The National Academies of
SCIENCES · ENGINEERING · MEDICINE

TRANSPORTATION RESEARCH BOARD

Chip Seals, Microsurfacing, and Fog Seals Specifications

September 14, 2021

@NASEMTRB
#TRBwebinar

PDH Certification Information:

- 2.0 Professional Development Hour (PDH) – see follow-up email for instructions
- You must attend the entire webinar to be eligible to receive PDH credits
- Questions? Contact TRBWebinars@nas.edu

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Providers Program. Credit earned on completion of this program will be reported to RCEP. A certificate of completion will be issued to participants that have registered and attended the entire session. As such, it does not include content that may be deemed or construed to be an approval or endorsement by RCEP.

RCEP

REGISTERED CONTINUING EDUCATION PROGRAM

#TRBwebinar

Learning Objectives

1. Identify factors important to the construction of chip seals, microsurfacing, and fog seals
2. Discuss recent advancement in the construction of these elements
3. Discuss gaps and experiences in the construction of these elements

#TRBwebinar

Overview of TRB Webinar

BY DINGXIN CHENG

CALIFORNIA PAVEMENT PRESERVATION CENTER, CSU, CHICO

SPONSORED BY TRB AKT 20 PAVEMENT PRESERVATION COMMITTEE

Introduction of Presenters

- Dr. Scott Shuler – Shulerconsultants
- Dr. Gary Hicks – R. Gary Hicks, LLC
- Mr. Jim Moulthrop – FP^2, Fugro
- Mr. John Fox – California Department of Transportation (Caltrans)

NCHRP Project 14-37 and Agency's Perspective

- 49 States with Emulsion Chip Seal Specifications
- 10 States with Hot Chip Seal specifications
- 24 States with Microsurfacing Specifications
- This is the national standard construction guide specs. Each one includes
  - Description
  - Material
  - Construction
  - Measurement
  - Payment
  - Standalone QA Guide

Implementation Project

NCHRP 20-44 (26) - Implementing Guide Specifications for the Construction of Chip Seals, Micro Surfacing, and Fog Seals.

Goal: Adoption of AASHTO Guide Specifications for Construction of Chip Seals, Micro Surfacing, and Fog Seals by all state DOTs.

Project Tasks:

1. Information Dissemination
2. Outreach
3. Training
4. Demonstrations

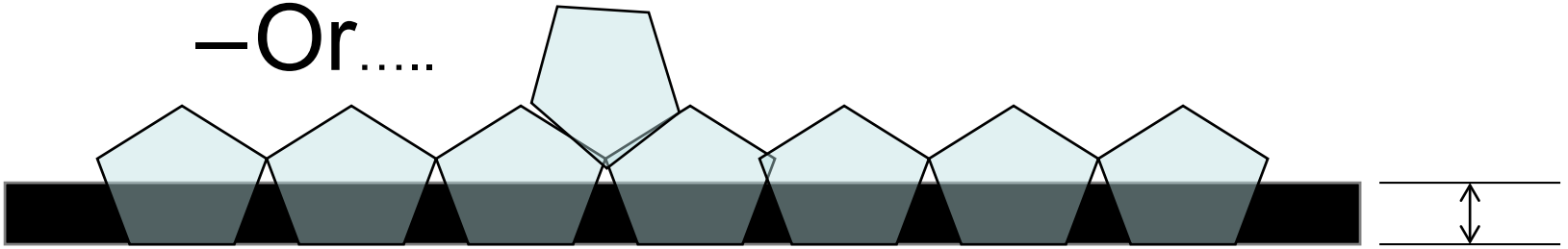
Design

- Chip Quantity
- Emulsion Quantity
- Substrate Condition

Chip and Emulsion Quantity

- Spread Rate
  - One Stone Thick

–Or…..



About 40%

Getting it One Stone Thick

- Do ‘Board Test’
  - Spread Chips One Stone Thick on 1 sy Board
  - Weigh it

Emulsion

- Spray Rate
  - Embed Chips about 30-50% Initially
  - Traffic Embeds to 75-90%

Spray Rate in gsy

%embedment x avg mat depth
x {1- (W / 62.4 G)}
x T + V

– Where
  - W = Loose Unit Weight of Aggregate, pcf
  - G = Bulk Specific Gravity of Aggregate
  - T = Traffic Correction
  - V = Surface Condition Correction

Substrate Condition

- Ball Penetration Test


OFF
ON
ZERO
inch/mm
TITAN
STAINLESS HARDENED

Surface Texture

Equipment Setup

First:
Take It’s Temp

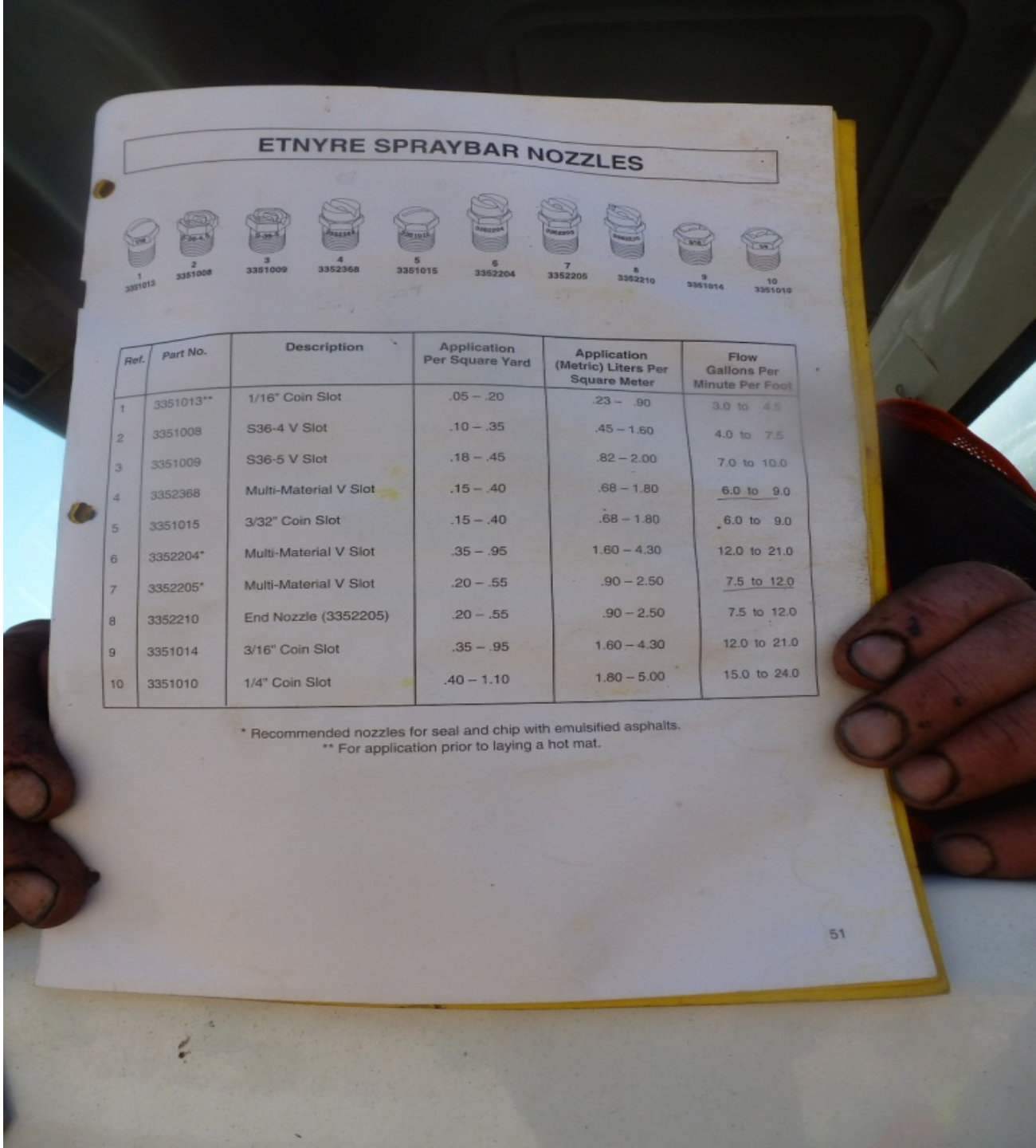
What's the Temperature?

Second:
Measure Viscosity

20 to 70 seconds at 85 to 150F for a 6 mm orifice
or
10 to 60 seconds at 85 to 140F for a 7.5 mm orifice

Third:
What's the Nozzle Size?

