ASPHALT INSTITUTE®

Tack Coat Best Practices

FHWA Cooperative Agreement Subtask

Tack? Who needs Tack?

Or Rollers?

OK – here's a little tack for you!

OK, OK, we'll use the distributor

OK, OK, we'll use the spray bar

You want tack – we'll give you tack

Tack Coat Best Practices Outline

- Terminology
- Purpose of Tack Coats
- Consequences of Poor Bond
- Relative Cost for Tack Coat
- Tack Coat Difficulties
  - Contractor
  - Agency
- Materials
  - Traditional
  - New Materials
  - Selection

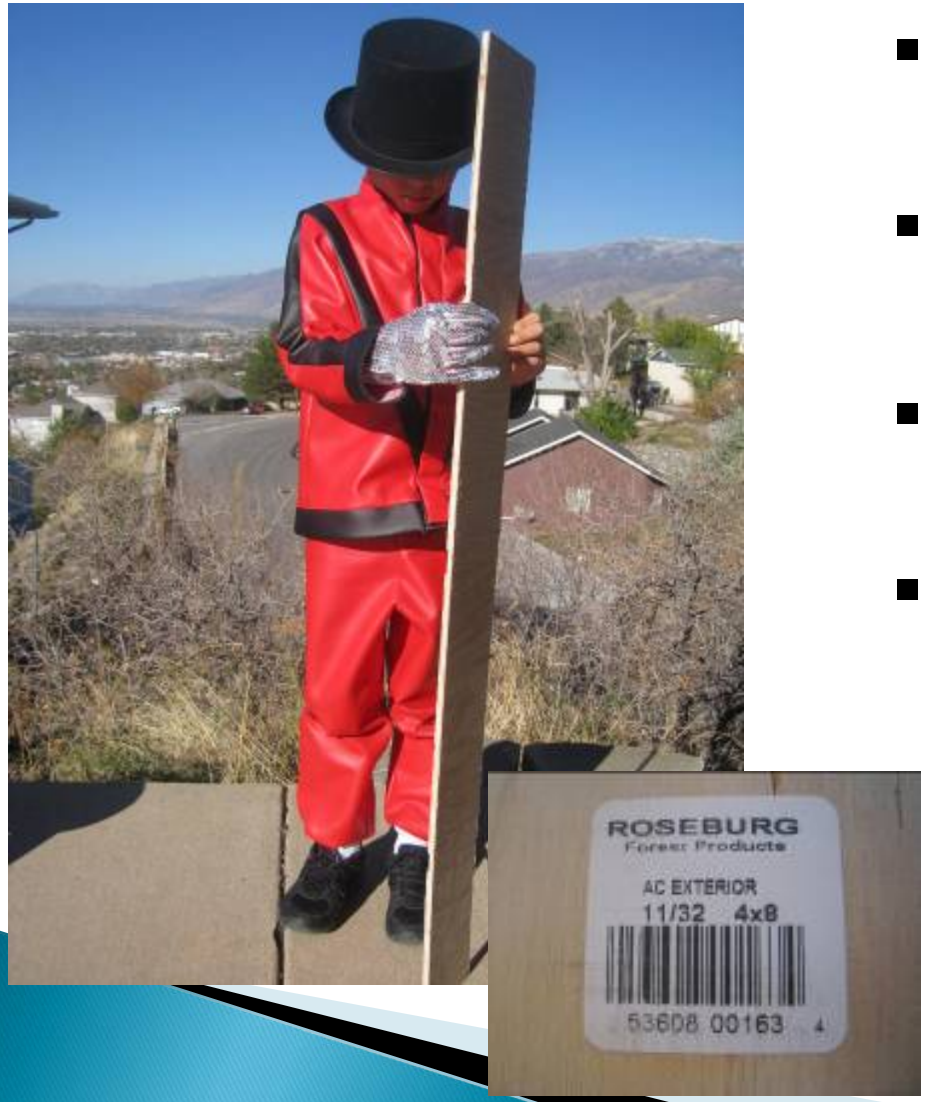
Tack Coat Best Practices Outline

- Handling and Storage of Tack
- Tack Coat Field Operations
  - Manuals of Practice
  - Research / Bond Strength Testing
  - Best Practices
    - Surface Preparation
    - Truck Setup
- Tack Coat Application Calculations
- Spray Pavers
- Review and Summary
  - Common Tack Coat Questions
  - Areas of Known Agreement

Purpose of Tack Coats

- **To promote the bond between old and new pavement layers.**
  - To prevent slippage between pavement layers.
  - Vital for structural performance of the pavement.
  - All layers working together.
  - To be applied along all transverse and longitudinal vertical surfaces.

Bonded Demonstration



- Mini Michael Jackson- ~60 lbs
- 11 sheets of plywood:
  48” x 8” x 11/32” each
- Measure deflection over 36” span
- Compare effect of full-slip versus fully bonded plywood sheets

I am redoing this demonstration as the hand placements on the next slide are a potential problem. Dave

Courtesy of Wayne Felix

Bonded Demonstration

21 Fold Difference

Consequences of Poor Bonding

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

Direction of traffic?

