

58th Idaho Asphalt Conference

October 25, 2018
University Inn, Moscow, Idaho

the 2018 Presentations

- 1 [Warm Mix Asphalt: Leveraging the Benefits](#), Dr. Leslie McCarthy, P.E., Villanova University, PA
- 2 [Superpave 5](#), Gerry Huber, P.E., Heritage Research Group, Indianapolis, IN
- 3 [Maximizing Pavement Life – 1, Considerations for Pavement Design](#), Mark Blow, P.E., The Asphalt Institute, Harrisburg, SD
- 4 [Maximizing Pavement Life – 2, Considerations for Construction Practice](#), Mark Blow, P.E., The Asphalt Institute, Harrisburg, SD
- 5 [Use of Advanced Technology for Quality Assurance in Alaska](#), Rich Giessel, P.E., Anchorage, AK
- 6 [Cold in-Place Recycling utilizing Engineered Emulsion: Project Selection and Construction Practices](#), Megan Chatfield, P.E., Western Federal Lands Highway Division, Vancouver, WA
- 7 [Testing fine aggregates according to AASHTO T-84 and the CoreLok device](#), Dr. Sunil Sharma, P.E., University of Idaho, Moscow, ID
- 8 [Tack Coat Synthesis](#), Mark Blow, P.E., The Asphalt Institute, Harrisburg, SD

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Speakers of the 58th Idaho Asphalt Conference, October 25, 2018

From Left: Gerry Huber, Fouad Bayomy, Megan Chatfield, Leslie McCarthy, Mike Santi, Richard Giessel, Mark Blow, and Emad Kassem

Not Pictured: [Sunil Sharma](#)

58th Idaho Asphalt Conference – October 24-25, 2018

Attendance List

Andy Abrams

Geotechnical Engineer

GPI
6 O'Donnell Road
Pullman, WA 99163
509-339-2000
aabrums@geoprocorp.com

Hamza Alkuime

Graduate Student

University of Idaho
alku4068@vandals.uidaho.edu

John Arambarri

Materials Engineer

Idaho Transportation Department
3311 W. State Street
Boise, ID 83703
208 332-7161
john.arambarri@itd.idaho.gov

Don Armstrong

Transportation Tech SR

Idaho Transportation Department
PO Box 837
Lewiston, ID 83501
208-799-4221
D2Admin@itd.idaho.gov

Brian Arnold

Quality Control

Idaho Materials & Construction
924 N Sugar St
Nampa, ID 83687
208-477-7579
brian.arnold@idahomaterials.com

Fouad Bayomy

Professor

University of Idaho
bayomy@uidaho.edu

Chip Becker

TTE

Idaho Transportation Department
5151 South 5th Ave
Pocatello, ID 83276
208-239-3387
chip.becker@itd.idaho.gov

Riley Bender

Engineer In Training

Idaho Transportation Department
PO Box 837

Lewiston, ID 83501
208-799-4225
D2Admin@itd.idaho.gov

Joseph Blake

Lab Technician

Idaho Asphalt Supply

Mark Blow

The Asphalt Institute
Harrisburg, SD

Scott Bontrager

Assistant City Engineer

City of Moscow Engineering
221 E. Second St
Moscow, ID 83843
208-883-7030
scollins@ci.moscow.id.us

Dan Boston

Materials Assistant

City of Spokane Engineering -
Construction Management
1225 E Maritetta Ave
Spokane, WA 99207-2751
509-625-7722
dboston@spokanecity.org

Randal Brunello

Staff Engineer

Idaho Transportation Department
206 Yellowstone Hwy
Rigby, ID 83442-5160
208-745-5617
randal.brunello@itd.idaho.gov

Walter Burnside

Engineer Manager 1

Idaho Transportation Department
216 S Date Street
Shoshone, ID 83352
208-886-7849
walter.burnside@itd.idaho.gov

Bob Buvel

Staff Engineer

City of Moscow Engineering
221 E. Second St
Moscow, ID 83843
208-883-7034
scollins@ci.moscow.id.us

Curtis Calderwood

Staff Engineer

Idaho Transportation Department
206 Yellowstone Hwy
Rigby, ID 83442-5160
208-745-5637
curt.calderwood59@gmail.com

Genessa Cebriak

Transportation Engineer 1

WSDOT - Eastern Region
2714 N. Mayfair St.
Spokane, WA 99207
509-323-8419
Browlad@wsdot.wa.gov

Megan Chatfield

Material Engineer

Western Federal Lands Highway
Division
Vancouver, WA

58th Idaho Asphalt Conference – October 24-25, 2018

Attendance List

Zac Childress

Transportation Technician 3
WSDOT
South Central Region
2809 Rudkin Road
Union Gap, WA 98903
509-577-1632
paulp@wsdot.wa.gov

Dustin Commons

Senior Project Manager
Lochner
3071 East Franklin Road
Suite 303
Meridian, ID 83642
208-559-4744
dcommons@hwlochner.com

Howard Cooley

Staff Engineer
Idaho Transportation Department
PO Box 837

Lewiston, ID 83501
208-799-4245
D2Admin@itd.idaho.gov

Tyler Coy

Staff Engineer
Idaho Transportation Department
3311 W. State Street

Boise, ID 83703
208-332-7161
tyler.coy@itd.idaho.gov

Brian Dagon

Construction Manager
Interstate Concrete and Asphalt
8849 W Wyoming Ave

Rathdrum, ID 83858
208-765-1144
brian.dagon@interstate-ica.com

Nathan Douglass

Staff Engineer
Idaho Transportation Department
206 Yellowstone Hwy

Rigby, ID 83442-5160
208-745-5684
nathan.douglass@itd.idaho.gov

Ebenezer Fanijo

Graduate Student
University of Idaho
fani7292@vandals.uidaho.edu

Garrett Frei

Project Engineer
J-U-B Engineers, Inc.
846 6th Street
Clarkston, WA 99403
509-254-6011
gfrei@jub.com

Tod Fukutomi

QA Engineer
MG2
1101 Second Ave, Suite 100
Seattle, WA 98101
206-962-6635
tod.fukutomi@mg2.com

Kevin Funke

Testing Services Manager
ALLWEST Testing & Engineering
2705 E Main Street
Lewiston, ID 83501
208-743-5710
kfunke@allwesttesting.com

Gary Gardner

Controller
Specialty Construction Supply
348 NW 13th Place
Meridian, ID 83642
208-322-6800
ggardner@specialtysupply.com

Rich Giessel

Statewide QA Engineer
Alaska DOT
Anchorage, AK
richard.giessel@alaska.gov

Robert Gordon

Engineering Asst, Transportation Staff
Idaho Transportation Department
PO Box 837
Lewiston, ID 83501
208-799-4236
D2Admin@itd.idaho.gov

Drew Harris

Project Manager
Knife River - Northwest
5450 S Gowen Rd

Boise, ID 83709
208-350-1224
drew.harris@kniferiver.com

Chris Hartman

Project Manager
Knife River - Northwest
5450 S Gowen Rd
Boise, ID 83709
208-350-1224
chris.hartman@kniferiver.com

Mumtahir Hasnat

Graduate Student
University of Idaho
hasn6815@vandals.uidaho.edu

Wayne Herbel

Federal-aid Engineer
LHTAC
3330 Grace Street
Boise, ID 83703
208-344-0565
wherbel@lhtac.org

58th Idaho Asphalt Conference – October 24-25, 2018

Attendance List

Jared Hopkins

Engineer, Technical 1
Idaho Transportation Department
PO Box 837
Lewiston, ID 83501
208-799-4238
D2Admin@itd.idaho.gov

Tracy Hopkins

Managing Member
Specialty Construction Supply
348 NW 13th Place

Meridian, ID 83642
208-322-6800
thopkins@specialtysupply.com

Fred Howe

TE3
WSDOT - North Central Region
2830 Euclid Ave. Bldg. A
Wenatchee, WA 98801
509-667-3000
brittag@wsdot.wa.gov

Gerry Huber

Associate Director of Research
Heritage Research Group
Indianapolis, IN

Ahmed Ibrahim

Faculty
University of Idaho
aibrahim@uidaho.edu

Nyerhovwo Charles Iwhiwhu

Graduate Student
University of Idaho
iwhi5970@vandals.uidaho.edu

Halley Jalbert

Project Manager
Interstate Concrete and Asphalt
8849 W Wyoming Ave
Rathdrum, ID 83858
208-765-1144
halley.jalbert@interstate-ica.com

Bryan Jensen

EIT
J-U-B Engineers Inc
422 W. Riverside Suite 304
Spokane, WA 99201
509-458-3727
bjensen@jub.com

Md Jibon

Graduate Research Assistant
Boise State University
Civil Engineering
1910 University Drive
Boise, ID 83725-2060
208-426-3710
mdjibon@u.boisestate.edu

Zak Johnson

District 5 Intern
Idaho Transportation Department
5151 South 5th Avenue
Pocatello, ID 83204
208-861-8136
zak.johnson@itd.idaho.gov

Jason Johnston

Project manager
Interstate Concrete and Asphalt
8849 W Wyoming Ave
Rathdrum, ID 83858
208-765-1144
jason.johnston@interstate-ica.com

Justin Joy

Idaho Asphalt Supply
Idaho Falls, ID

Jeff Kasma

Street Supervisor
City of Nampa Street Division
106 W Railroad St
Nampa, ID 83687
208-468-5830
kasmaj@cityofnampa.us

Emad Kassem

University of Idaho

Cindy Kinzer

Senior Design Engineer
City of Spokane
P.O. Box 494
Colbert, WA 99005
509-625-6397
ckinzer@spokanecity.org

Kerby Kirkham

Staff Engineer
Idaho Transportation Department
PO Box 837
Lewiston, ID 83501
208-799-4248
D2Admin@itd.idaho.gov

Eric Kokernak

Staff Engineer
Idaho Transportation Department
PO Box 837
Lewiston, ID 83501
208-799-4234
D2Admin@itd.idaho.gov

Al Kravtsov

Transportation Engineer 1
WSDOT
2714 N Mayfair St
Spokane, WA 99206
509-324-6161
kravtam@wsdot.wa.gov

Tim Kyker

Assistant Materials Engineer
City of Spokane Engineering -
Construction Management
1225 E Maritetta Ave
Spokane, WA 99207-2751
509-625-7722
tkyker@spokanecity.org

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Attendance List

Simpson Lamichhane

Graduate Student
University of Idaho
lami6023@vandals.uidaho.edu

Matt Lyman

Transportation Engineer 3
WSDOT
2714 N Mayfair St
Spokane, WA 99206
509-324-6266
lymanM@wsdot.wa.gov

Scott Malone

Engineer Manager 2
Idaho Transportation Department
216 S Date Street
Shoshone, ID 83352
208-886-7804
scott.malone@itd.idaho.gov

Chip McCallum

Director of Business Development
TenCate Geosynthetics Americas
365 South Holland Drive
Pendergrass, GA 30567
770-932-2826
C.Mccallum@Tencategeo.com

Leslie McCarthy

Associate Professor
Villanova University
Villanova, PA 19085
leslie.mccarthy@villanova.edu

Myron McCarty

Streets Dept
City of Heyburn
941 18th St / PO Box 147
Heyburn
Heyburn, ID 83336
208-679-8158
apclerk@heyburn.id.gov

Jack McCoy

Western States Equipment
Company
jack.mccoy@wseco.com

Drew Meppen

Engineer Manager
Idaho Transportation Department
206 Yellowstone Hwy
Rigby, ID 83442-5160
208-745-5627
drew.meppen@itd.idaho.gov

Marti Miller

Project Manager - Division of Public Works
Division of Public Works/State of Idaho
502 N. 4th Street
Boise, ID 83702
208-332-1920
marti.miller@adm.idaho.gov

Debakanta Mishra

Assistant Professor
Boise State University
Civil Engineering
1910 University Drive
Boise, ID 83725-2060
208-426-3710
debmishra@boisestate.edu

Timothy Morgan

Director of Transportation Materials Testing & Inspection
2791 S. Victory View Way
Boise, ID 83709
208-376-4748
morgant@mti-id.com

Ahmed Muftah

Post-Doc
University of Idaho
muft3556@vandals.uidaho.edu

Engineer

Hodge & Associates, Inc.
405 S Washington
Moscow, WA 83843
208-882-3520
hodge@moscow.com

Derek Noyes

Staff Engineer
Idaho Transportation Department
206 Yellowstone Hwy
Rigby, ID 83442-5160
208-745-5683
derek.noyes@itd.idaho.gov

Anson Parke

Streets Department Manager
City of Heyburn
941 18th St / PO Box 147
Heyburn
Heyburn, ID 83336
208-679-8158
apclerk@heyburn.id.gov

Ned Parrish

Research Program Manager
Idaho Transportation Department
P.O. Box 7129
Boise, ID 83707-1129
208-334-8296
ned.parrish@itd.idaho.gov

John Perfect

3460 Greenwich Road
Coeur d'Alene, ID 83815
208-664-4630
jolero@gmail.com

Jason Perry

Project Manager
Interstate Concrete and Asphalt
8849 W Wyoming ave
Rathdrum, ID 83858
208-765-1144
jason.perry@interstate-ica.com

Erik Peterson

Utility Technician

Nuri Nimmer

58th Idaho Asphalt Conference – October 24-25, 2018

Attendance List

City of Moscow Engineering
221 E. Second St
Moscow, ID 83843
208-883-7034
scollins@ci.moscow.id.us

Jeremie Pettingill

Staff Engineer

Idaho Transportation Department
206 Yellowstone Hwy
Rigby, ID 83442-5160
208-745-5315
jeremie.pettingill@itd.idaho.gov

Kyle Rainer

Engineering Technician

City of Moscow Engineering
221 E. Second St
Moscow, ID 83843
208-883-7034
scollins@ci.moscow.id.us

Dave Richards

Technical Engineer

Idaho Transportation Department
3311 W State St
Boise, ID 83703
208-334-8448
Dave.Richards@itd.idaho.gov

Sayed Sadeghi

Graduate Student

University of Idaho
hsadeghi@uidaho.edu

Mike Santi

Idaho Transportation Department
mike.santi@itd.idaho.gov

Alan Scharbrough

supervisor

Payette County
3894 NW 1st Ave
New Plymouth, ID 83655
208-278-3402
alans@payettecounty.org

Kelly Schild

URETEK
kellyschild@gmail.com

Shaun Scott

Staff Engineer

Idaho Transportation Department
3311 W. State Street
Boise, ID 83703
208-332-7161
shaun.scott@itd.idaho.gov

Patrick Severance

Development Review Supervisor

City of Lewiston.org
PO Box 617
215 D Street, Suite B
Lewiston, ID 83501
208-746-1316
shood@cityoflewiston.org

Eric Shanley

Director of Highways

Lakes Highway District
11341 N Ramsey Road
Hayden, ID 83835
208-772-7527
bonny@lakeshighwaydistrict.com

Sunil Sharma

Professor

University of Idaho
Moscow, ID 83844

Brett Siweck

Engineer

Mead & Hunt, Inc.
330 E Main St
Ste B
Pullman, WA 99163
707-284-8673
brett.siweck@meadhunt.com

Robert Smith

Staff Engineer

State of Idaho - Transportation
Department D6 Rigby, ID
206 N Yellowstone Ave

Rigby, ID 83442

208-745-5663
robert.smith@itd.idaho.gov

Nathanael Snyder

Construction

Interstate Concrete And Asphalt
1000 baldy mountain rd
sandpoint, ID 83864
208-255-3697
nathanael.Snyder@interstate-ica.com

Scot Stacey

Engineer Manager 1

Idaho Transportation Department
216 S Date Street
Shoshone, ID 83352
208-544-7901
scot.stacey@itd.idaho.gov

Gene Staggs

TESL

Idaho Transportation Department
5151 South 5th Avenue
Pocatello, ID 83204
208-234-3612
gene.staggs@itd.idaho.gov

Chase Steigers

E.I.T

J-U-B Engineers, Inc.
846 6th Street
Clarkston, WA 99403
509-254-6011
csteigers@jub.com

58th Idaho Asphalt Conference – October 24-25, 2018

Attendance List

Nate Suhr

Senior Engineering Technician
City of Moscow Engineering
221 E. Second St
Moscow, ID 83843
208-883-7034
scollins@ci.moscow.id.us

Al Turner

Mead & Hunt, Inc.
al.turner@meadhunt.com

Shawn Turpin

Senior Geotechnical Engineer
ALLWEST Testing & Engineering
2705 E Main Street
Lewiston, ID 83501
208-743-5710
sturpin@allwesttesting.com

Rik Van Gelder

Engineering Tech
Lakes Highway District
11341 N Ramsey Road
Hayden, ID 83835
208-772-7527
bonny@lakeshighwaydistrict.com

Steve VanDebogert

Western States Asphalt
svandebogert@wsasphalt.com

Cody Vezina

IA Inspector
Idaho Transportation Department
5151 South 5th Avenue
Pocatello, ID 83204
208-239-3326
sharon.short@itd.idaho.gov

Haifang Wen

Associate Professor of Civil & Environmental Engineering
Washington State University
PO Box 642910
Pullman, WA 99164-2910
509-335-4602
haifang_wen@wsu.edu

Mark Wheeler

Technical Engineer
Idaho Transportation Department
3311 W State St
Boise, ID 83703
208-334-8887
Mark.Wheeler@itd.idaho.gov

Samuel Williams

Construction
Interstate Concrete And Asphalt
1000 baldy mountain rd
Sandpoint, ID 83864
208-255-3697
Samuel.Williams@interstate-ica.com

Denice Wright

TESL
Idaho Transportation Department
5151 South 5th Avenue
Pocatello, ID 83204
208-234-3605
denice.wright@itd.idaho.gov

Doug Yearsley

Staff Engineer
Idaho Transportation Department
216 S Date Street
Shoshone, ID 83352
208-886-7830
Doug.Yearsley@itd.idaho.gov

Janet Zarate

Staff Engineer
Idaho Transportation Department
PO Box 837
Lewiston, ID 83501
208-799-4243
D2Admin@itd.idaho.gov

Dave Zhai

Idaho Asphalt Supply

Muhammad Zubery

Federal-aid Engineer
LHTAC
3330 Grace Street
Boise, ID 83703
208-344-0565
mzubery@lhtac.org

Warm Mix Asphalt: Leveraging the Benefits

Leslie Myers McCarthy, Ph.D., P.E.

Associate Professor of Civil Engineering, Villanova University



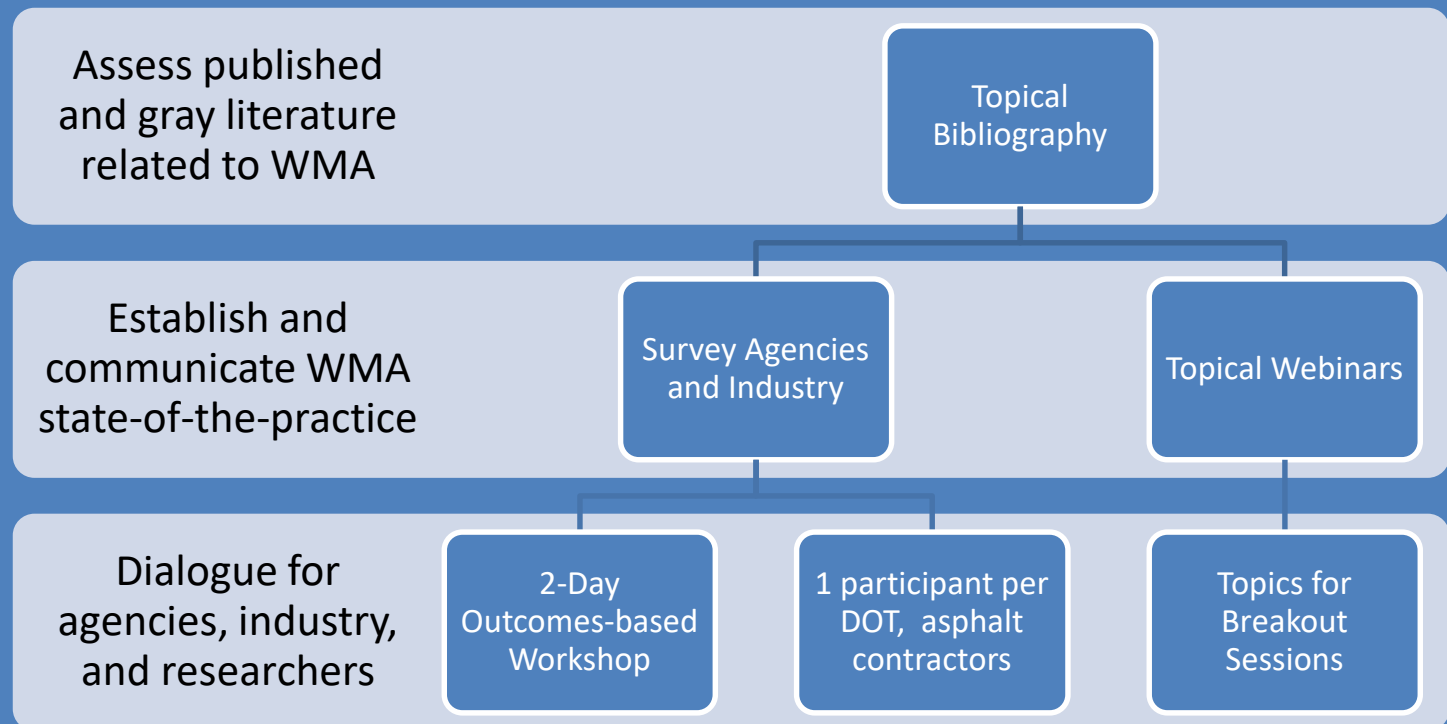
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NCHRP Project 20-44(01):

Increasing WMA Implementation by Leveraging the State-of-Knowledge

Project Approach



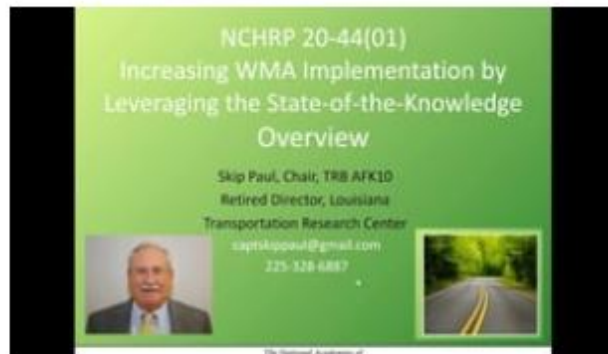
Warm Mix Briefs

Available online at:

<http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectI>

NCHRP Project 20-44: Increasing WMA Implementation by Leveraging the State-of-the-Knowledge

Sort: [Preset](#) | [Date](#) | [Alphabetical](#) | [Plays](#) | [Likes](#) | [Comments](#) | [Duration](#)



Introduction to NCHRP Series

1 week ago



NCHRP Project 20-44, Module 1: Overvie...

1 month ago



ALBUMS

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243 Collections

1 Following

Survey of Agencies and Industry

Establish the State-of-the-Practice:

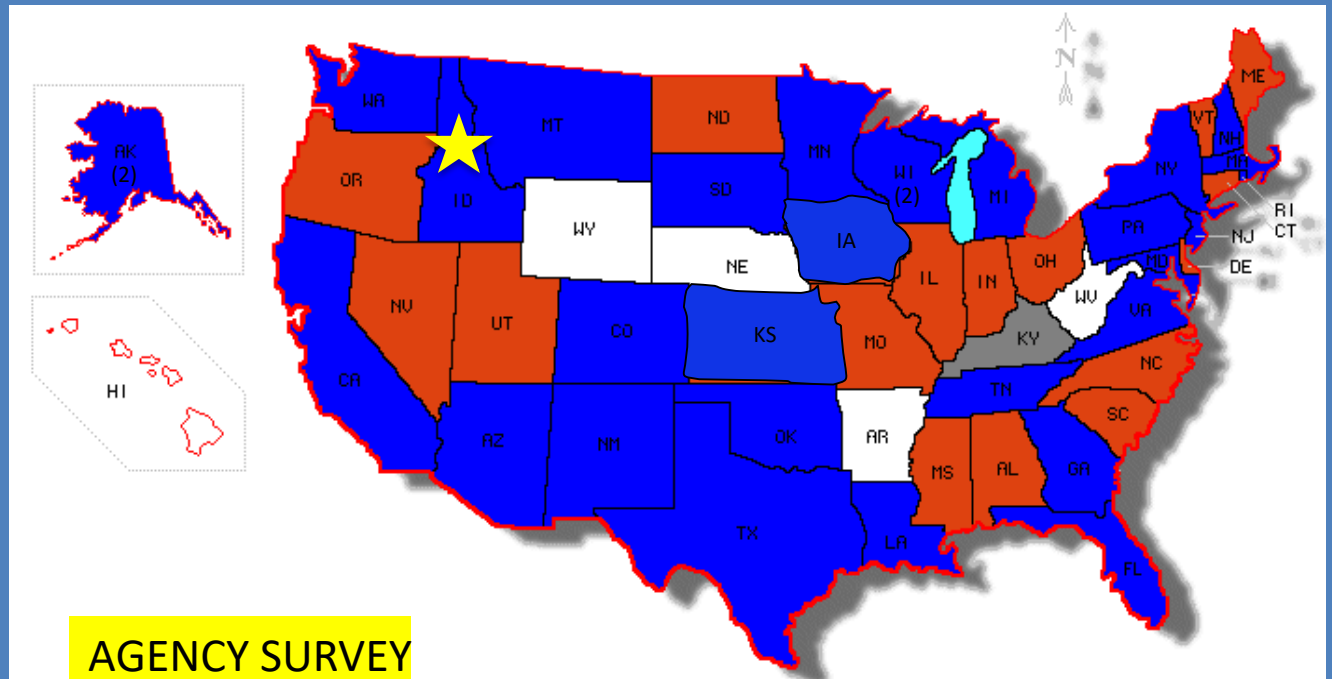
- Definitions of WMA
- Practices related to use and performance of WMA
- Identify barriers to better adoption of tools for WMA implementation
- Identify observed or perceived challenges to increased usage of WMA
- Identify best management practices (BMPs) for successful use of WMA on paving projects



Survey: Idaho Responses (2017)

Key Points:

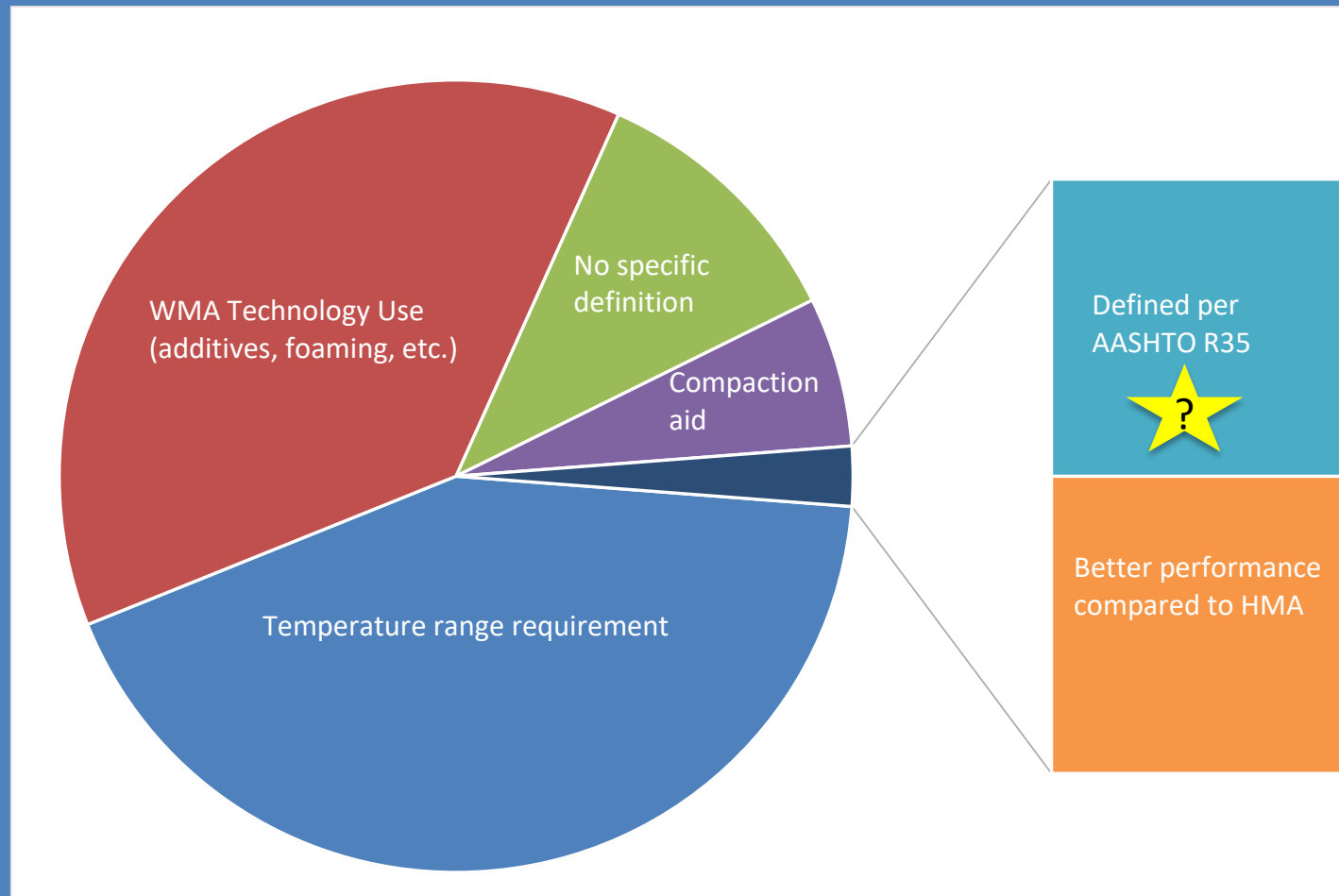
- WMA reported to be < 10% of total asphalt proportion in 2016
- Interest in continuing education programs
- Allow contractor's choice for WMA rather than specifying its use
- Incorporate procedures to show WMA is not that different than HMA



What really is Warm Mix Asphalt?

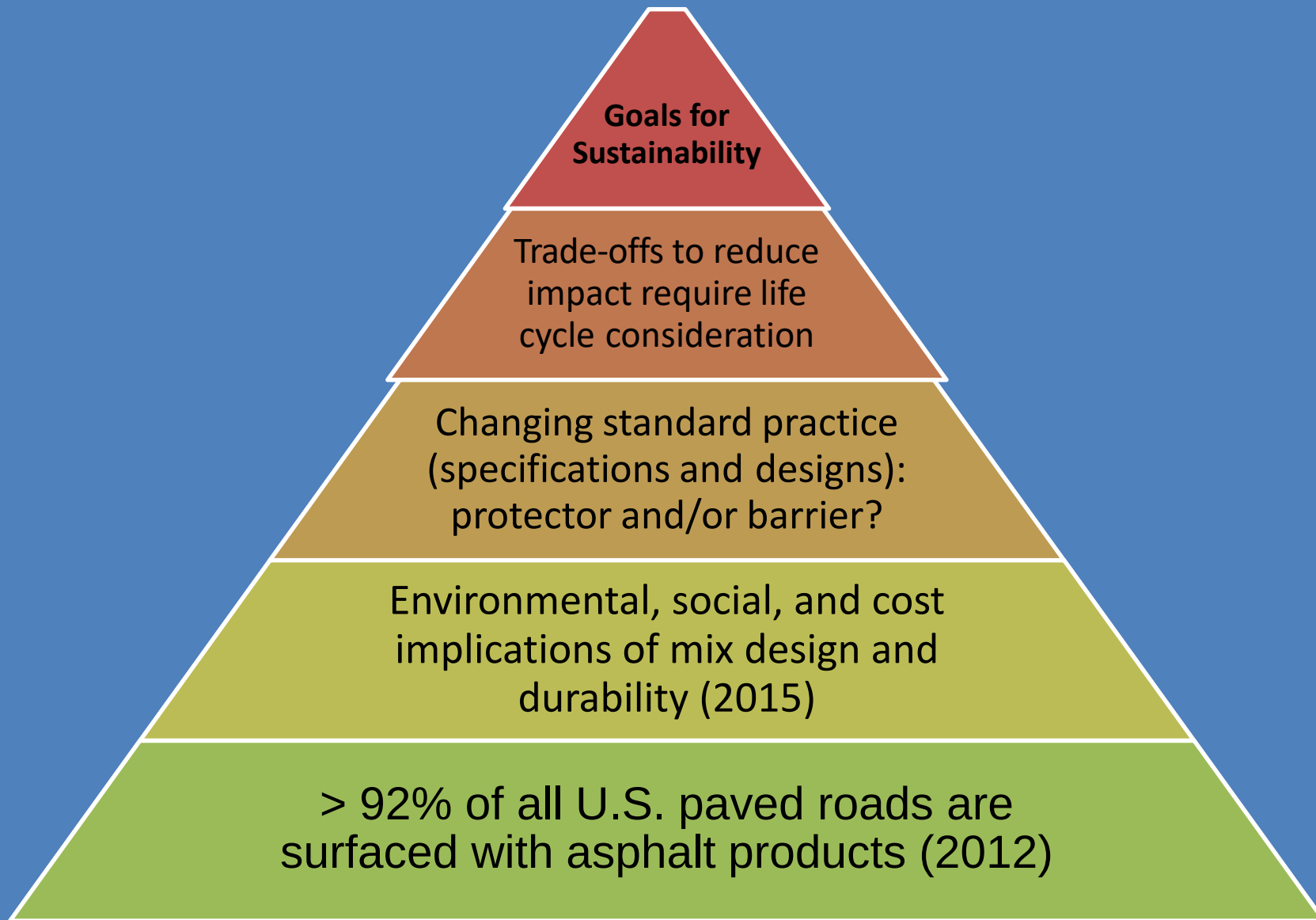
Agency survey revealed...

55 agencies - - 51 different definitions for WMA



Why Capture WMA Usage ?

For Consideration...