The Right Nozzle for the Job



ETNYRE SPRAYBAR NOZZLES

Ref.	Part No.	Description	Application Per Square Yard	Application (Metric) Liters Per Square Meter	Flow Gallons Per Minute Per Foot
1	3351013**	1/16" Coin Slot	.05 – .20	.23 – .90	3.0 to 4.5
2	3351008	S36-4 V Slot	.10 – .35	.45 – 1.60	4.0 to 7.5
3	3351009	S36-5 V Slot	.18 – .45	.82 – 2.00	7.0 to 10.0
4	3352368	Multi-Material V Slot	.15 – .40	.68 – 1.80	6.0 to 9.0
5	3351015	3/32" Coin Slot	.15 – .40	.68 – 1.80	6.0 to 9.0
6	3352204*	Multi-Material V Slot	.35 – .95	1.60 – 4.30	12.0 to 21.0
7	3352205*	Multi-Material V Slot	.20 – .55	.90 – 2.50	7.5 to 12.0
8	3352210	End Nozzle (3352205)	.20 – .55	.90 – 2.50	7.5 to 12.0
9	3351014	3/16" Coin Slot	.35 – .95	1.60 – 4.30	12.0 to 21.0
10	3351010	1/4" Coin Slot	.40 – 1.10	1.80 – 5.00	15.0 to 24.0

* Recommended nozzles for seal and chip with emulsified asphalts.
** For application prior to laying a hot mat.

ROSCO SPRAY NOZZLE GUIDE

NOZZLE SIZE	PART NO.	FLOW RATE GPM MAX	APPLICATION RATE GAL PER SQ YD
No. 00	35565	1.2	.03 - .08
No. 0	32917	3.0	.05 - .20
No. 1	32918	4.0	.10 - .30
No. 2	32919	8.5	.25 - .55
No. 3	32920	13.5	.35 - 1.0

CORRECT NOZZLE DEPENDS ON APPLICATION RATE, TRUCK SPEED AND TYPE OF MATERIAL BEING SPRAYED.

- EXCEEDING NOZZLE MAX FLOW RATE MAY CAUSE FOGGING.
- EXCEEDING 400 FPM TRUCK SPEED AT MAX APPLICATION RATE FOR NOZZLE WILL EXCEED MAX FLOW RATE.
- USING NOZZLE TOO LARGE WILL CAUSE POOR SPRAY PATTERN.

36986

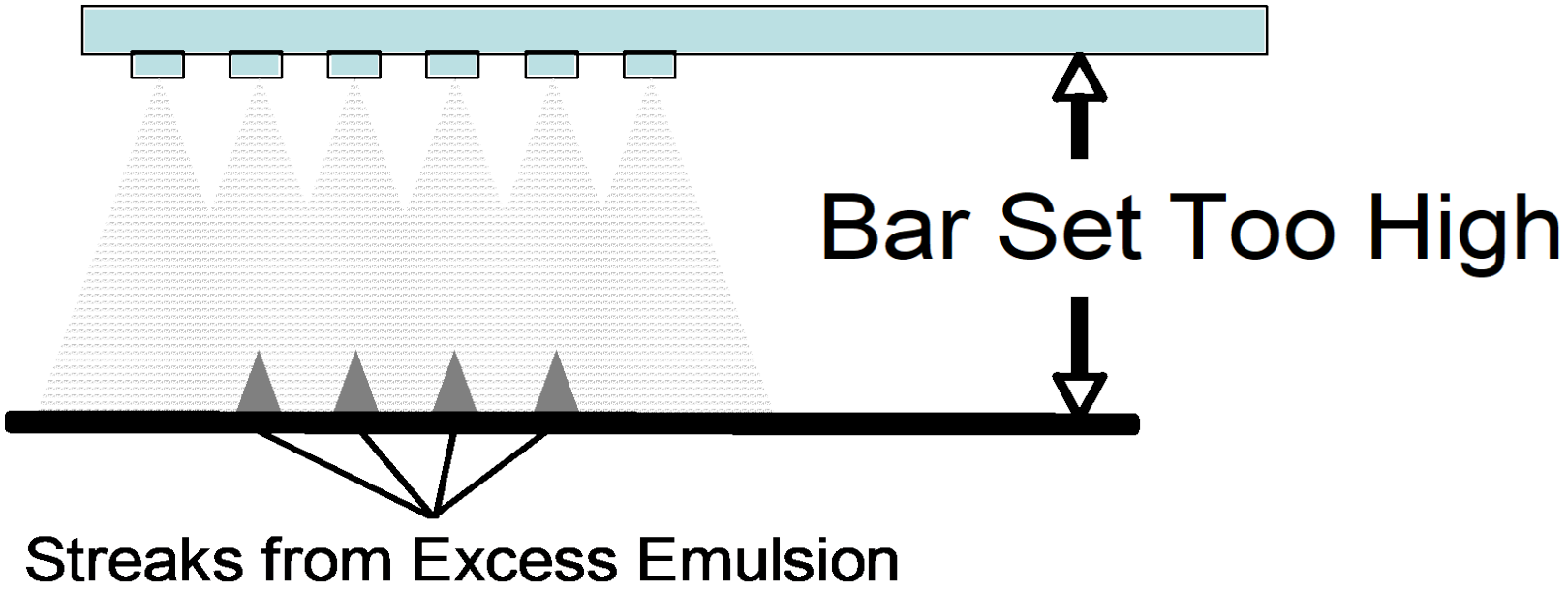

95
15

Fourth:
Where Do They Go?

15 to 30 degrees

Fifth:
How High The Bar?

This is Too High


Bar Set Too High
Streaks from Excess Emulsion

This is the Result

Sixth:
Are We Spraying the Correct Rate?

Use the Gauge?

NO !

Use the Dip Stick

Seventh
Is the Spreader Calibrated?


How Even is the Veil ?

Measure the Distance and Width to Get Rid of Two or Three Truckloads

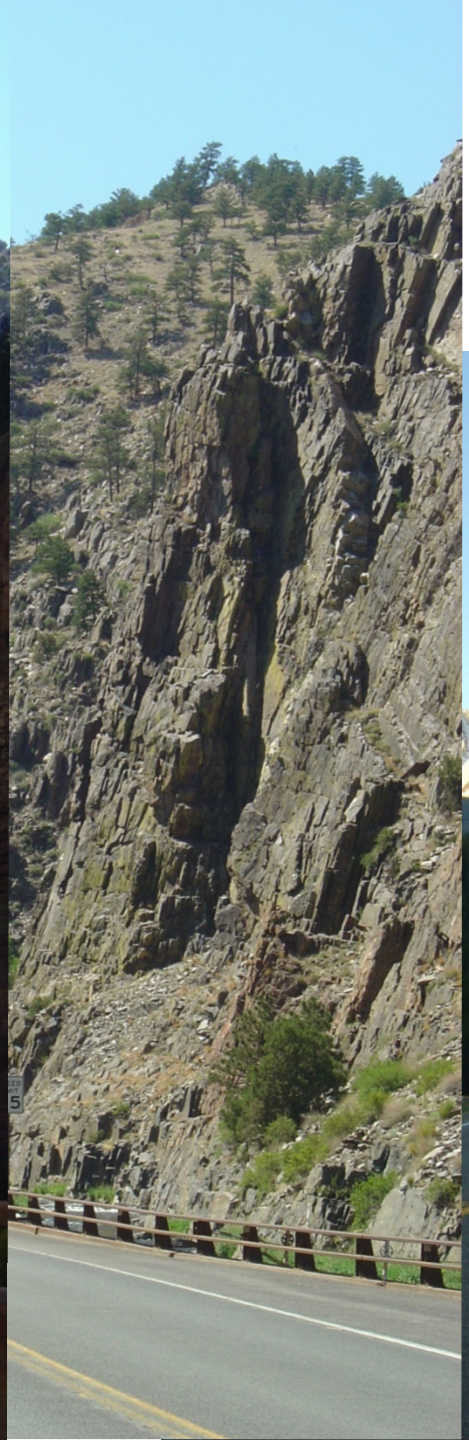
This is Your Chip Spread Rate

Eighth
How Many Rollers?

- Rubber-Tire
  - 3 mph, Max (fast walk)
  - Equal Tires
  - Equal Tire Pressure
- Enough for 1 Coverage Before Gelling

Ninth: When to Sweep?

- When Moisture Lost is 85% of Original


Thank You !