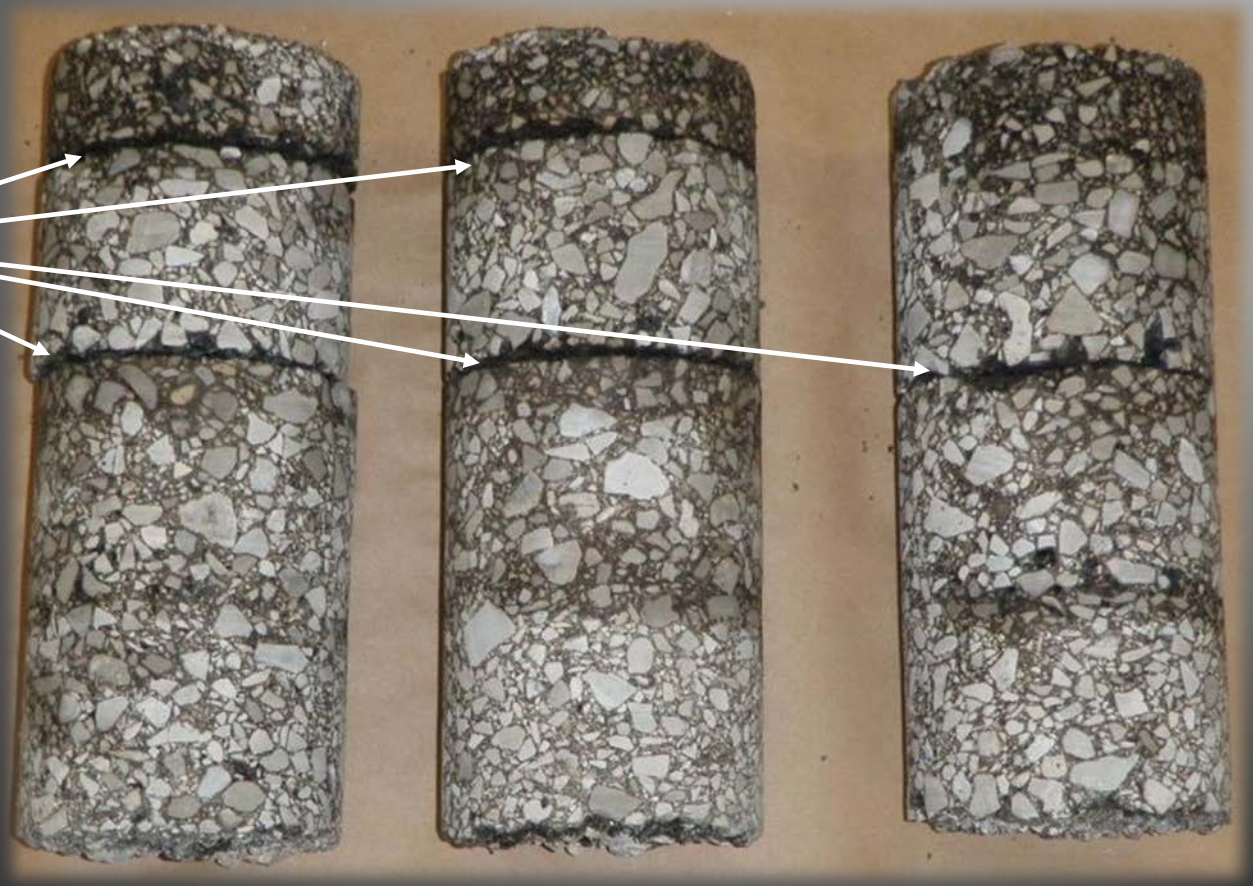
Loss of Fatigue Life Examples

- 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

8 – 10 years (est.) Interstate Pavement

Cores Showing Debonding

Bonding Failures



Forensic Investigations of Debonding at the NCAT Test Track

AUBURN UNIVERSITY

SAMUEL GINN COLLEGE OF ENGINEERING

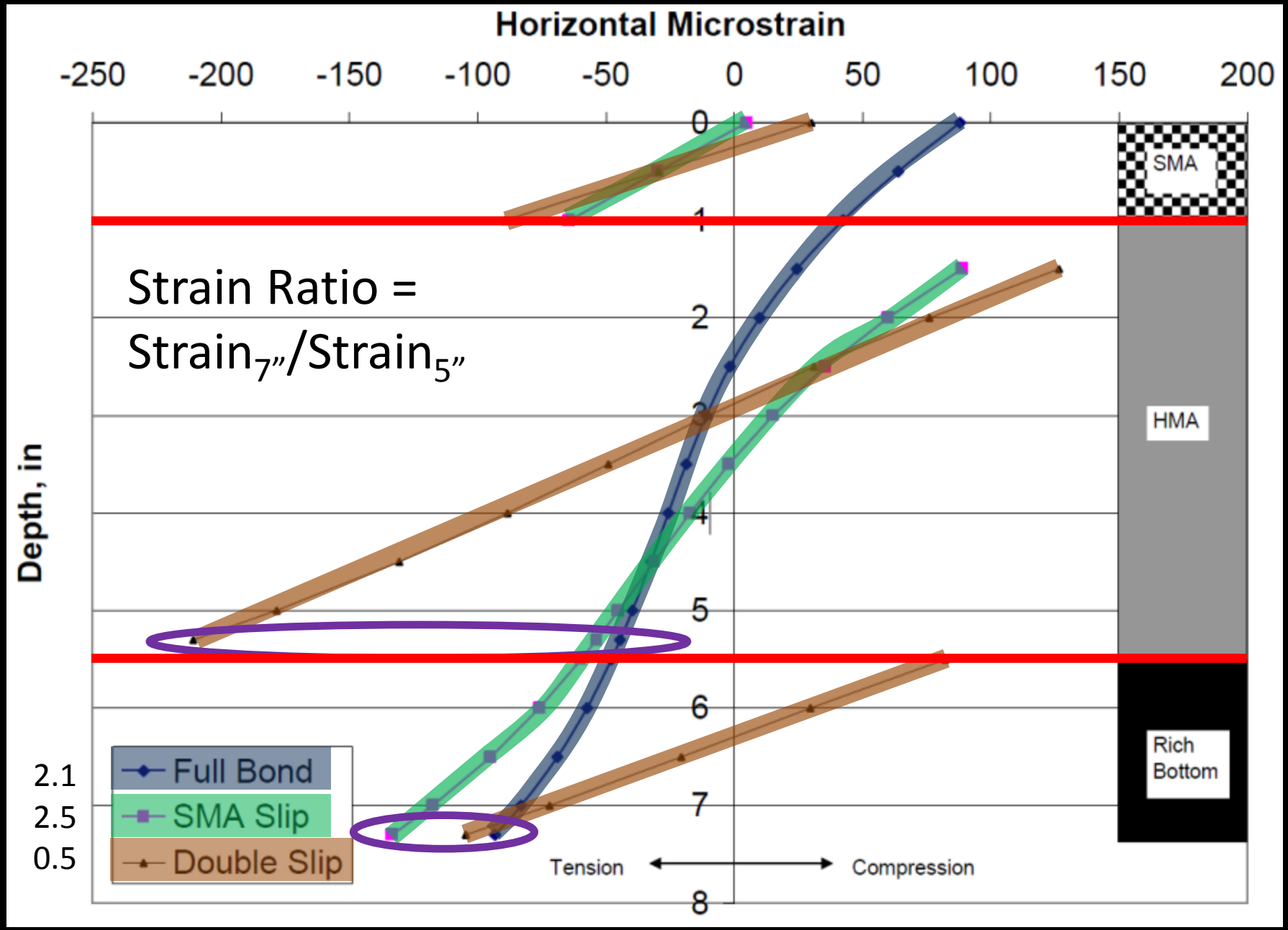
Dr. David Timm

National Center for Asphalt Technology NCAT at Auburn University

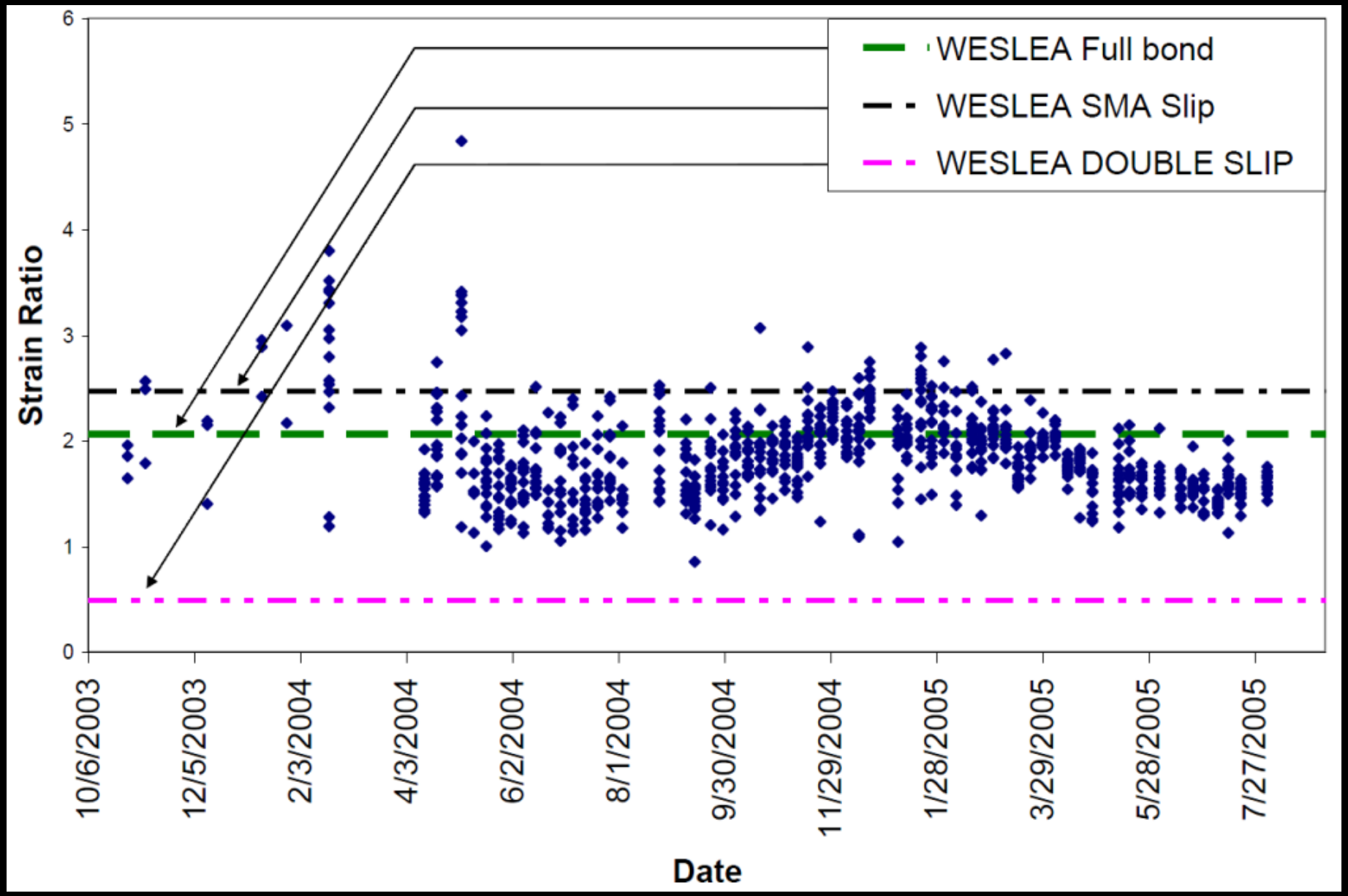
N7 vs N8

N8 - Trench