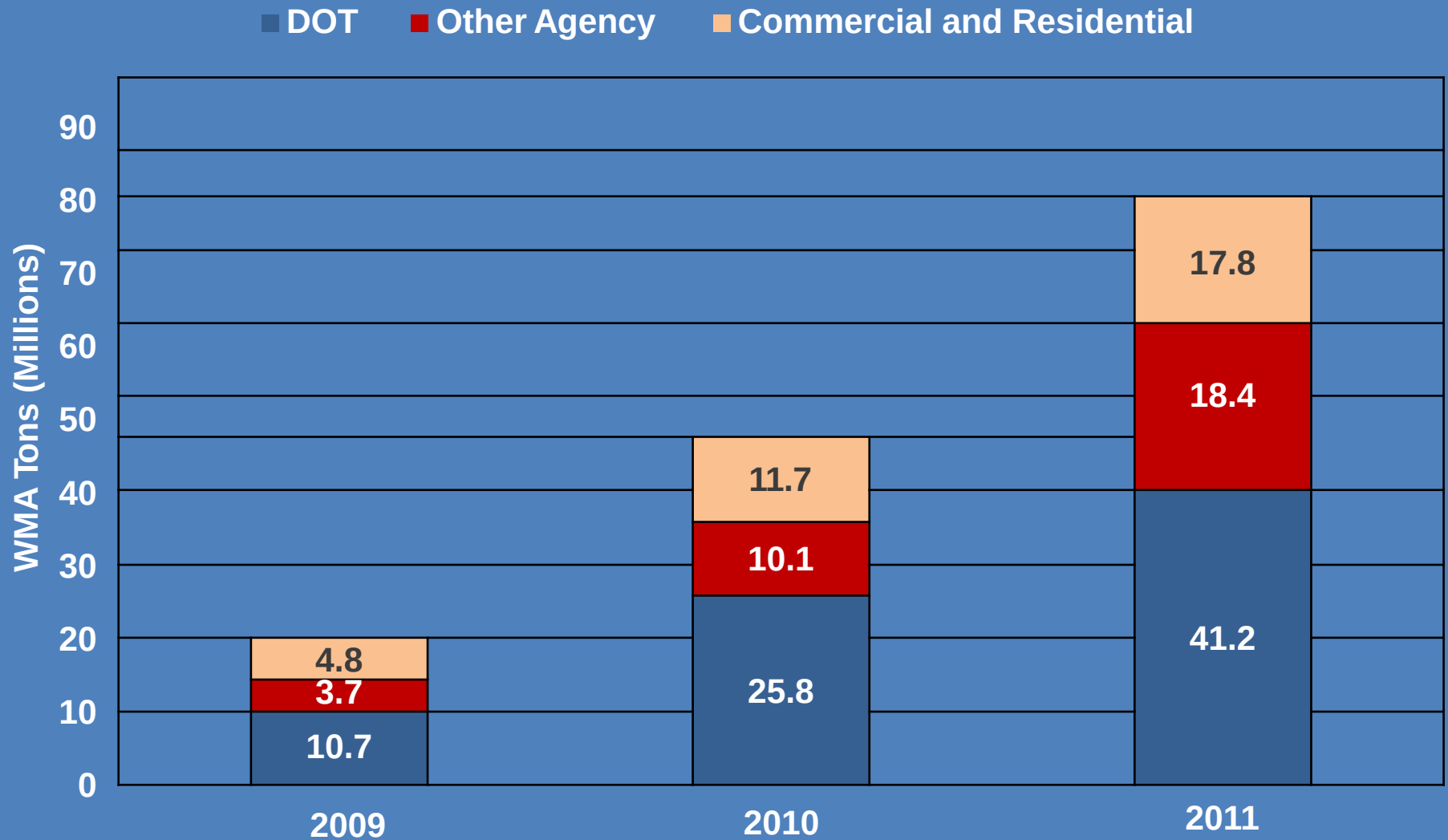


Driving Factors for Warm Mix Asphalt

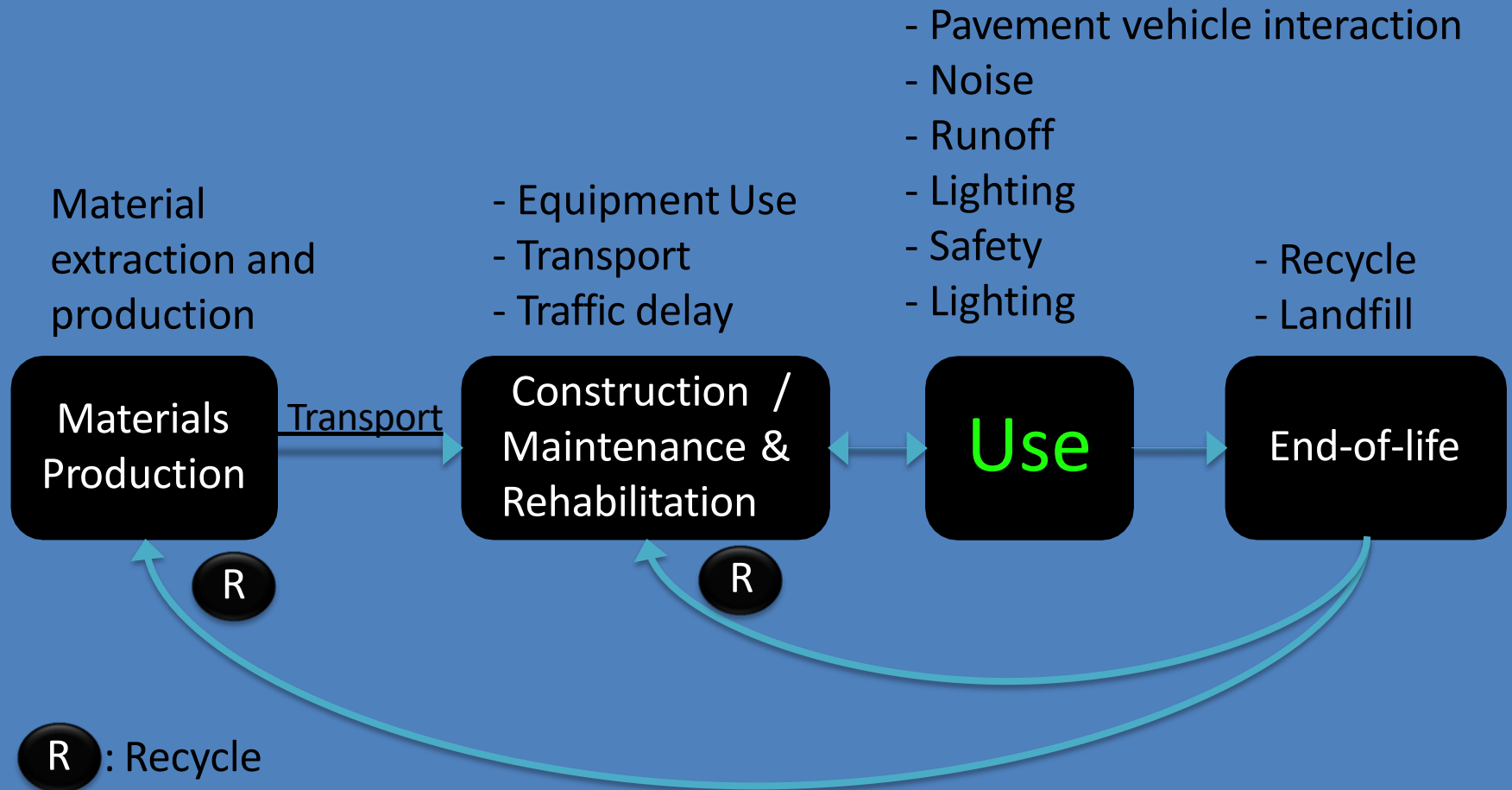
- Environmental & societal concerns
 - NIMBY
 - Reduce haul distances by opening WMA-only plants with reduced temperatures (encourages use of local materials)
- Sustainable development
 - Increase material performance and time between future maintenance and rehabilitation treatments
- Green construction
 - Easily combined with recycled materials
- Reduction of energy consumption
- Reduction in CO₂ emissions
- Reduced worker exposure
 - Faster compaction “get in, get out, stay out”
- Extension of construction season
 - Faster project delivery
 - Reduced user delay costs over time



Increased Use of WMA in US



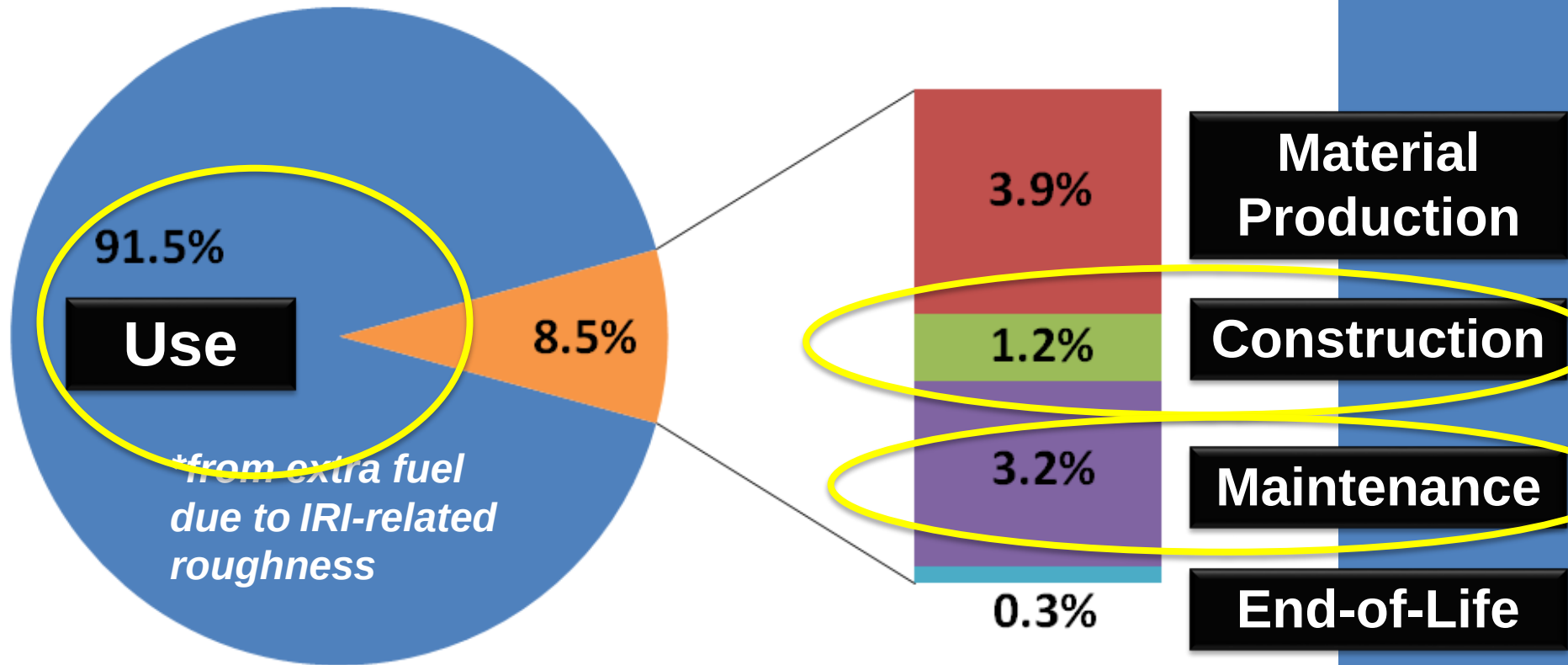
Pavement Life Cycle



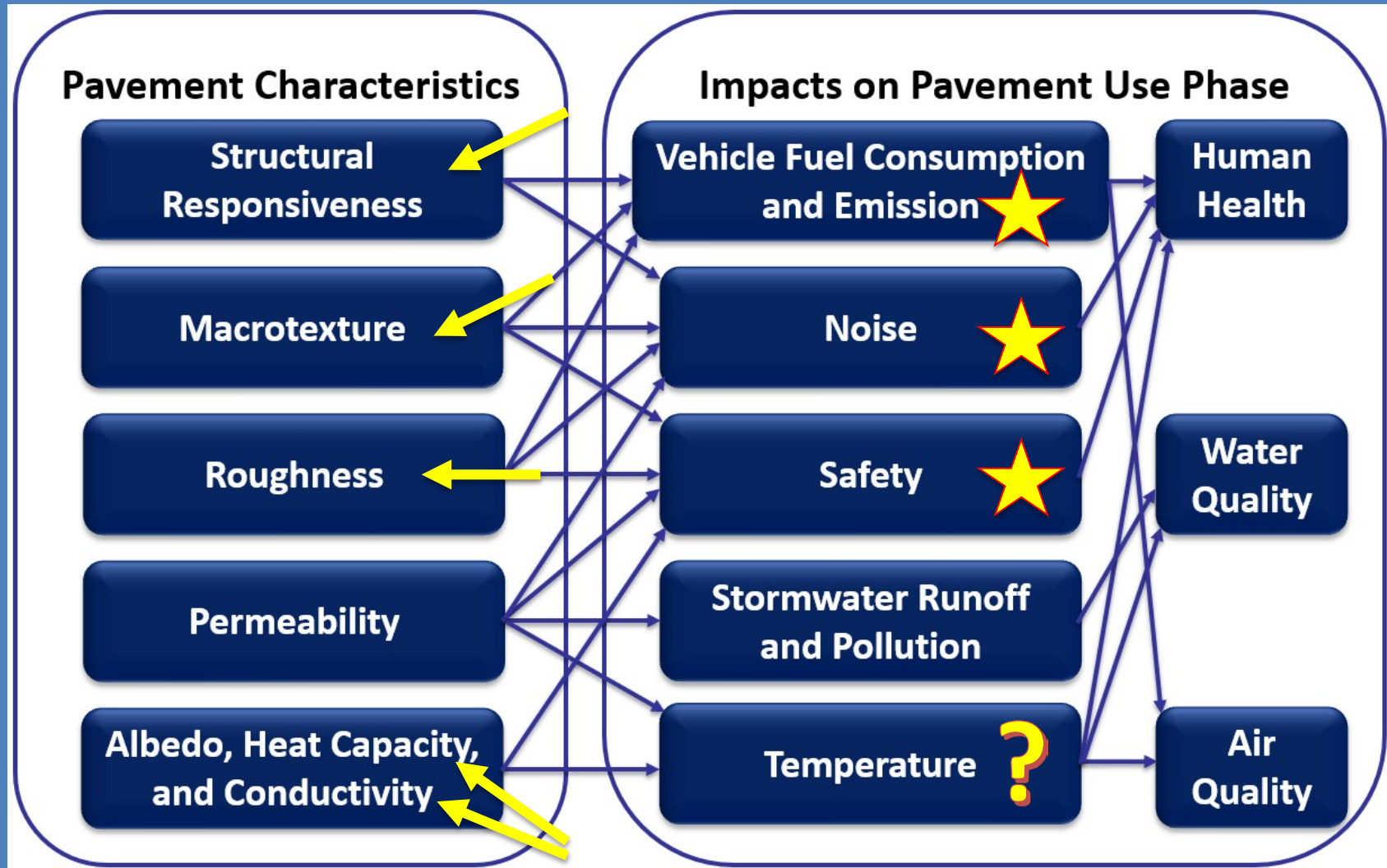
From: Kendall et al, 2010

No Temperature Drop? No Effect?

Energy Consumed in an Asphalt Pavement Life Cycle (from FHWA 2015)



WMA & the Use Phase



From: FHWA, 2015

Driving Factors for Warm Mix Asphalt:

Without Temperature Reduction

- Environmental & societal concerns
 - Reduce haul distances by opening WMA-only plants with reduced temperatures (encourages use of local materials)
- Sustainable development
 - Increase material performance and time between future maintenance and rehabilitation treatments
- Green construction
 - Easily combined with recycled materials
- Reduction of energy consumption
 - Less compactive effort, drop one roller compactor
- Reduction in CO₂ emissions
- Reduced worker exposure
 - Faster compaction “get in, get out, stay out”
- Extension of construction season
 - Faster project delivery
 - Reduced user delay costs over time



IDEAS for IDAHO

The Challenges...

Agencies

- Limitations with existing specifications
 - Temperature requirements
 - Prescriptive or permissive specifications
 - *Neither type rewards innovation*
- Limitations on allowable technologies

Contractors

- Lack of incentives within existing bid environment
 - *Lowest bid price wins project*
- Logistics of plant production for various customers

Other

- Lack of effective technology transfer tailored to the right audiences
- Long term performance and/or track record not available for all WMA technologies

No cohesive leadership → no motivation!

Production & Construction Challenges

- Fear of the unknown or change to existing techniques, lack of experience with materials
- Aggregate moisture concerns & condensation in silos or baghouses
- Switching between HMA and WMA in production
(different customers = different requests)





Review Bidding Environment

- Provide incentives for using WMA
 - If there is an incentive, verify use of WMA
 - Bid review includes technical points for use of WMA, which could offset the cost of additives & production changes (which results in higher bid costs)
- Create a WMA specific bid or line item
- Challenges with realizing full savings in a low-bid environment
 - Economic advantages may be understated if full production, placement, and performance aren't considered



The Solutions...



More effective training documents for target audiences

★ Short online videos, 1-pg targeted briefing documents

Don't use method or permissive specifications

★ Shift to end-result or performance-based specs

Create case studies & a process for agencies to collaborate

★ Tie into or expand asset management database for WMA

★ Repository for approved product lists and technology updates

★ Clearly communicate benefits for local agencies & contractors





WMA in Idaho: Today,... in the Future?

Considerations...

- Is a guide specification enough? WMA item called out specifically?
- Loosen up the spec, incentivize the contract (LEED-type credits)?
- How do local agencies procure asphalt mix?
- What contract types are available for local agencies to use WMA?
- Is the state's APL clearly written for local agencies to access?
- What should the performance criteria be for other spec types?



IDEAS:

- Cooperative efforts at the regional level to track impact (project lists)
- Long term impacts disseminated on fact sheets through LTAP/APA
- Communication between departments within an agency
- Environmental benefits/impacts - joint effort between agencies, contractors, academia
- Database platform and integration for effective monitoring
- Performance metrics: penalties/incentives paid, density, smoothness, public complaints
- Monitor cost savings: equipment use, work zone duration, etc.

EXAMPLE: Quantifying Traffic Delays

Energy and emissions contribution of traffic delays, due to construction activities

➤ *Often ignored in pavement LCAs*

Impact on environment, due to traffic delays, may be quantified using appropriate tools:

- ❖ Traffic simulator to estimate driving schedule under changing roadway capacity
- ❖ EPA's MOVES software to calculate additional emissions and energy consumption with changing driving schedules

Vehicle Emissions Simulations

EPA's MOVES

- Emission modeling system for mobile sources
- Energy consumption
- Emissions to air
 - 120+ emissions



EPA's NONROAD

- Emission modeling system for non-road equipment
- Energy consumption
- Emissions to air
 - HC, CO, NO_x, PM, SO₂, and CO₂



From: FHWA, 2015



LCA Inventory Database

- ✓ Construction equipment
- ✓ Hauling
- ✓ Total use-phase traffic emissions
- ✓ Road related use-phase traffic emissions
- ✓ Congestion & work zone-related emission inventories

Take Idaho 53 for example...

Near Rathdrum, Idaho

Review ITD Road Data

- Heavy truck count?
- Closest asphalt plant?
- Maintenance schedule?
- Pavement condition history?

Road Data

Traffic Counts Maps - GIS CADD Pavement Management

A Brief History of Idaho Pavement Management

In 1977, the Idaho Transportation Department began a review of existing pavement management programs with the goal of adopting one to fit Idaho's needs. The department acquired a Pavement Performance Management Information System (PPMIS) and made it operational on ITD's mainframe computer. From 1978, the ITD steadily improved and modified it to meet specific conditions in Idaho. It was tested and refined by both ITD and consultant contract. By 1986, it was able to perform simplistic economic optimization.

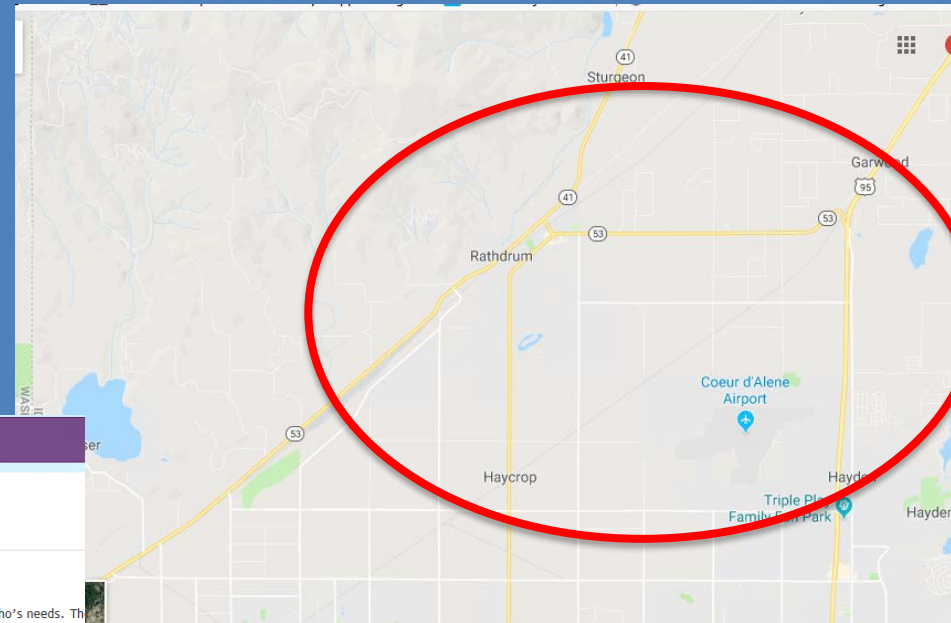
In 2007, ITD began running our pavement data through the HERS-ST (Highway Economic Requirements System, STate model), at <http://www.fhwa.dot.gov/infrast/hersindex.cfm>. This online software from FHWA uses pavement deterioration curves to predict pavement behavior. However, the HERS-ST model results had to be manipulated by hand in order to meet the conditions of Idaho weather, terrain and other factors, which was a painstaking process.

The new PMS System

In 2009, ITD purchased a pavement management and maintenance management software package. This new software housed a pavement management system (PMS) and a maintenance management system (MMS) to work in tandem as part of the Department's long-term vision for asset management. This software contains a robust database that houses several kinds of data, such as bridges, maintenance activities, pavement condition, traffic data, skid data, R-values, boring logs and several others.

The Pavement Management System (PMS) has allowed ITD to refine the way we calculate and analyze data, by:

- implementing new pavement performance curves calibrated by ITD engineers
- implementing decision trees that mimic District engineering choices



Idaho SR53: Case Study for WMA?

Near Rathdrum, Idaho

❖ Maintenance history & condition ratings

- Top-down cracking in wheel paths?
- ✓ WMA = better compaction, less susceptible to TDC

SR-53 Candidate for Tracking Performance of WMA...

- Cost (bid, construction, etc.)
- Haul distance
- Time for constr./user delays
- Compaction information
- Monitor performance, and manual maintenance schedule
- Public complaints & noise
- Safety and IRI over time



NEXT STEPS

- Outreach ideas
 - Provide basic training materials to LTAP
 - Community of practice for WMA users (industry & public and commercial sectors)
 - Grant programs
 - Chief Engineer & District secretary presentations, IAA, other target audiences (pavement preservation & user/producer groups)
 - Contractor outreach/education to customers
 - Local agency coordinators at DOT and construction/maintenance decisionmakers

Talk with your DOT – your thoughts count!

Thank you!!

**Idaho Asphalt Contractors & Suppliers
Idaho Transportation Department
University of Idaho!**



Leslie McCarthy, Ph.D., P.E.
Associate Professor of Civil Engineering
Villanova University
Leslie.mccarthy@villanova.edu

Idaho Asphalt Conference

Moscow, ID

October 25, 2018

Superpave5

Superpave Design at Five Percent Air Voids

Gerry Huber
Heritage Research Group

Marshall Mix Design

- Design Air Voids 3-5%

Construction (8%)

- Field Compaction
 - 8% after rolling
 - 4% after traffic

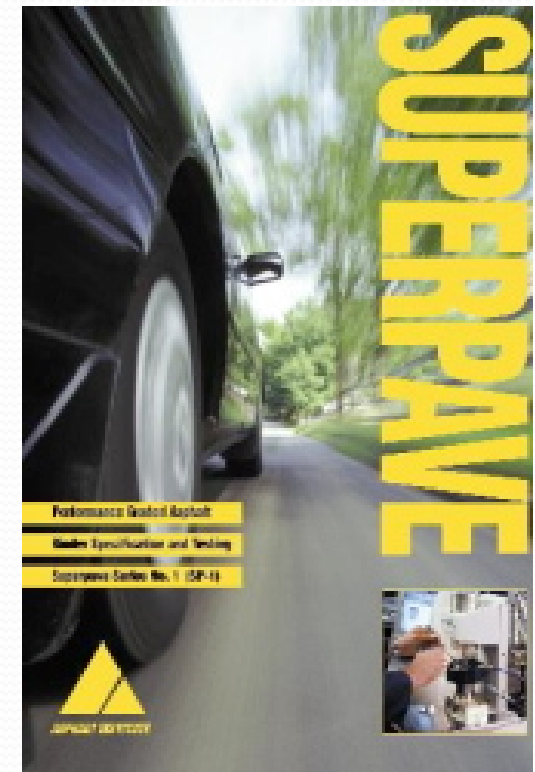
Decreases to

Service Life (4%)

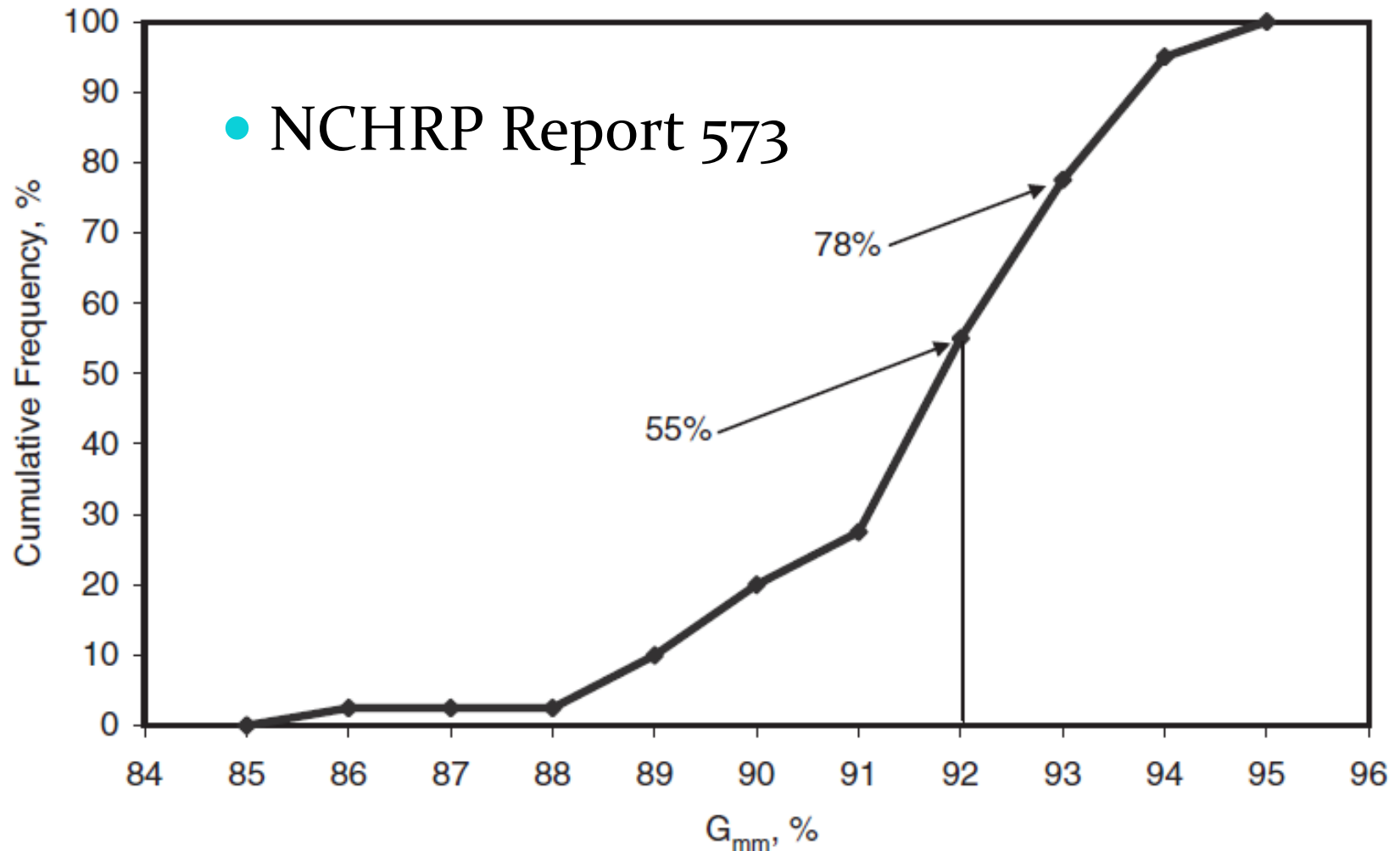


Strategic Highway Research Program

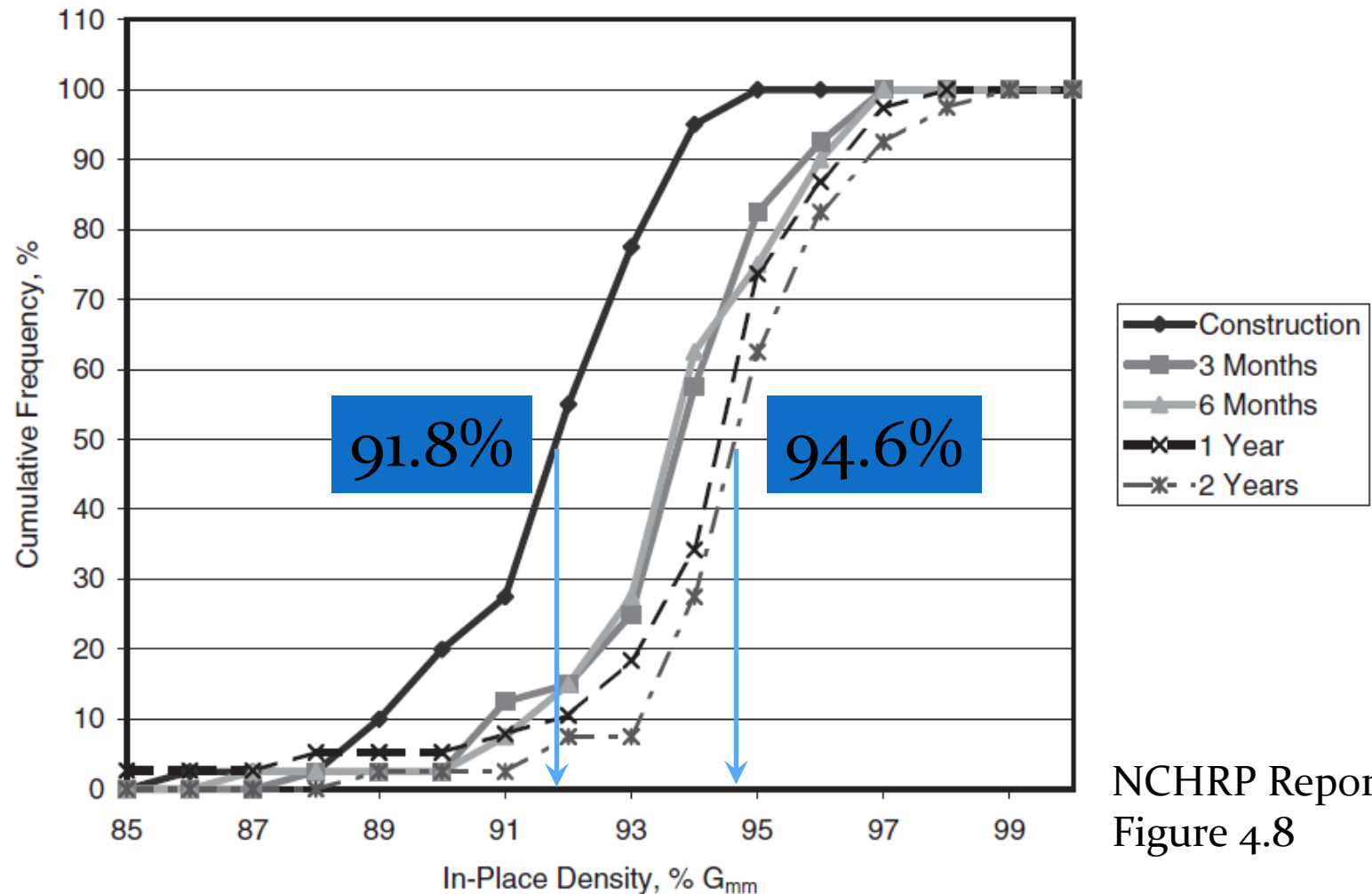
- “Marshall” carried forward
- Design air voids fixed at 4%
- Recommended compaction
 - Set at 92% Gmm



As-Constructed Air Voids



Typical Final Density



NCHRP Report 573
Figure 4.8

LCPC Developed Mix Design Method





Design to 5%



Construct to 5%

Performance Good



Superpave5

- Inspired by LCPC



Superpave 5 Concept

- Mix Design
5% air voids



- Field Compaction
95% Gmm



- No change in asphalt
content

Asphalt Content R

	Superpave 4		
NM	VMA	Voids	Vbe
10.0	15.0	4.0	11.0
12.5	14.0	4.0	10.0
19.0	13.0	4.0	9.0
25.0	12.0	4.0	8.0

Design Gyration Must Change

Purdue University Evaluated Engineering Properties

ESAL	Gyrations	Mixture Type	
		9.5-mm	19.0-mm
3-10 million	70	X	
	50	X	
	30	X	
10-30 million	70	X	X
	50	X	X
	30	X	X

Study Conclusions

- Designs at 4% Air Voids
And 93% Gmm Compaction

100 gyrations



- Designs at 5% Air Voids
And 95% Gmm Compaction

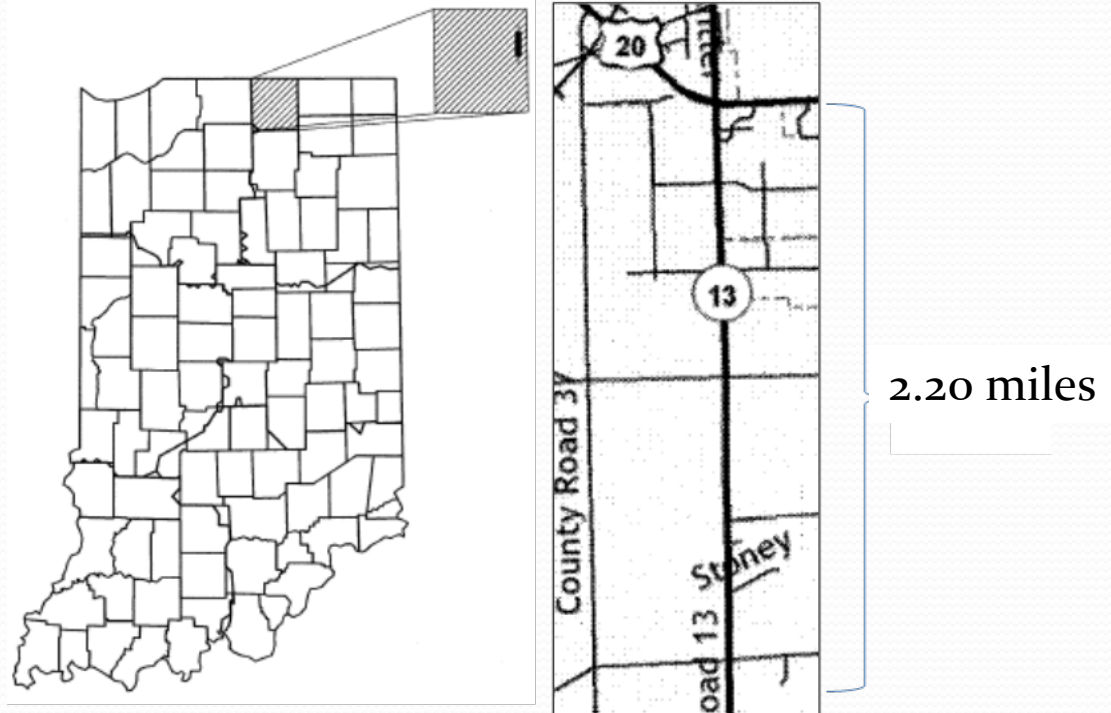
30 gyrations

Design Recommendations

- <3 million ESALs 30 gyrations
- 3 million to 30 million ESALs 50 gyrations
- ~~>30 million ESALs 70 gyrations~~

SR 13, Middlebury, Indiana

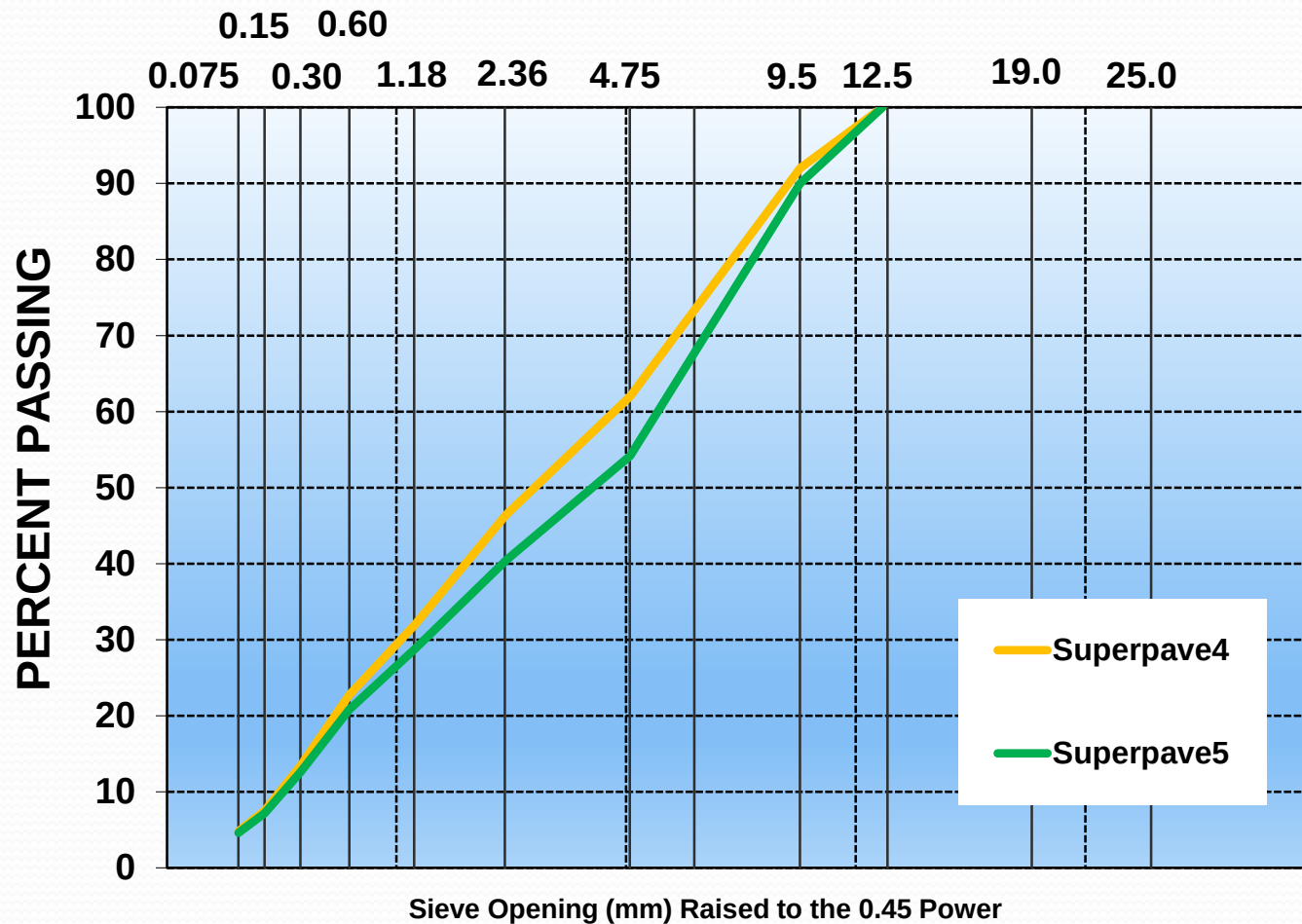
- 2013 Trial Project
 - 13,400 AADT
 - 19% heavy trucks