NCHRP PROJECT 14-37

Guide Specifications for the Construction of Hot Applied Chip Seals

TRB Webinar, September 14, 2021

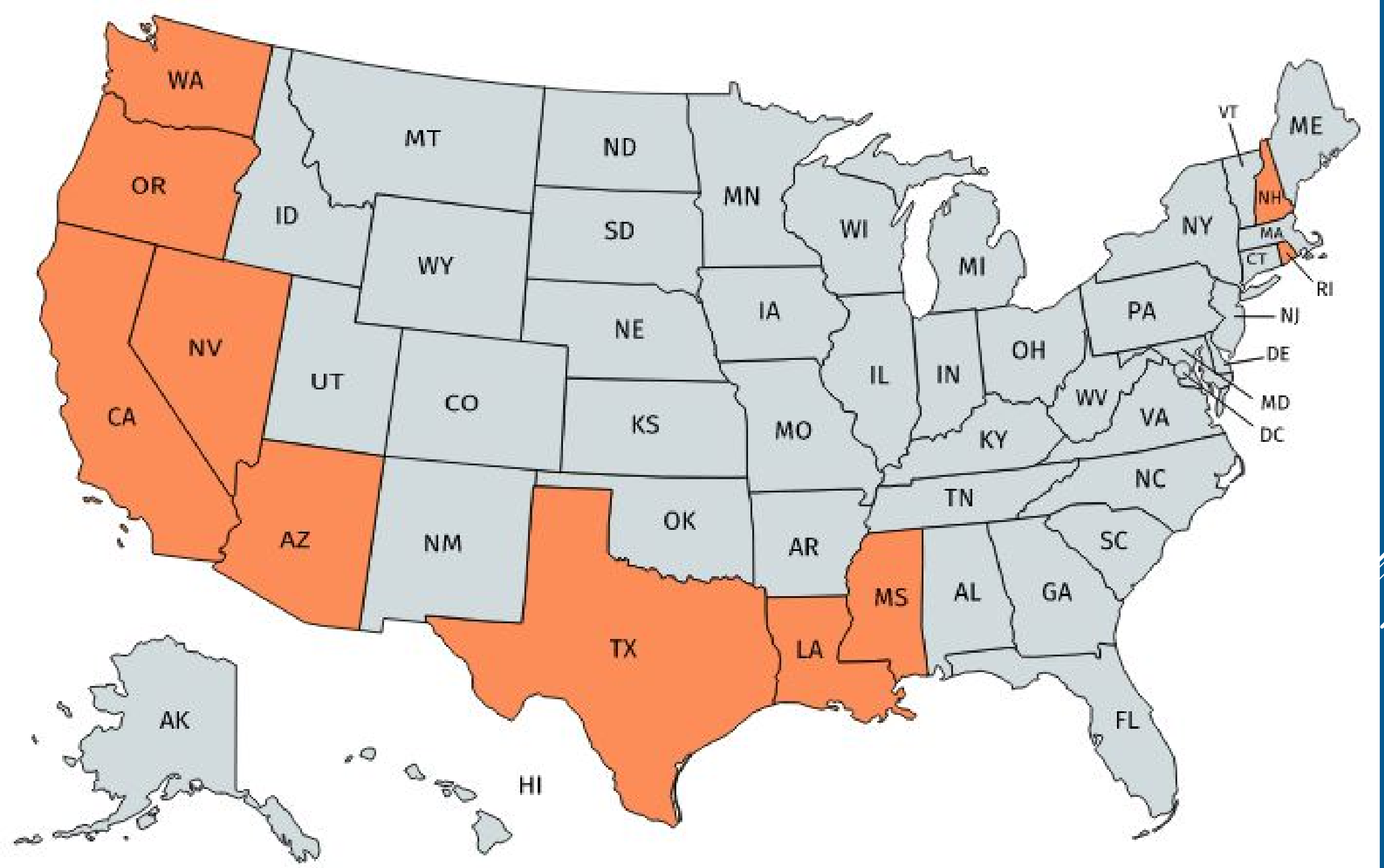
by

Dr. R. Gary Hicks, P.E

R. Gary Hicks LLC.

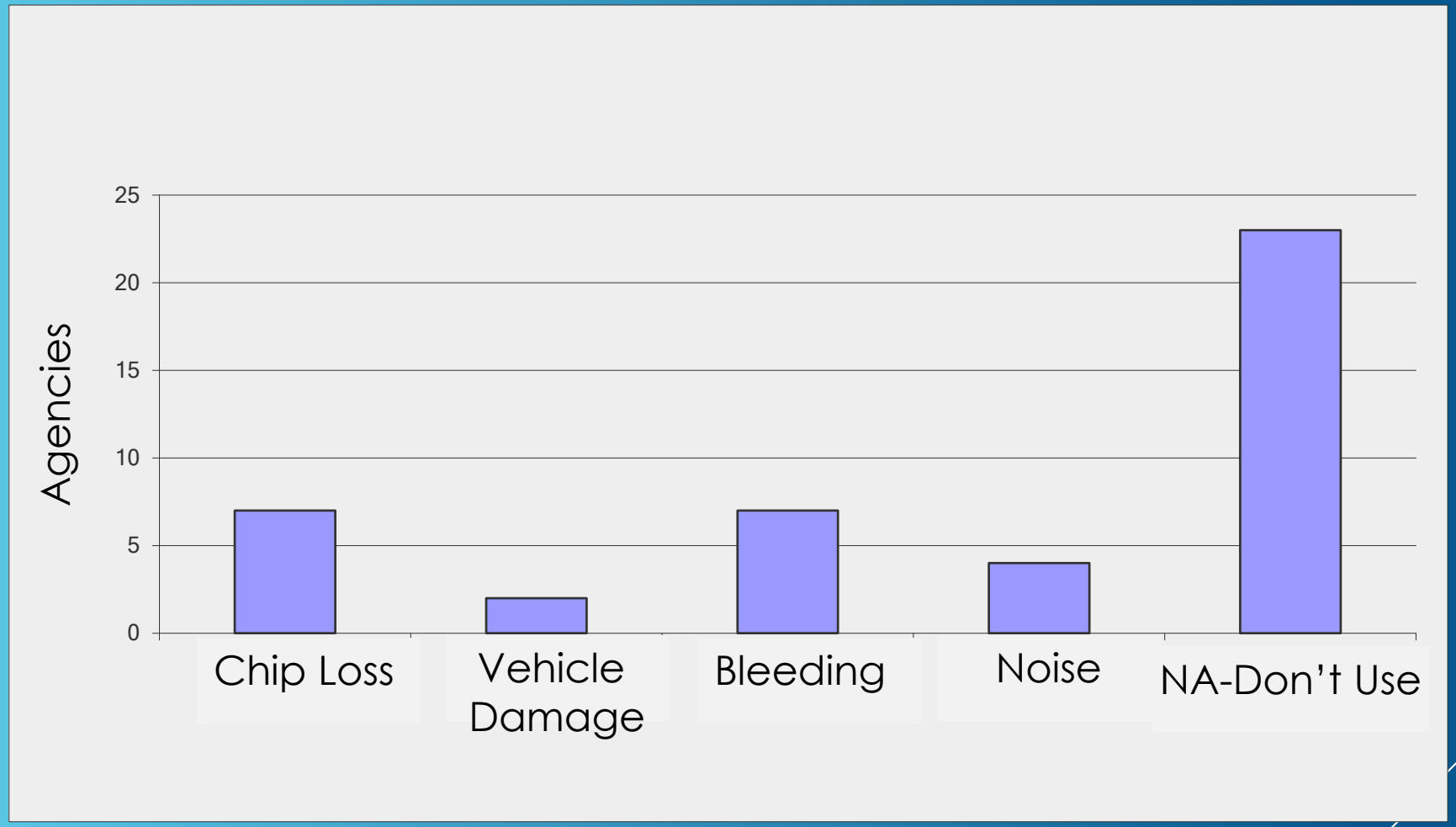
RESEARCH EFFORT

- Traditional literature review
- Survey of states
  - 10 States with Hot Chip Seal specifications
  - Mostly used in the northeast and southwest
  - Slightly different products used between the different areas
  - Guide development-an iterative approach