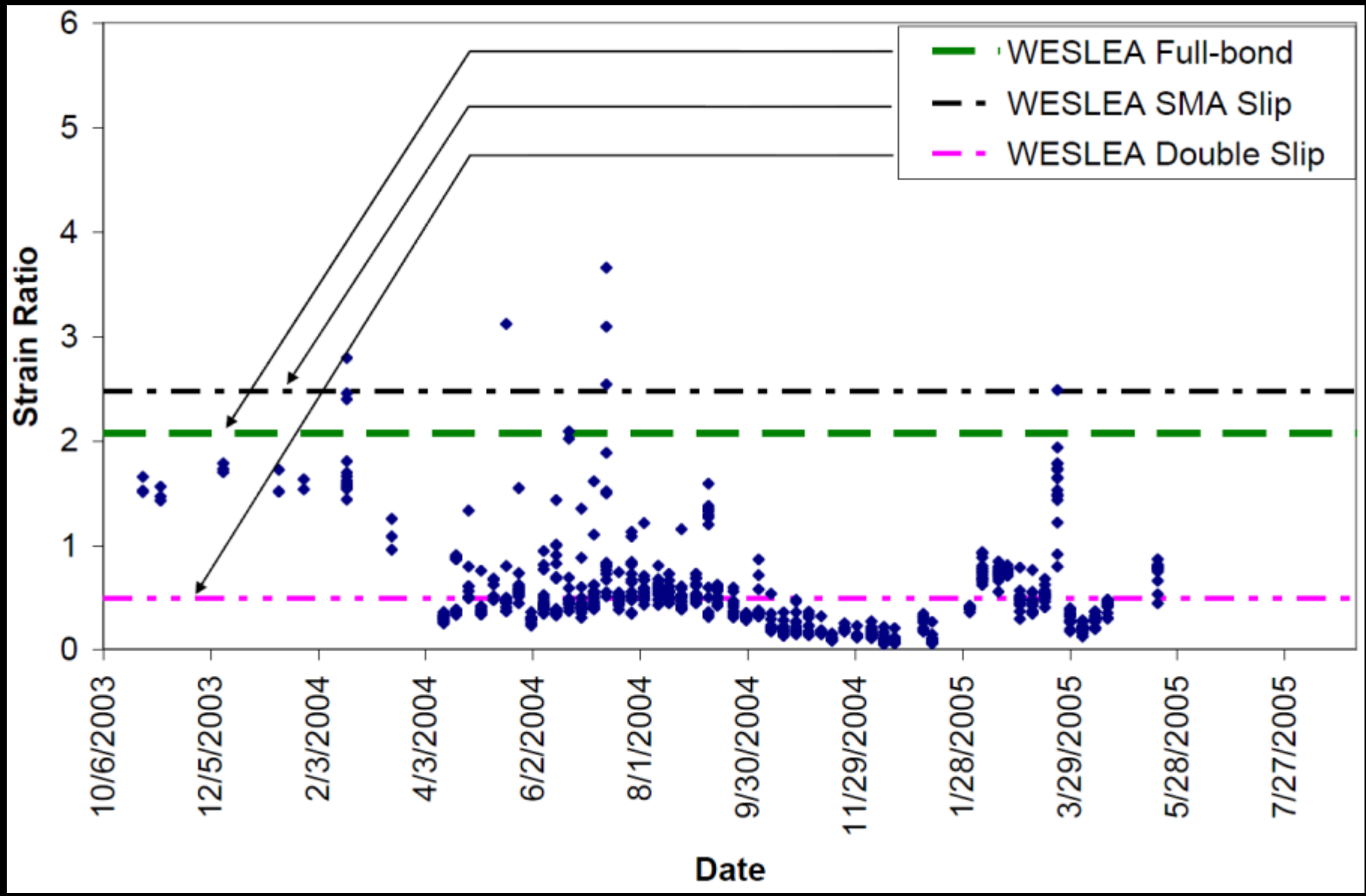
Strain Investigation



Measured Strain vs Theoretical – N7



Measured Strain vs Theoretical – N8



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

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

Standard Emulsion Specifications

- Anionic Emulsion Specifications
  - AASHTO M 140-8
  - ASTM D 977-05

Pen Values 100-200 +				Pen Values 40 - 90	
RS-1	RS-2	HFRS-2		MS-2h	HFMS-2h
MS-1	MS-2	HFMS-1		SS-1h	QS-1h
HFMS-1	HFMS-2	HFMS-2S			
SS-1					

Standard Emulsion Specifications

- Cationic Emulsion Specifications
  - AASHTO M 208-01
  - ASTM D 2397-02

Pen 100-250		Pen 40-90
CRS-1		CMS-1h
CRS-2		CSS-1h
CMS-2		CQS-1h
CSS-1		

Concern Over Proprietary Products

- Promote competition…
- But, innovative products that could perform better than traditional options
- 23 CFR 635.411
- FHWA Guidance:
  - State DOT may specify proprietary products
  - State DOT certifies that there is no suitable alternative product or that the product is needed for synchronization.
  - FHWA must approve through a public interest finding.