Mix Designs

	Superpave4	Superpave5
#11 Steel Slag	40	43
#12 Limestone	20	17
Stone Sand	15	18
Natural Sand	18	15
RAS (Shingles)	7	7

Gradation



Mix Designs

	Superpave4	Superpave5
#11 Steel Slag	40	43
#12 Limestone	20	17
Stone Sand	15	18
Natural Sand	18	15
RAS (Shingles)	7	7

	Superpave4	Superpave5
Gyrations	100	30
Asphalt Content	5.1%	5.4%
Recycled Binder Ratio	0.206	0.193
Air Voids	4.0	5.0
VMA	15.5	17.0



Counter-Flow Drum Mix Plant



Superpave4



Superpave5 Compaction

Mix Construction Properties

	Superpave4			Superpave5		
	Design	QC	QA	Design	QC	QA
Asphalt, %	5.1	5.1	5.0	5.4	5.5	5.2
Air Voids, %	4.0	3.5	4.1	5.0	4.5	4.0
Density, %Gmm	-	-	91.6	-	94.7	96.9

2018 Core Locations

Location	Superpave4	Superpave5
1	206+66	155+95
2	147+37	180+25
3	124+74	214+74

Project built June 2013



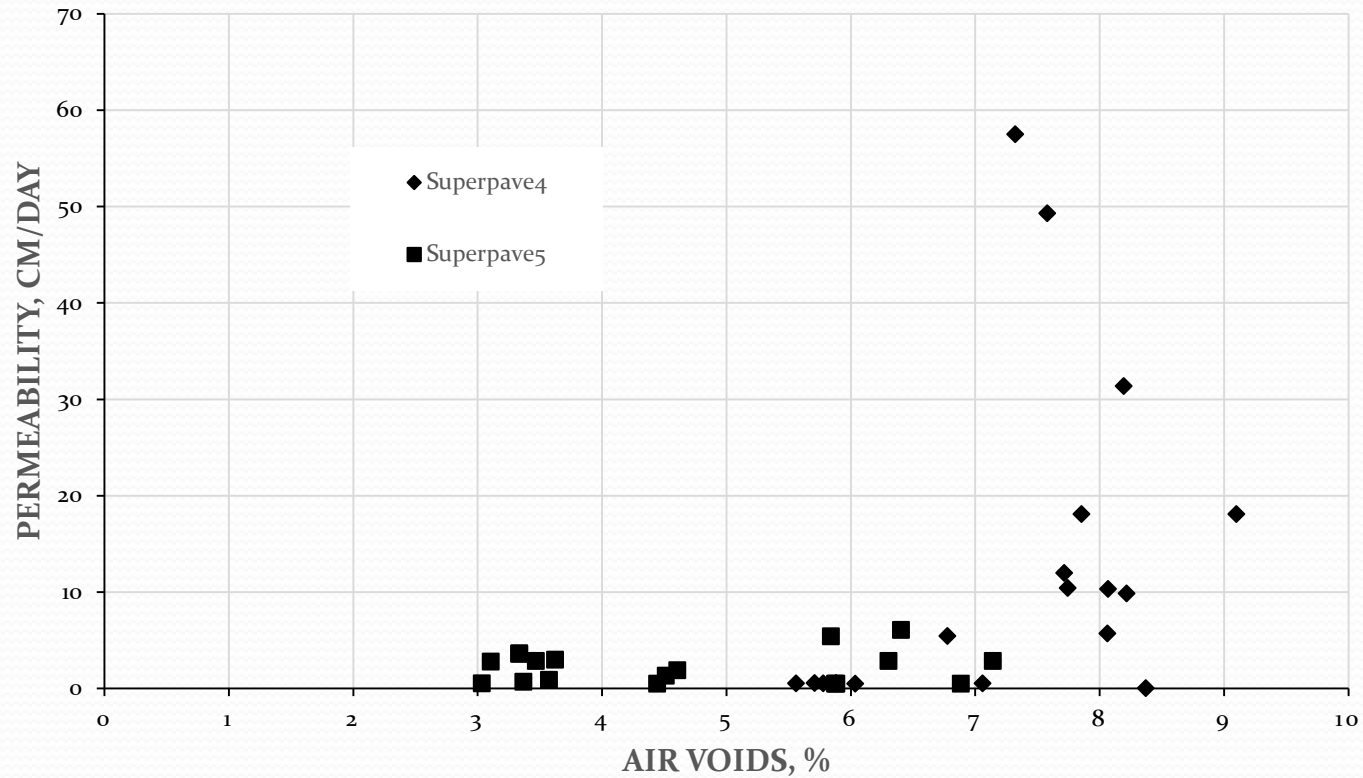
Six Cores At Each Location

Core Properties

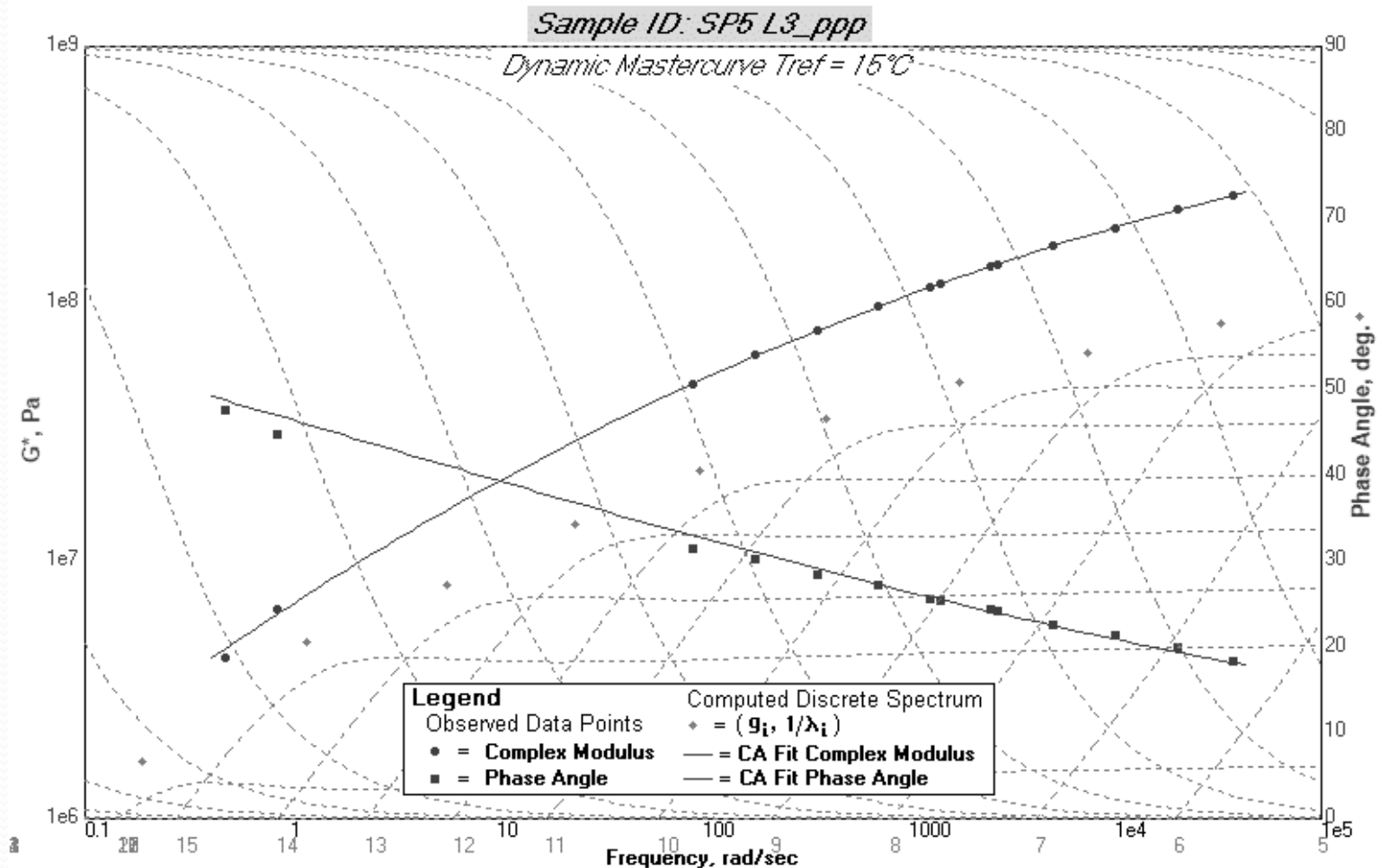
	Superpave4			Superpave5		
	Loc 1	Loc 2	Loc 3	Loc 1	Loc 2	Loc 3
Thickness, in.	1.47	1.48	1.36	1.39	1.43	1.69
Asphalt, %	5.34	5.35	5.56	5.67	5.36	5.82
Density, %Gmm	91.8	94.0	92.3	95.7	93.6	96.6

Average Values

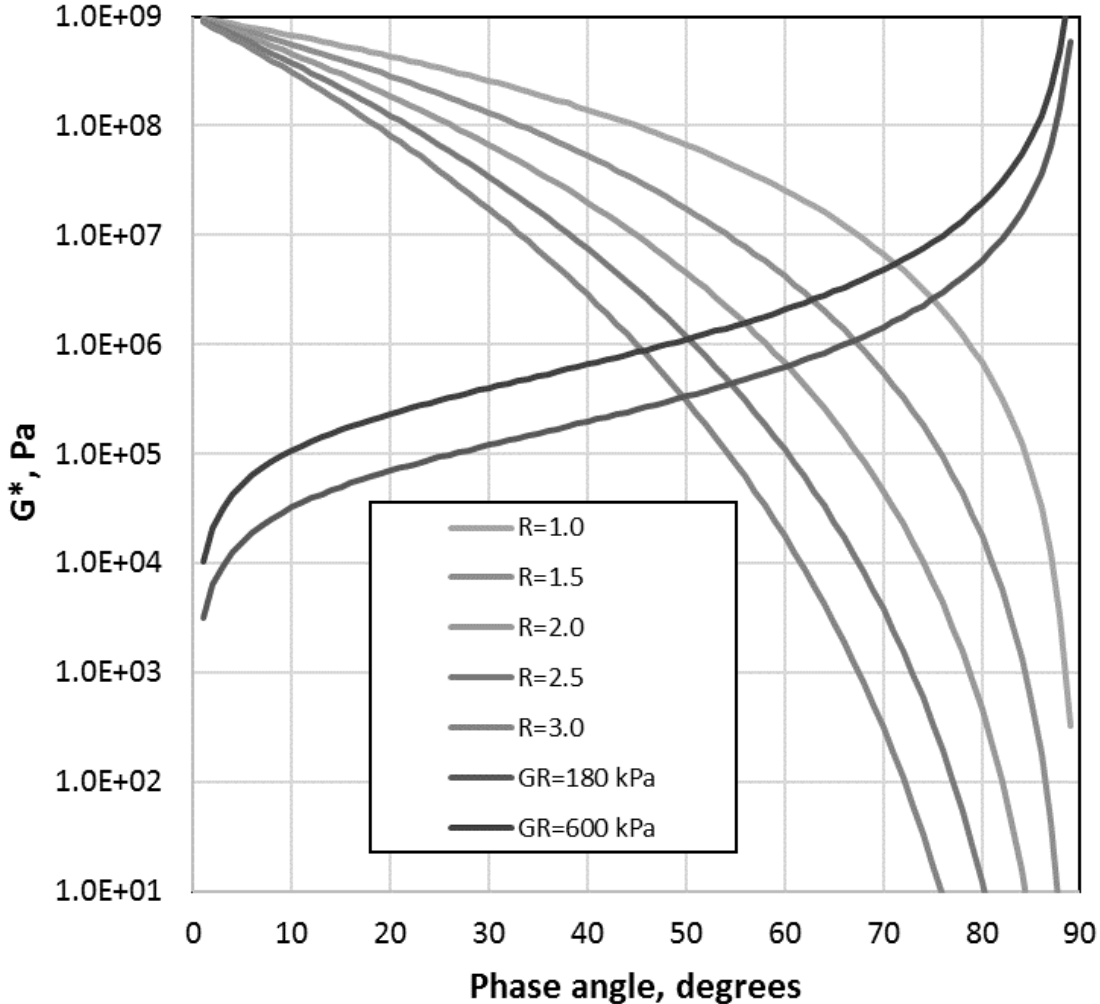
Permeability



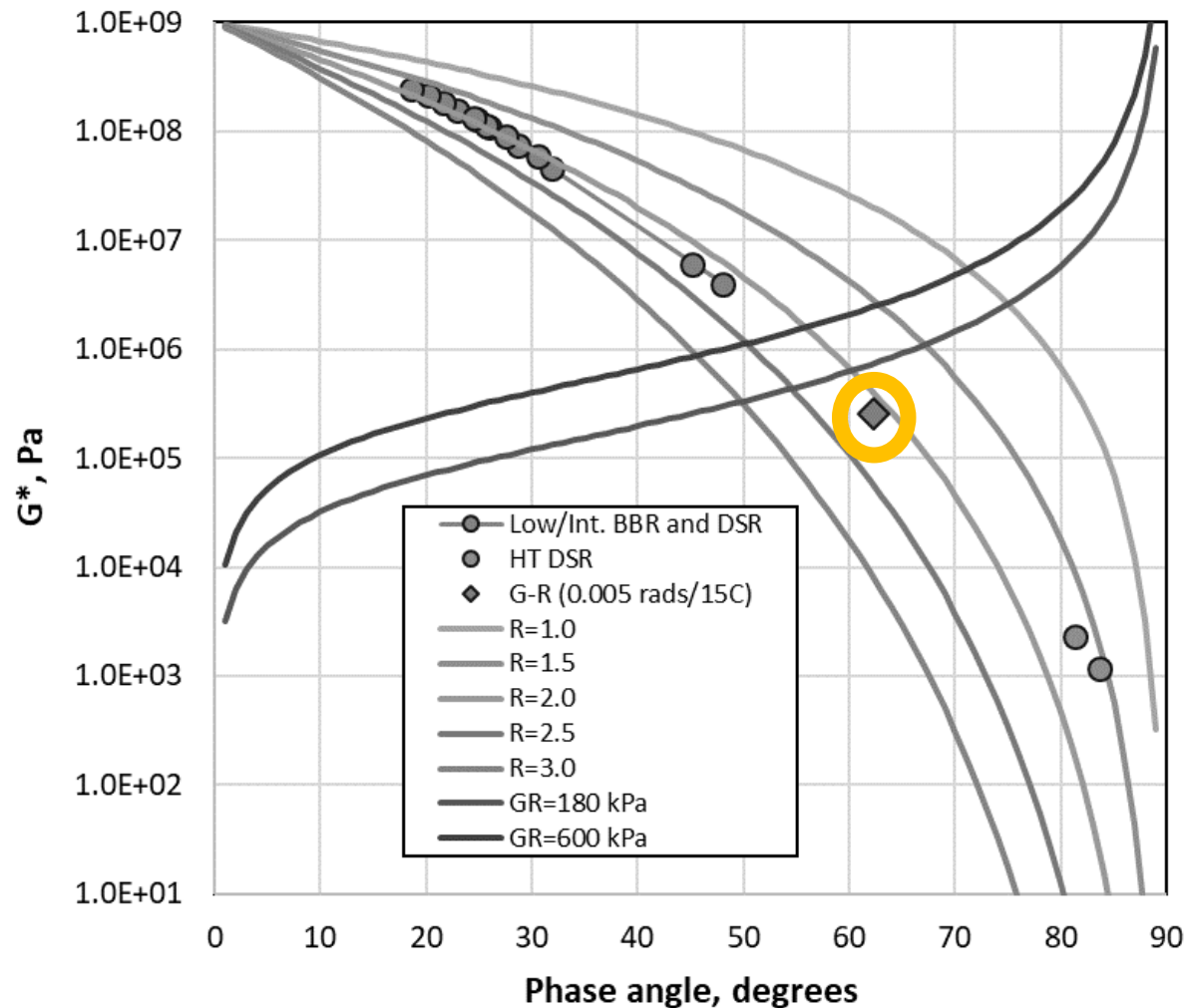
Recovered Binder Master Curve



Glover Rowe



Glover Rowe, SP5, Location 3



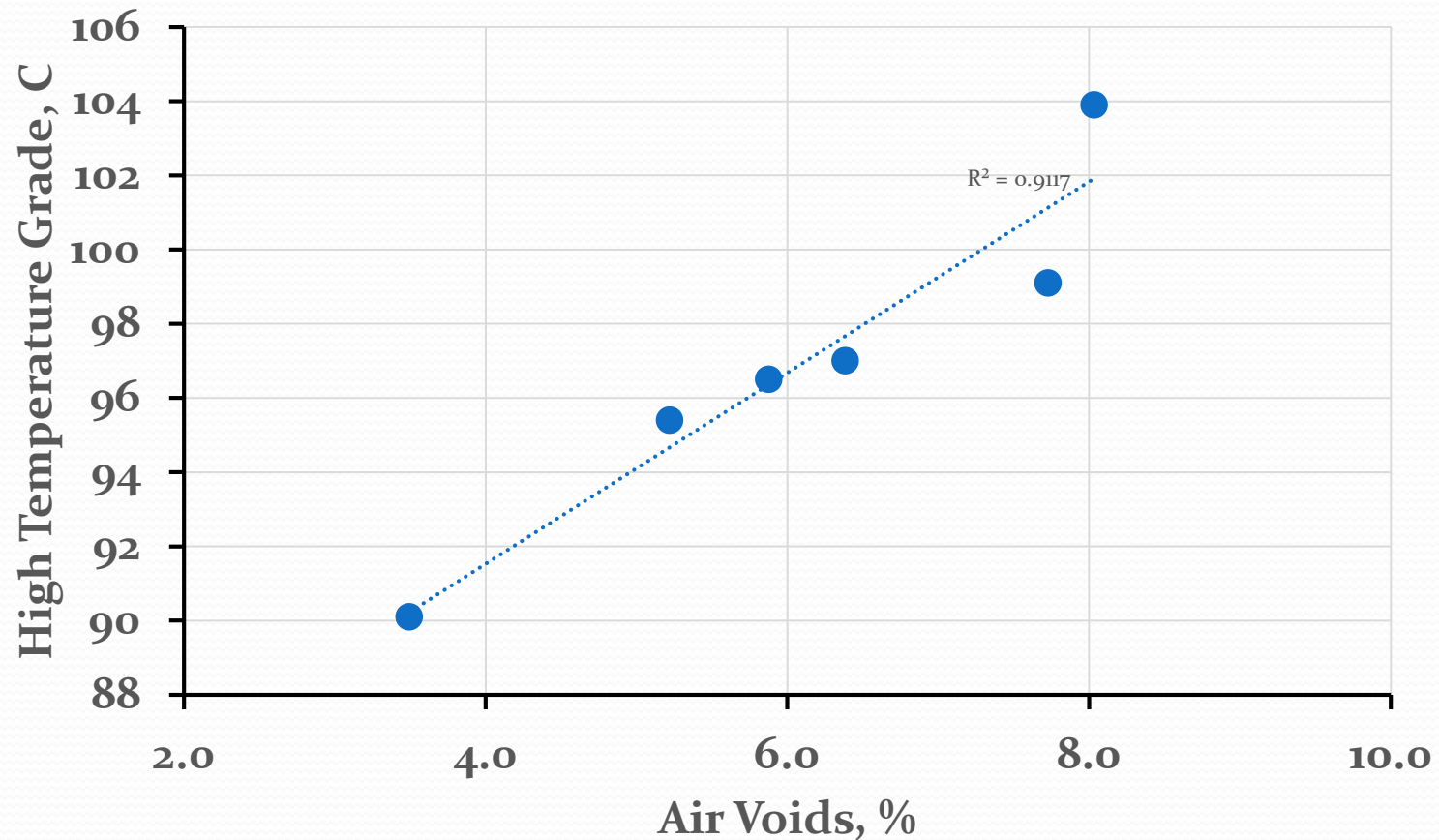
Glover Rowe Results

		Glover Rowe Value	Expected Performance
Superpave4	Location 1	880	Should crack
	Location 2	363	Might Crack
	Location 3	858	Should crack
Superpave5	Location 1	170	Should Not Crack
	Location 2	315	Might Crack
	Location 3	69	Should Not Crack

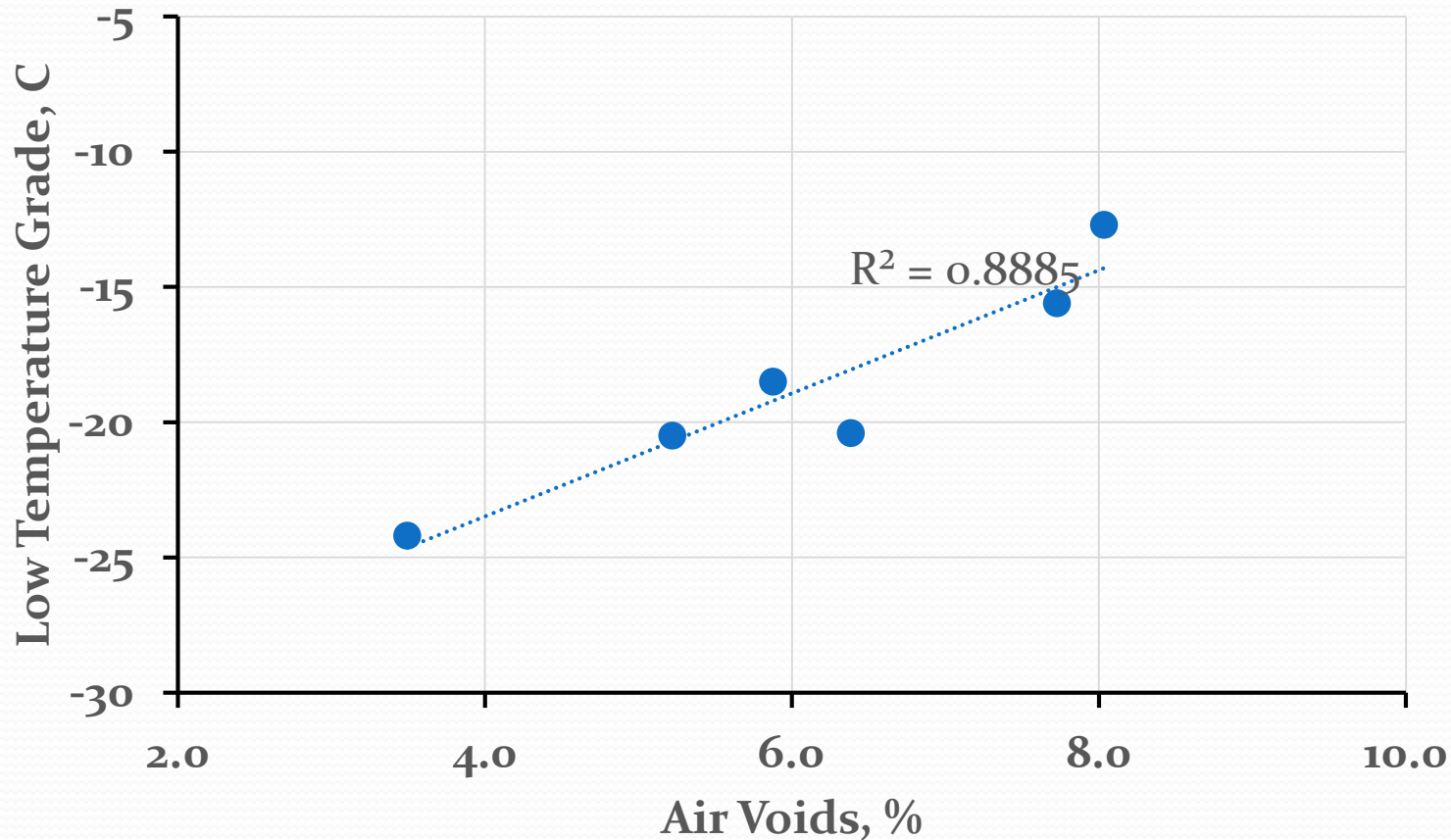
Recovered Asphalt Binder Grade

	Superpave4				Superpave5			
Location	High Fail Temp., °C	Low Fail Temp m, °C	Low Fail Temp, S, °C	ΔT_c , °C	High Temp Grade, °C	Low Temp Grade, m, °C	Low Fail Temp., S, °C	ΔT_c , °C
1	99.1	-15.6	-24.8	-9.2	95.4	-20.5	-24.9	-4.4
2	97.0	-20.4	-25.8	-5.4	96.5	-18.5	-23.4	-4.9
3	103.9	-12.7	-23.1	-10.4	90.1	-24.1	-25.7	-1.5
Average	100.0	-16.2	-24.6	-8.3	94.0	-21.0	-24.7	-3.6

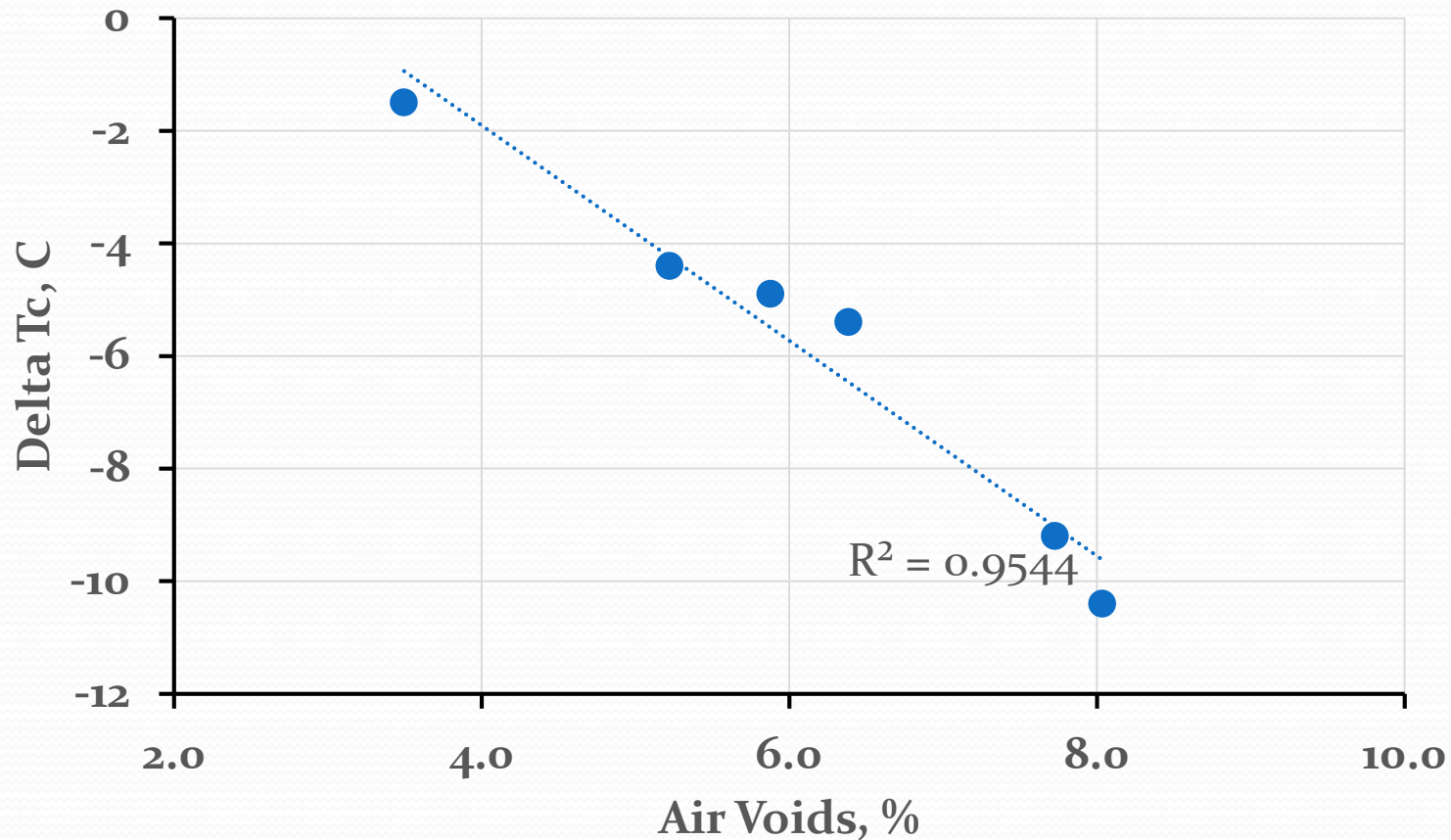
Correlation PG High Temp to In-Place Air Voids



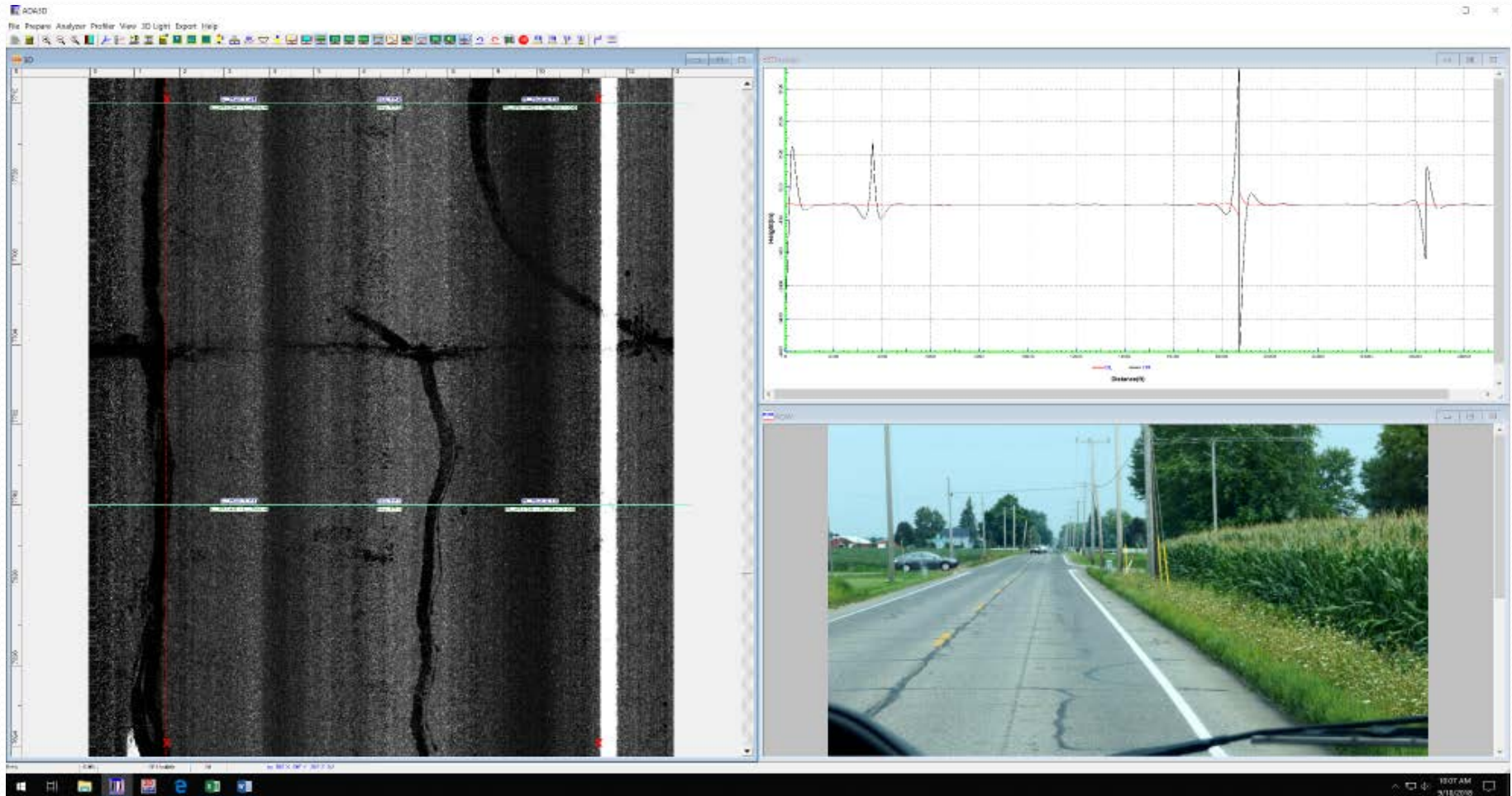
Correlation PG Low Temp to In-Place Air Voids



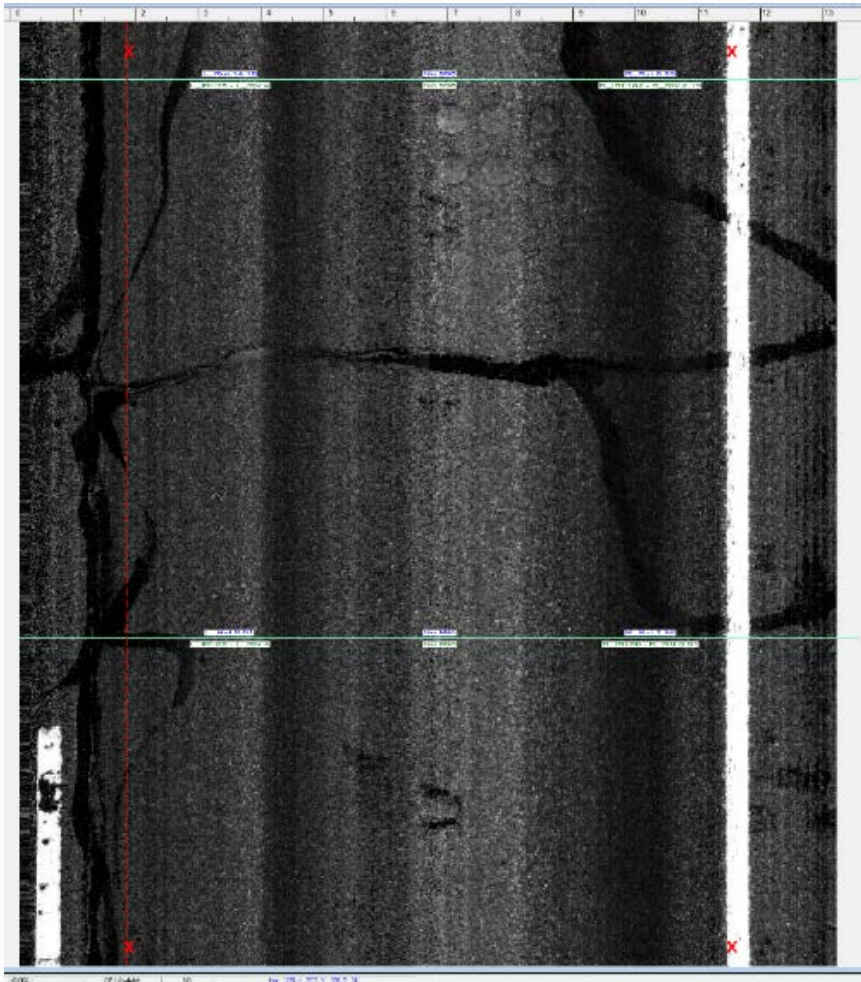
Correlation Delta Tc to In-Place Air Voids



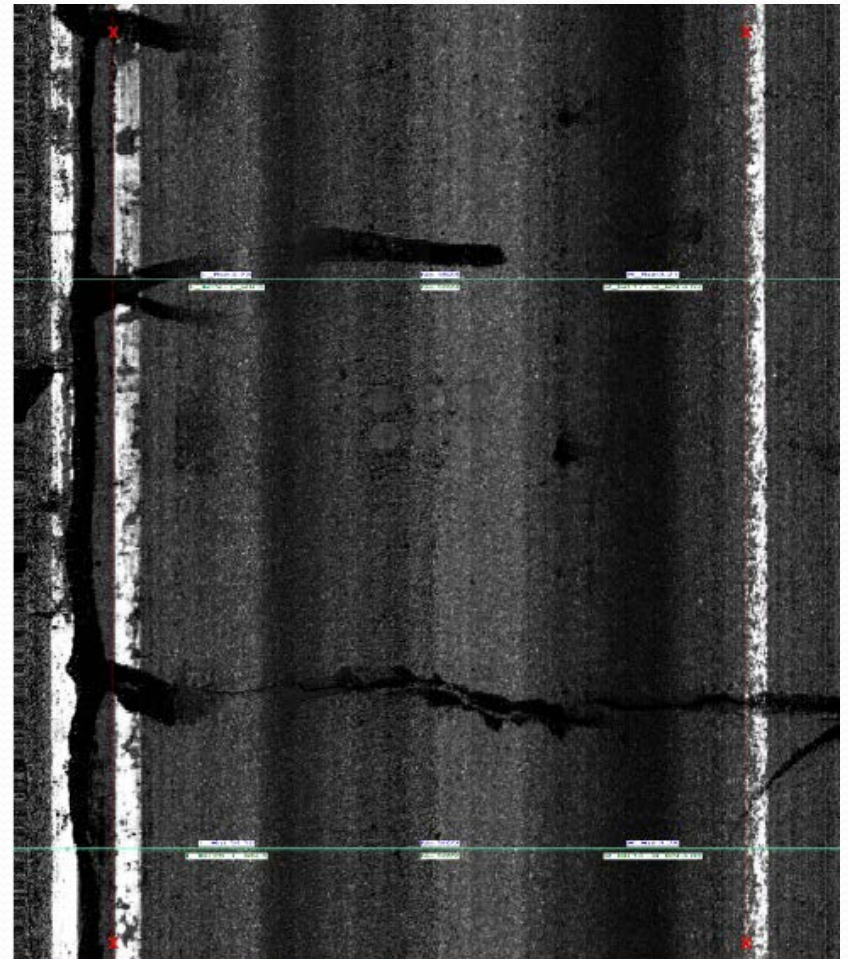
Pavement Condition Collection



Superpave4



Superpave5





Superpave4

Superpave5



Superpave4



Superpave5



Superpave4

Superpave5



What Did We Learn?