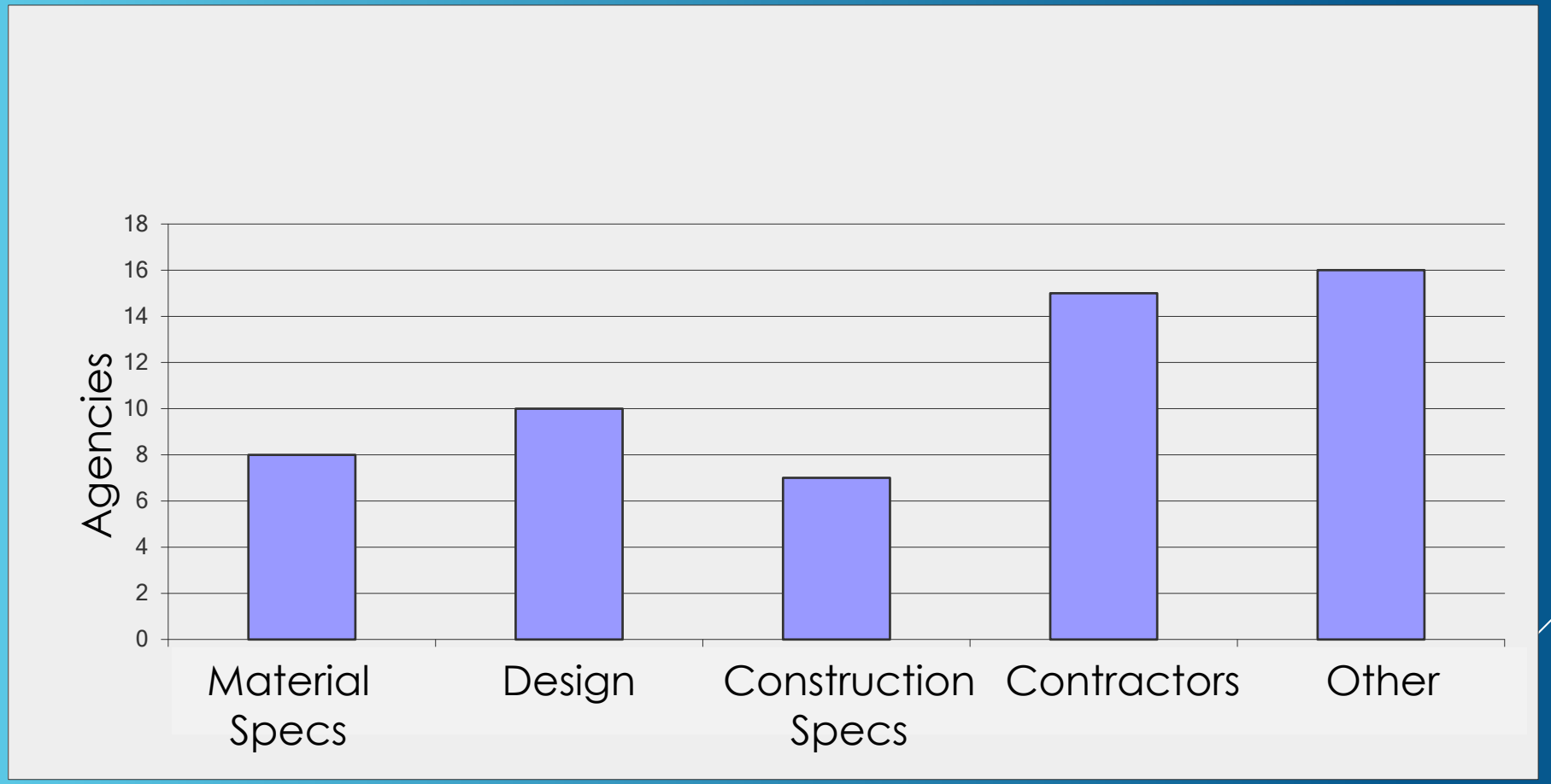


Hot Chip Seal States

HOT CHIP SEALS PROBLEMS



WHY IS PERFORMANCE POOR?



CONSTRUCTION GUIDES

AASHTO OUTLINE FOR CONSTRUCTION GUIDE SPECIFICATIONS

- Description
- Material
- Construction
- Measurement
- Payment

MATERIALS

EQUIPMENT

ASPHALT DISTRIBUTOR

Applies Binder to the surface, it must:

- Be Calibrated
- Accurately control application rate
- Provide uniform coverage in both transverse and longitudinal directions
- Hold a specific temperature
- Have adjustable spray bar for double or triple overlap
- Have correct nozzles

AGGREGATE SPREADER

Spreads aggregate onto the hot applied binder, it must:

- Be calibrated
- Deliver the desired application rate using computerized controls
- Adjust to varying widths
- Distribute the aggregate uniformly in transverse and longitudinal directions

ROLLERS IN RELATION TO THE CONSTRUCTION TRAIN

BROOMS

Cleans the road surface before binder is applied and after aggregate is rolled

- Motorized
- Vertical pressure control
- Plastic bristles

CONSTRUCTION OF TEST STRIP

- Similar project placement conditions:
  - Time of day
  - Temperature
  - Humidity

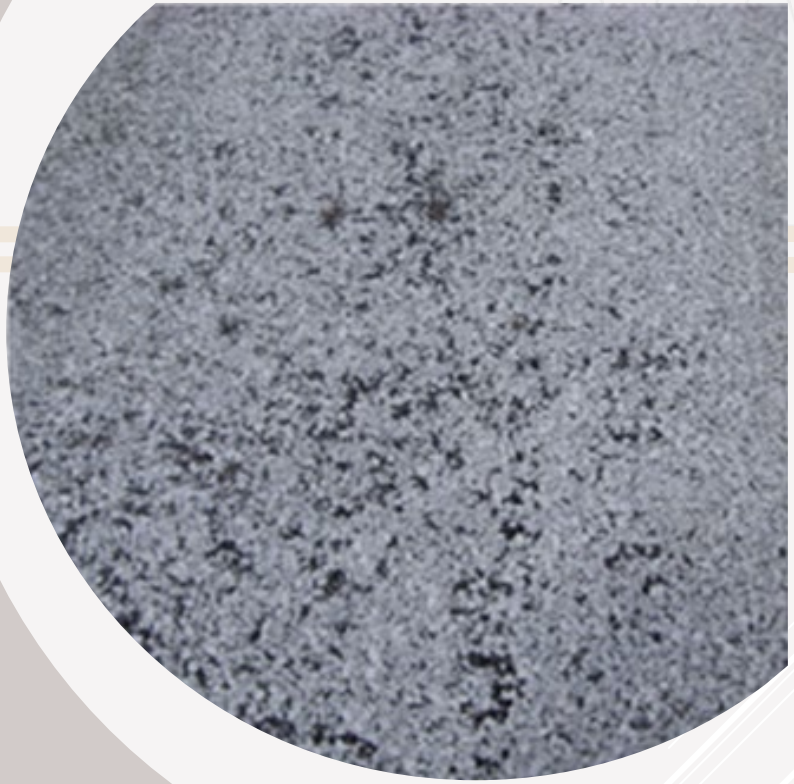
CONSTRUCTION

- Weather
  - 50°F and rising
  - During daylight or night hours hours
  - Suspend when pavement exceeds 140°F
  - Surface shall be dry

CONSTRUCTION

- Binder Application
  - Should be at specified temperature
  - Binder placed within +/-5% of the design rate
  - Some binder should be visible through the chips (salt and pepper look)
  - Binder should not be sticking to the tire rollers

CONSTRUCTION



Aggregate Application

- Aggregate shall be hot and pre-coated
- Shall be similar to design rate, but adjustments are almost always necessary in the field

CONSTRUCTION

- Transverse Joints - A roofing felt or heavy construction paper joint shall be used so excess asphalt and chips are not placed at the joint.

CONSTRUCTION

- Rolling
  - First pass of rollers must be within 2 minutes of applying aggregate.
  - Roller speed, 3MPH or less
  - Three complete passes
  - Position rollers so entire width of chip sealed surface is covered
  - If desired, a steel wheel roller can be used for final pass

CONSTRUCTION

- Sweeping
  - When-as soon as possible
  - How-with vacuum or kick brooms
  - Why-to prevent flying rock

CONSTRUCTION

- Fog Seal – The chip seal shall be allowed to set up before placement of a fog seal
- With hot applied it can be sooner depending on the weather

MEASUREMENT/PAYMENT

- Measurement 
  - Binder – by volume at 60°F
  - Aggregate – by area of pavement surfaced

- Payment
- Unit costs or total area covered
  - Unit cost – Binder(gal), Aggregate(tons), Fog seal(gal)
  - Total area covered – Chip seal(yd^2)

JESHOOTS.com

CRITICAL KEY TO SUCCESS

- Incorporate a QA program
- Developed for Emulsion Chip Seals but not yet developed for Hot Applied Chip Seals

Emulsion Chip Seal Quality Assurance Guide

Description: Chip Seal

Emulsion Chip Seal is an application of an emulsified asphalt binder covered with an application of clean graded aggregate to an existing asphalt surface. The emulsified asphalt binders may be modified with various polymers such as latex, tire and natural rubbers. Aggregate must be durable consisting of crushed stone, gravels, or manufactured aggregates varying in size from ⅝ inch to a minimum of ¼ inch.

Quality Assurance (QA)

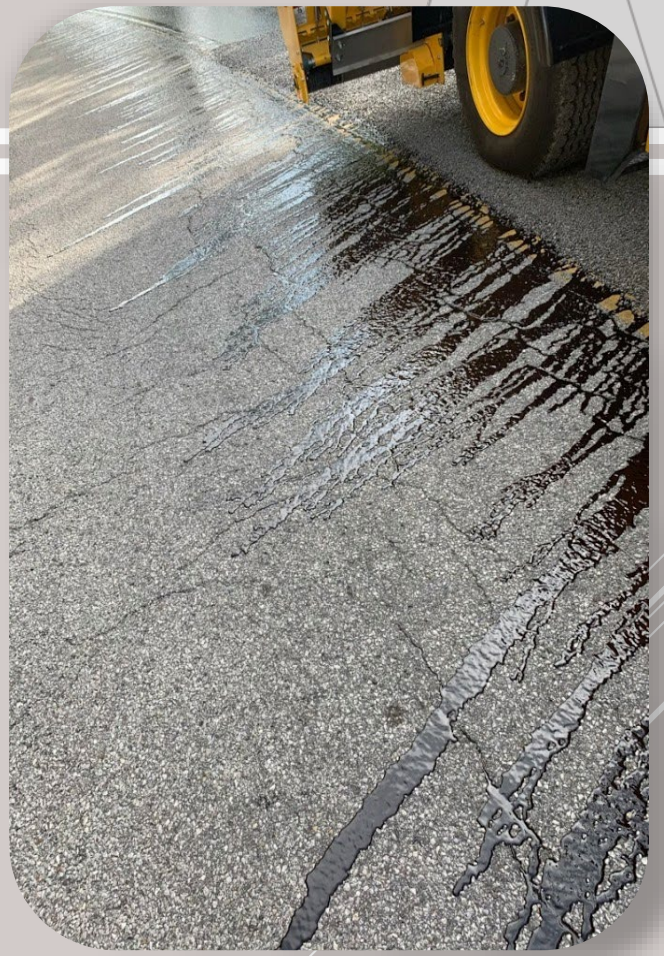
AASHTO R 10 provides standard definitions for terms used in quality assurance procedures.