Reduced Tracking Materials

- TRACKLESS™ (NTSS-1HM)
  - Blacklidge Emulsions Product
  - Patented Product
  - Anionic Emulsion
  - 0-20 Pen Base Asphalt
- CAT-TAC (CNTT)
  - Hunt Refining Company Product
  - Patent Pending
  - Cationic Emulsion
  - 45-90 Pen Base Asphalt

17 States Known to Allow Reduced Tracking Tack Materials

- Alabama
- Florida
- Georgia
- Illinois
- Louisiana
- Maryland
- Mississippi
- Pennsylvania
- New York
- North Carolina
- Ohio
- Oklahoma
- South Carolina
- Tennessee
- Virginia
- West Virginia
- Texas

Handling of Emulsions

- Do NOT mix anionic and cationic emulsions.
- Vertical tanks preferred—skin formation.
- Protect from freezing.
- Avoid overheating—typically <180°F.
- Minimal low-shear pumping.

Asphalt Institute Burn Information

KEEP COOL

DO NOT PANIC OR DELAY

ON-SCENE FIRST AID FOR ASPHALT BURNS

- Immediately address any Airway, Breathing or Circulation concerns and START COOLING with water
- Do NOT try to remove asphalt from skin
- Quickly place affected area under running/flowing water (ice or cold packs may be used in the event water is unavailable)
- Leave the asphalt burn area uncovered
- Notify others
- CALL FOR HELP!

Storage Options

- Tank—long-term storage
- Tanker—short-term storage
- Distributor Truck—short-term storage

Tack Coat
Field Operations

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
  - Tort Claims
  - Pulling Up of Pavement

Manuals of Practice

- Asphalt Institute
  - MS-4 *The Asphalt Manual, 7th Edition* (2007)
  - MS-16 *Asphalt Pavement Preservation and Maintenance, 4th Edition* (2009)
  - MS-19 *Basic Asphalt Emulsion Manual, 4th Edition* (2008)
  - MS-22 *Construction of Hot Mix Asphalt Pavements, 2nd Edition*
- Comments
  - AI has a long history of promoting the proper use of tack coats.

Current Research

- SHRP II
- Colorado
- Illinois
- Louisiana
- NCAT
- Texas
- Wisconsin
- International

NCHRP Report 712

- Looked at numerous test methods (shear, tension, torsion)
- Many tack materials
- Four application rates (gsy residual)
  - 0.00
  - 0.031
  - 0.062
  - 0.155
- International survey
- Variety of surfaces both AC and PCC
  - New
  - Old
  - Milled
  - Unmilled
  - Dry
  - Wet
  - Clean
  - Dirty
- Eight test temps.
  - -10—60°C

Testing Methods

- Materials
  - Emulsion
  - Paving grade asphalt
- Field/Laboratory Bond Testing
  - Shear Testing
  - Torsion Testing
  - Pull-Off Testing (tension)
  - Cyclic

Comments on Testing Options

- Shear Testing
  - Lab test
  - Quick
  - Repeatable
  - Most widely promoted
  - Uses common lab equipment
  - Cleanly ranks materials
- Torsional Testing
  - Lab or field test
  - Quick
  - Poorer repeatability (manually ran)
- Tension Testing
  - Lab or field test
  - Quick
  - Repeatable
  - Cleanly ranks materials
  - Used in Texas and Kansas
- Cyclic Testing
  - Lab test
  - More time consuming
  - Repeatable
  - Cleanly ranks materials

Best Practices for getting the material on the road!