**Aging of Asphalt Binder
Directly Related to
In-Place Air Voids**

Asphalt Binder Properties

- Construction
 - 80% PG 70-22
 - 20% PG 130 -0 (est.)
- Five Years in Service
 - Superpave4 PG 100-16
 - Superpave5 PG 94-21

Effect on
Life?

Superpave5

No



B/C ratio?

58th Annual IAC



Maximizing Pavement Life – Part 1 Considerations for Pavement Design

Mark D. Blow P.E.
Sr. Regional Engineer
Asphalt Institute
Oct. 25, 2018
Moscow, Idaho

A.K.A.- How To

Design, Construct and Maintain HMA Pavements to Maximize Pavement Life



- STATE OF SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION
PLANS FOR PROPOSED
PROJECT NH-P 0019(430)
SD HIGHWAY 19
CLAY COUNTY
ASPHALT CONCRETE RESURFACING,
PAVEMENT MARKING & GUARDRAIL
PCN 05U**

PROJECT

**END SD19
MIDDLE SEGMENT**
STA. 580+00
MRM 15.00 ±0.350
MILEAGE 17.024
(48' N of Jct 307th St)

**BEGIN SD19
SOUTH SEGMENT**
STA. 0+00
MRM 0.36 ±0.004
MILEAGE 0.363
(At End Bridge)

STRUCTURE 16-197-194
27'-0" to 27'-0"
Curb, Cont. Gutter Bridge
Cont. Verrill River
207'-0" to 201'-0" MRM 5.64
Two Approach Slopes
2.922'-64" ± 0.008 MRM

**BEGIN SD19
MIDDLE SEGMENT**
STA. 36+70
MRM 5.00 ±0.007
MILEAGE 8.732
(At End Curb & Gutter
105' N of SDO50 Edge)

SD 19 DESIGN DESIGNATION

SEGMENT	SOUTH	MID	NORTH
ADT(0016)	1,330	1,021	760
ADT(2038)	1,731	1,363	985
DIV	21%	19%	22%
D	52%	52%	52%
T DIV	10.2%	12.0%	14.4%
T ADT	4.8%	4.3%	6.6%
V	65 MPH	65 MPH	65 MPH

**END SD19
NORTH SEGMENT**
STA. 59+72
MRM 25.27 ±0.010
MILEAGE 27.021
(32.5' S of SDO50 Edge)

STRUCTURE 16-194-193
27'-0" to 27'-0"
Curb, Cont. Gutter Bridge
Cont. Verrill River
195'-0" to 192'-0" MRM 28.25

STRUCTURE 16-194-190
27'-0" to 27'-0"
Curb, Cont. Gutter Bridge
Cont. Verrill River
195'-0" to 192'-0" MRM 28.25

STRUCTURE 16-194-191
27'-0" to 27'-0"
Curb, Cont. Gutter Bridge
Cont. Verrill River
195'-0" to 192'-0" MRM 28.25

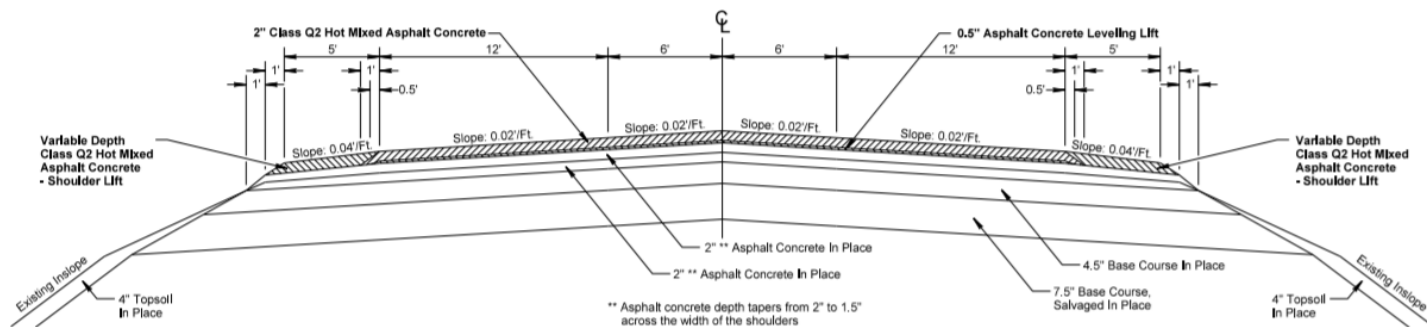
STRUCTURE 16-194-192
27'-0" to 27'-0"
Curb, Cont. Gutter Bridge
Cont. Verrill River
195'-0" to 192'-0" MRM 28.25

STRUCTURE 16-194-195
27'-0" to 27'-0"
Curb, Cont. Gutter Bridge
Cont. Verrill River
195'-0" to 192'-0" MRM 28.25

**BEGIN SD19
NORTH SEGMENT**
STA. 19+30
MRM 15.00 ±0.350
MILEAGE 17.024
(48' N of Jct 307th St)

INDEX OF SHEETS

Sheet	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301
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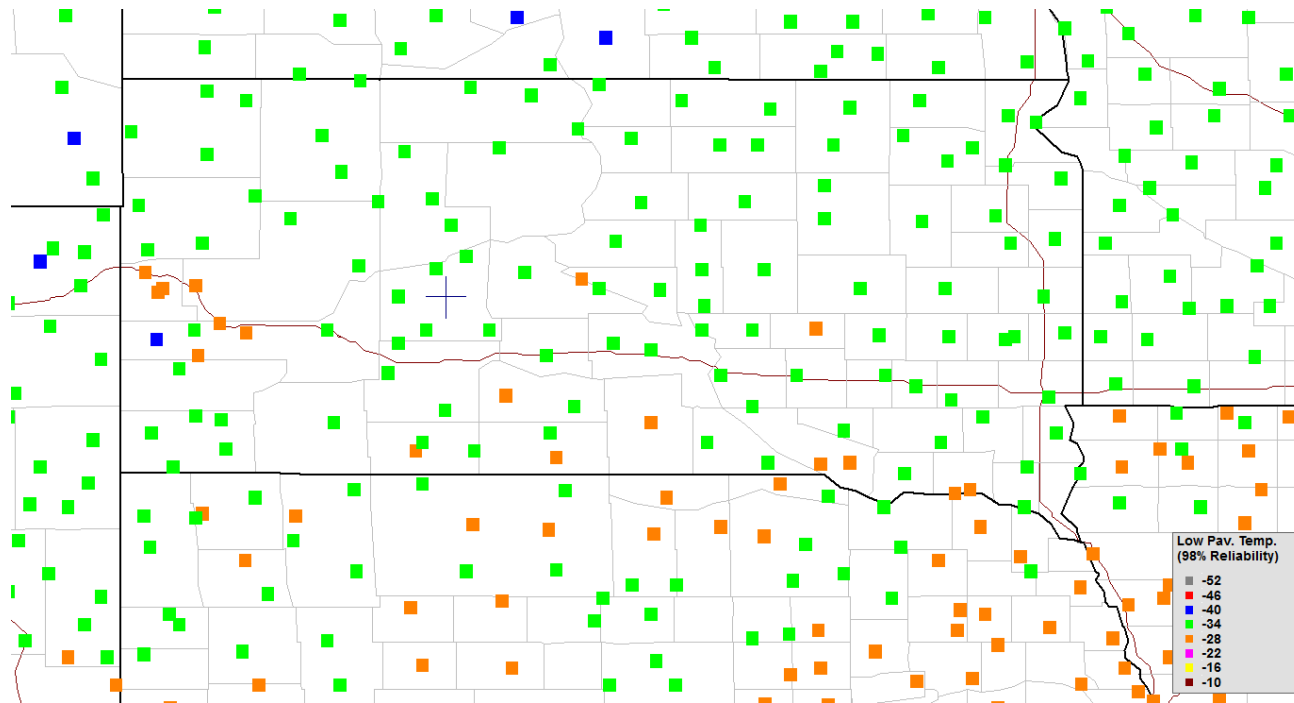


Binder Type

Design - Section 1

Prevent Thermal Cracking

- Use PG -34 Binders on New Construction
- 25 year old SHRP recommendation



LTPPBind v3.1

https://infopave.fhwa.dot.gov/Page/Index/LTPP_BIND

Consider high performance binders on overlays

- Reduced rutting
- Reduced cracking
- Better crack seal performance
- Maintain existing crack resistance

PG 64-22 modified, no rutting

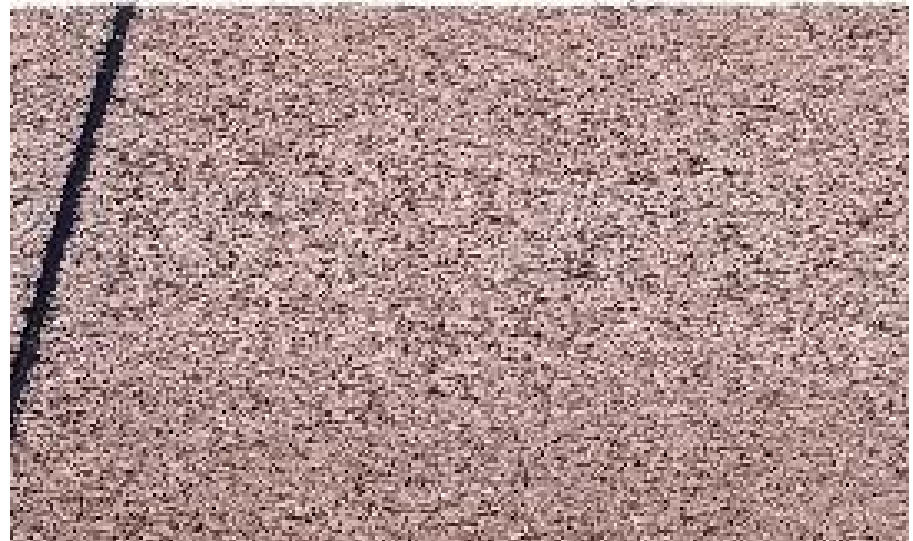


PG 67-22 unmodified, 15mm rut



I-29 North of Beresford

- Orig. 1962 PCC
- 1999 - 3" HMA
- 2004 – 1.5" Class S
✓ PG 70-28
- 2004 – Saw/Seal
- 2009 – Sealed
secondary cracks



But what does it cost?

2016 SDDOT Ave. Unit Bid Prices

Description		Unit	Total Quantity	Average Bid Price
PG 58-28	Asphalt Binder	Ton	15,547.30	\$433.74
PG 58-34	Asphalt Binder	Ton	125,661.00	\$485.86
PG 64-22	Asphalt Binder	Ton	519.60	\$470.63
PG 64-28	Asphalt Binder	Ton	182,175.80	\$457.38
PG 64-34	Asphalt Binder	Ton	61,502.20	\$499.15

**Highest to Lowest Difference = \$65.41/ binder ton
@ 6% Binder = \$3.92 / ton of mix**

Simple county overlay

10 mile overlay, No milling

Item	Quantity	Units	Unit Price	Amount	% of Project Cost
PG64-28	1,575.50	Ton	\$ 462.07	\$ 727,991.29	48.5%
Class E Mix	25,627.20	Ton	\$ 22.82	\$ 584,812.70	39.0%
% Binder	6.1%	Tot. Mix Cost =		\$ 1,312,803.99	87.5%
	Tot Project Cost =		\$ 1,500,814.57	100.0%	

Assuming a \$65.41 binder cost increase,

		Expected Service Needed increase in	
		Life (Years)	Life (Years)
Binder cost increase	14.2%	15	1.0
Project cost increase	6.9%	20	1.4
		25	1.7

Complicated Interstate overlay

20 + mile overlay, underdrains etc.

Item	Quantity	Units	Unit Price	Amount	% of Project Cost
PG64-28	1,823.80	Ton	\$ 400.00	\$ 729,520.00	3%
PG64-34	11,152.60	Ton	\$ 430.00	\$ 4,795,618.00	21%
Tot Project Cost =				\$ 22,565,024.00	

Assuming a \$65.41 binder cost increase,

		Expected Service Needed increase in	
		Life (Years)	Life (Years)
Binder cost increase	15.4%	15	0.6
Project cost increase	3.8%	20	0.8
		25	0.9

Smaller Urban / Grading

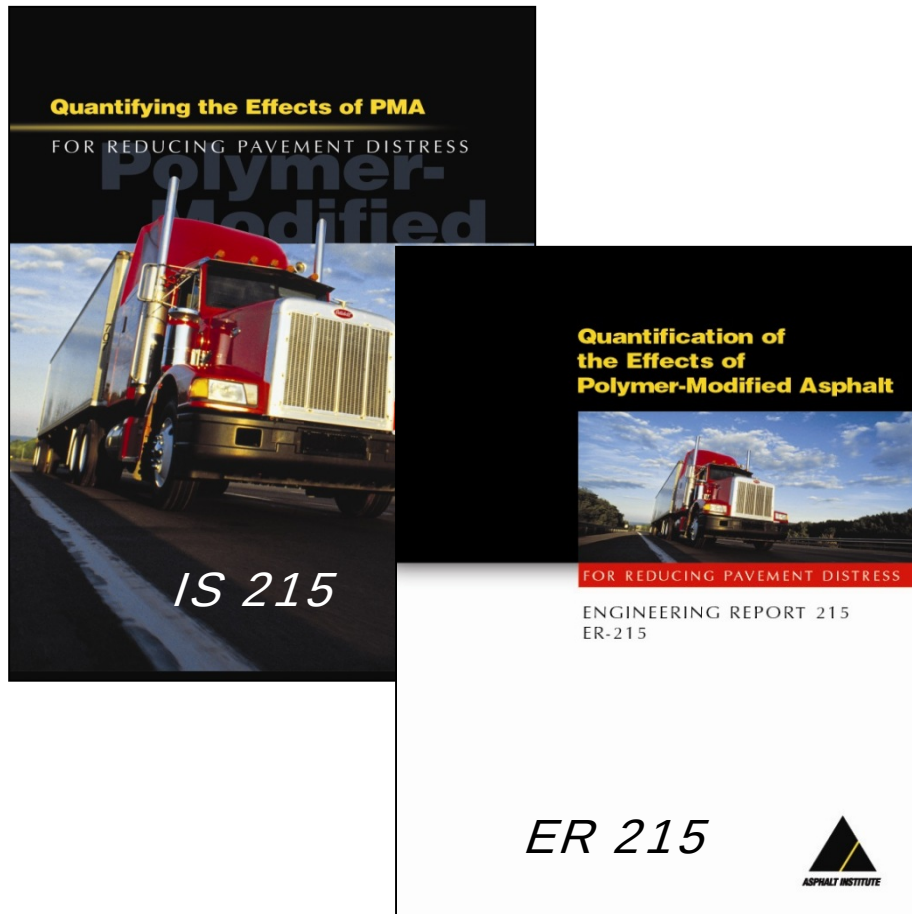
1 mile 3-Lane, grading, C&G, sidewalks, lighting and new asphalt surface

Item	Quantity	Units	Unit Price	Amount	% of Project Cost
PG58-28	447.70	Ton	\$ 730.00	\$ 326,821.00	9.3%
Class HR	9,518.50	Ton	\$ 33.00	\$ 314,110.50	8.9%
% Binder	4.7%	Tot. Mix Cost =		\$ 640,931.50	18.2%
	Tot Project Cost =			\$ 3,521,707.00	

Assuming a \$65.41 binder mix cost increase,

		Expected Service Needed increase in Life (Years)	
Binder cost increase	9.0%	15	0.12
Project cost increase	0.8%	20	0.17
		25	0.21

Quantifying the Effects of PMA for Reducing Pavement Distress



This study (published in Feb 2005) used national field data to determine enhanced service life of pavements containing polymer modified binders versus conventional binders. The data is from a variety of climates and traffic volumes within North America.

Summary of Expected Increase in Service Life, Years, Based on M-E Damage Based Analysis



Assumptions: Unmodified sections designed for 20 yr. life. Also, PMA in top 4 inches.

Site Factor	Condition Description		Added Life
Foundation	Non-expansive, coarse soils		5-10
	Expansive and plastic soils (PI>35)		2-5
	Frost Susceptible in cold climate		2-5
Water Table & Drainage	Deep		5-10
	Shallow; adequate		5-8
	Shallow; inadequate		0-2
Existing Pavement Condition	HMA	Good	5-10
		Poor-extensive cracking	1-3
	PCC	Good	3-6
		Poor-faulting & cracking	0-2

Continued: Summary of Expected Increase in Service Life, Yrs



Assumptions: Unmodified sections designed for 20 yr. life. Also, PMA in top 4 inches.

Site Factor	Condition Description		Added Life
Climate; Temp. Fluctuations	Hot	Hot Extremes	5-10
	Mild		2-5
	Cold	Cold Extremes	3-6
Traffic, Truck Volumes	Low	Intersections	5-10
		Thoroughfares	3-6
		Heavy Loads	5-10
	Moderate		5-10
	High		5-10

Recycled Binders



NCHRP REPORT 452 - Results

- Blending occurs at higher RAP contents. At low RAP contents, effects are not significant.
- Results from all phases support concept of a tiered system.
 - Mix ETG recommendations were largely confirmed.

RAP mixtures should be able to perform at least as well as virgin mixes.

ACTION	RAP
No Change in Binder Grade	15% or less
One Grade Lower	16 - 25%
Use Blending Charts	>25%

Adopted in AASHTO M323
Superpave Volumetric Mix Design

Moderation is the key



**"I LIMIT MYSELF TO ONE
GLASS OF WINE A DAY."**



Project #1: High RAP (RAS) + WMA Accelerated Pavement Test

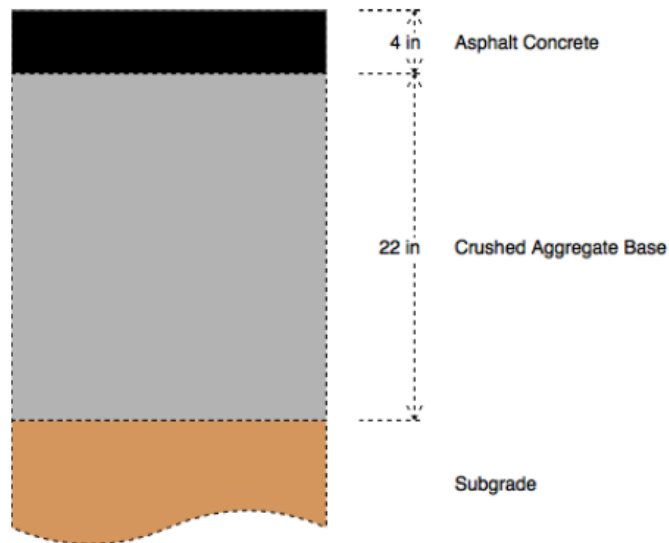




The Experiment

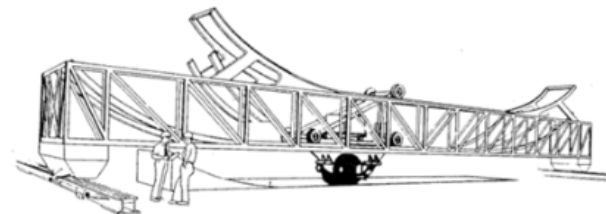
Structure

- 10 Lanes (10 Mixes)
- Build in 2013



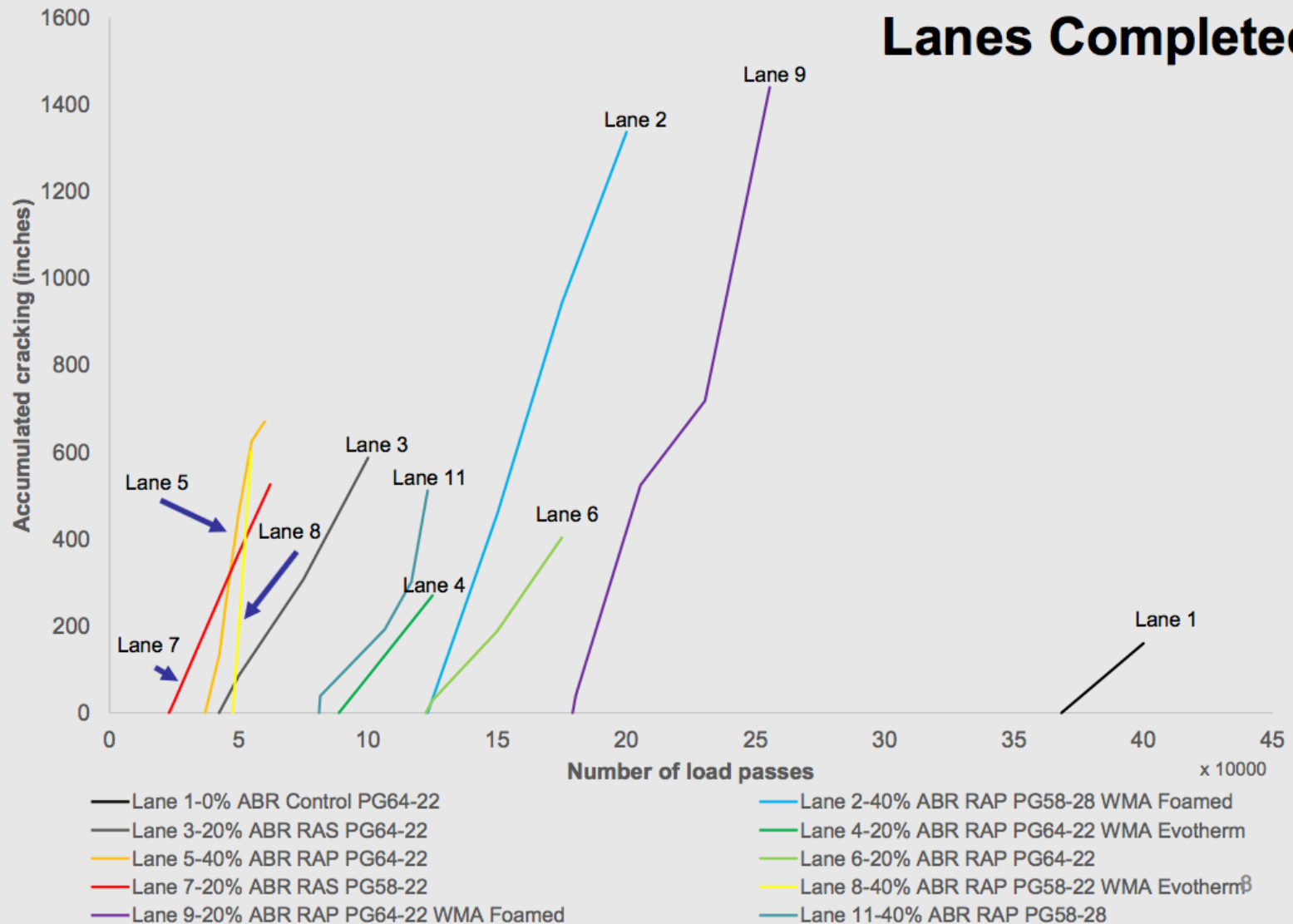
Materials

- 2 Binder Grades
- RAP/RAS
- 2 WMA Technologies
- 3 ABR contents





Lanes Completed



Acknowledgement



WHRP

Wisconsin Highway Research Program



- Project 0092-14-06 Critical Factors Affecting Asphalt Durability
 - Evaluate changes to the composition of asphalt mixtures that WisDOT should consider to improve durability
 - Resistance to load associated cracking
 - Resistance to aging

<http://wisconsindot.gov/documents2/research/14-06-revised-final-report.pdf>

Advanced Asphalt Technologies, LLC



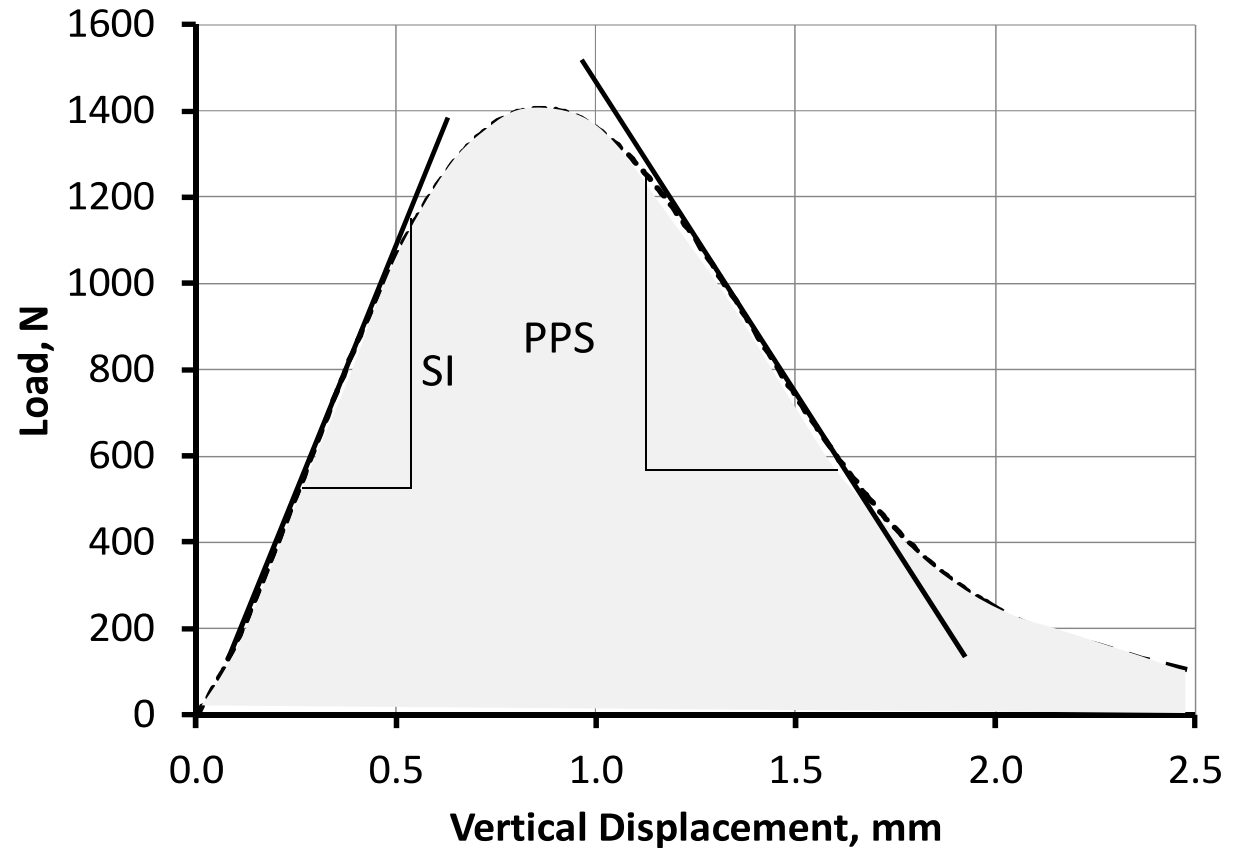
"Engineering Services for the Asphalt Industry"

Illinois SCB (Flexibility Index)



SI = Stiffness Index
Slope @ 50% of Peak
Load

AI=Aging Index
 $= SI_{LTOA} / SI_{STOA}$



FI = Energy/Post Peak Slope
Resistance to cracking increases
with increasing FI

I Asphalt Technologies, LLC



"Engineering Services for the Asphalt Industry"

Effect of Recycled Binder

No Grade Change

VBE	Low Grade	RBR	FI	% of Control Life
10.5	-28	0.00	6.5	100
10.5	-28	0.05	6.0	92
10.5	-28	0.10	5.5	84
10.5	-28	0.15	5.0	77
10.5	-28	0.20	4.5	69
10.5	-28	0.25	4.0	61
10.5	-28	0.30	3.5	53

AASHTO M 323 Change

VBE	Low Grade	ABR	FI	% of Control Life
10.5	-28	0.00	6.5	100
10.5	-28	0.05	6.0	92
10.5	-28	0.10	5.5	84
10.5	-28	0.15	5.0	77
10.5	-34	0.20	6.9	105
10.5	-34	0.25	6.3	97
10.5	-34	0.30	5.8	89

Advanced Asphalt Technologies, LLC



"Engineering Services for the Asphalt Industry"

Thickness Design

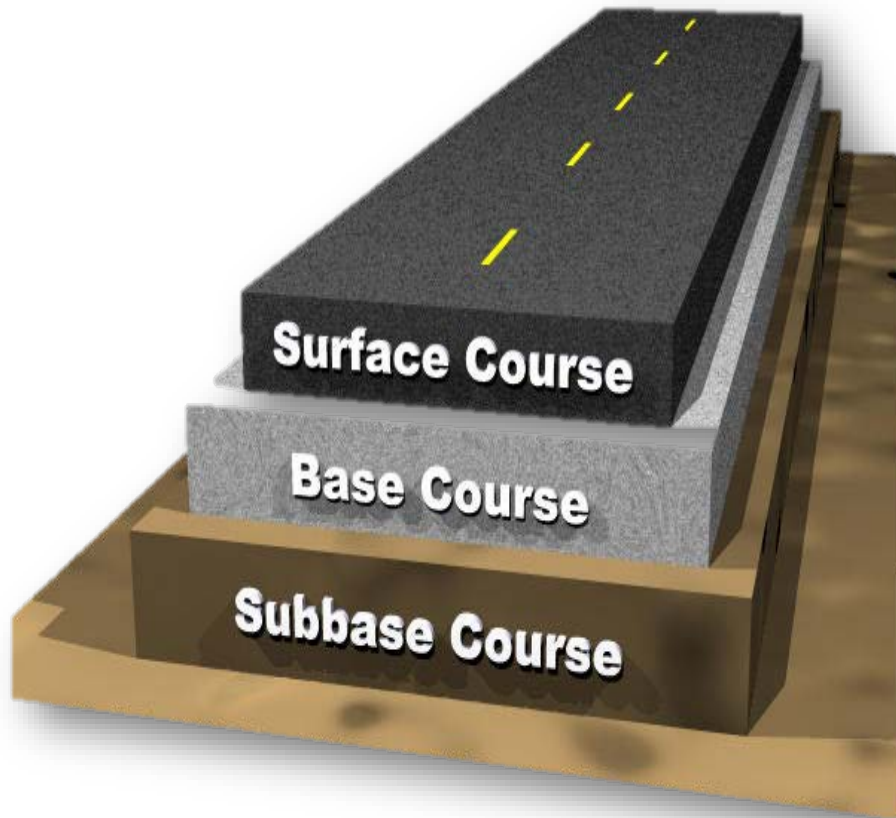
Design - Section 2

Pavement Design



PaveXpress

A Simplified Pavement Design Tool



AASHTO has been developing MEPDG for high volume roads, but a gap has developed for local roads and lower volume roads.

What Is PaveXpress?

A free, online tool to help you create simplified pavement designs using key engineering inputs, based on the AASHTO 1993 and 1998 supplement pavement design process.

- Accessible via the web and mobile devices
- Free — no cost to use
- Based on AASHTO pavement design equations
- User-friendly
- Share, save, and print project designs
- Interactive help and resource links

www.PaveXpressDesign.com

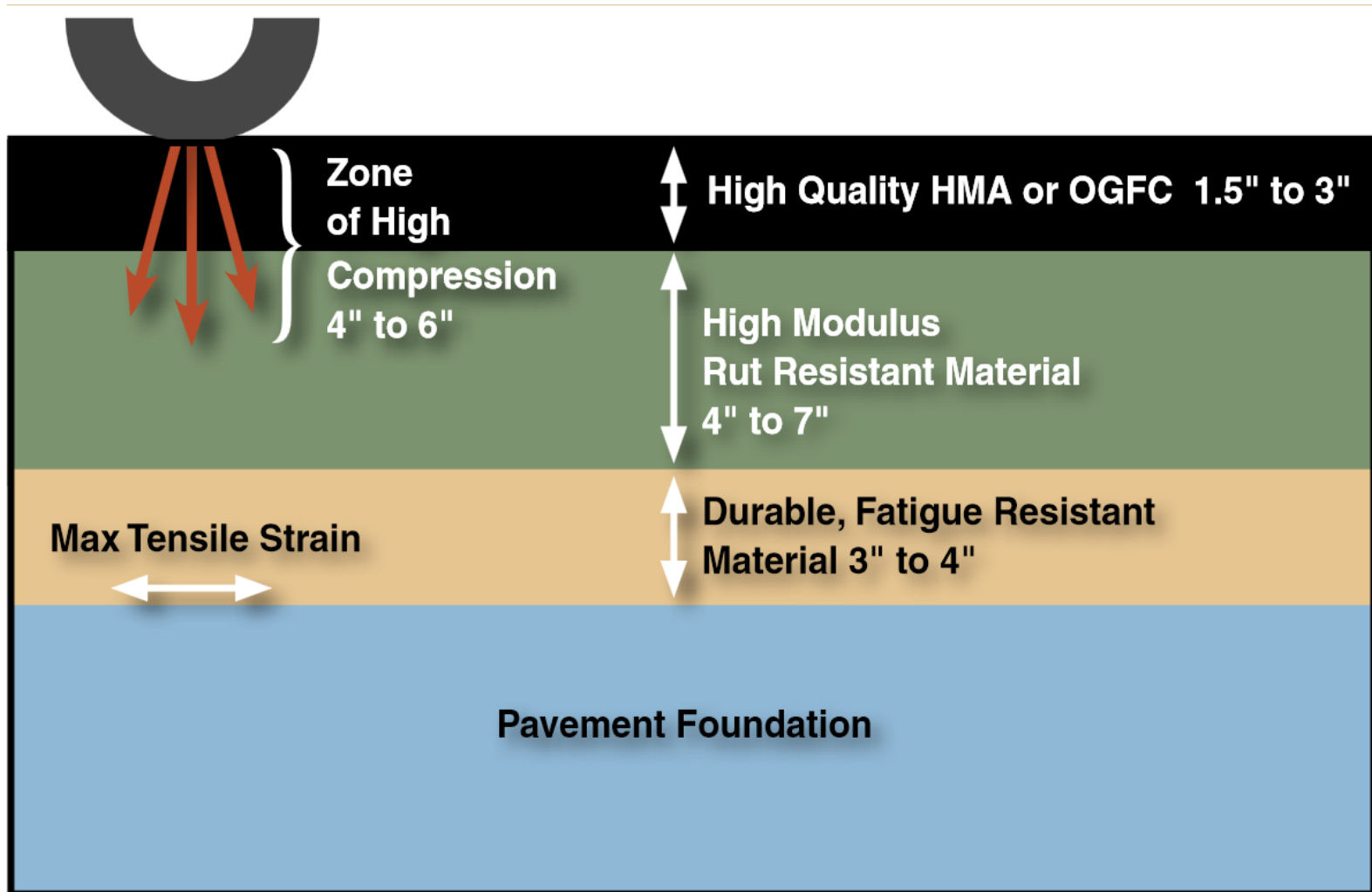




PerRoad is uses the mechanistic-empirical design philosophy. The program couples layered elastic analysis with a statistical analysis procedure (Monte Carlo simulation) to estimate stresses and strains within a pavement. In order to predict the strains which would prove detrimental for fatigue cracking or structural rutting.

www.asphaltroads.org/perpetual-pavement

What does a P. P. look like?



Ya But, Ya But
Does
Asphalt
Really Last ?