QA is defined as all those planned and systematic actions taken by the Agency and Contractor to provide the necessary confidence that the procured material and workmanship will satisfy the quality requirements of the contract.

QA includes Quality Control (QC), Acceptance and Independent Assurance (IA).

QC is the system used by the Contractor to monitor, assess and adjust production and placement processes to ensure that the material and workmanship will meet the specified quality. QC is the responsibility of the Contractor.

Acceptance is the system used by the Agency/ Engineer to measure the degree of compliance of the quality of the materials and workmanship with the Contract requirements. Acceptance is



QUALITY CONTROL

- Personnel –
  - QC Manager – responsible for development and implementation of the Quality Control Plan
  - QC Technicians – responsible for sampling and executing QCP
  - Certified Crew Members
- Testing Facilities and Equipment
  - Lab for testing of both binders and aggregates

http://tsp2-etf.org/specs-checklists/

STATUS OF HOT APPLIED CONSTRUCTION GUIDE

Latest draft can be found at https://www.pavementpreservation.org/wp-content/uploads/ETF/Specifications/Finals/407_Hot%20Applied%20Chip%20Seal%209-4-20%20(V-3).pdf

AASHTO has balloted on the guide but the materials specs and design practices were not developed by the AASHTO TSP-2 ETF. This still needs to be done.

IMPLEMENTATION OF THE GUIDES

- How to Best Implement the Construction Guides?
  - Webinars, Travelling Short Courses, and Field Demos
- Potential Barriers to Rapid Implementation
  - Industry and Agency Pushback
- Identifying Impact of Guides
  - Increased and Proper Use of Hot Applied Chip Seals
  - Improved Performance

TSP2 EMULSION Task Force

WHAT WE EXPECT-GOOD, FINISHED, & STRIPED

Thank you
rghicks40@outlook.com

NCHRP Project 14-37

Guide Specifications for the Construction of Micro Surfacing

TRB WEBINAR, SEPTEMBER 14, 2021

JAMES S. MOULTHROP, P.E. (PA, AZ)

Agenda

- Research Effort
- Survey of State DOTs
- Construction Guide Specification Development
- Critical Keys to Success

Research Effort

- Traditional Literature Review
- 18 States with Micro Surfacing Specifications (As Reported)
- Used by many local Governments
- Different aggregate gradations used- Types I, II, & III


Photo Courtesy of Vance Bros.

Survey of State DOTs

- Short Internet Questionnaire to All 50 States
  - Maintenance and Construction Engineers
  - 18 States Responded
  - Sent out multiple reminders

Construction Guide Specification (contains commentary)

MICRO SURFACING

Guide Specification Acknowledgement

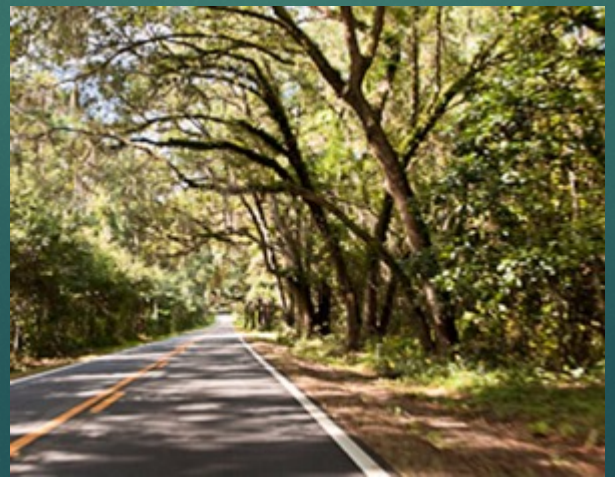
- Balloted through AASHTO COMP 5b – Pavement Preservation
- Review and assistance from the AASHTO TSP- 2 Emulsion Task Force

Section 408

Construction Guide Specification for Micro Surfacing

Construction

Weather Requirements



Mix Design – PP 83

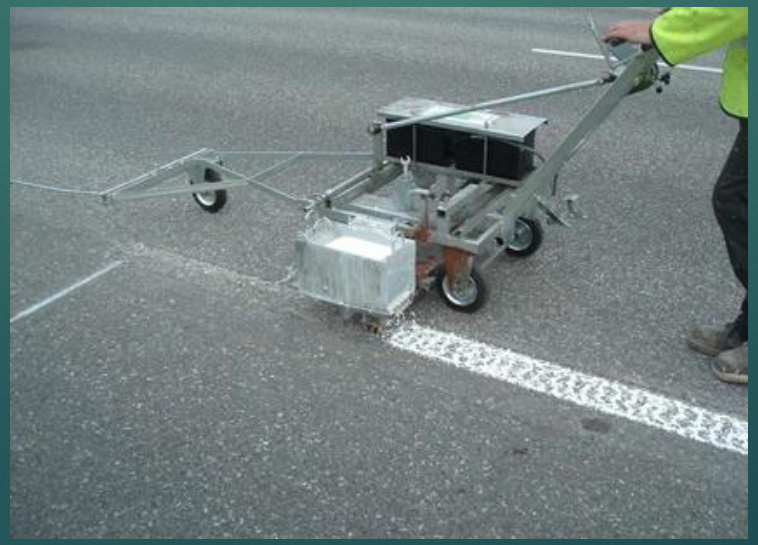
Materials - MP 28

Mix Design Components

- Mix Time
- Cohesion
- Stripping
- Wet Track (1-hour and 6-day)
- Lateral Displacement
- Sand Adhesion

Construction - Pre-Construction Meeting

Construction – Surface Prep

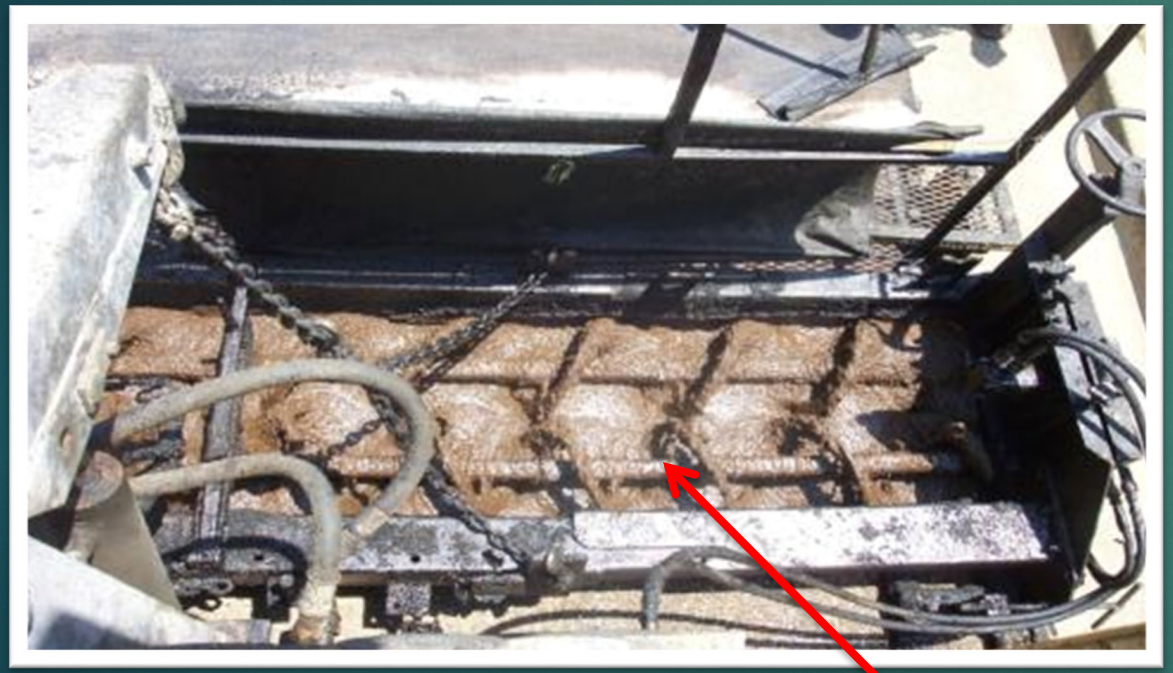


Application Equipment

Continuous Run Machine

Truck Mounted Unit

Application Equipment – Spreader Boxes



Augers Required

Calibration

- Each machine should be calibrated with the aggregate and emulsion to be used.
- The name of the person who carried out calibration and documentation should be provided.