Distributor Truck Setup

Distributor Truck Setup

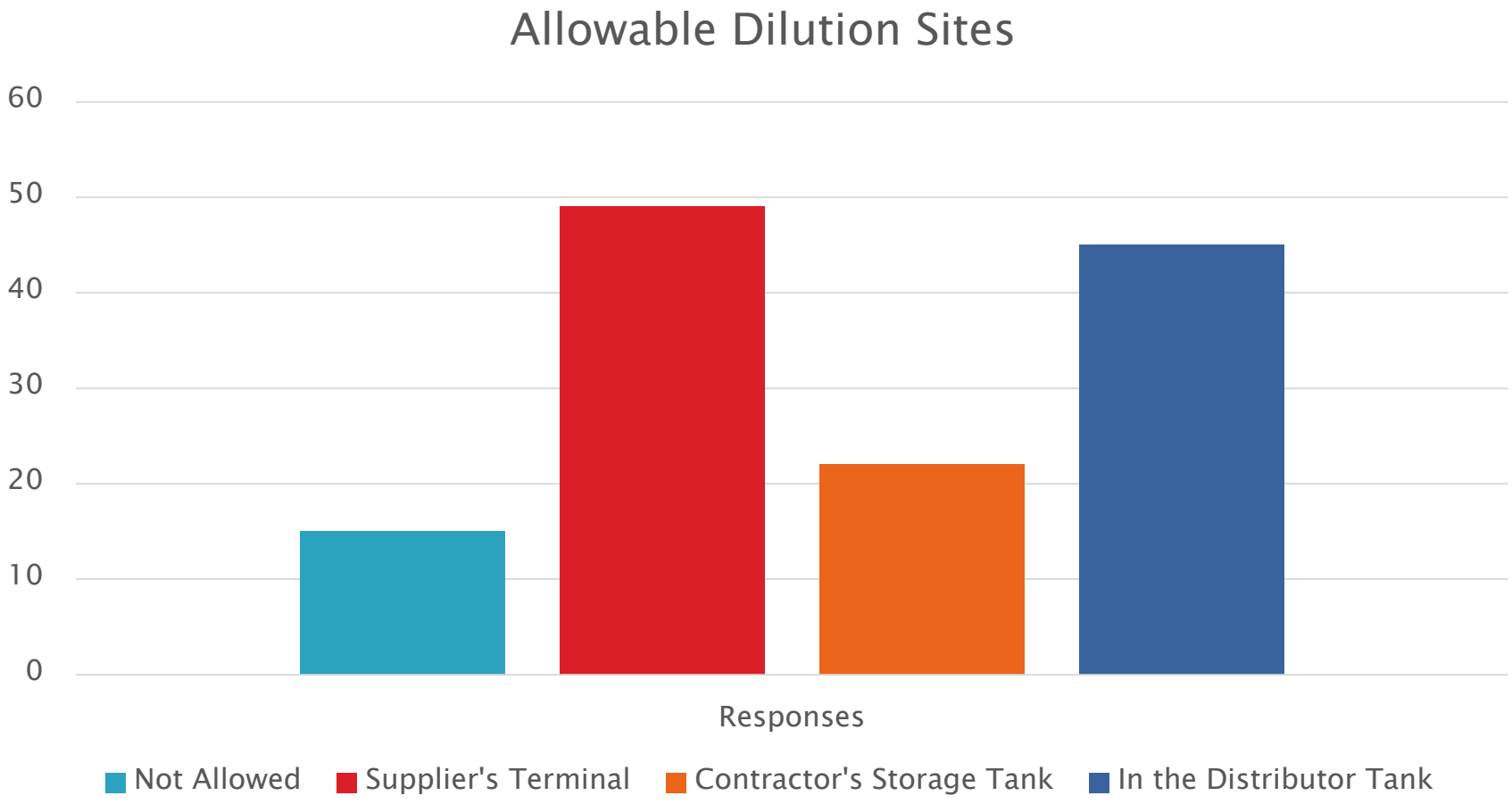
- Liquid temperature
  - Monitor and Match to material
- Calibrate distributor truck
  - Spray bar height
  - Spray bar pressure
  - Nozzle angle
  - Nozzle selection
  - Thermometers
  - Volumeter

Tack Coat Application

Application Calculations

- Student Exercises

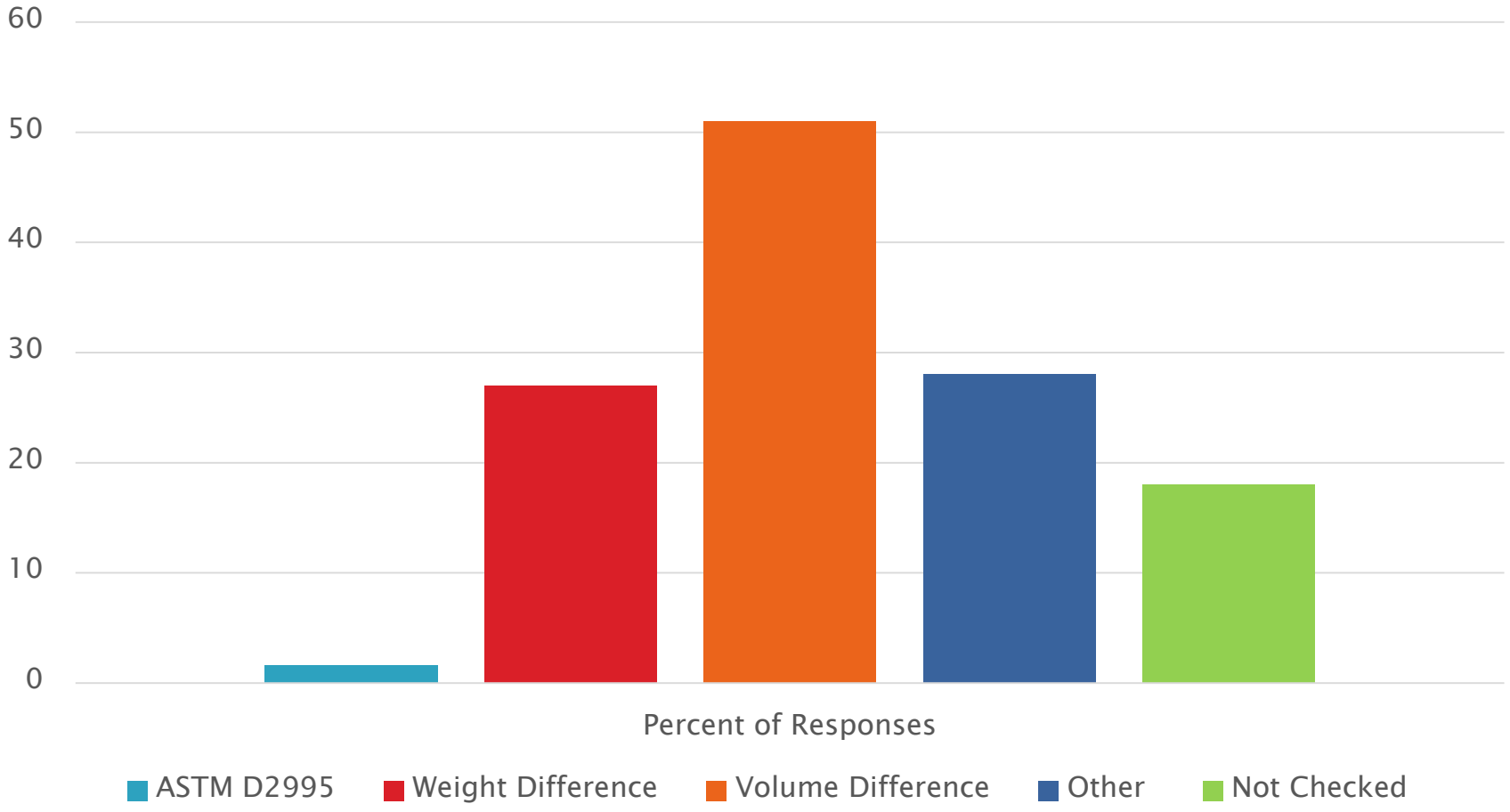
Dilution Allowance Information (NCHRP Report 712)