I-90 W of Wall ≈ 860 TADT

HIGHWAY 090 E

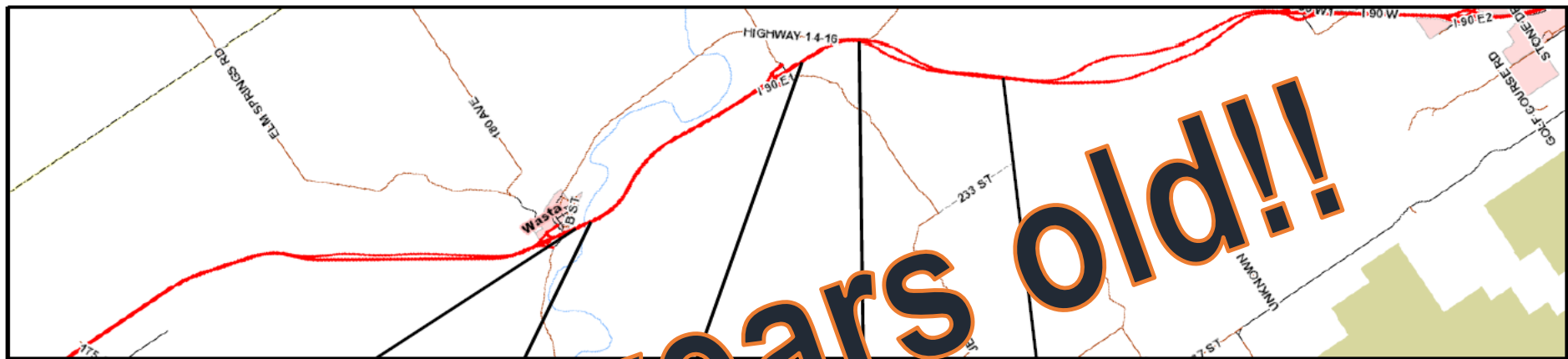
Beginning MRM = 98.14
Ending MRM = 102.00

RURAL



HIGHWAY 090 E

Beginning MRM = 98.14
Ending MRM = 102.00



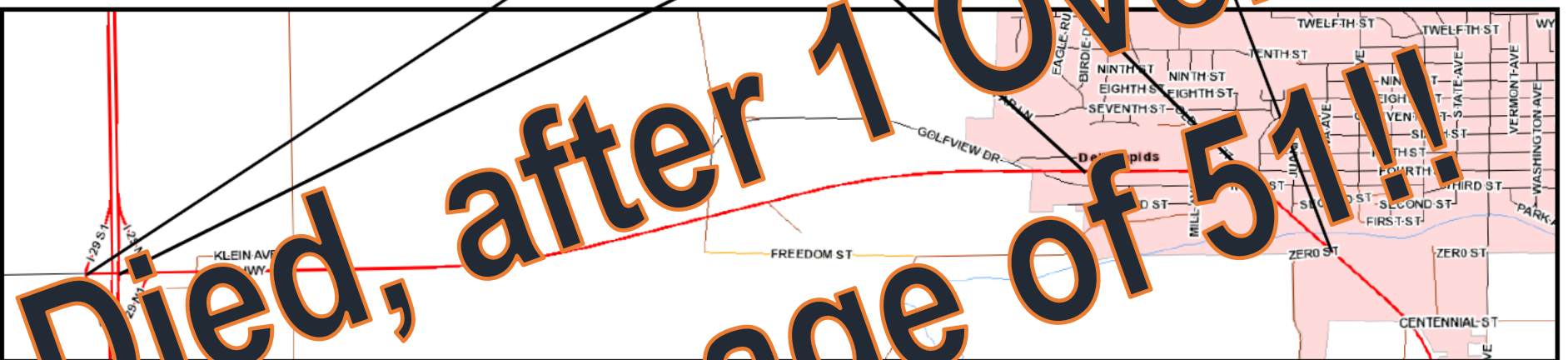
STRUCTURAL DESCRIPTION		THK	FD	FD
Surf Type		AC/N/D	AC/N/D	AC/N/D
Shouldr Type		AC/N/D	AC/N/D	AC/N/D
Surf Width	32 (032)	24 (024)	24 (024)	24 (024)
Lf Shldr Width	4 (04) / (0)	4 (04) / (0)	4 (04) / (0)	4 (04) / (0)
Rt Shldr Width	10 (10) / (0)	10 (10) / (0)	10 (10) / (0)	10 (10) / (0)
Widths-RDWY/ROW	032/470/470	038/470/470	038/470/470	038/470/253
Roadbed Layer 1		2015/AS3/1.3	2015/AS3/1.3	2015/AS3/1.3
Roadbed Layer 2		2002/TC/0.0	2002/TC/0.0	2002/TC/0.0
Roadbed Layer 3		1999/AH3/1.5	1999/AH3/1.5	1999/AH3/1.5
Roadbed Layer 4		1999/AH3/1.5	1993/AG3/2.0	1999/AH3/1.5
Roadbed Layer 5		1977/AE4/3.5	1993/AG3/3.0	1977/AG4/2.0
Roadbed Layer 6		1964/AF3/1.5	1993/AG3/3.0	1969/AG3/2.0
Roadbed Layer 7		1964/BB3/4.0	1993/BS5/12.0	1969/AE3/6.0
Roadbed Layer 8		1964/BU5/4.0		1969/BU8/12.0
Roadbed Layer 9		1964/BU8/6.0		

115 D.R. West ≈ 190 TADT

HIGHWAY 115
Beginning MRM = 104.13
Ending MRM = 107.51

RURAL

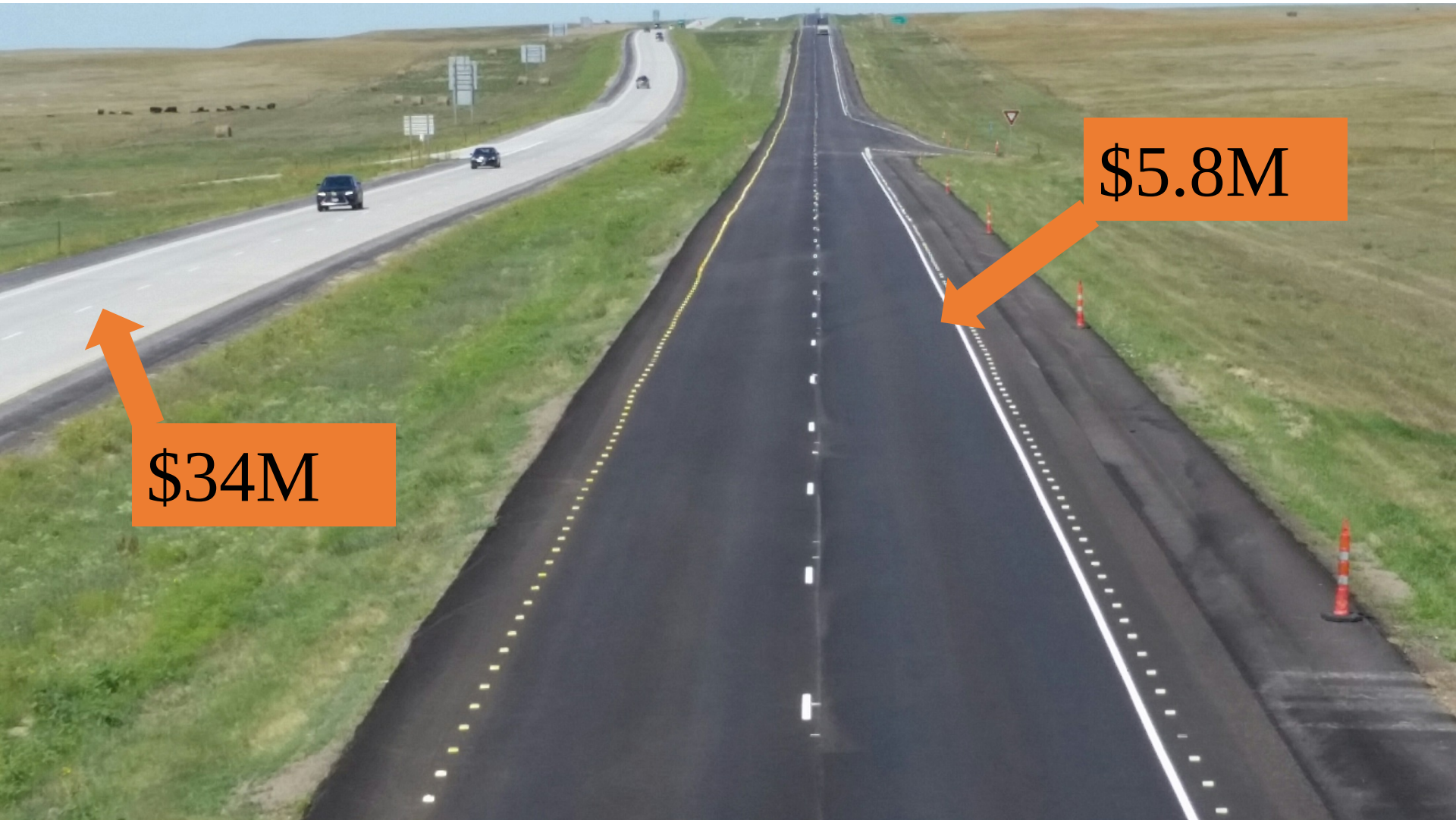
HIGHWAY 115
Beginning MRM = 104.13
Ending MRM = 107.51



STRUCTURAL DESCRIPTION		
Surface Type	FL	
Shouldr Type - Prim/Secndry	AC/N/D	
St Width	24 (024)	
Lf Shldr Width-Prim/Secndry	6 (06) / (0)	
Rt Shldr Width-Prim/Secndry	6 (06) / (0)	
Widths-RDWY/ROW/Grass/Min	036/200/200	
Roadbed Layer 1	2008/TS3/0.4	
Roadbed Layer 2	1999/TC/0.0	
Roadbed Layer 3	1990/TS3/0.5	
Roadbed Layer 4	1986/AG3/2.0	
Roadbed Layer 5	1975/TS3/0.5	
Roadbed Layer 6	1967/AG3/3.0	
Roadbed Layer 7	1967/AE3/5.0	
Roadbed Layer 8	1967/BU8/12.0	



How it looks today



\$34M

\$5.8M

58th Annual IAC



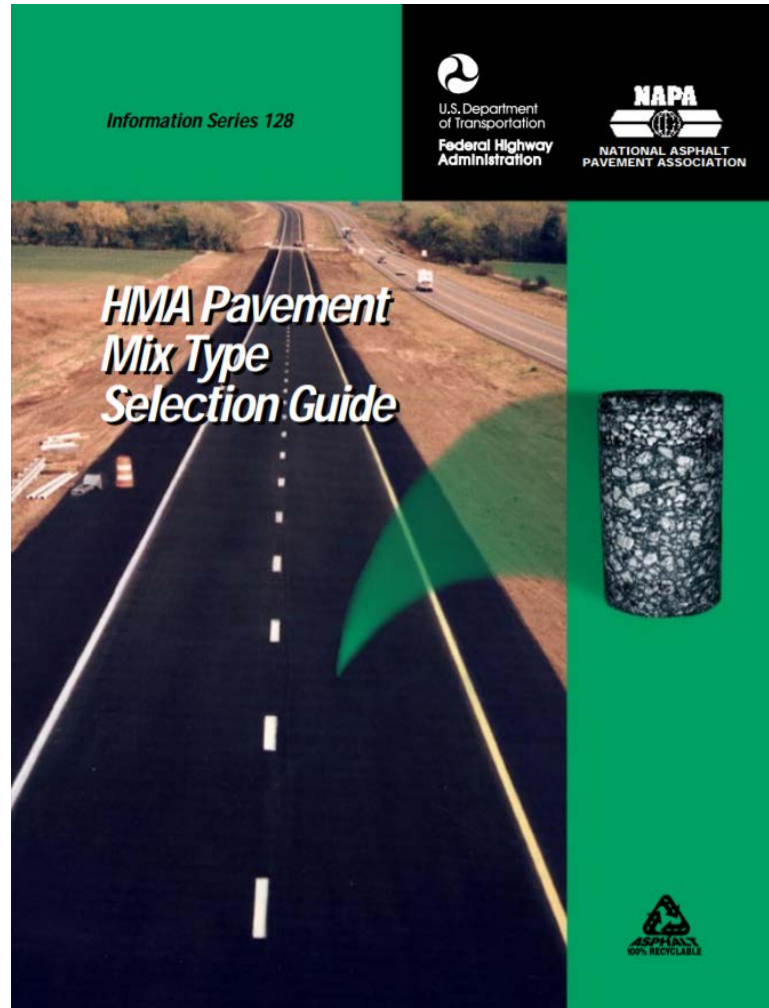
Maximizing Pavement Life – Part 2 Considerations for Construction Practice

Mark D. Blow P.E.
Sr. Regional Engineer
Asphalt Institute
Oct. 25, 2018
Moscow, Idaho

Lift Thickness and Mix Type

Design - Section 3

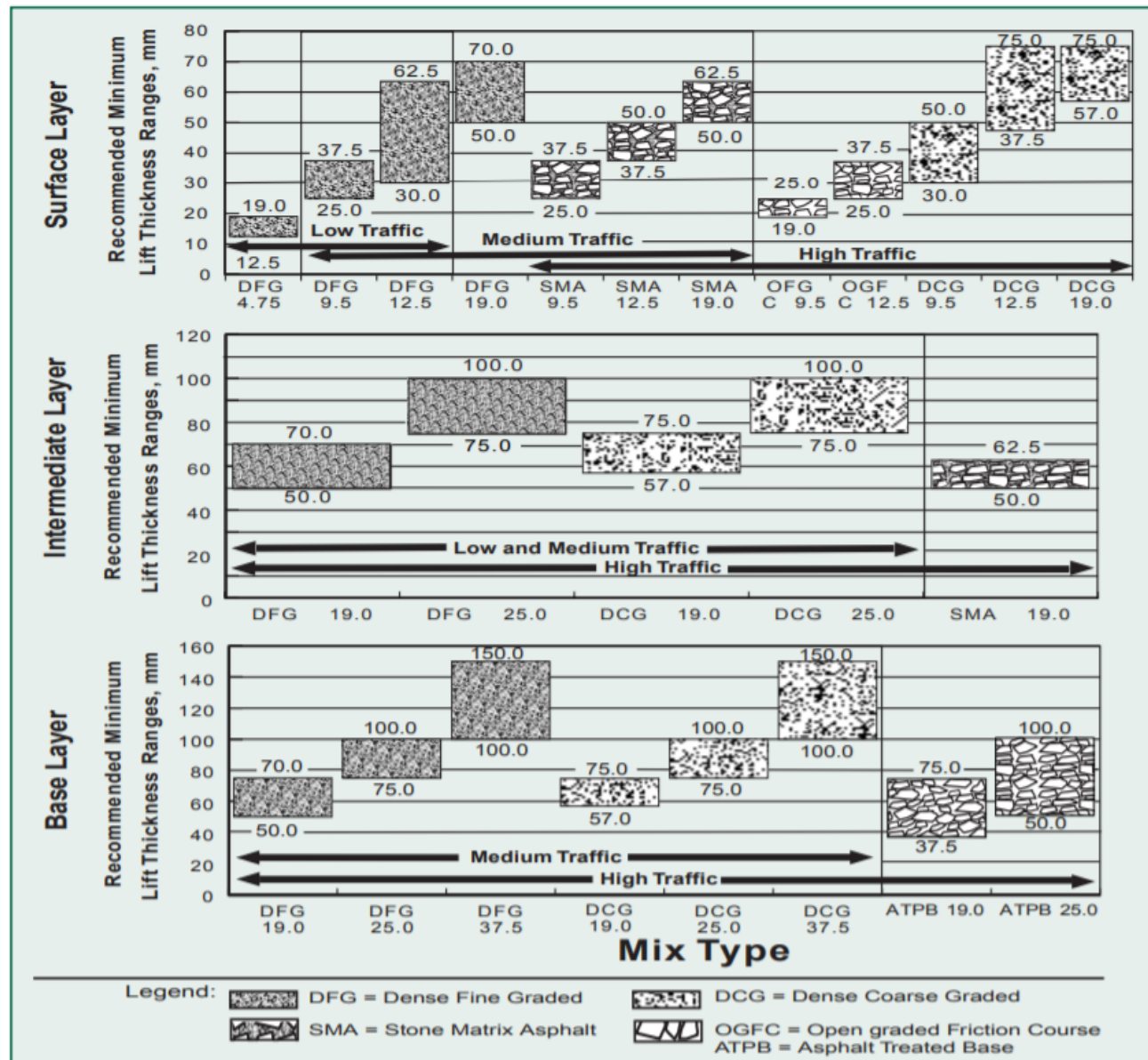
Mix Type



<https://www.fhwa.dot.gov/publications/research/infrastructure/pavements/asphalt/HMA.pdf>

Recommended Lift Thickness

FIGURE 3: Recommended Mix Types for Surface, Intermediate and Base Courses



NMAS grading is different than older “Topsize” Grading

Old Rule of Thumb - Minimum lift thickness = 2x Topsize

NMAS - Minimum compacted thickness

- ✓ 4 times nominal aggregate size
- ✓ 3 times nominal aggregate size for fine graded mixtures

- Thicker lifts are easier to compact
- Cool slower providing longer compaction time

Minimum -----NOT MAXIMUM !

Mixtures can vary significantly

Table 1

Requirements	Class D		Class E		Class G	
	Type 1	Type 2	Type 1	Type 2	Type 1	Type 2
Sieve	Percent Passing					
1 inch	100		100		100	
3/4 inch	97-100	100	97-100	100	97-100	100
5/8 inch						
1/2 inch	75-95	97-100	75-95	97-100	75-95	97-100
3/8 inch						
#4	45-75	60-80	45-75	60-80	45-75	60-80
#8	30-55	40-60	30-55	40-60	30-55	40-60
#16	20-45	25-50	20-45	25-50	20-45	25-50
#40	10-30	15-35	10-30	15-35	10-30	15-35
#200	3.0-7.0	4.0-8.0	3.0-7.0	4.0-8.0	3.0-7.0	4.0-8.0

**Table F - Gyratory Controlled QC/QA
Gradation*¹**

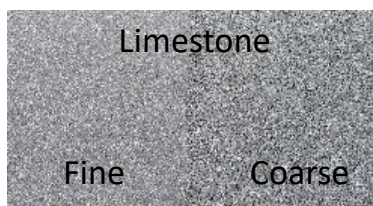
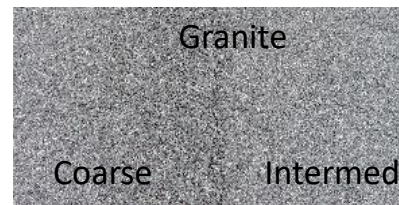
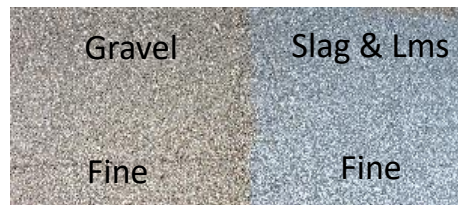
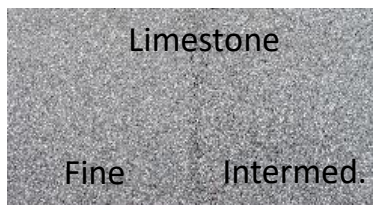
	Control Points (percent passing)	
Sieve Size	Min.	Max.
3/4 inch	100	
1/2 inch	90	100
3/8 inch		85
#8	30	55
#200	2.0	7.0

Lift Thickness



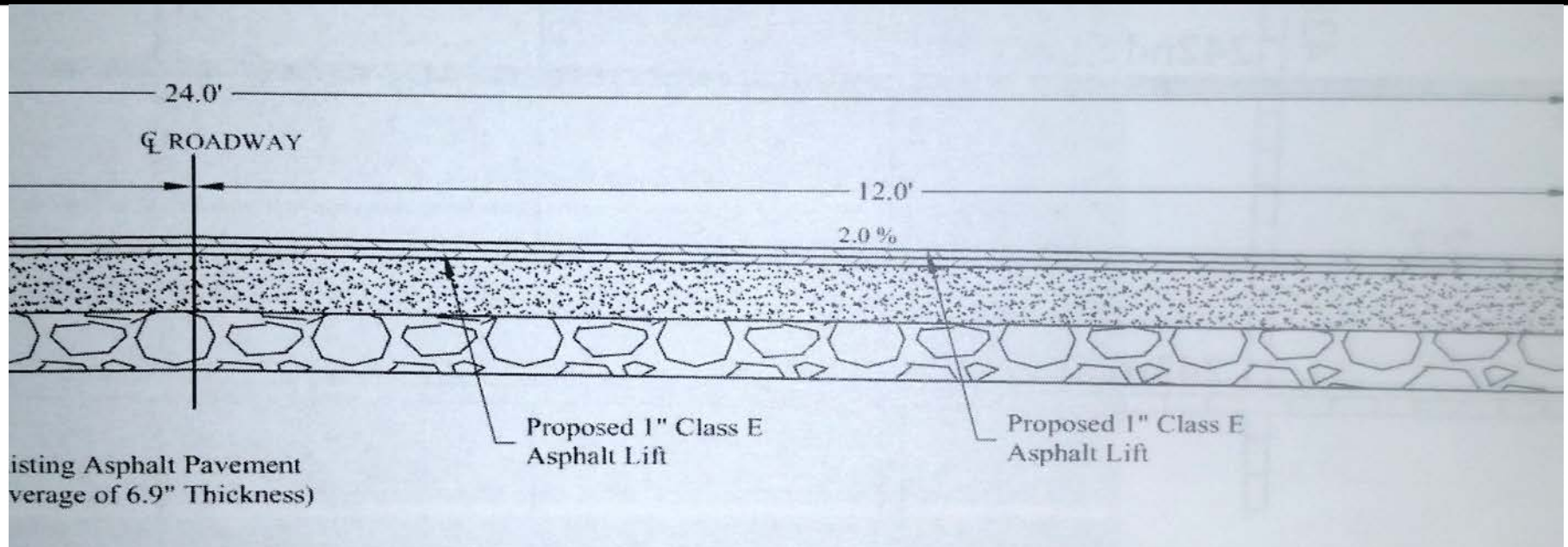


NCAT Test Track 1st Cycle



Coarse, intermediate, and fine gradations. **No differences in rutting performance!**

Lift Thickness



Construction

1. Tack Coat
2. Longitudinal Joints
3. Density



Tack Coat

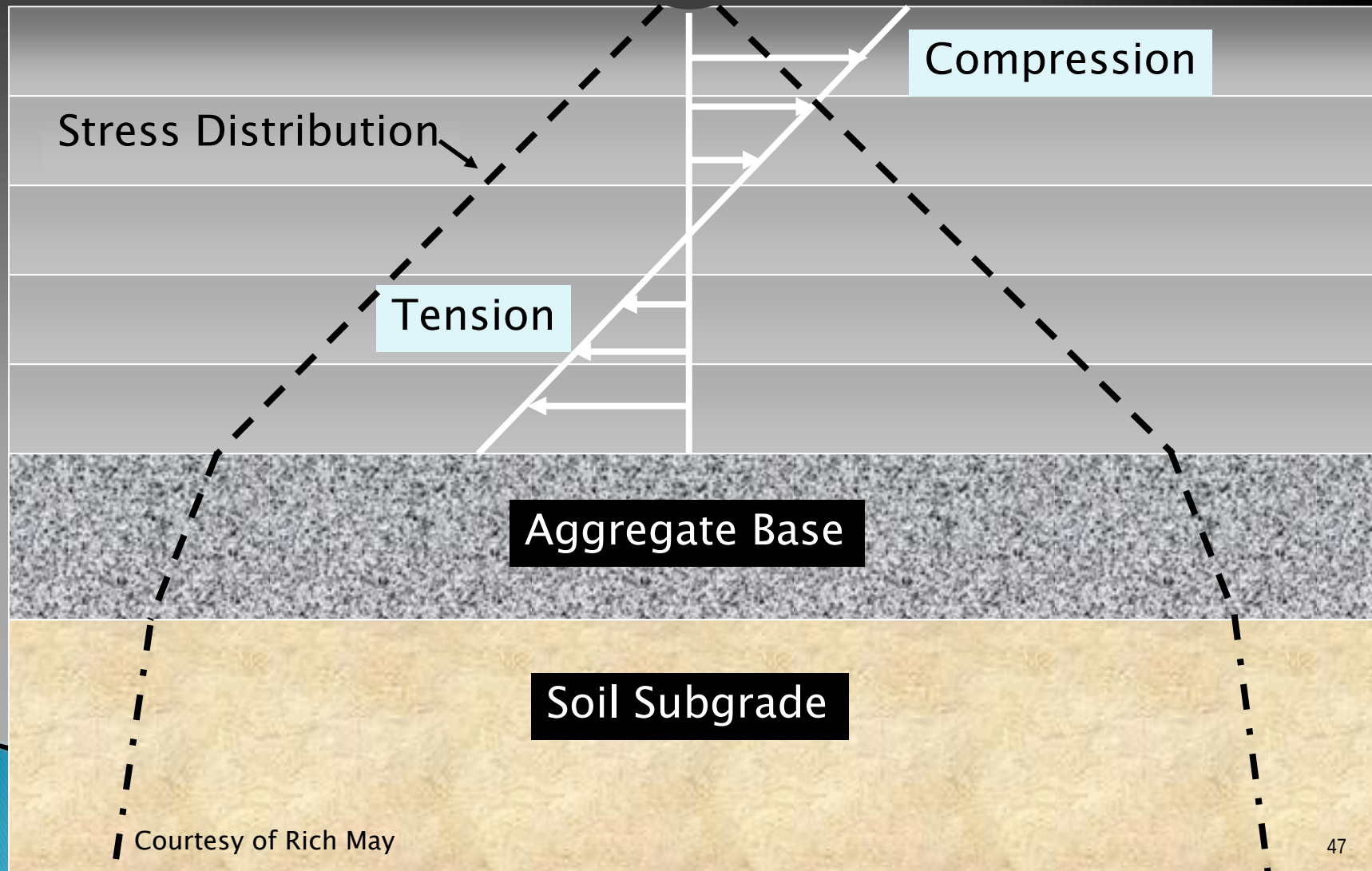
Construction - Section 1



Pavement Behavior

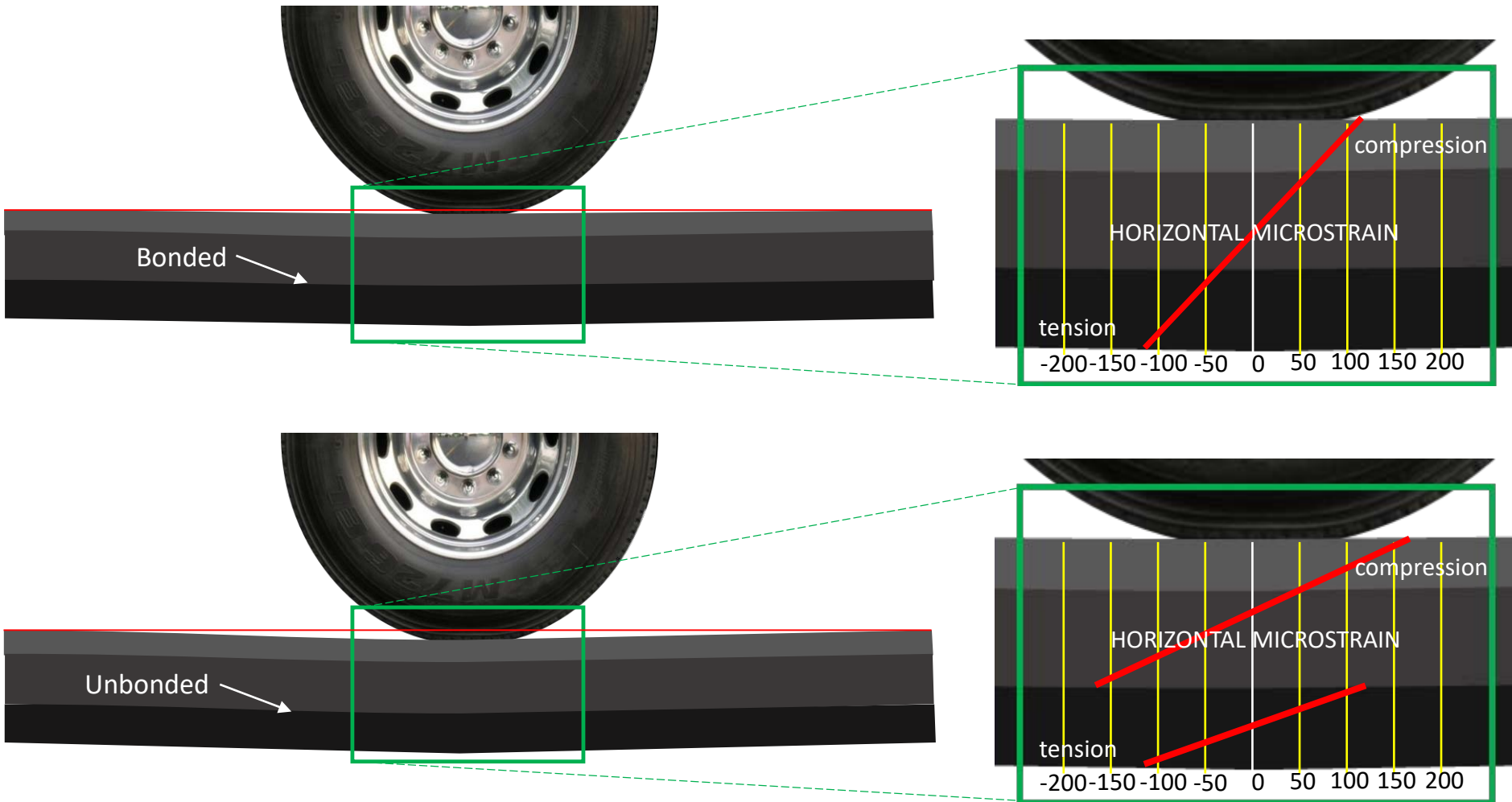
Load Distributed by Tire

Shear Transfer





Consequences of Debonding



Proper Tack Coat

Surface Type	Residual Rate (gsy)	Appx. Bar Rate Undiluted* (gsy)	Appx. Bar Rate Diluted 1:1* (gsy)
New Asphalt	0.020 – 0.045	0.030 – 0.065	0.060 – 0.130
Existing Asphalt	0.040 – 0.070	0.060 – 0.105	0.120 – 0.210
Milled Surface	0.040 – 0.080	0.060 – 0.120	0.120 – 0.240
Portland Cement Concrete	0.030 – 0.050	0.045 – 0.075	0.090 – 0.150



Longitudinal Joints

Construction - Section 2

Longitudinal Joints



Core #2 (No Overlap)



Core #7 (No Overlap)



Core #9 (Overlap 1 1/2")



Core #10 (Overlap 1 1/2")

Ski Best for Smoothness

(reference is average over length of ski)



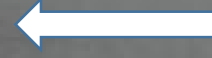
Versus Joint Matcher,
which is best for joint
(reference is exact location
just in front of auger)

Note: If underlying
pavement already smooth,
some contractors feel they
can get good joint with ski,
but must finish 1/10" high



Destined for Failure

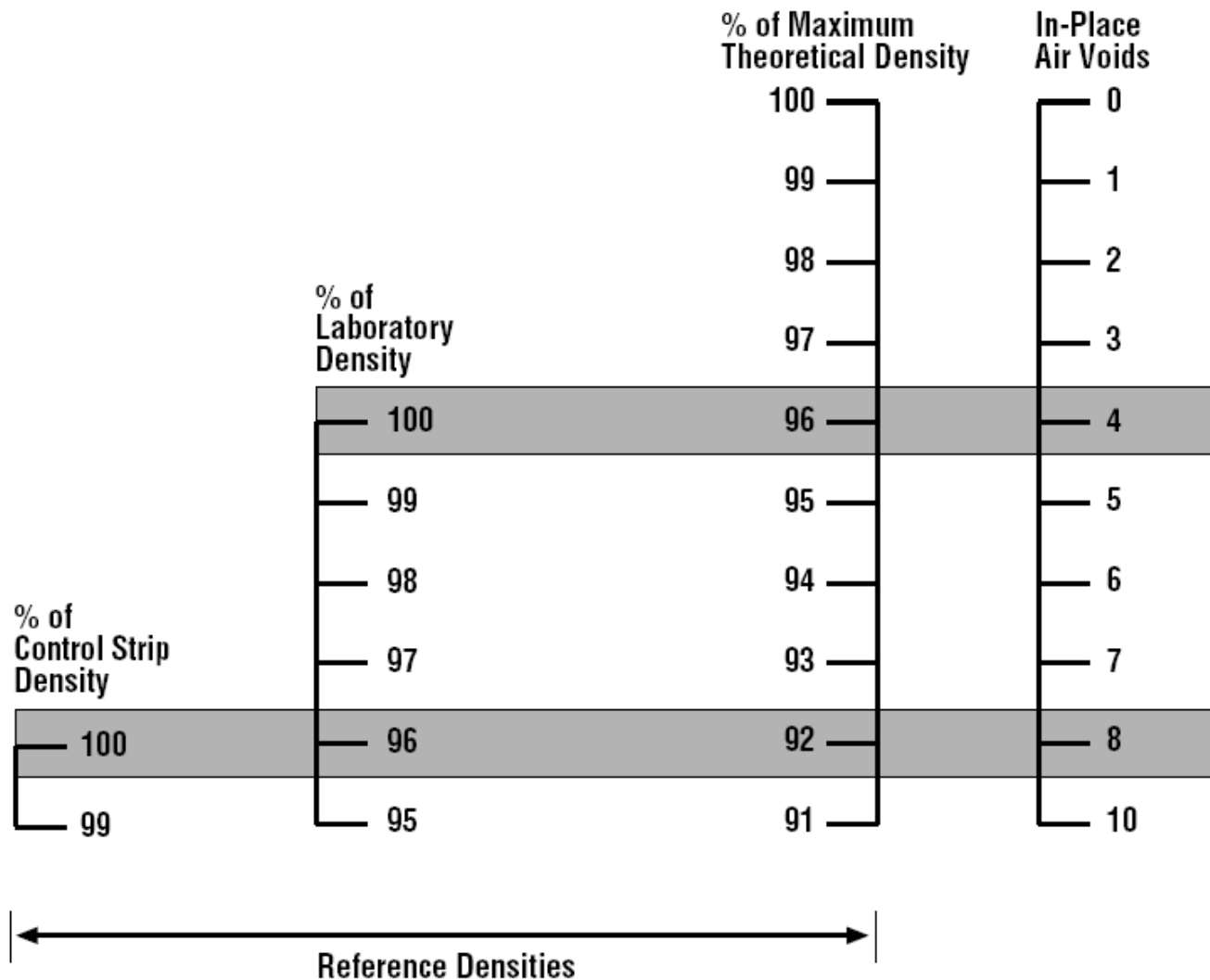
Likely that the hot side of joint was starved of material at these locations and bridging occurred.