Test Strip

- Proper Evaluation Items include:
  - Proportion optimization
  - Application rate verification
  - Uniformity of surface texture
  - Equipment in good condition
  - Adequate workforce
  - Cure Time
  - Workmanship
  - Proper alignment

Application of Mixture

- Fogging
- Handwork
- Rut Filling
  - Scratch course (less than ½")
  - Rut box (½" or more)
- Rolling, if needed

Application – Workmanship

- Joints
  - Longitudinal
  - Transverse
  - Intersections
- Edge Lines
- Handwork
- Drag Marks

Traffic Control

- Shall conform to the requirements of the Manual on Uniform Traffic Control Devices (MUTCD)
- Traffic control devices shall be in accordance with State and local requirements

Project Documentation

- Aggregate used
- Emulsified asphalt used
- Mineral filler used
- Water used
- Additive used
- Surface area completed
- Surface area application rate
- Percentage of emulsified asphalt

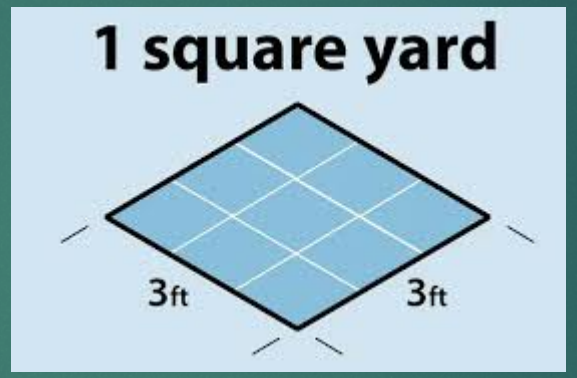
Quality Control

- Personnel –
  - QC Manager – responsible for development and implementation of the Quality Control Plan
  - QC Technicians – responsible for sampling and executing QCP
  - Certified Crew Members
- Testing Facilities and Equipment
  - Lab for testing of both emulsions and aggregates

Measurement & Payment

Emulsified Asphalt

Aggregate



Mineral Filler

Critical Keys to Success

- Assure materials specification are met
- Follow a properly prepared mix design
- Perform calibration
- Communication is a must
- Incorporate a QC program into spec
- Trained (certified) inspector & contractor staff

Summary

Materials

Design

Construction

Performance

Thank You!

jimmoulthrop@gmail.com

California Department of Transportation (Caltrans)

Experience with Fog Seals

TRB WEBINAR
SEPTEMBER 14, 2021

John Fox, P.E.
District Maintenance Engineer
District 9, Caltrans

Caltrans History of Fog Seals.

- Prior to 1998 fog/rejuvenating seals in use Statewide via construction contracts and State Forces maintenance.

- 1998 contract fog seal incident resulted in moratorium on contract fog seals on the traveled way until "**Level of comfort**" was reached.
  - Fog seal reduced surface friction due to improper application.
  - Level of comfort- That contract fog seals do not endanger the traveling public.
  - Challenge- how to reach this level of comfort.
-

Caltrans History of Fog Seals

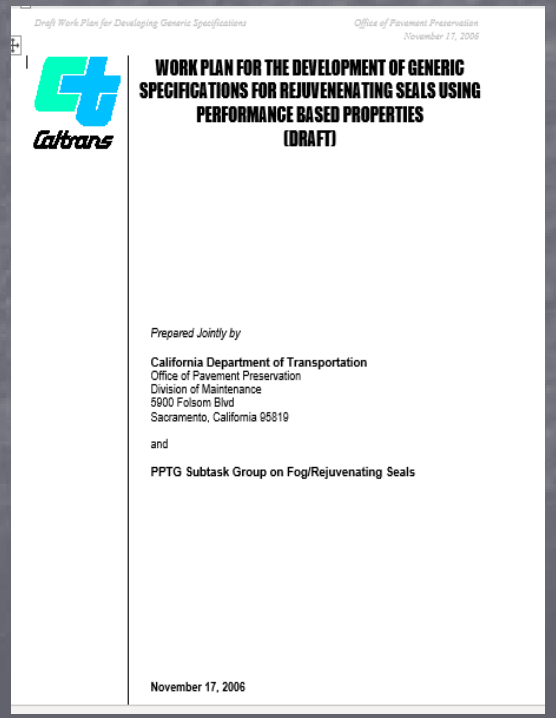
- Fog Seals applied by State Forces (Maintenance) still permitted. Over 1,003 lane miles sealed in 2012.
- Flush coat on chip seal contracts still allowed, but with sand cover!
- 2006 Caltrans Pavement Preservation Task Group (PPTG) tasked to develop generic specification for contract fog seals that provides “Level of Comfort” to lift moratorium.
- PPTG studies in cooperation with California Pavement Preservation Center in 2007, 2009, 2012 to investigate materials performance and effects of fog seals on surface friction.
- 2008 Caltrans Maintenance Technical Advisory Guide (MTAG) updated to provide best practices for maintenance applied fog seals.

Purpose of PPTG Fog Feal Studies

- Develop generic fog seal specification

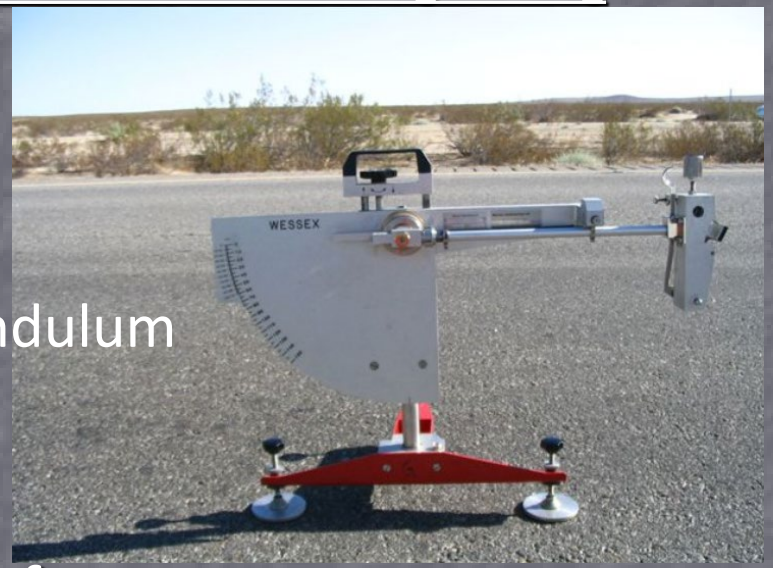
- Study competing fog seal materials head-to-head on various pavement surfaces.
  - Polymer modified rejuvenating emulsions with 5% rejuvenator
  - Straight Rejuvenating emulsions with some asphalt, and no asphalt
  - Tall oil pitch emulsion
  - Standard SS1h and CQS

- Determine which material properties resulted in increased pavement performance. Develop specification around those properties or performance.
  - Bending Beam Rheometer tests on pavement cores to measure stiffness



Purpose of PPTG Fog Feal Studies

- Address safety concern to gain “Level of Comfort”.
  - **What defines adequate surface friction?**
  - **Determine contract acceptance criteria for safety of traveling public.**
  - Study use of different devices to measure surface friction characteristics **before and after fog sealing** and determine appropriate acceptance criteria based on those findings.
    - British Pendulum
    - Caltrans Portable Skid Device
    - ASTM Towable Skid Trailer
    - Sand Patch
    - Circular Track Meter
    - Dynamic Friction Tester
  - **Identify device that could be used by Maintenance Engineer for prequalification of suitable fog seal candidates with consideration of post fog seal surface friction.**



British Pendulum

Prequalification to determine suitable fog seal candidates based on measured existing surface characteristics and expected measured decrease in something such as skid number is problematic.

This would eliminate many good fog seal candidates that have been historically successfully fog sealed.

What's the solution? There are many variables affecting the tire/pavement interface, and many studies on the subject.

Caltrans Portable Skid Tester

This much we do know;

Good Fog Seal Candidates

Aged/dry dense-graded HMA &
any HMA with texture
or sanding

Open/gap
graded HMA

Chip seals

BAD Fog Seal Candidates

Dense tight rich surfaces
NOT suitable !

- Application rate is function of existing pavement surface condition. Surface condition may vary across lane. Check in & outside wheel tracks.
- Use ring test kit or other similar method to determine, verify, and document proposed application rate.