Calculating field application rates

- There are three primary methods of determining field application rates.
  - Determination by volume.
  - Determination by weight or mass.
  - Determination by direct measurement, ASTM D2995
- We will first look at determination by volume.

Application Verification (NCHRP Report 712)



Calculating rates by Volume

- The rate of material applied is calculated by determining the volume of material distributed. Either by:
  - Using a tank stick method where the depth of material is measured in the tank and the volume is calculated or by the use of a pre-calibrated stick.
  - Or, by observation and recordation of an onboard volume meter or gauge.

Dipstick Method

- Measure Asphalt Volume in Truck
- Record Asphalt Temperature
- Spray Tack Coat Over Known Area
- Measure Asphalt Volume in Truck
- Correct Volume for Temperature Variation from 60°F

Dipstick Equation:

$$\frac{9 \times Gallons\ Applied}{Width \times Length}$$

Note: 9 to convert from square feet to square yards. Use as required.

Calculating rates by Volume

- When using a tank volume method for determining the quantity of material distributed, the temperature must be determined and the volume of material corrected to 60°F.

- Lets work an

Example Problem

Calculating rates by Weight (Mass)

- Calculating an application rate by weight is the most accurate method.
- Bill of lading from the supplier should contain a 60°F wt. per gallon.
- Weight measurements are not affected by temperature.
- However constant weighing after each shot can be complicated.
- Recommend using this method for full load applications, calibration, etc.

Direct Measurement using ASTM D2995

- Field Measurement of Application Rate
  - Longitudinally
  - Transversely
  - Units of Gallons/Yard^2 (Liters/Meter^2)

Photos courtesy of
Dr. Louay Mohamad

Direct Measurement using ASTM D2995

- Method A—Weighing Pads
  - Pre-weigh pads
  - Secure pads to surface
  - Apply tack coat
  - Reweigh pads
  - Calculate application rate

Direct Measurement using ASTM D2995

- Method B—Volume-Based Calculations
  - Spray tack coat into containers for a set time period
  - Determine volume collected for each nozzle
  - Calculate transverse uniformity
  - Calculate longitudinal rate incorporating truck's velocity

Photo courtesy of TxDOT, Maintenance Division

Inconsistent Application

Location	Application Rate	Residual Rate
Left Wheel Path	0.075	0.051
Center of Lane	0.047	0.032

Photo courtesy of MODOT

Critical elements in determining application rates

- Dilution rates are critical in determining final application rates.
- Temperature is important in determining accurate volumetric calculated rates.
  - Higher than 60°F, need to spray more emulsion.
  - Lower than 60°F, need to spray less emulsion.
- Uniform application spreads in distributing tack on the surface of the road.
- Samples of emulsion from the spray bar are only good for estimating dilution rates and residual binder properties.