Density

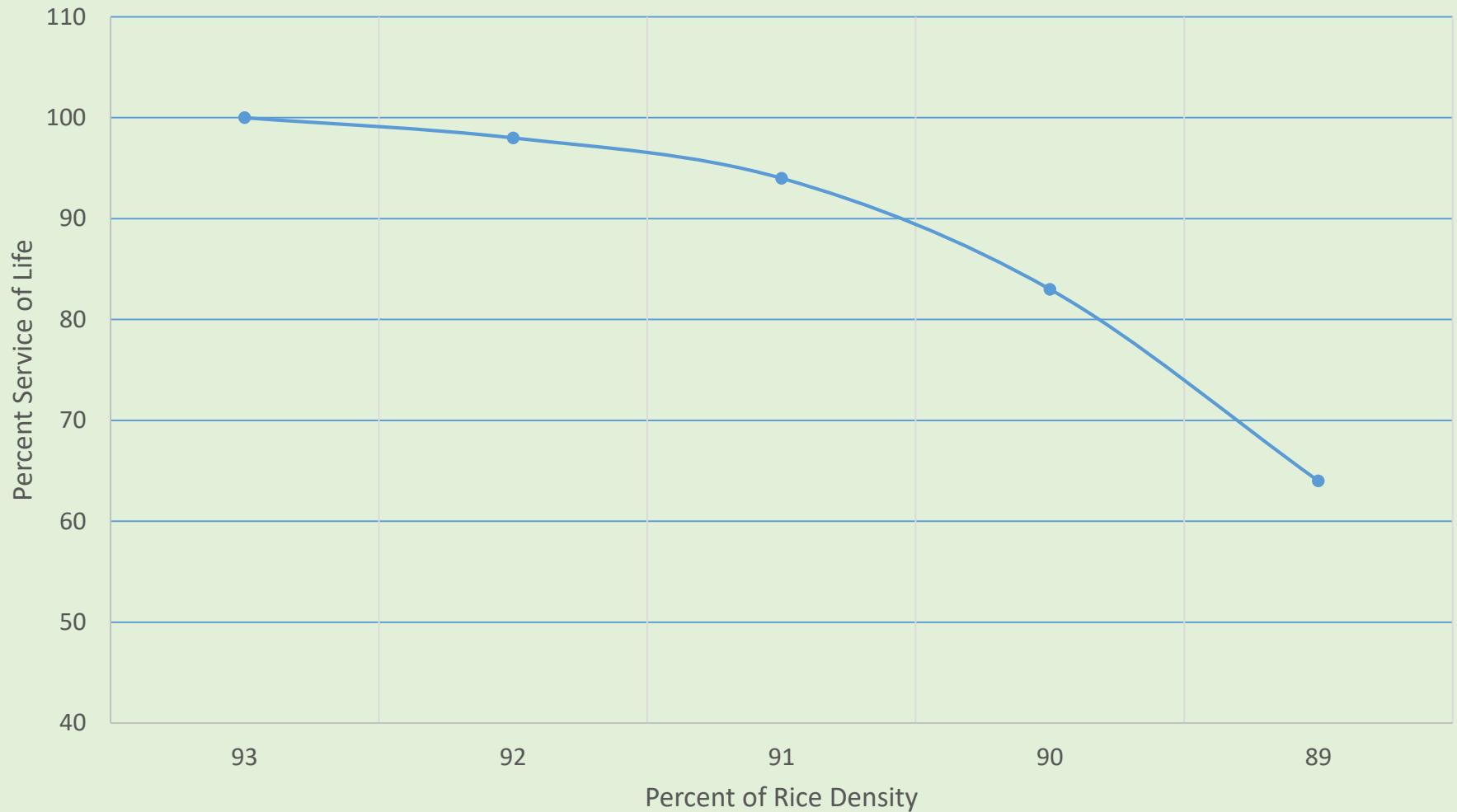
Construction - Section 3

Reference Densities



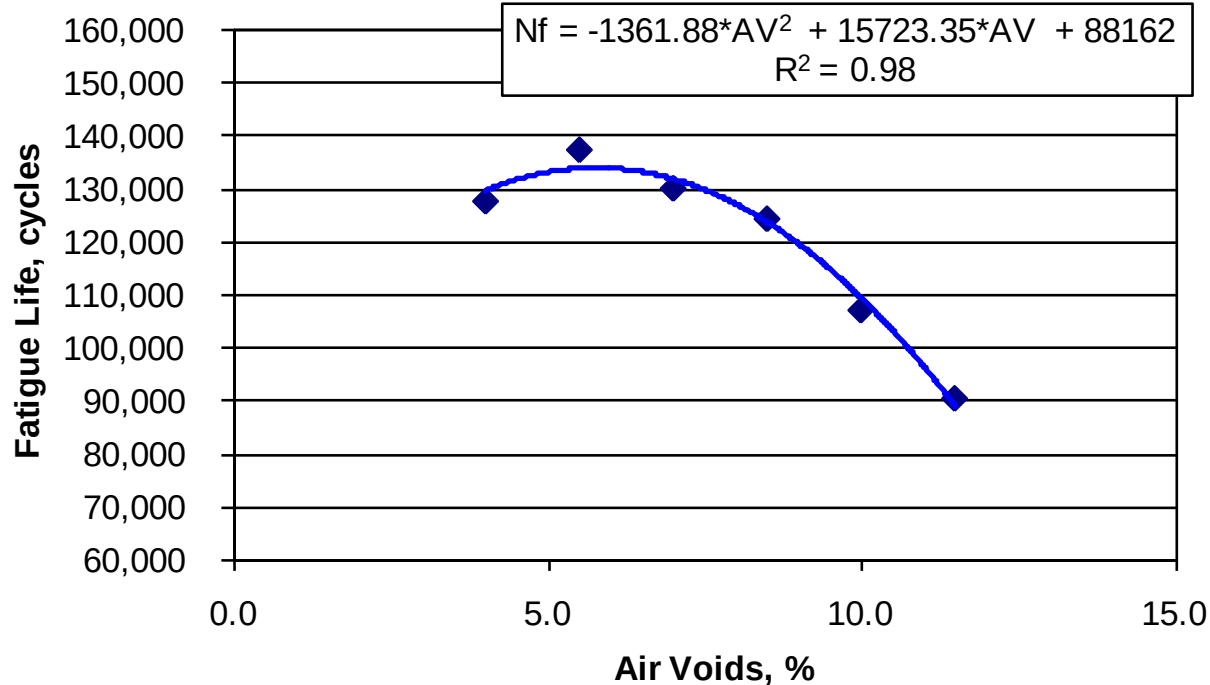
Density vs. Loss of Pavement Service Life

Washington State DOT Study



In-Place Voids vs Fatigue Life

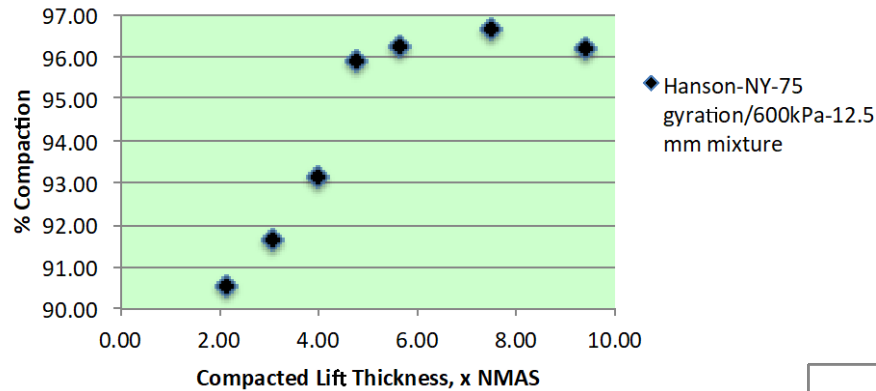
Effect of Percentage of Air Voids on Fatigue Life
20C, 500 microstrain



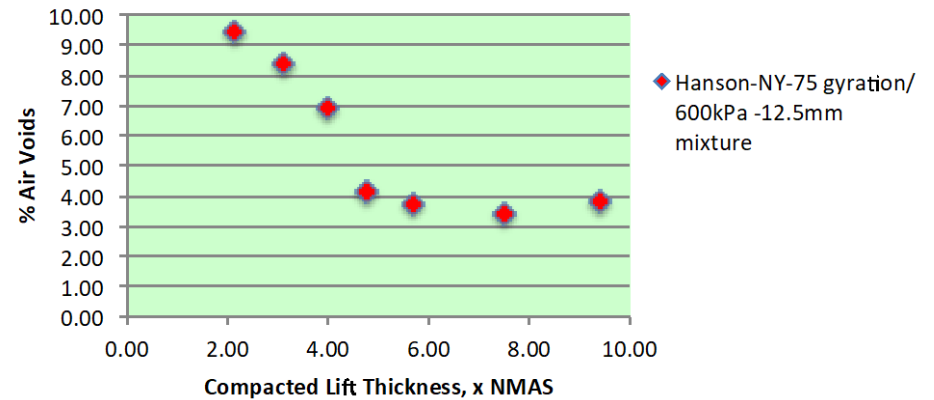
UK-AI Study
1.5% increase
in density
leads to 10%
increase in
fatigue life.

Density vs. Lift Thickness

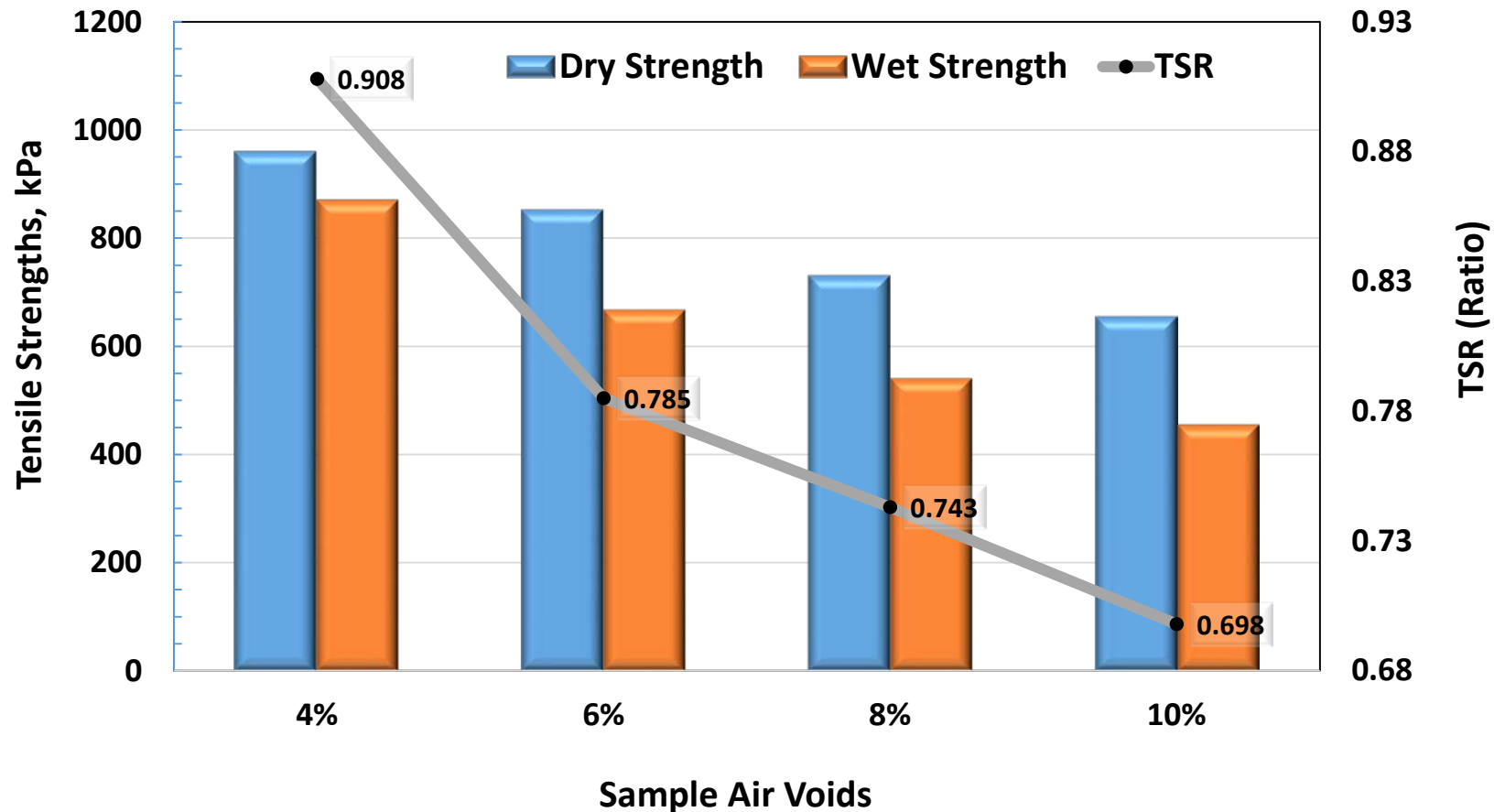
Effect of Lift Thickness On Achieving Density



Effect of Lift Thickness On Achieving Density



Tensile Strength & Moisture Susceptibility vs. Air Voids AASHTO T 283



FHWA Performance Based Mix Design

	Fatigue Cracking	Rutting
Design Air Voids For every 1% increase	40% increase	22% decrease
Design VMA For every 1% increase	73% decrease	32% increase
Compaction Density For every 1% lower in-place Air Voids (Increasing Density Improved Both!)	19% decrease	10% decrease

Courtesy of Nelson Gibson

Maintenance

Crack Sealing & Surface Treatments

Think permeability

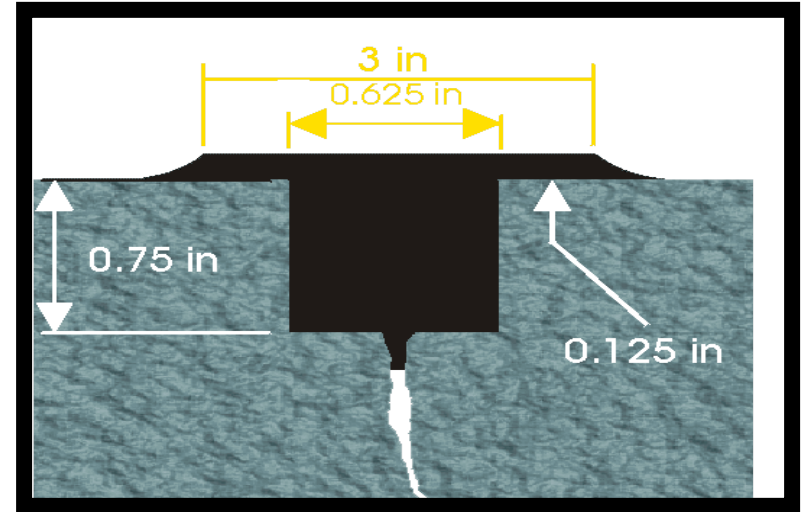
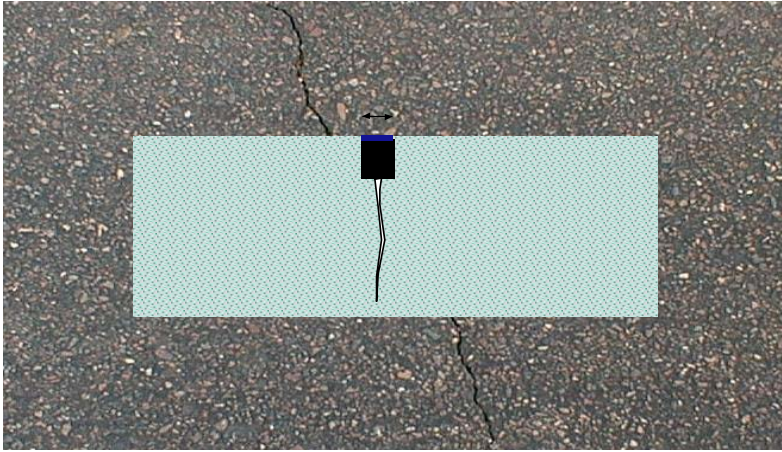


Photo: Wes McNett

Crack Sealing



Crack Sealing



Surface Treatments





Optimal Timing of Preventive Maintenance for Addressing Environmental Aging in Hot-Mix Asphalt Pavements

R. Michael Anderson, Principal Investigator
Asphalt Institute, Inc.
Lexington, KY

December 2014

Research Project
Final Report 2014-45

Minnesota
Department of
Transportation

**RESEARCH
SERVICES
&
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**Office of
Transportation
System
Management**



The TH 56 test section confirmed the hypothesis, with mixture testing indicating that the subsections with chip seals applied more than two years after construction had essentially the same fracture energy properties as the unsealed control subsection. The findings from this test section imply that to mitigate damage from environmental aging, the initial treatment from a preservation standpoint should occur within the first two years of the pavement's life. After that, while some benefits may still be obtained from treatment, it appears that the damage from environmental aging may have already substantially occurred.

New 2-day Workshop in 2019

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Thank you for your attention



Discussion/Questions?

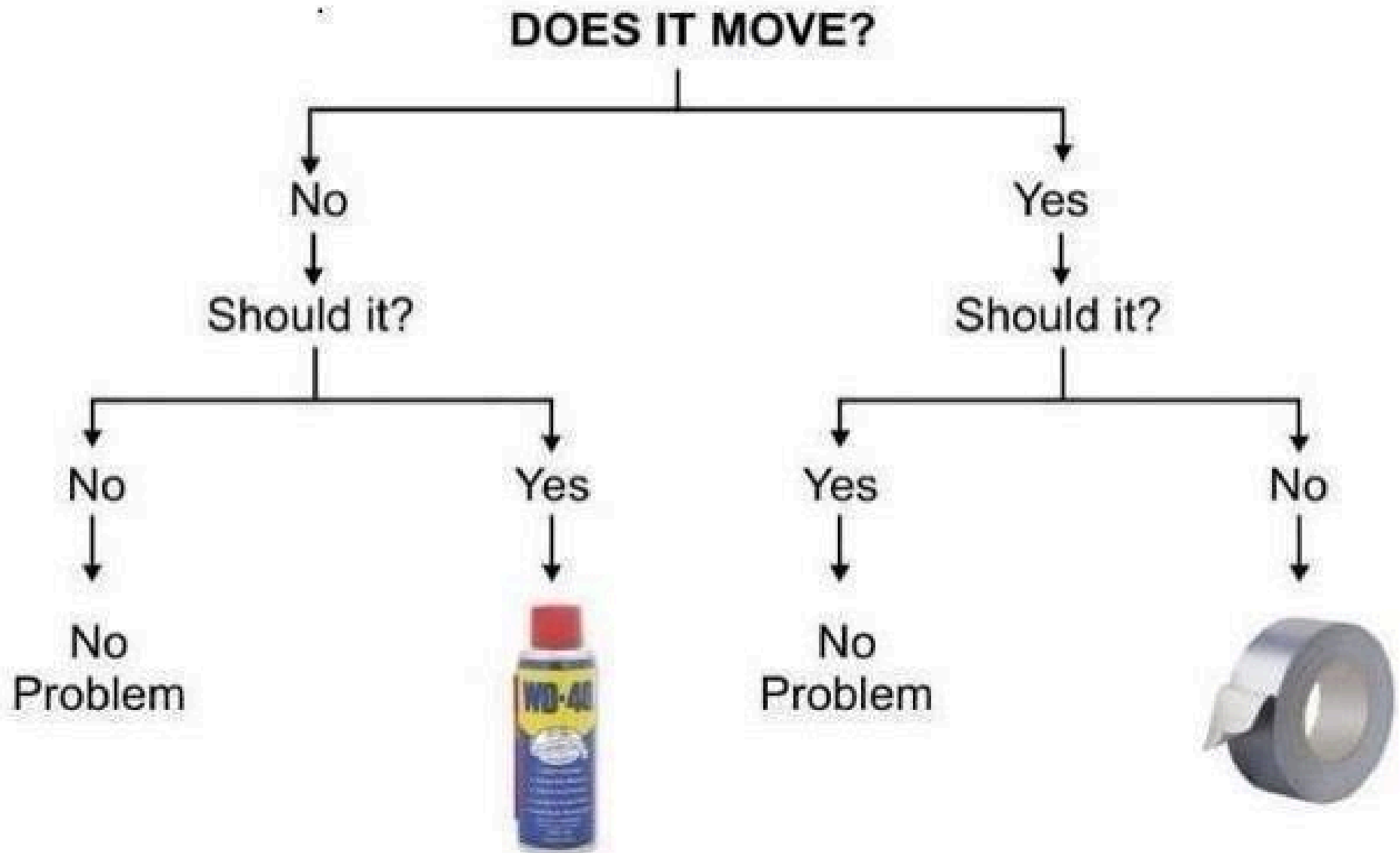


Alaska Department of Transportation & Public Facilities

Use of Advanced Technology for Quality Assurance in Alaska
Rich Giessel

Idaho Asphalt Conference: October 25, 2018

Engineering Flowchart





Outline

1. Failure Modes Drive Testing Philosophy Shift
2. Implementation History of ICTs in Alaska
3. Surprising things we have discovered with Dielectric Profiling System (DPS) GPR
4. Main Features of Continuous-Full-Coverage Specifications for Compaction Acceptance
5. Compaction Defect Mapping and Remediation



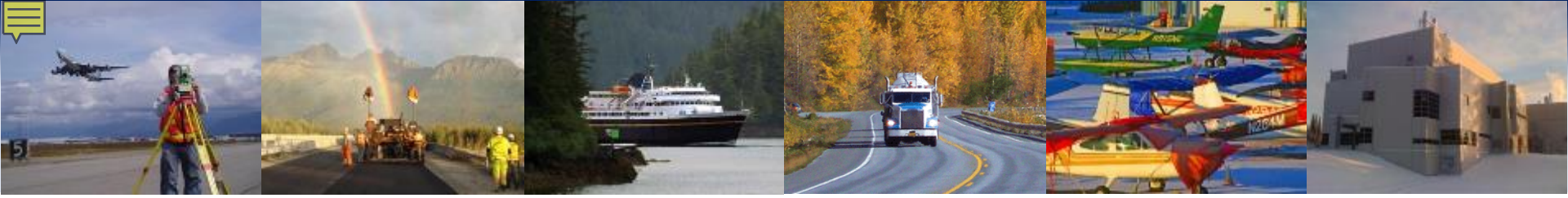
1. Failure Modes of Asphalt Paving

Major Failure Modes:

1. Studded Tires (a political problem)
2. Poor Compaction (a construction problem)
3. Poor Tack Bond Between Layers (a Specification and pay item problem)

Minor Failure Modes:

- Stripping (a surface chemistry problem)
- Rutting & Shoving (a mix design problem)



Avoidable Major Failure Modes

Avoidable Major Failure Modes:

2. Poor Compaction
3. Poor Tack Bond Between Layers

Our focus will be on **Enhancing Compaction**



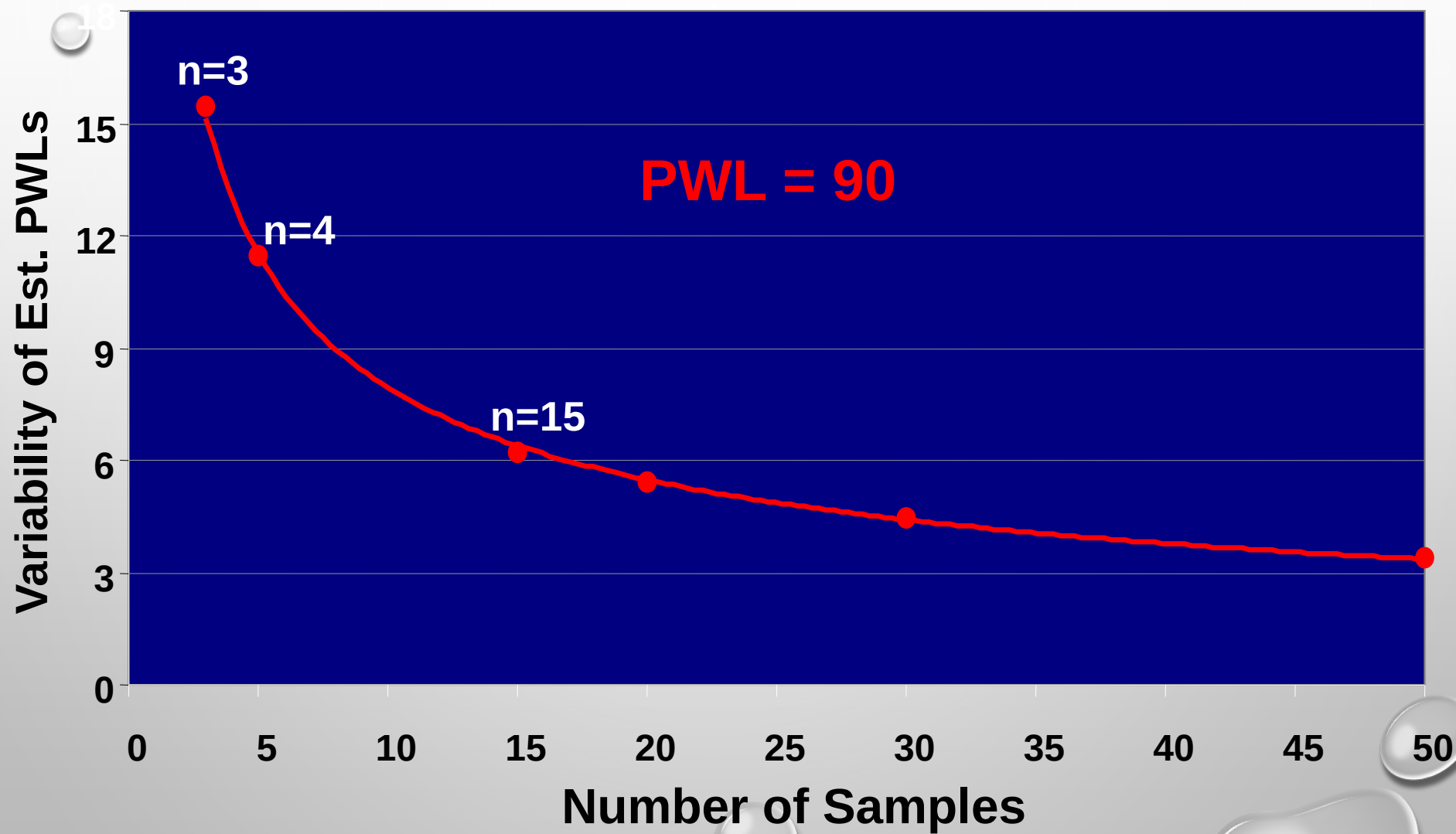
Required Shift in Philosophy-1

- We Must Abandon Random Testing

“The primary problem is not so much to determine the average conditions, as it is to make reasonably certain that possibly the most unfavorable conditions are known over a given area that may give rise to soft spots.”

Donald M. Burmister (1948)

OPTIMAL SAMPLE SIZE





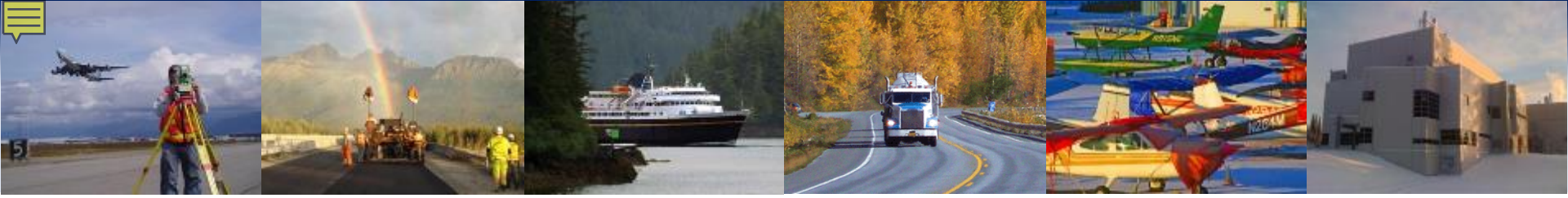
Required Shift in Philosophy-2

- Adopt current state-of-practice technology to achieve 100% testing & inspection coverage
 - Intelligent Compaction (IC) Rollers provide 100% pass coverage, temperature, ICMVs
 - Paver Mounted Thermal Profilers (PMTTP) provide 100% thermal mapping of mat
 - Asphalt Surface Dielectric Profiling Systems (DPS) using Ground Penetrating Radar (GPR) provide 100% Mapping of compaction

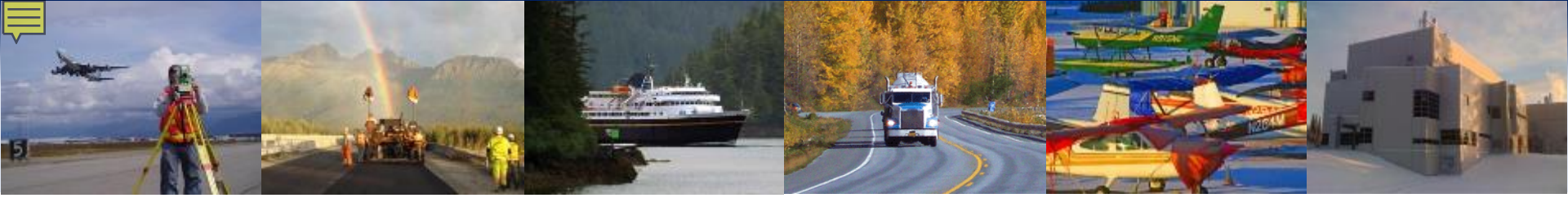


Expected Outcomes

- No potholes or raveling joints
- Longer-life pavements
- Much less maintenance
- Lower life-cycle cost



2. Implementation History of ICTs in Alaska



Intelligent Compaction Rollers

- Intelligent Compaction Rollers required at Sitka Airport for Night Paving. (Bruce Brunette 2013)
- Echelon Paving also employed to reduce longitudinal joints from 11 to 5.



Paver Mounted Thermal Profiler (2015)





Pave IR Benefits

- Real-time thermal mapping, color display on paver provides immediate feedback to DOT and paving crew



Example Pave-IR Display

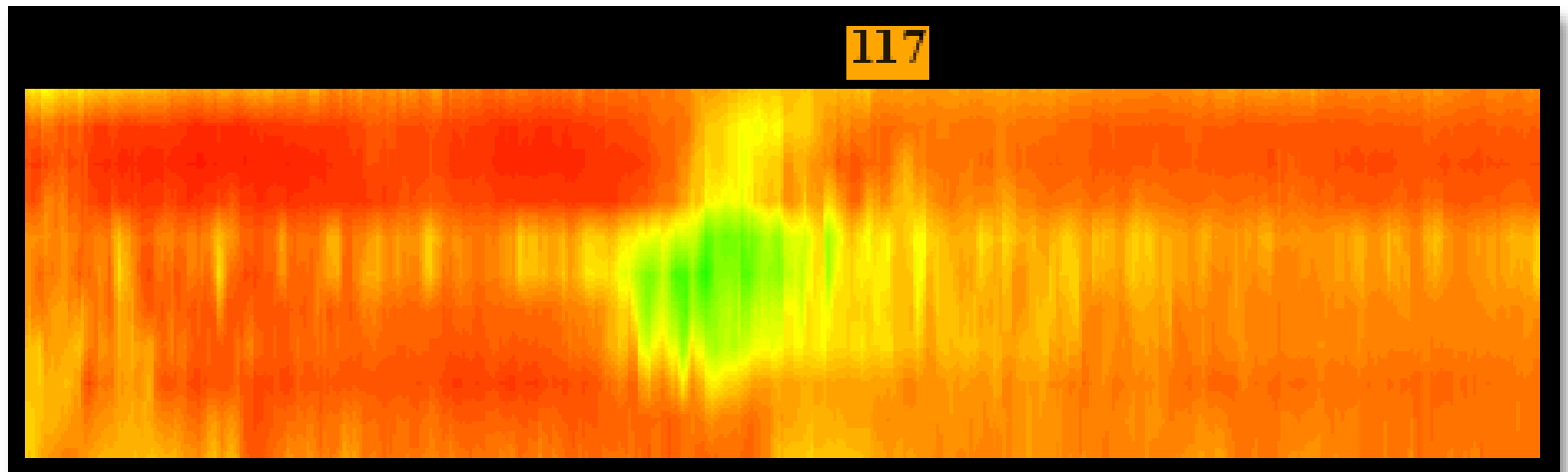
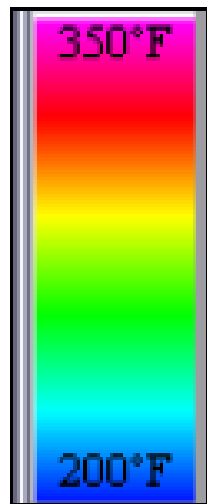


Figure 3.2. Thermal profile from US-29 (continued).



Birth of a Pothole

Research Report – July 1, 2001

Research Project Agreement T9903, Task A3

Cyclic Segregation

**CONSTRUCTION-RELATED ASPHALT CONCRETE
PAVEMENT TEMPERATURE DIFFERENTIALS
AND THE CORRESPONDING DENSITY
DIFFERENTIALS – Report No: WA-RD 476.1**

Washington State Transportation Center (TRAC)

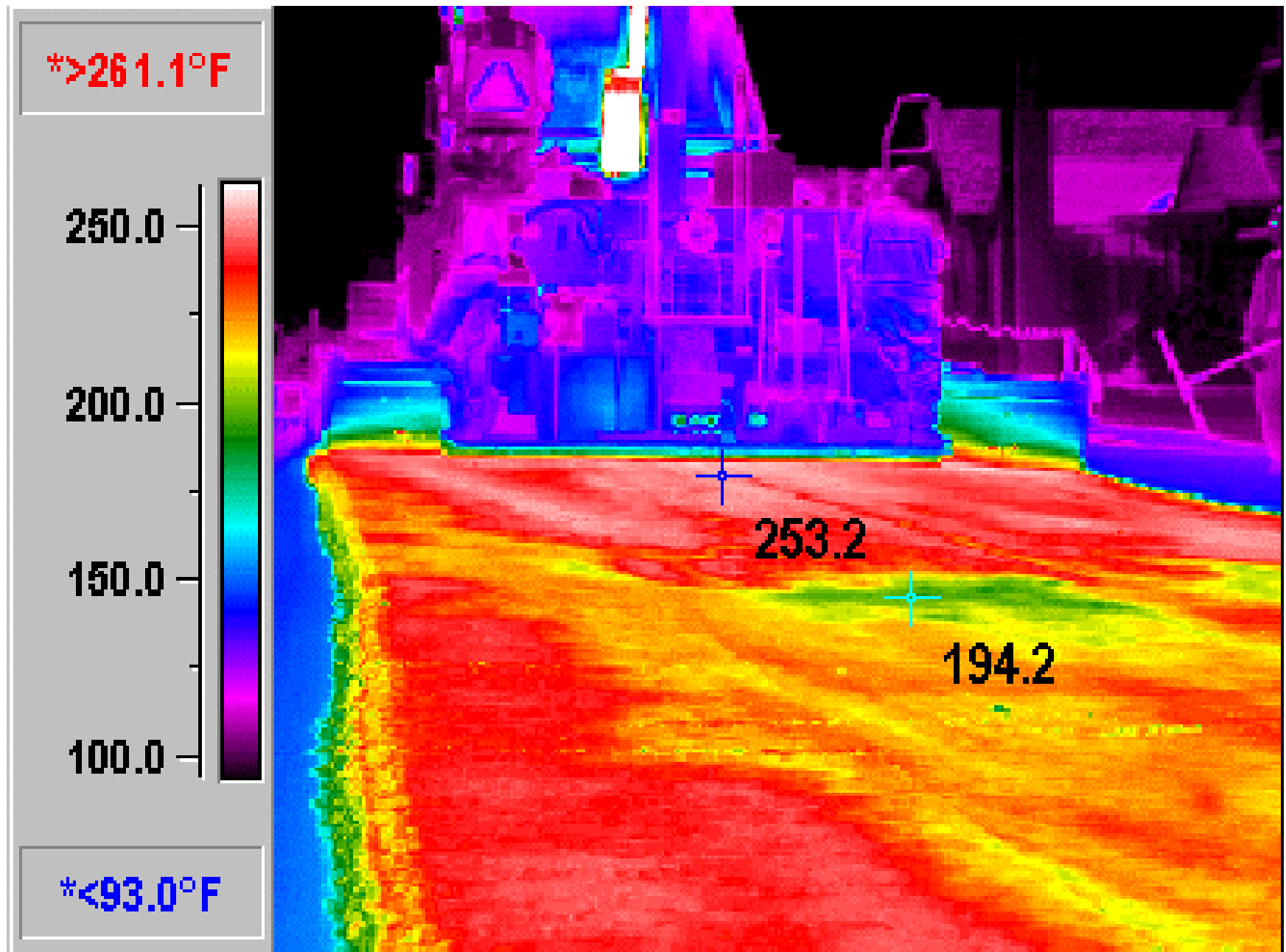
University of Washington, Box 354802

University District Building

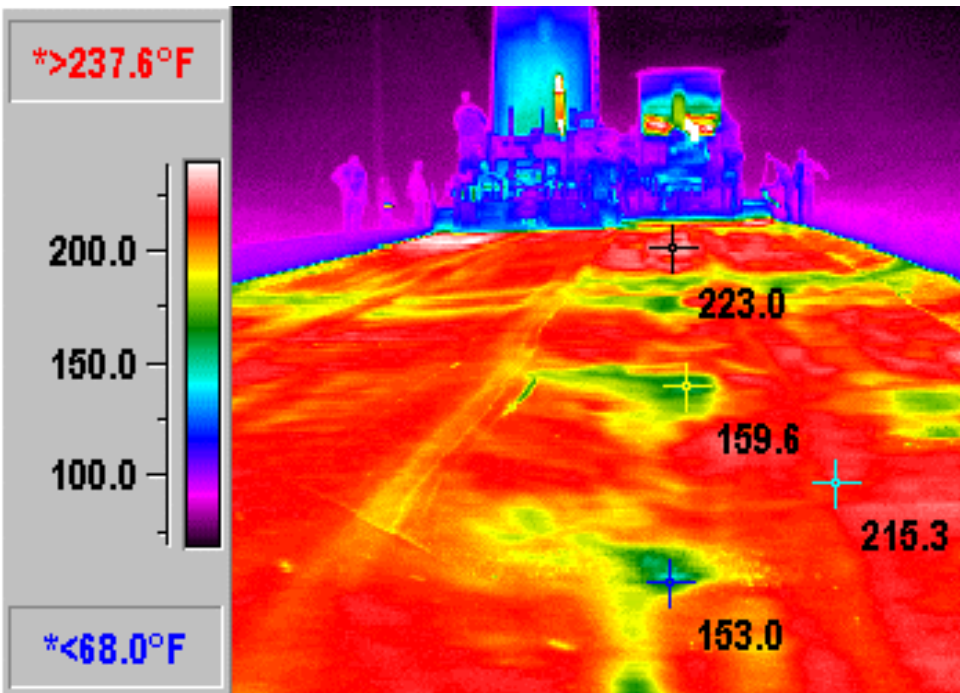
1107 NE 45th Street, Suite 535

Seattle, Washington 98105-4631

Tarped vs Not Tarped



Cold Spots - Infrared vs B&W Photo





Glenn Hwy Incentive (2016)

- Pay a \$75 Bonus for each 150' segment with No Thermal Segregation (0-25⁰ F variation)
- 2140 each 150' segments = \$160,500 potential bonus on 15 miles of 4 lane highway



No Incentive

- No bonus for 150' segments with Moderate Thermal Segregation (25-50⁰ F)



Penalty or Disincentive

- \$75 Penalty (not used on Glenn Hwy) for each 150' segment with Severe Thermal Segregation ($>50^{\circ}$ F)
- Only used the Carrot☺



PMTP Use Rewards Good QC

- PMTP is an objective tool for rewarding best practices such as:
 1. Tarping all loads
 2. Steady delivery of material to project with a minimum number of paver stops
 3. Tying loads together when dumping
 4. Use of Material transfer vehicle to homogenize temperature and smooth material flow to paver



Newest Methodology (2016)

- Dielectric Profiling System (DPS) using Ground Penetrating Radar (GPR) gives:
 1. Dielectric Mapping
 2. Readout as % Voids, % Compaction, or Density in asphalt mat in real-time once calibration data from drilled cores has been entered.