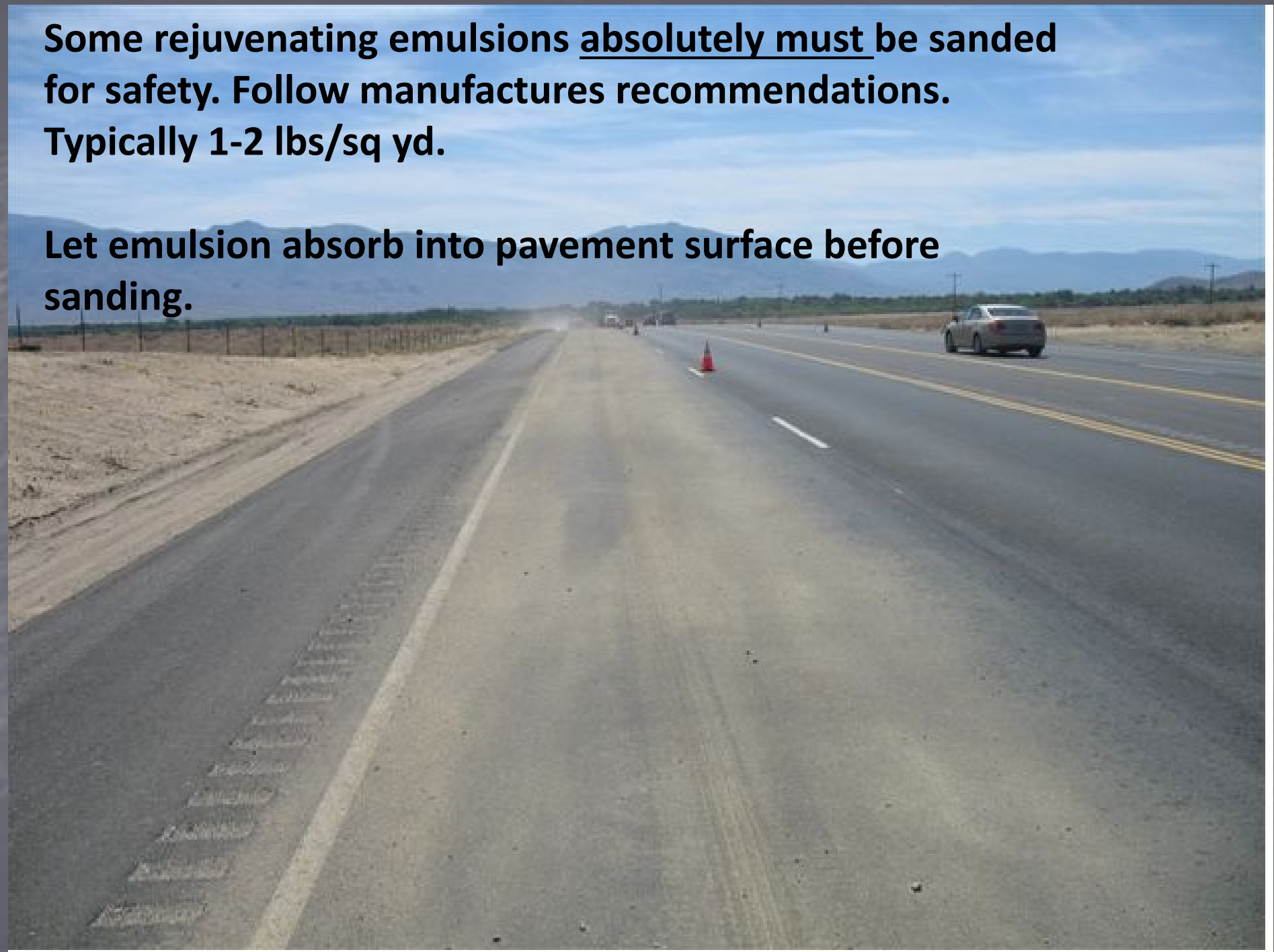

Shoot 500’ test strip to verify shot rate. Traveled way wheel tracks and shoulder may require different shot rates.
PMRE @ 0.10 gal/sq yd, 3 year old DGAC. No sanding required!

Typical application rates for 60/40 emulsion @ 50/50 dilution.

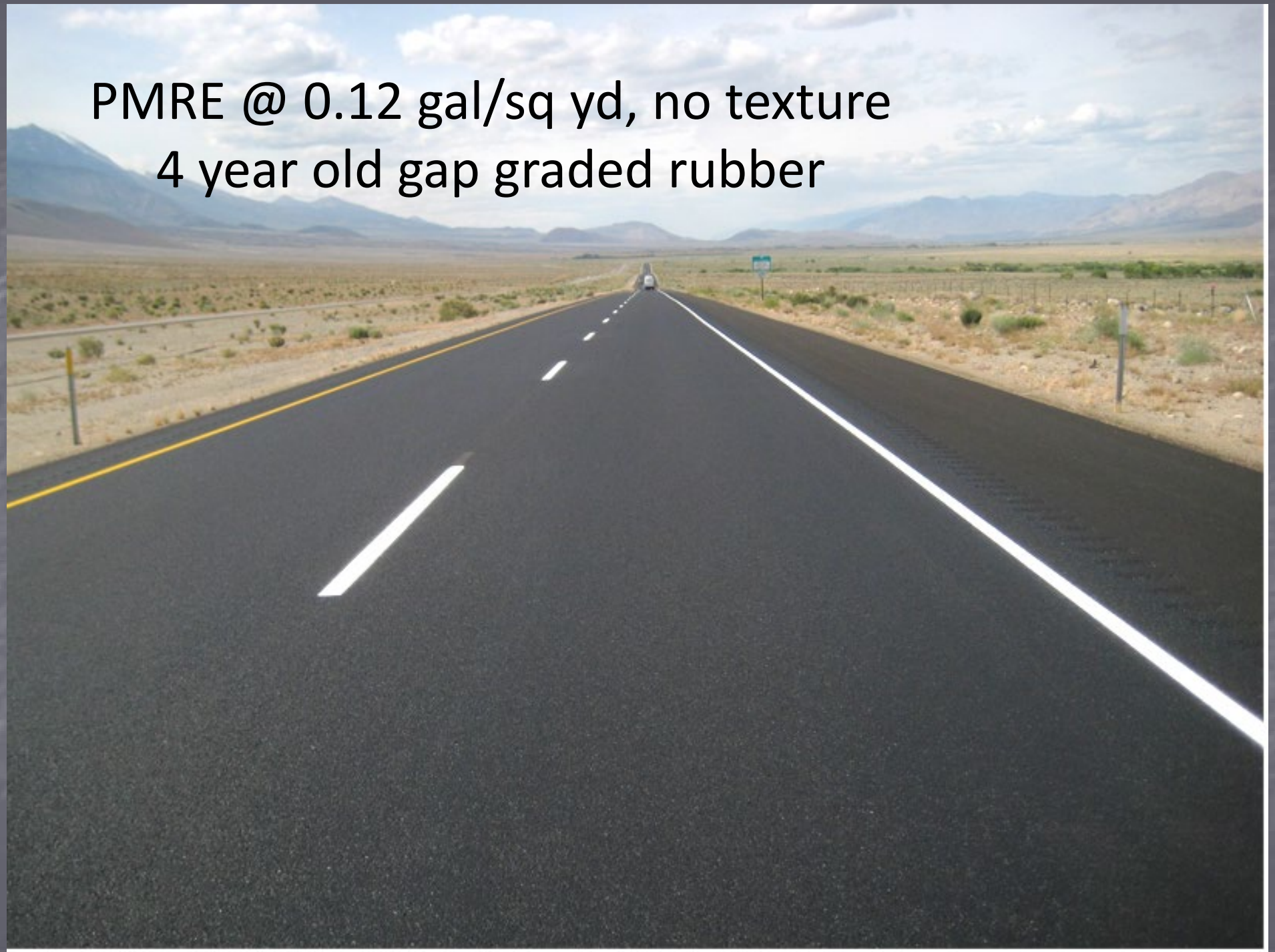
- Absorption into pavement surface is critical. Bubbles are good indicator.

- OGAC: 0.10-0.14 gal/sq yd.
- Gap graded: 0.08-0.12 gal/sq yd.
- Chip Seal: 0.09-0.12 gal/sq yd.
- DGAC: 0.08-0.10 gal/sq yd.

Test section. Fog sealing new pavement can significantly reduce surface friction. SN 65 to SN 9!


Some rejuvenating emulsions absolutely must be sanded for safety. Follow manufactures recommendations. Typically 1-2 lbs/sq yd.
Let emulsion absorb into pavement surface before sanding.