Tracking and Pickup

Pictures courtesy of Road Science™

Spray Pavers

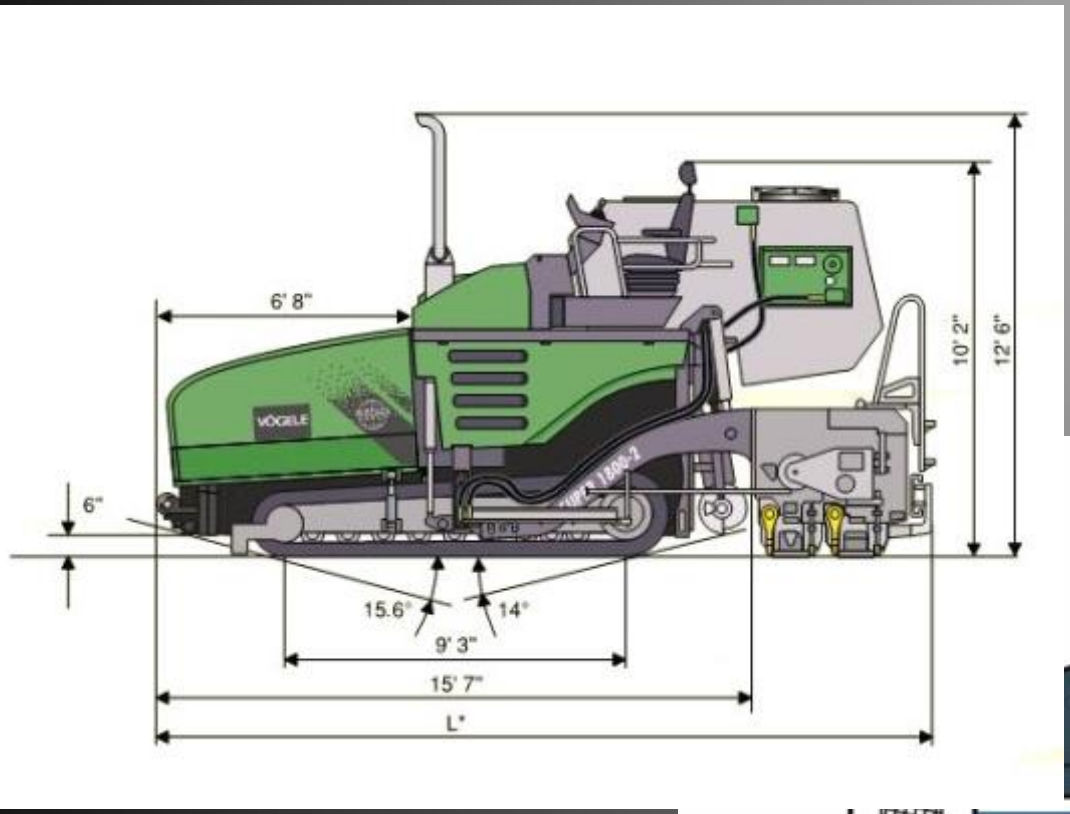
Spray Pavers/Bonded Overlays

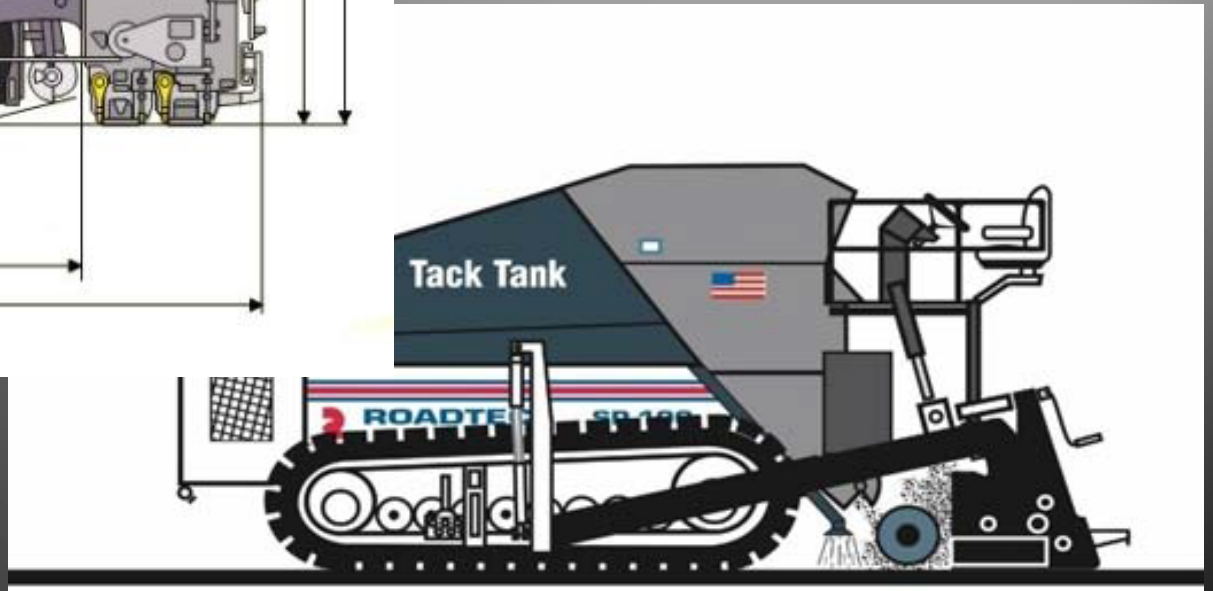
- Spray Paver-Single Pass Paving and Sealing
  - Hot mix asphalt overlay
  - Polymer modified emulsion tack
  - Placed with spray paver
    - Paver & Distributor
  - High Application Rates
    - 0.08-0.20 gsy residual
- Examples
  - BondTekk®—bonded overlay
  - Novachip®—thin bonded overlay

Spray Pavers/Bonded Overlays

- Vögele: Spray Jet attachment
- Roadtec: SP 200 Spray Paver
- Limited Number of States Specifying
- Europe
- Specialty Emulsion-Using a Standard Distributor
  - UltraFuse Bond Coat

Spray Paver Illustrations





ROADTEC STEALTH PAVER WITH TACK TANK

Purported Spray Paver Benefits

- No tracking of the tack
- Better bonding of overlays
  - Increased Overlay life
  - Reduce Rutting
  - Reduce Cracking
- Improved joint compaction
- Easier compaction

Review and Summary

Common Tack Coat Questions

- **Experts commonly disagree**
- "Do I still need to tack…"
  - Milled Surface
  - "Fresh" Pavement
  - Late season/cooler days
- Asphalt Institute recommends tacking all surfaces

Common Tack Coat Questions

- "When can I pave on the emulsion?"
  - Has it Broke?
  - Does it need to be Set?
  - Fresh—spray pavers
- Asphalt Institute recommends paving begin after the emulsion has broke.
- Spray pavers are an engineered system that are designed to perform without emulsion break.

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.

Areas of Known Agreement

- Layer Bonding is Vital
- Surface Preparation
  - Clean
  - Dry
- Millings 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


ASPHALT INSTITUTE®
Questions?