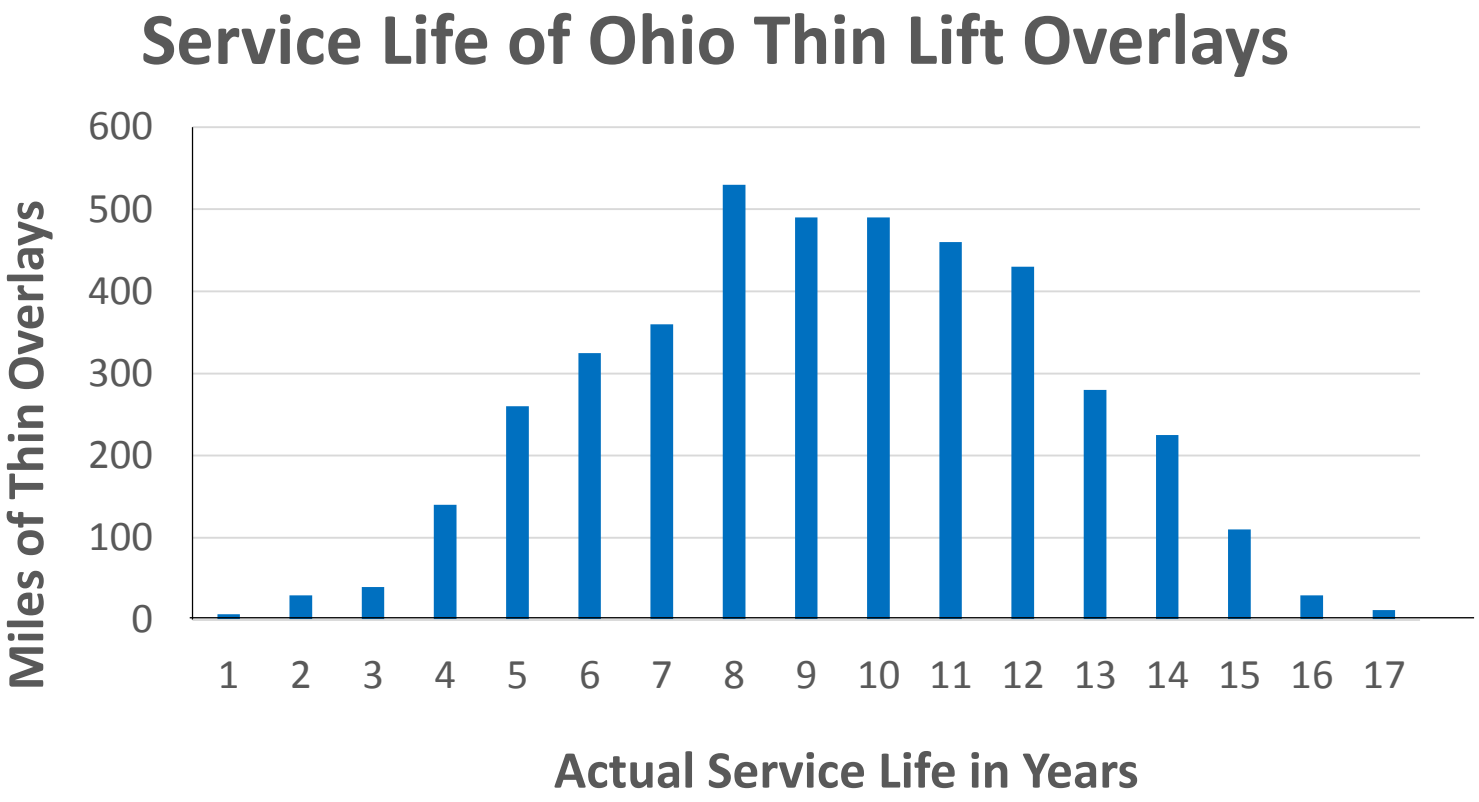


NCAT - Brown and Heitzman 2013

Permeability in a coarse-graded 12.5mm Superpave surface mix in Oklahoma. The allowable gradation band was subsequently fined up as one step in a program to address permeability issues. Roadway density in this area was approximately 93% of G_{mm}.