PMRE @ 0.13 gal/sq yd, no texture
4 year old OGAC in Death Valley National Park


PMRE @ 0.12 gal/sq yd, no texture
4 year old gap graded rubber

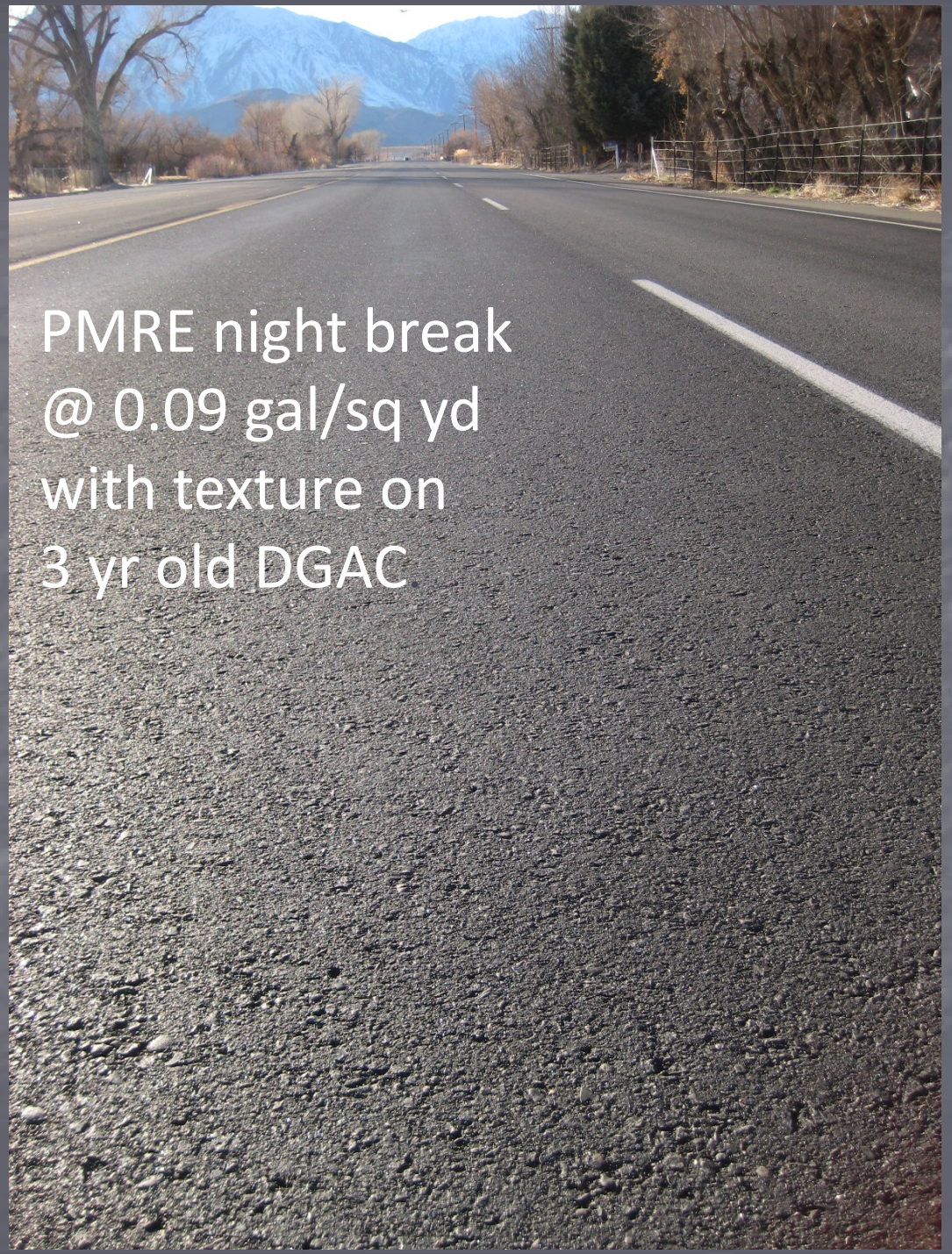
Use quick set emulsions for faster return to traffic. Quick set emulsion @ 0.09 gal/sq yd on 3/8” chip seal.

Texture Seal: Emulsion and aggregate applied with one truck in one pass

PMRE @ 0.10 gal/sq yd with texture on 5 year old DGAC
Copper slag agg, #30, angular, hard, black @ 0.7 lbs/sq ft


Use fog seals designed for nighttime application if daytime application won't work.
PMRE night break @ 0.13 gal/sq yd with texture on 6 yr old gap graded rubber

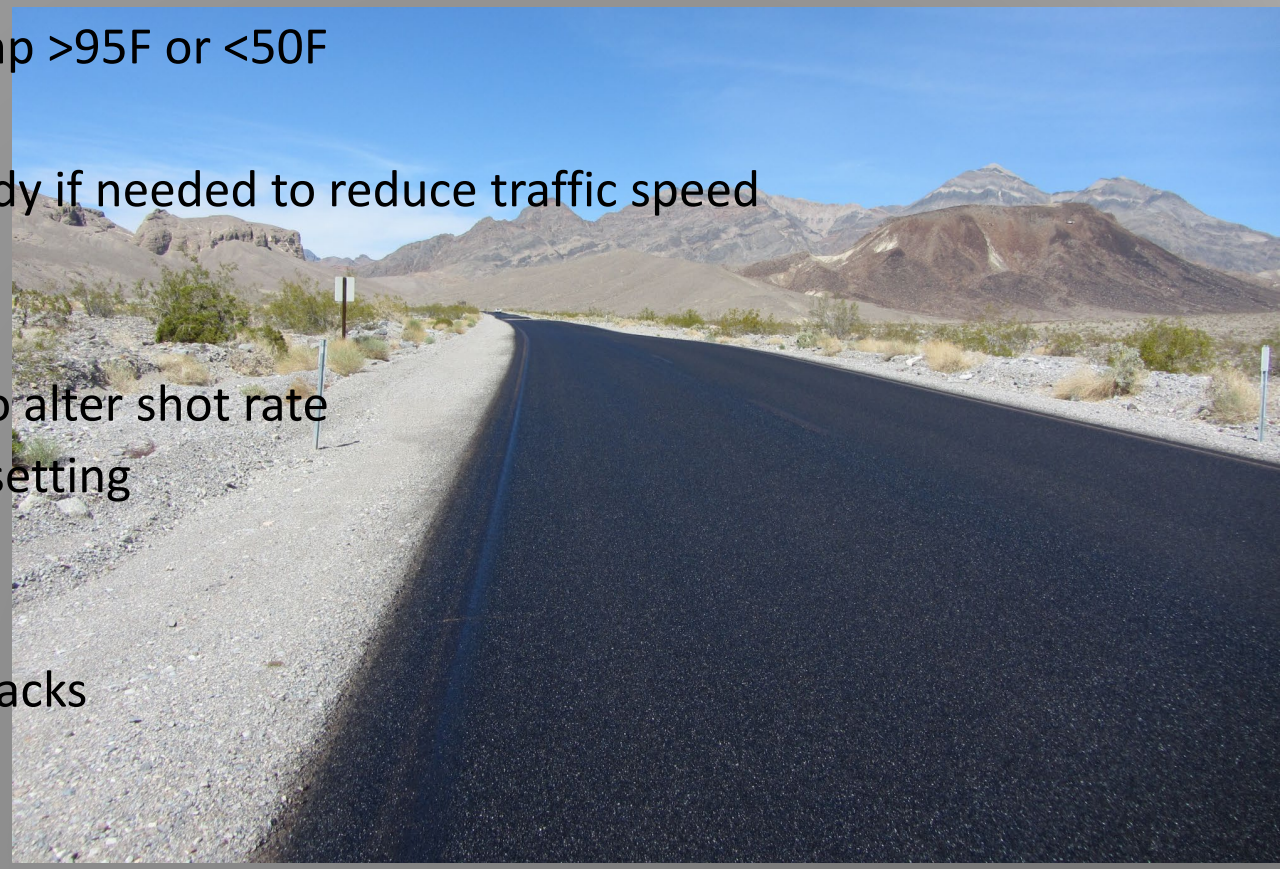

LIBERTY
1971


PMRE night break
@ 0.09 gal/sq yd
with texture on
3 yr old DGAC


Have water truck ready to flash set emulsion and remove tackiness in order to open to traffic if shooting during hot weather.

Lessons Learned in Fog Seals Since 2007

- **Have experienced personnel running the job**
- Shoot at right time of year. Don't shoot if ambient temp >95F or <50F
- Don't shoot if rain is forecast in next several days
- Have Portable Changeable Message Sign, or signs handy if needed to reduce traffic speed
- Check shipping papers to **verify product and dilution**
- Don't shoot without verifying application rate
- Confirm shot rate (Shoot 500' test) and be prepared to alter shot rate
- Have sand and water available for friction, blotting & setting
- Schedule re-striping, remarking the same day
- No need to mask markings
- Open to traffic when material has set and no longer tracks
- **Skid numbers/surface friction will go down**
- Skid numbers can take up to 2 months to fully recover
- Fog sealing brand new pavements can dramatically reduce skid numbers
- Fog seal with texture seal, or sanding, can alleviate skid concerns
- Many fog and rejuvenating seal products available
- **Be prepared,** stay on job until it's safe to open to traffic



What's Next for Caltrans?

Pavement & Materials Partnering Committee (PMPC)
Work Product Scoping Document
2021 Section 37 Fog Seals Update
August 3, 2021

Excerpt:

Purpose

The purpose is to review Section 37-4 of Standard Specifications and Standard Special Provisions (SSP) to make the necessary modifications or corrections to increase the use of fog seals statewide. The revisions may include terminology and minor specification changes.

Background

Fog seals are an important and proven method in pavement preservation. However, an updated method to design and/or place fog seals is needed to ensure improved safety to the traveling public. AASHTO is currently revising their Fog Seal Design and Construction Practice documents. As such, the Department may need to revise our specifications to be consistent with AASHTO. There may also be changes and technical improvements in the pavement preservation industry that need to be evaluated for possible adoption into the specifications.

Questions? Contact:

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Today's Panelists

Moderator: DingXin Cheng,
California State University, Chico

R. Gary Hicks,
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John Fox,
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James Moulthrop,
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Scott Shuler,
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