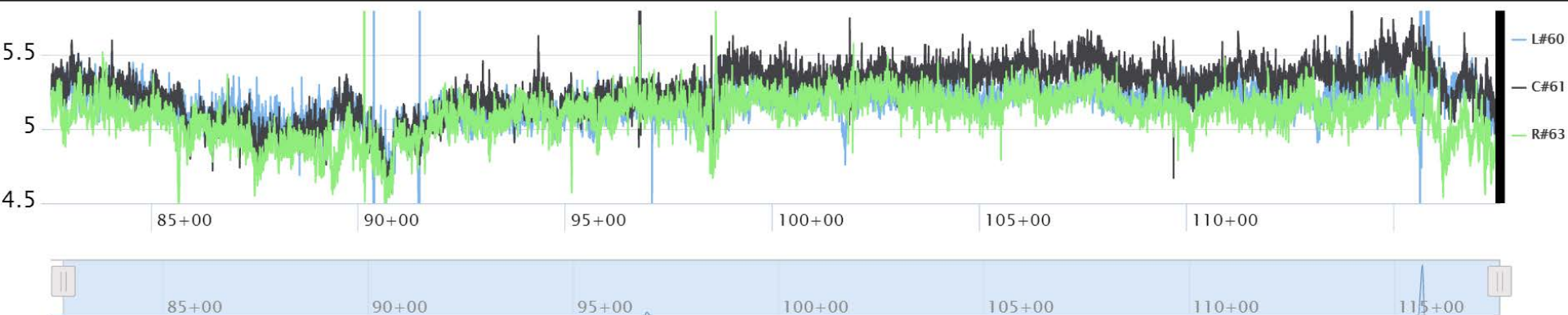
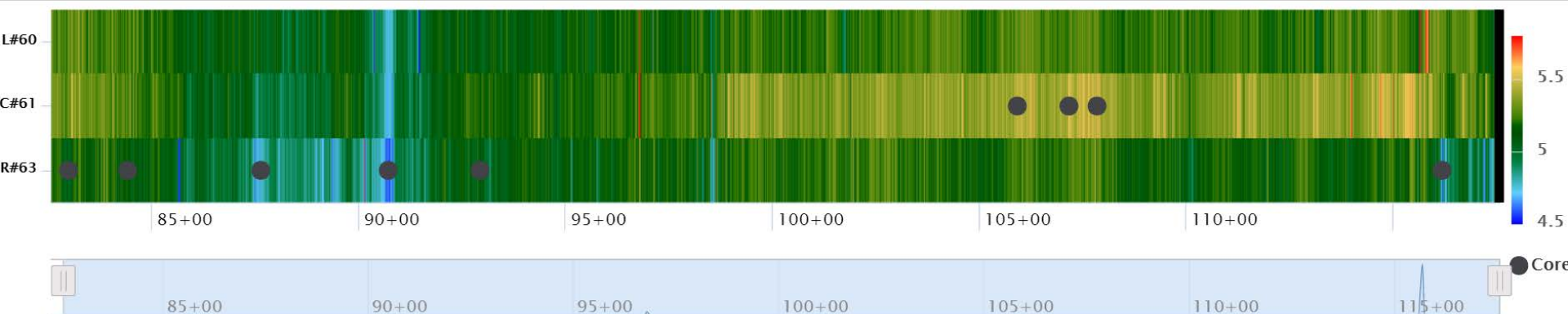
(Note: Testing equipment became commercially available in May 2016 with FCC approval. Alaska purchased the 10th machine made in October 2016)

Fritz Cove Dielectric (July 2018)

Heatmap + Histogram

Heatmap + Linechart

Linechart + Histogram




Main Menu


Statistics


Core Locations

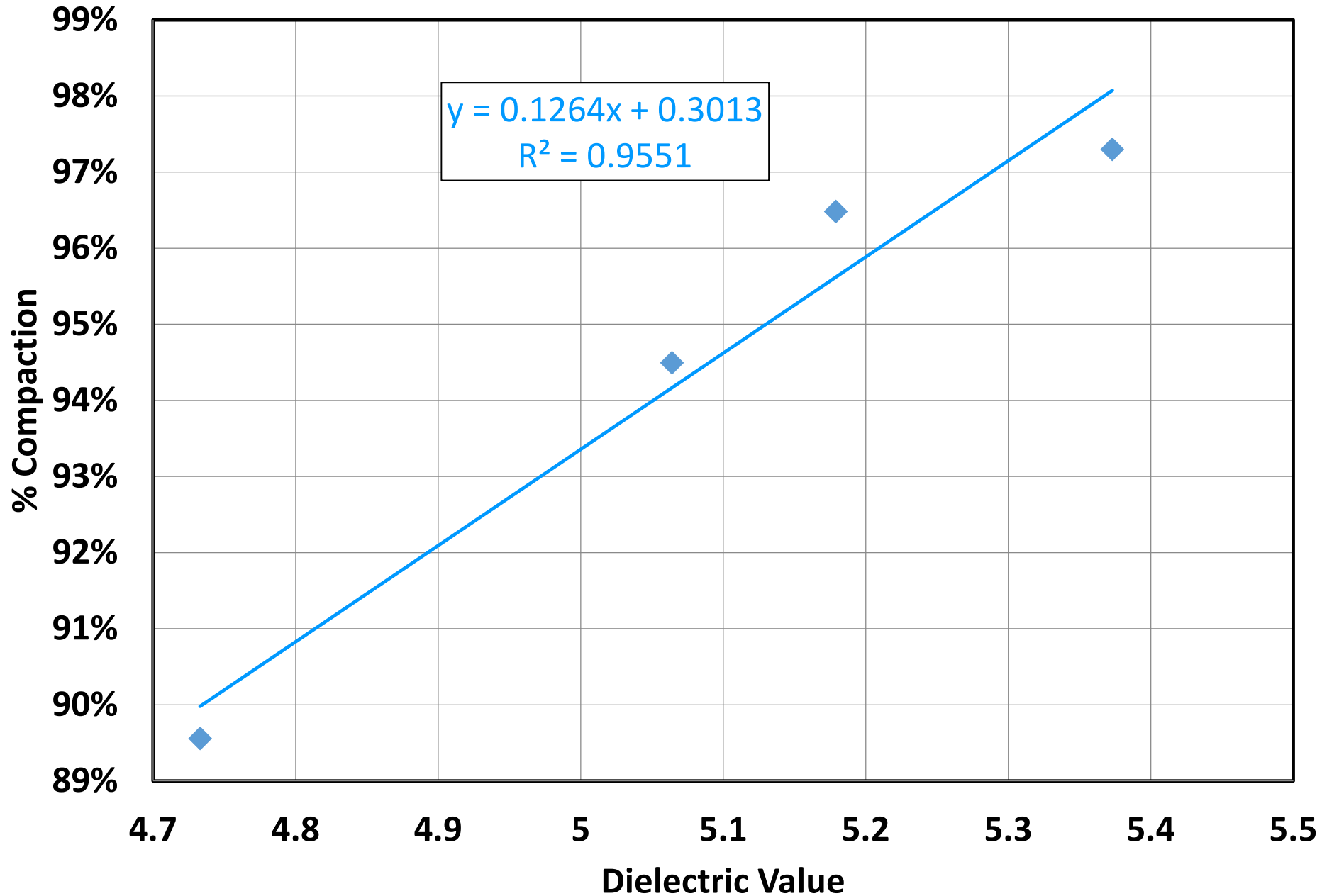

Export


Display Options


Back



Mainline Dielectric vs % Compaction

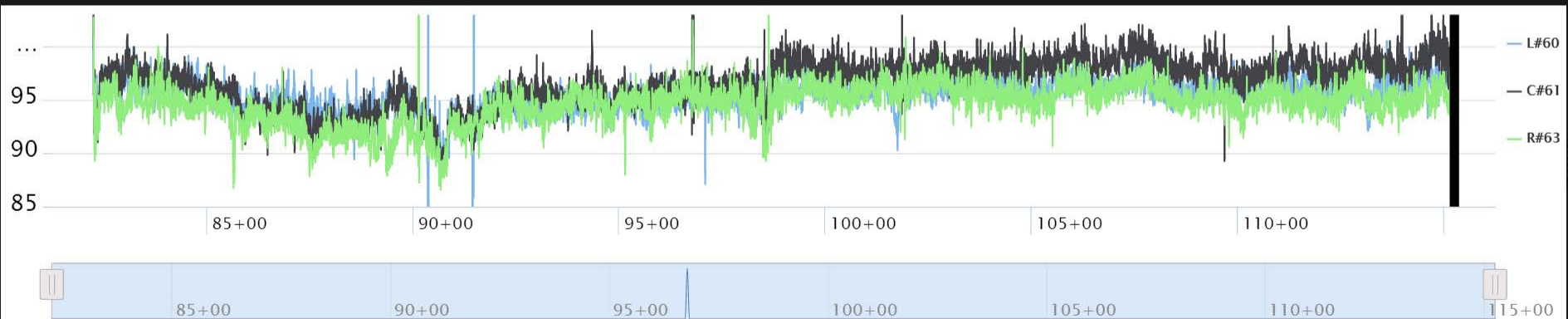
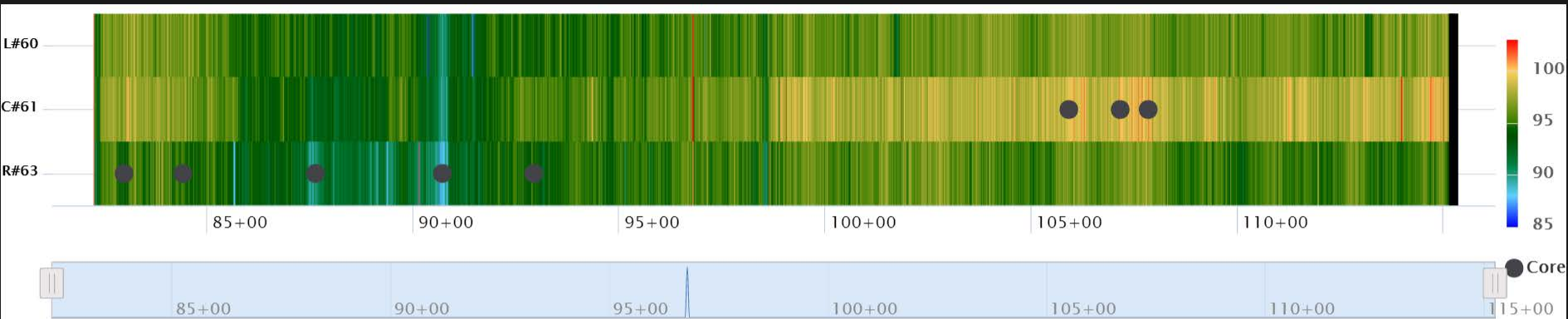


Fritz Cove % Compaction

Heatmap + Histogram

Heatmap + Linechart

Linechart + Histogram



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DPS - PaveScan RDM (2017)





PaveScan RDM

- PaveScan Rolling Density Meter Provides:
 - Geo-located Data
 - 400,000 pulses per second processed with equivalent time sampling to produce 60 scans/sec
 - 60 scans (dielectric readings) per second recorded to Raw Data File
 - =10 Dielectric readings per foot of travel at 6 ft/sec (~ 4 mph walking speed) per antenna



What is Dielectric?

- Related to Speed of RADAR through a Material

$$e = C^2 / V^2 \quad \text{or} \quad (V = C / \sqrt{e})$$

Where: e = Dielectric

C = Speed of light in a vacuum

V = Speed of RADAR in material



Relative Speeds of RADAR

RADAR is fastest in Air $e = 1$ ($V=C$)

RADAR is slowest in Water $e = 81$ ($V=1/9C$)

Asphalt Concrete $e = 4-7$ ($V=0.5-0.35C$)

(note more air gives lower dielectric, i.e. RADAR passes through porous asphalt faster)

LOW DIELECTRIC = LOW DENSITY

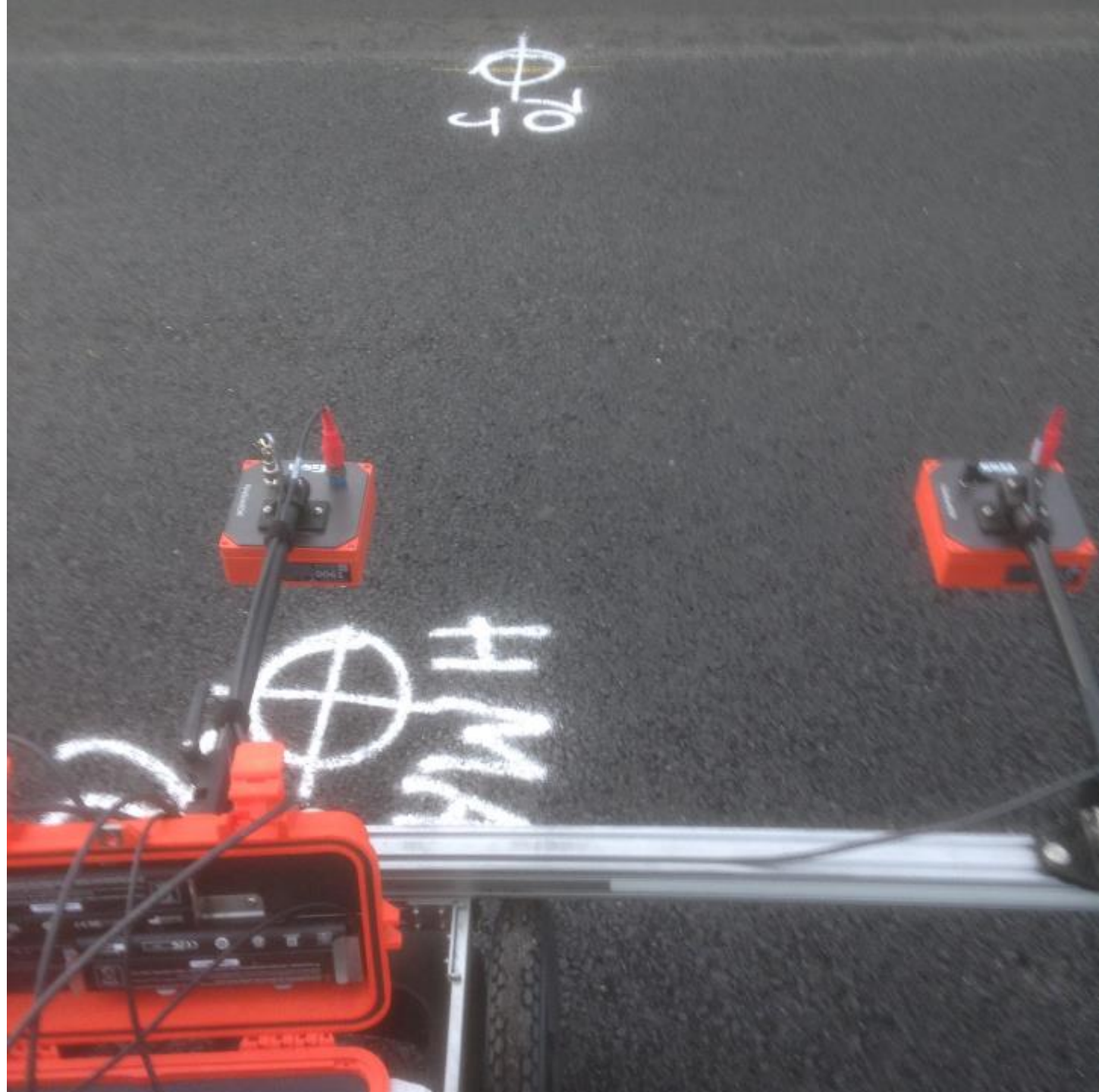


3. Surprising things we have discovered with DPS GPR



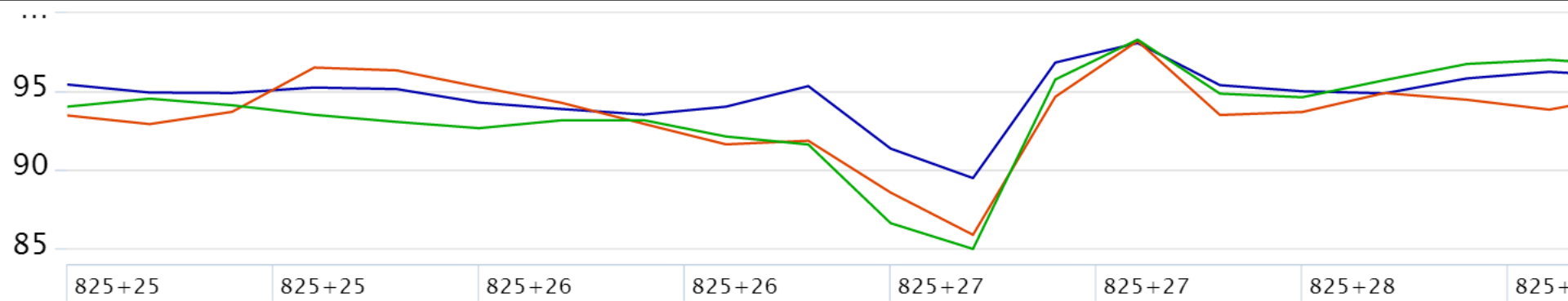
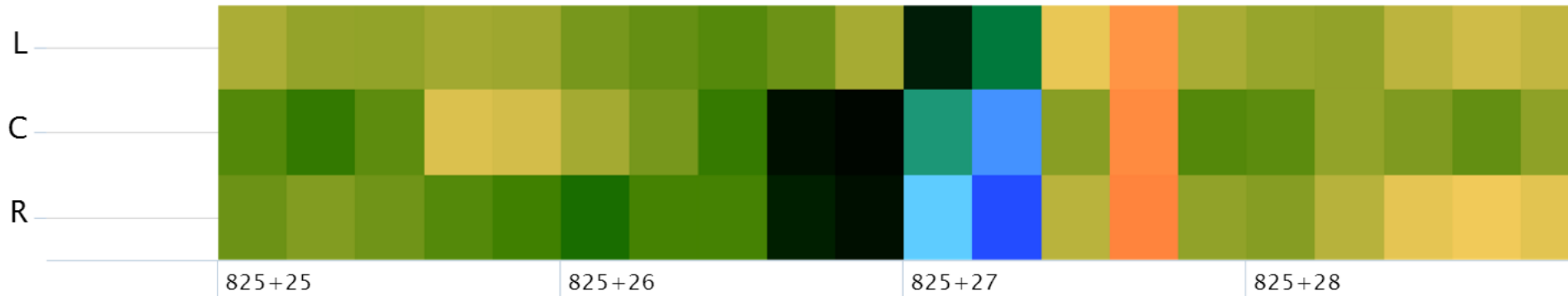
What can we “SEE” with GPR?

- Answer: Defects we have never “SEEN” before
- For example, density variation across a longitudinal joint



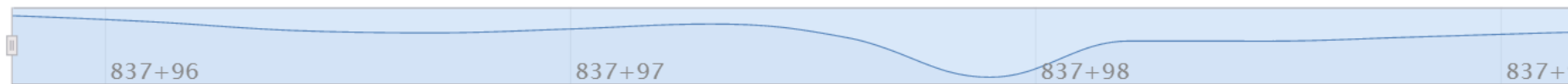
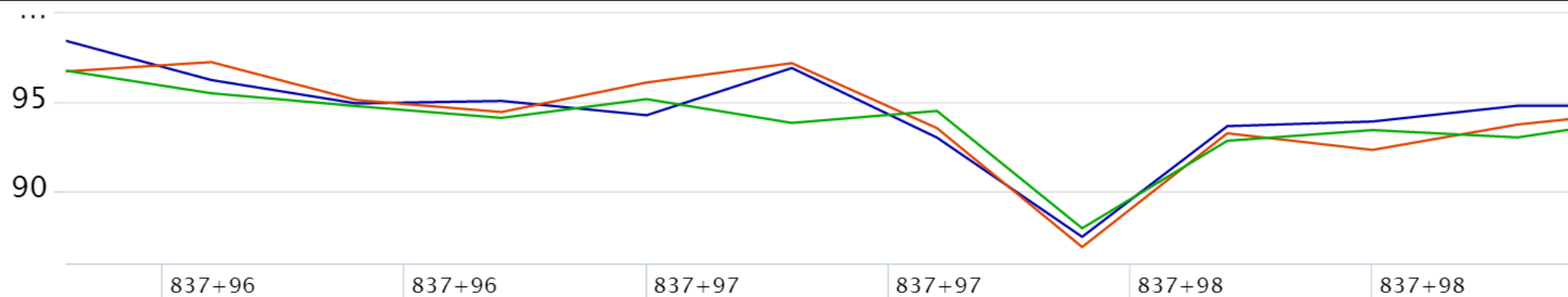
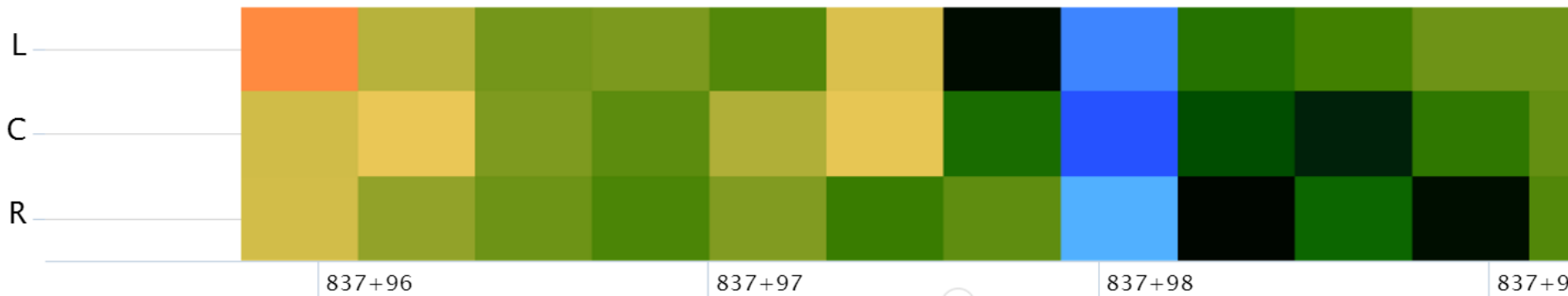


Core 70J (91.7%) – Resolution 0.25 ft



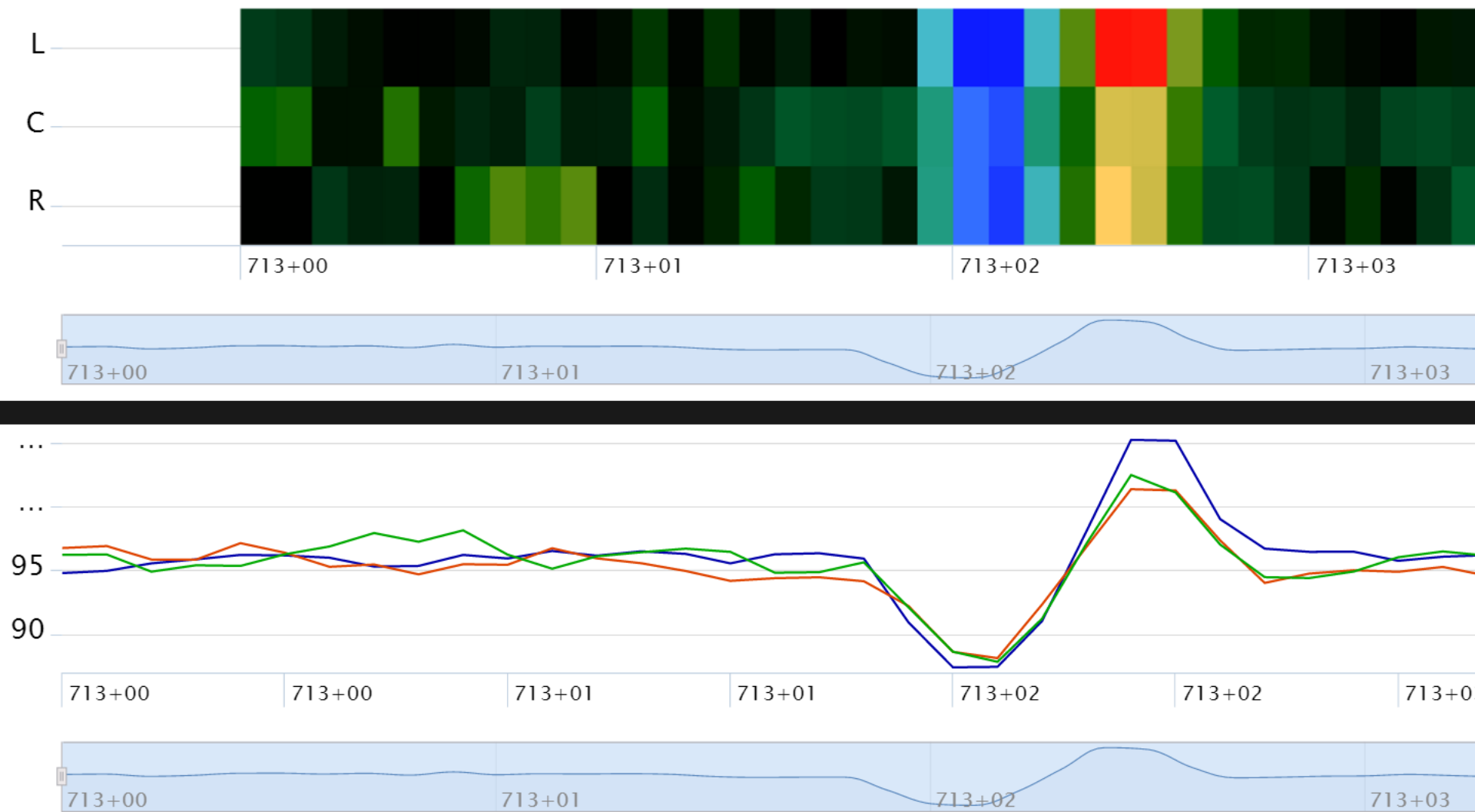


Core 69J (92.9%) – Resolution 0.25 ft





Core 87J (94.9%) – Resolution 0.10 ft





Core 87J – Distance Statistics

Sensor Position↓	Total Dist ↓↑	Median↓↑	Average↓↑	Min ↓↑	Max ↓↑	Standard Dev ↓↑
Center	4.2	95.2647	95.2054	88.1275	101.343	2.28774
Left	4.2	96.161	95.9437	87.4141	105.199	3.10059
Right	4.2	96.0255	95.6037	87.8418	102.452	2.49736

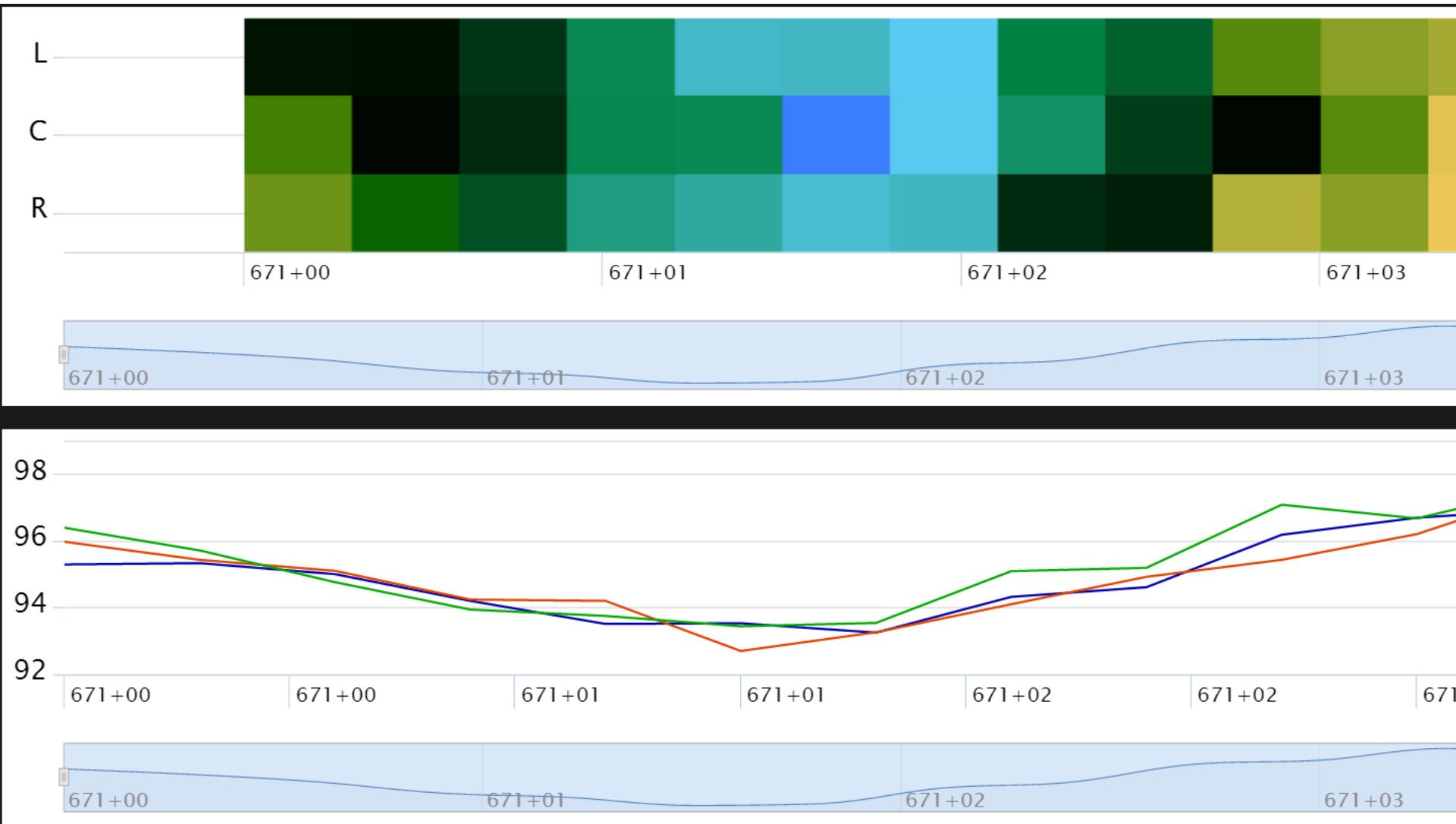


Core 87J – Time Statistics

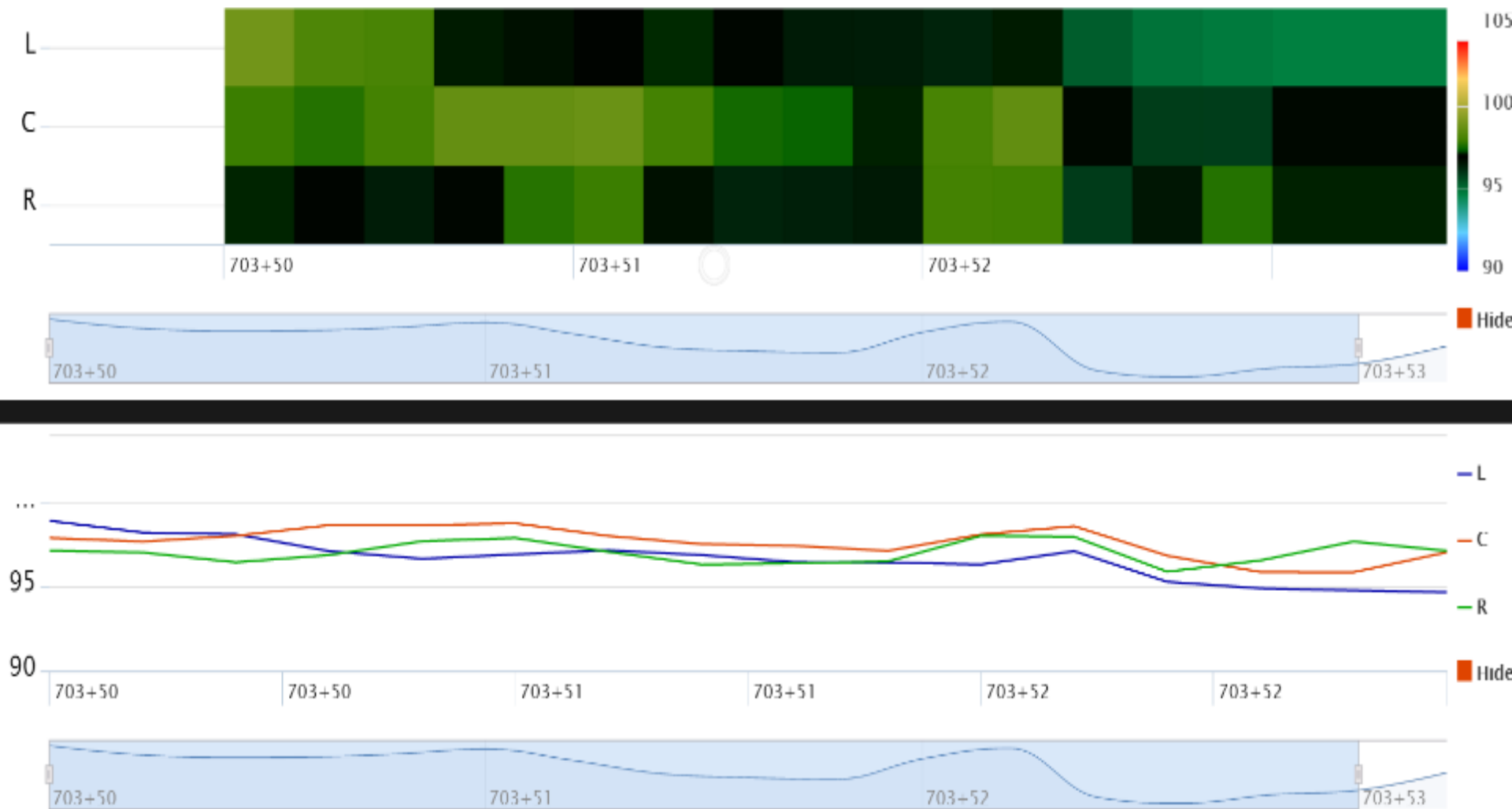
Sensor Position↓	Total Dist ↓↑	Median↓↑	Average↓↑	Min ↓↑	Max ↓↑	Standard Dev ↓↑
Center	1269	87.8607	87.8692	86.8951	88.8963	0.306642
Left	1269	86.557	86.5422	84.4503	87.6718	0.34858
Right	1269	88.985	88.9778	87.8945	90.2777	0.352063



Core 85J (92.4%) – Resolution 0.25 ft



Calibration Core 19J (96.2%) 0.25 ft





Longitudinal Joint at Core 19J

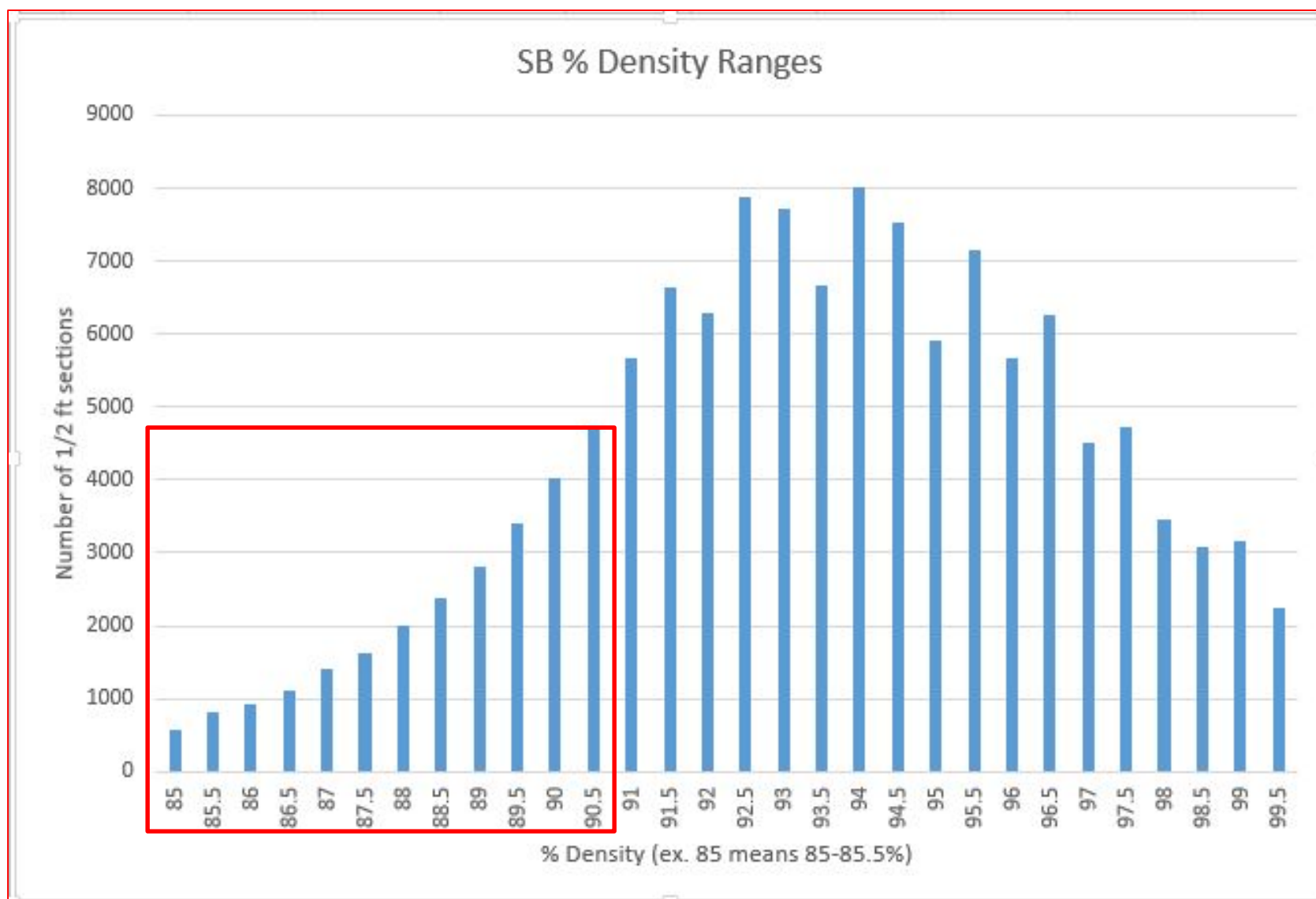




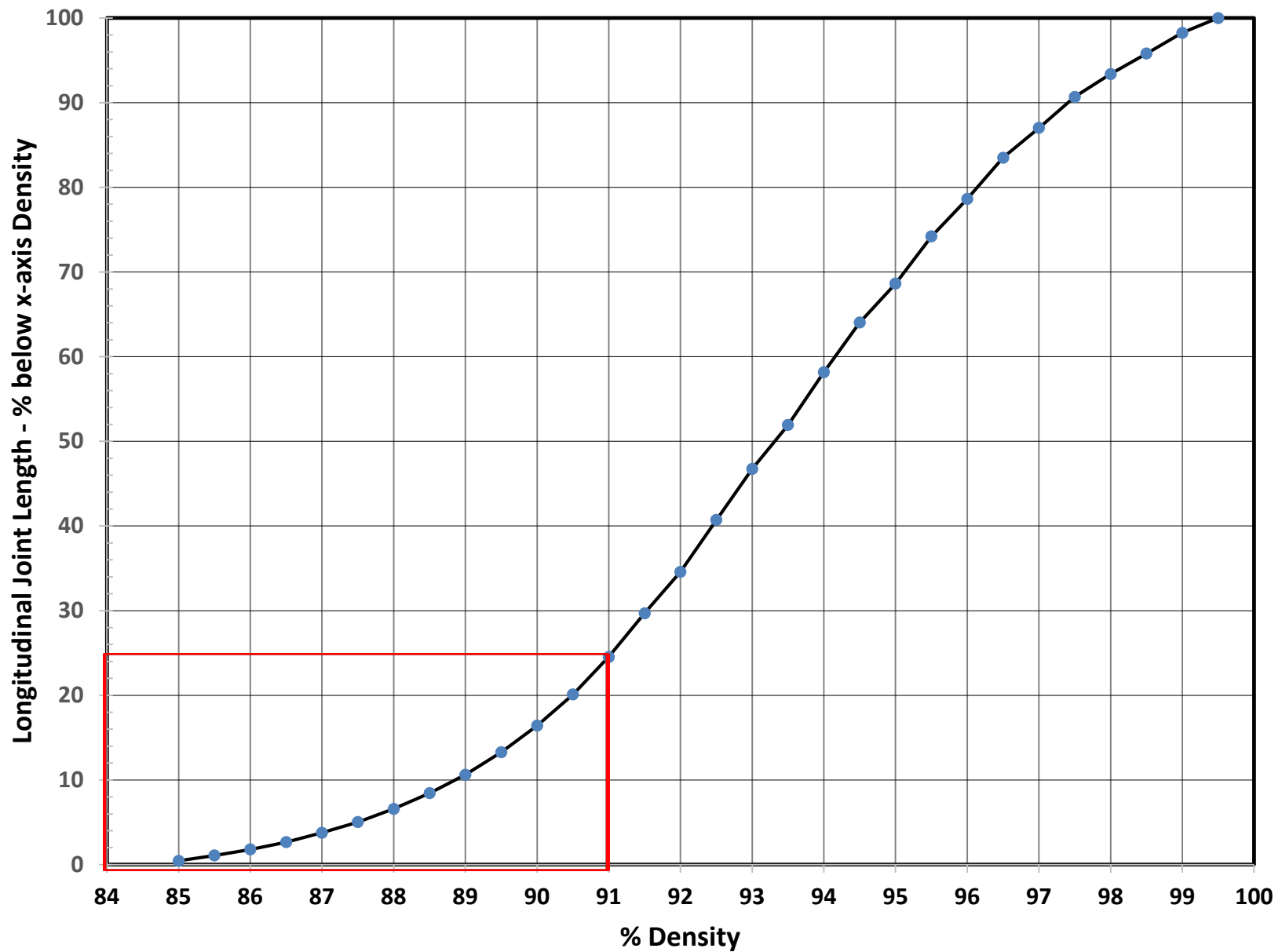
165 Core Densities: 90.9 to 97.8%

Compaction Summary - 2017 Data		
	% Compaction	
	Bulk/MSG	Bulk/MSG
	Panel	Joint
SB-L1 Average Panel Density (20 Cores)	94.8	
NB-L1 Average Panel Density (17 Cores)	95.4	
SB-L2 Average Panel and Joint Densities (33 Cores)	94.9	94.1
SB-L3 Average Panel and Joint Densities (3 Cores)	95.5	93.4
NB-L2 Average Panel and Joint Densities (28 Cores)	94.7	95.0
Project Averages	94.9	94.5
Max	97.6	97.8
Min	92.3	90.9
Note:		
50 of 101 (50%) of Panel Cores 95.0% or Higher		
26 of 64 (41%) of Joint Cores 95.0% or Higher		