Service Life of Thin Asphalt Overlays

Total Miles = 4075
No. of Sections = 1923
Mean Service Life = 9.1 yrs
St. Dev. = 3.0 yrs



FHWA/OH-2008/4
Effectiveness of Thin Hot Mix Asphalt Overlay on Pavement Ride and Condition Performance
Chou, Datta, Pulugurta

Project Selection - Thin Asphalt Overlays

The quality of the pavement being overlaid *greatly* influences the expected service life of thin asphalt overlays.

A thin asphalt overlay applied to a pavement which is not structurally sound will have a short service life, no matter what type of material is used or how well it is constructed.

It is critical to select the correct type of project for a thin lift overlay to ensure a long service life!

Project Selection - High Volume Projects?

While thin asphalt overlays are often used for low to moderately trafficked roadways, they can successfully be used on high volume roadways as well.

Maybe not in Alaska - Studded Tire Wear

Asphalt roadways tend to wear from 0.1” to 0.3” per million passes of studded tires. On a high volume roadway, that could wear through a thin asphalt overlay in a year or two, depending on the traffic and number of vehicles with studded tires.

Components of a Basic Evaluation

- **Visual Survey**
- **Structural Assessment**
  - No structural improvement required
- **Drainage Evaluation**
  - What changes are needed
- **Functional Evaluation**
  - Ride quality
  - Skid resistance
- **Discussion with Maintenance Personnel**
- **Utilize pavement management data if available**

At the plant:

- Thin lift mixes are composed of a high percentage of fine aggregate
- Fine aggregate stockpiles have higher moisture contents than coarse aggregate stockpiles
- Attention must be given to the proper drying of all aggregates, which may mean slowing down
- Moist aggregates contribute to stripping and also tenderness issues with mixes

On the project:

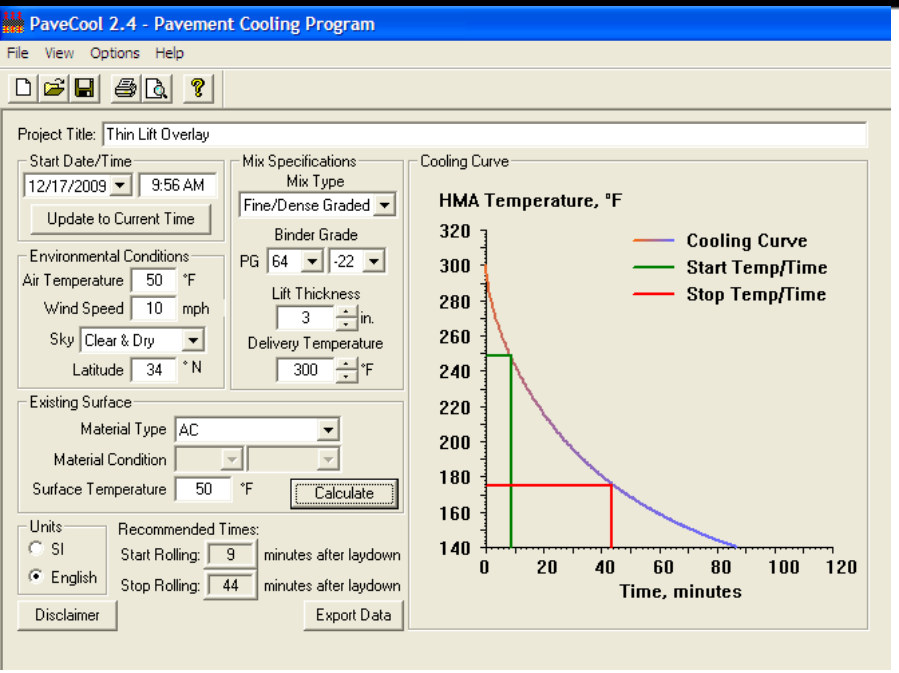
- Because the overlay is thin, the interface between the old and new pavement is in close proximity to the shear forces created by vehicles during turning and braking movements.
- Therefore, the tack coat between the old surface and the new overlay is especially important

On the project:

- Realize that when paving thin lifts, each ton goes a long way and the paver can get down the road very quickly
- Don't allow the paver to leave the rollers behind
- Thin lifts cool very rapidly and need to be compacted more quickly than thicker lifts

Hello-o-o-o-o back there!

Time Available for Compaction

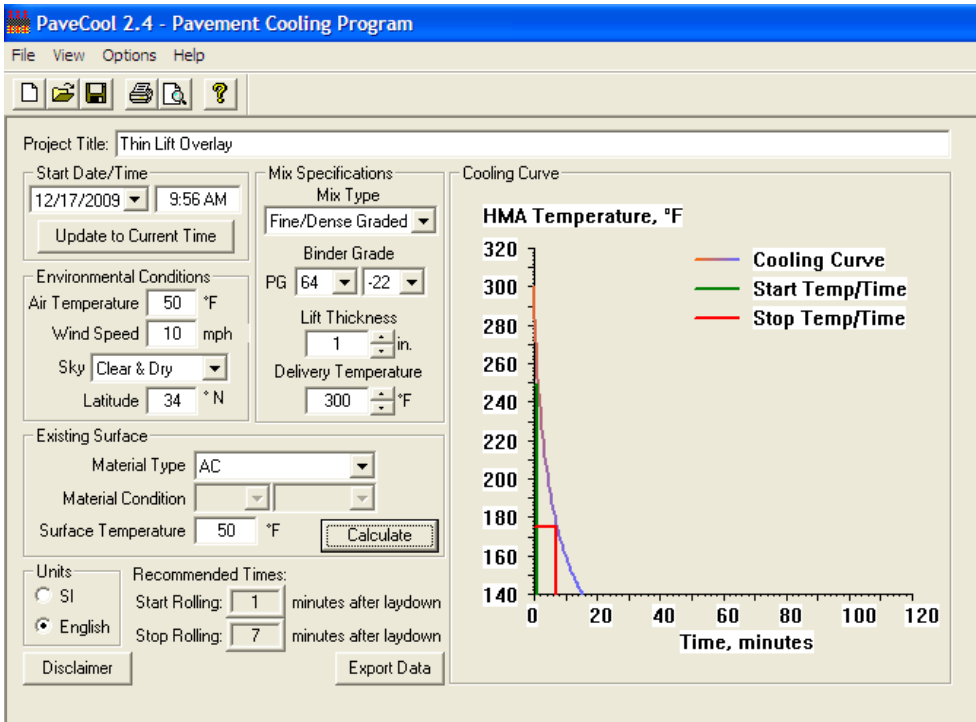


3 Inch Lift

50°F Air, Surface Temp

Mix Delivery temp - 300°F

44 minutes to complete compaction operations



1 Inch Lift

50°F Air, Surface Temp

Mix Delivery temp - 300°F

7 minutes to complete compaction operations

At the plant:

- There is a temptation to run the plant much hotter because of the faster heat loss of HMA placed in thin lifts
- This will volatilize the light fractions of the binder much more quickly and prematurely age the mix

On the project:

- Rolling strategies depend on the type of thin lift
- For Superpave and SMA, you *may* be able to use a vibratory roller - check for roughness, broken aggregate
- Otherwise, use static rollers. (may be able to use pneumatic on Superpave)

On the project:

- For PFCs and OGFCs, use only static rollers, and one or two passes to seat the mix onto the existing surface. The mix is intended to be permeable, so don't overcompact.
- Don't use pneumatic rollers because they pick up badly on OGFC and SMA mixes

Determining roadway density on thin lifts:

- Cannot get accurate, repeatable results from thin roadway cores
- If the thickness is at least 1”, thin lift nuclear gauges or electromagnetic gauges could be used
- Roller patterns are often set and documented as sole source of QC/QA

Questions?