SB(Joint CL) Density Histogram

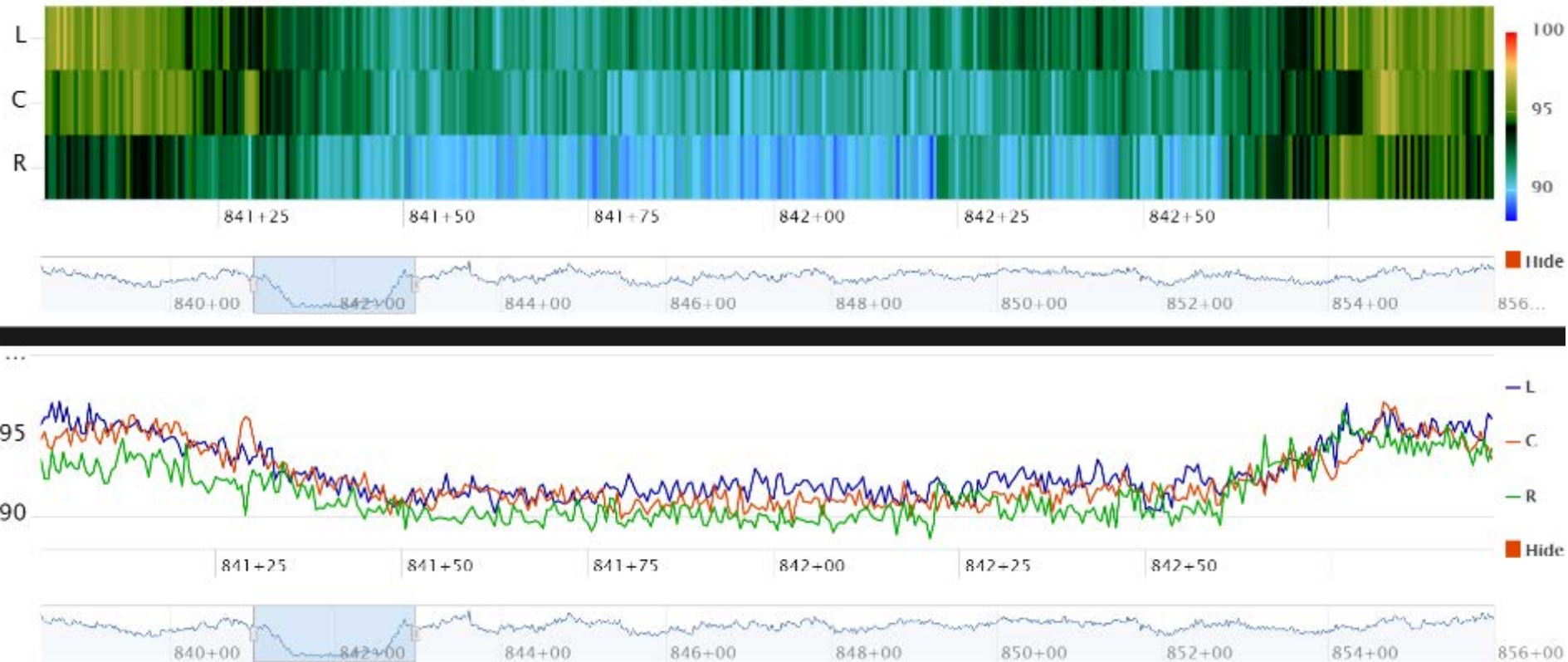


SB Joint Cumulative Densities - 24.5% below 91%

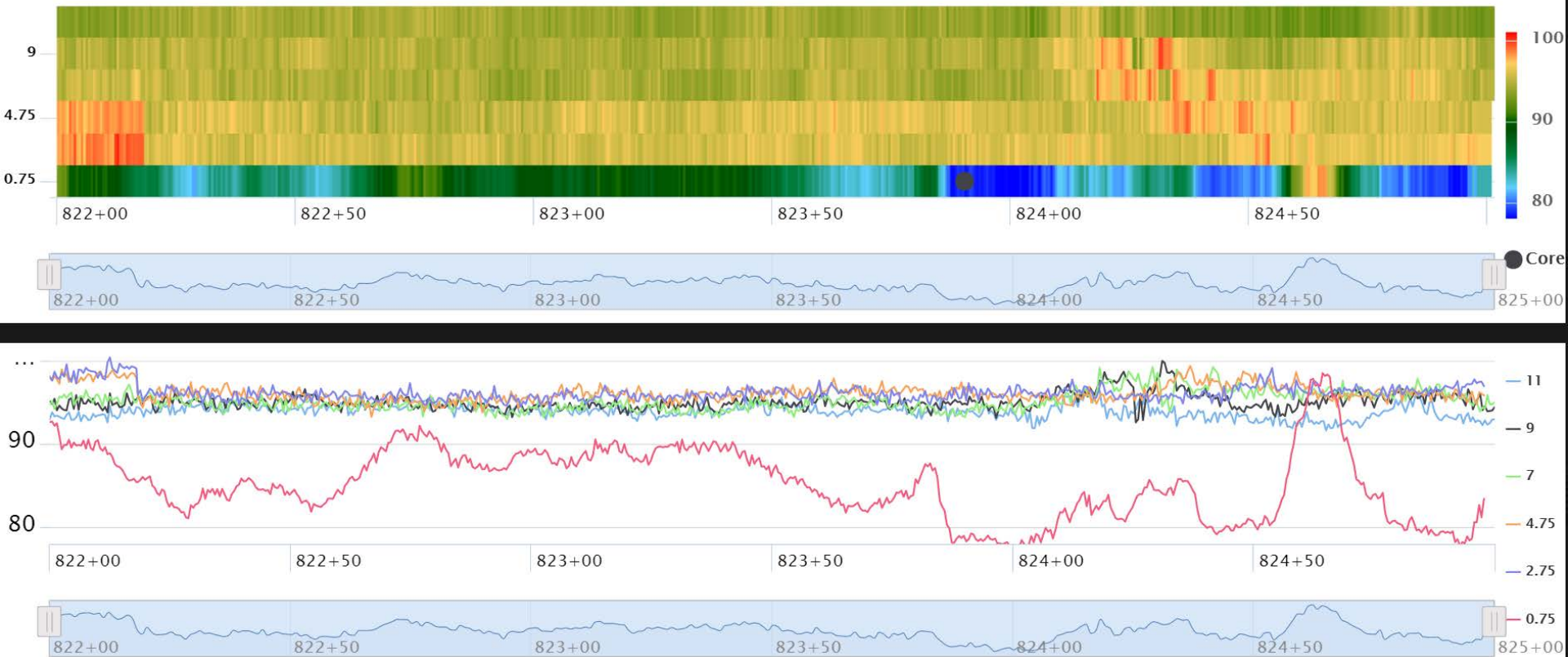


Low Density is Typical at Bridges

S. Birchwood Bridge, SB Lane 2, 18-24' LT

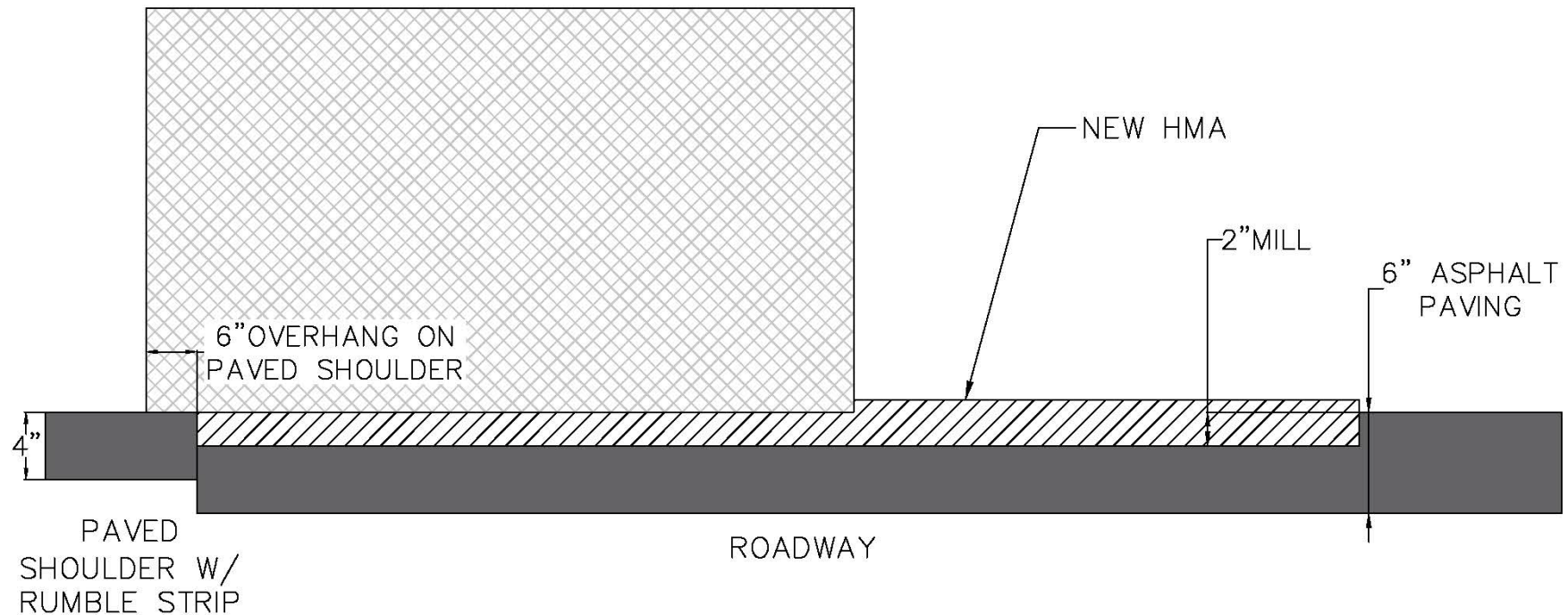


Low Density Adjacent Rumble Strip



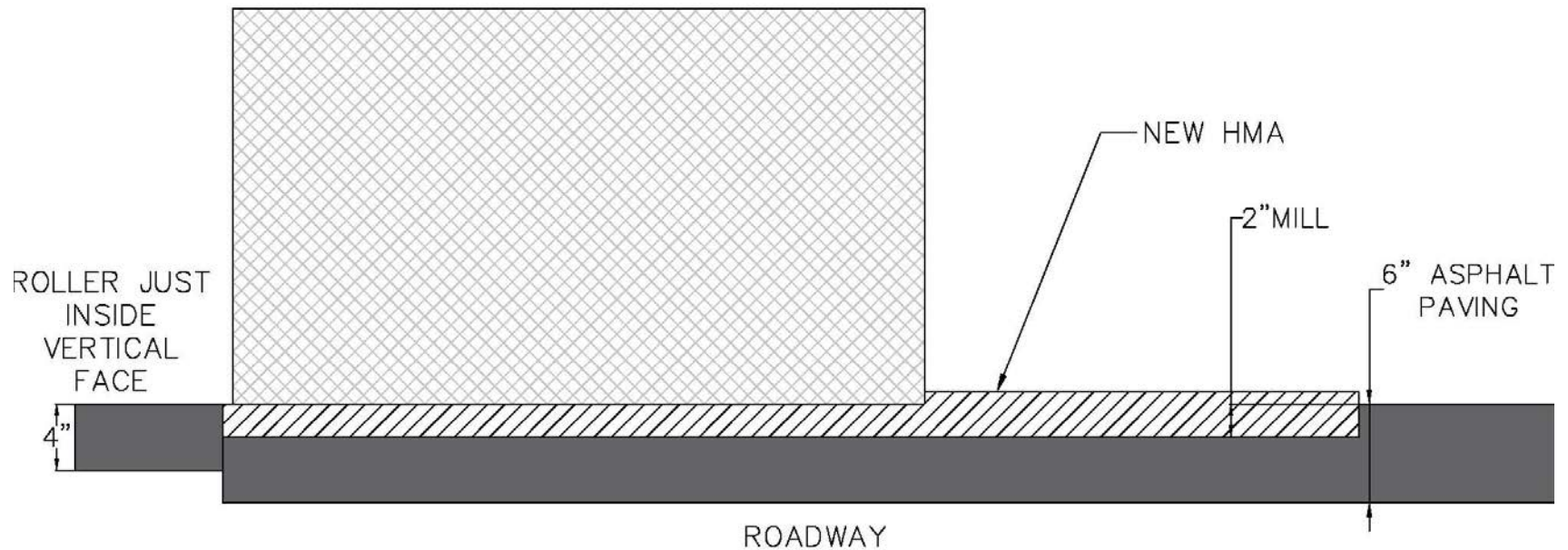
We don't want a "Pretty" edge joint

ROLLER DRUM POSITION – PASS 1



We Want a “Compacted” edge joint

ROLLER DRUM POSITION – PASS 2





4. Main Features of CFC Specs for Compaction Acceptance

What Changes?

The main specification change for implementation of GPR technology is substituting Percent Conforming (PC) for Percent Within Limits (PWL) in the Density Pay Factor.

For a lot (5000 tons) of asphalt, placed in a 2" thick lift, PC will be based on approximately 400,000 density readings (one per square foot, assuming an asphalt density of 150 pcf). PWL for that same lot of asphalt would be based on 10 density readings (one per subplot).



What % Conforming thresholds should trigger repair, R&R?

Mat Density Pay Factor = $0.55 + PC/200$, allowing up to 5% bonus at PC = 100%. (Lower limit of PC = 50%, PF = .80)

- Remove and Replace is triggered if PF is below 0.80

What PC should trigger repair with Sand Seal?

- Perhaps from PC = 50% to 70%, PF = 0.80 to 0.90?

Or

- Perhaps from PC = 50% to 80%, PF = 0.80 to 0.95?



Cost of Potholes

American drivers pay [an estimated \\$3 billion a year](#) to repair damage caused by potholes, according to AAA. Over a five-year period, 16 million drivers reported their vehicles were damaged by potholes, from tire punctures and bent wheels to suspension damage.

Instead of Percent Conforming
should we use defect size and
low compaction threshold for
repair criteria?

What size low-compaction area should trigger mat repair?

Current programming allows PaveScan Operator to Select defect size and compaction threshold for identification and mapping of both linear and area defects.

What size area should trigger repair?
(Currently using 8 ft²)

What % compaction should trigger repair?
(Currently using <92%)



What length of low-compaction Longitudinal Joint should trigger repair?

What length should trigger joint repair?
(Currently using 5 ft)

What % Compaction should trigger repair?
(Currently using <91%)

What equipment might one see
when incentives are given for
superior mat & joint compaction?



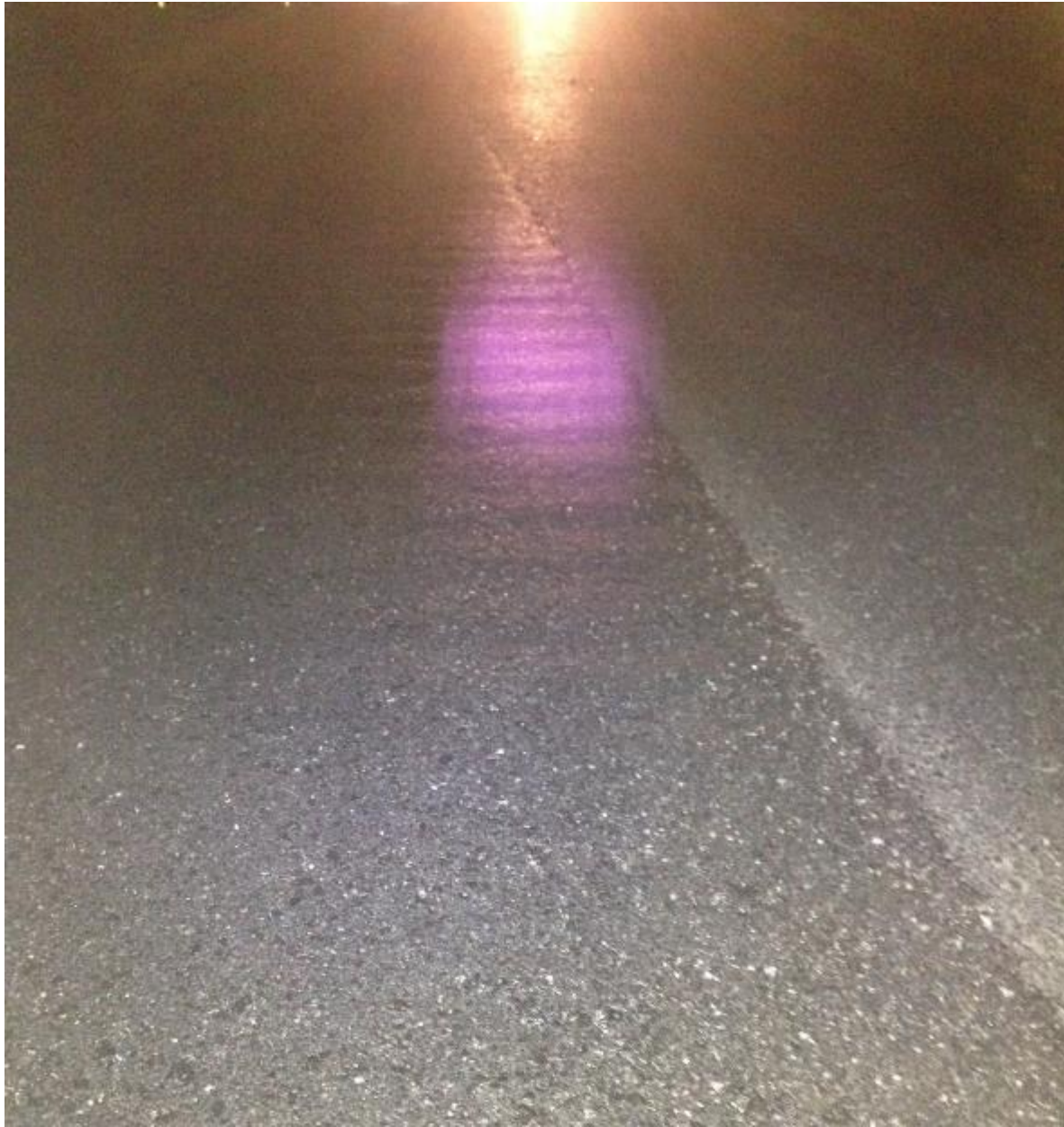


16-8527

E650



What you don't want to see







5. Compaction Defect Mapping & Remediation

Portage Glacier Road

File 008 Area Defects

Legend

-  Area Defect
-  Feature 1
-  Linear Defects
-  Portage
-  Portage Glacier Cafe and Gallery

Google earth

Image © 2018 DigitalGlobe

© 2018 Google

Image Municipality of Anchorage



4000 ft

Portage Glacier Road

Linear Defects - Longitudinal Joint

Legend

-  Area Defect
-  Feature 1
-  Linear Defects
-  Portage
-  Portage Glacier Cafe and Gallery



Google earth

Image Municipality of Anchorage

1000 ft

Portage Glacier Road

Linear Defects - Longitudinal Joint

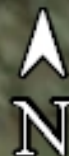
Legend

-  Area Defect
-  Feature 1
-  Linear Defects
-  Portage
-  Portage Glacier Cafe and Gallery

Google earth

© 2018 Google

Image Municipality of Anchorage



100 ft



Portage Glacier Road

Sta. 191-181, 11-17' Right
Area defects

Legend

-  Area Defect
-  Portage
-  Portage Lake & Byron Glacier -Portage Valley AK 6-20-2010





Number and % Defective – File 001

Station	Starting Distance	Segment (ft)	Defective %	# of 2-D Defects	Defect Straddles Segments
181	0	89.5	4.07	1	No
182	0	100	10.95	2	No
183	0	100	3.65	0	No
184	0	100	0.17	0	No
185	0	100	15.92	3	Yes
186	0	100	16.09	2	Yes
187	0	100	51.08	3	Yes
188	0	100	62.02	1	No
189	0	100	32.84	2	Yes
190	0	100	31.51	5	Yes
191	0	0	33.33	0	No

Station 184, 0.17% Defective

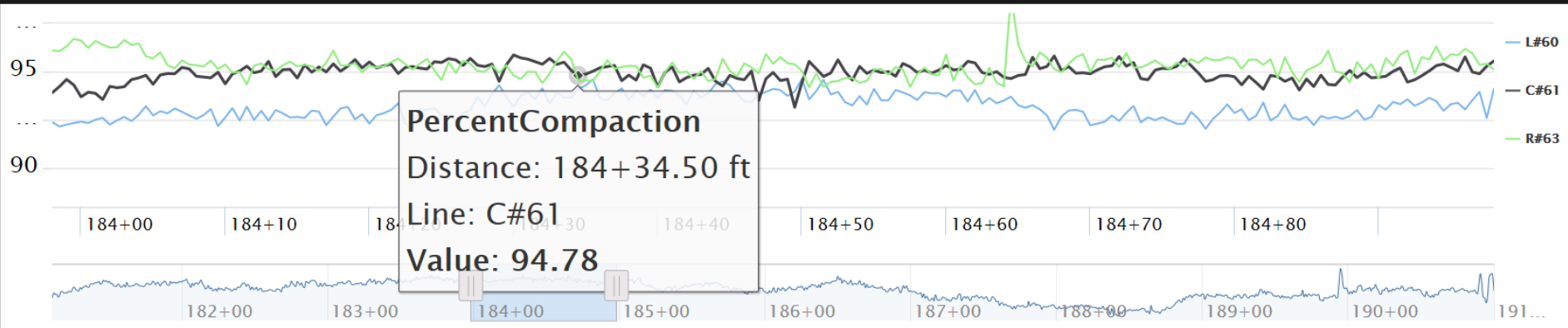
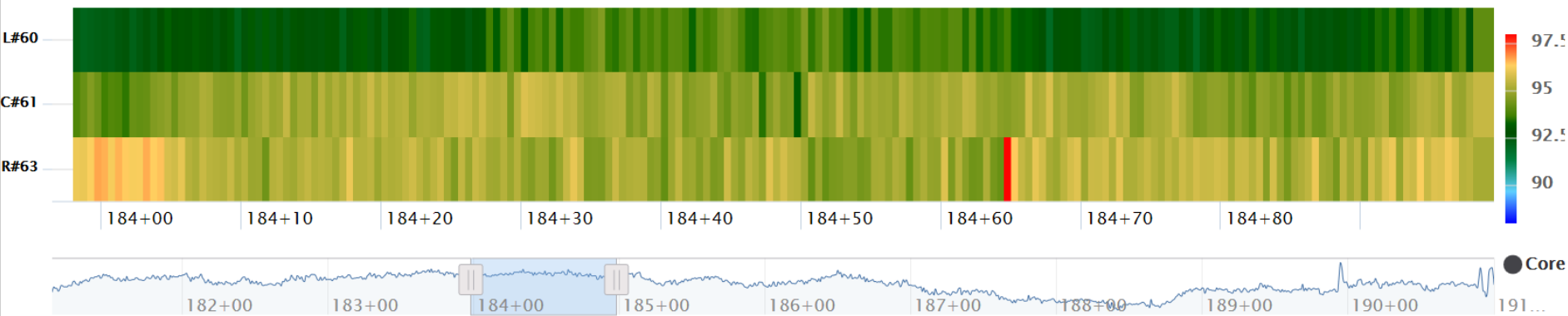
Playback File: File__001

PaveScan.RDM

Heatmap + Histogram

Heatmap + Linechart

Linechart + Histogram



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Station 188, 62% Defective

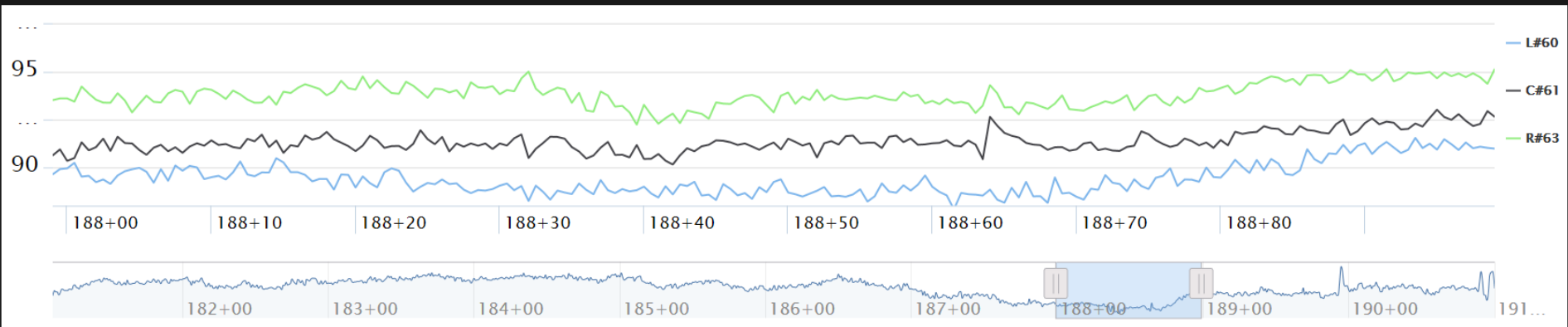
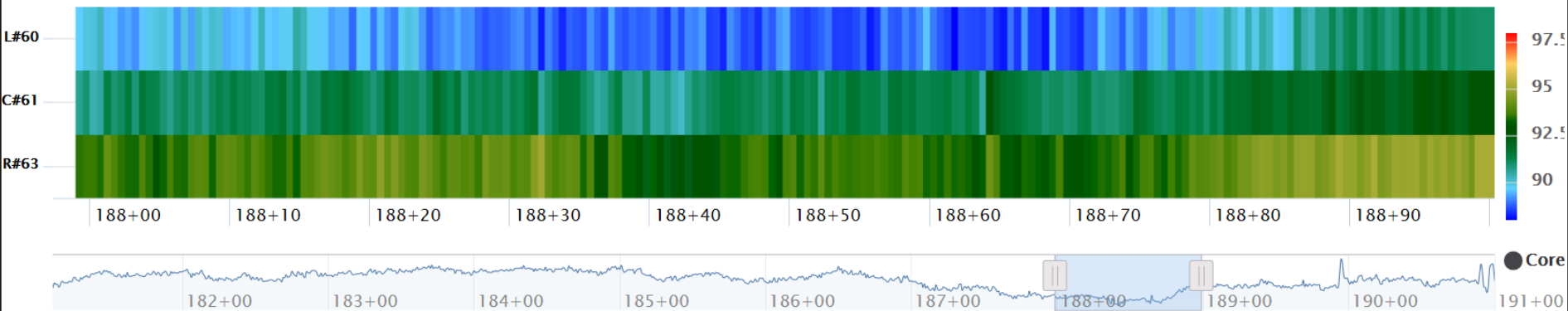
Playback File: File__001

PaveScan.RDM

Heatmap + Histogram

Heatmap + Linechart

Linechart + Histogram



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Defect Locations – File 001

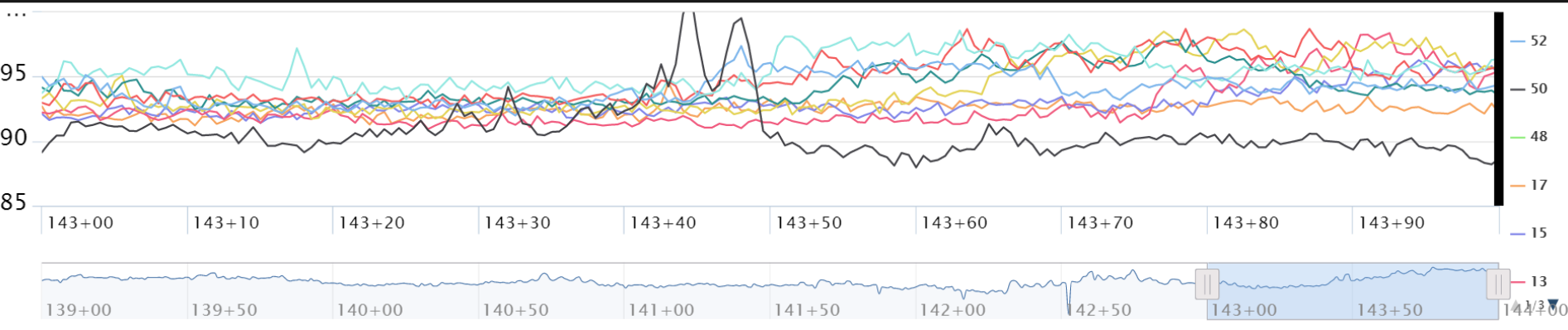
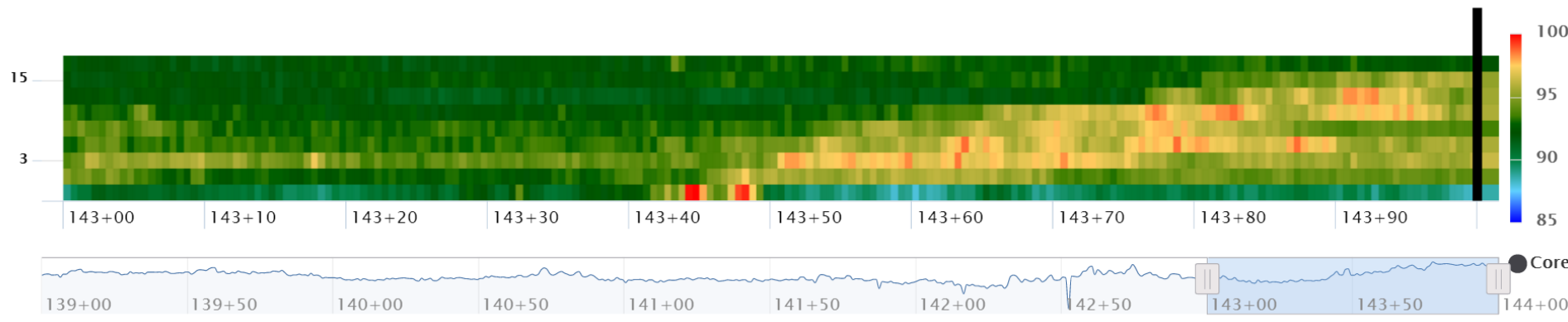
Starting Station	Start Distance (ft)	Ending Station	End Distance (ft)	Start Offset (ft)	End Offset (ft)
181	11.75	181	15.75	17.75	15.75
182	48.25	182	52.75	17.75	15.75
182	65.25	182	73.75	17.75	15.75
185	62.75	185	73.25	17.75	15.75
185	73.75	185	91.75	17.75	15.75
185	97.75	186	2.25	17.75	15.75
186	80.25	186	86.75	17.75	15.75
187	6.25	187	14.25	17.75	13
187	16.75	187	21.25	17.75	13
187	22.75	189	93.25	17.75	13
189	96.75	190	7.25	17.75	15.75
190	8.25	190	17.75	17.75	15.75
190	18.25	190	42.75	17.75	13
190	49.25	190	89.25	17.75	13
190	91.25	190	95.75	17.75	15.75

Portage Glacier Rd - Sta 139-144

Heatmap + Histogram

Heatmap + Linechart

Linechart + Histogram



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Glenn Hwy at Eagle River Bridge

Lane 1 Compaction Coverage





Glenn Hwy at Eagle River Bridge Lane 1 Area Defects





Glenn Hwy at Eagle River Bridge

Lane 1 Linear Defects





Rich Giessel

richard.giessel@alaska.gov

(907) 269-6244



richard.giessel
@alaska.gov
907-269-6244



COLD IN-PLACE RECYCLING UTILIZING ENGINEERED EMULSION: PROJECT SELECTION AND CONSTRUCTION PRACTICES

Megan Chatfield, PE

Materials Engineer

Western Federal Lands Highway Division



ASPHALT RECYCLING METHODS

MATERIALS

- Engineered Emulsion (approx. 3%)
 - Lime or cement (approx. 1%, used as a mineral filler and curing aid)
 - Water (approx. 1%)
 - Recycled asphalt pavement
-
- Fog Seal (application rate 0.05 to 0.15 gal/sqyd)
 - Blotter

ASPHALT RECYCLING METHODS

- Cold In-Place Recycling (C-I-R)
 - Milling
 - Re-mixing
 - Placing and compacting
 - Same day operation
- Central Plant Recycling
 - Milling and removal
 - Line and grade adjustments
 - Central plant mixing
 - Hauling, placing and compacting

C-I-R PROCESS



C-I-R PROCESS



C-I-R PROCESS



ASPHALT RECYCLING METHODS

- Cold In-Place Recycling (C-I-R)
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- Central Plant Recycling
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 - Line and grade adjustments
 - Central plant mixing
 - Hauling, placing and compacting

CENTRAL PLANT RECYCLING



CENTRAL PLANT RECYCLING



- Requires a lot of storage space
- Multiple handling operations

CENTRAL PLANT RECYCLING



CENTRAL PLANT RECYCLING





LAYDOWN PROCESS

LAYDOWN PROCESS



- C-I-R: Leave thin section of existing asphalt in place
 - Provides support for the milling train
 - Uniform material

LAYDOWN PROCESS



- Utilize pickup machines or
- End dumps directly into the paver



LAYDOWN PROCESS

- Material uniformly coated with emulsion
- Reduce down to 1.5 inch minus

LAYDOWN PROCESS



LAYDOWN PROCESS



- Allow material to begin cure prior to compaction
- Climate will adjust cure time
 - Shaded
 - High humidity
 - Temperature
- Emulsion supplier can provide cure accelerant

LAYDOWN PROCESS

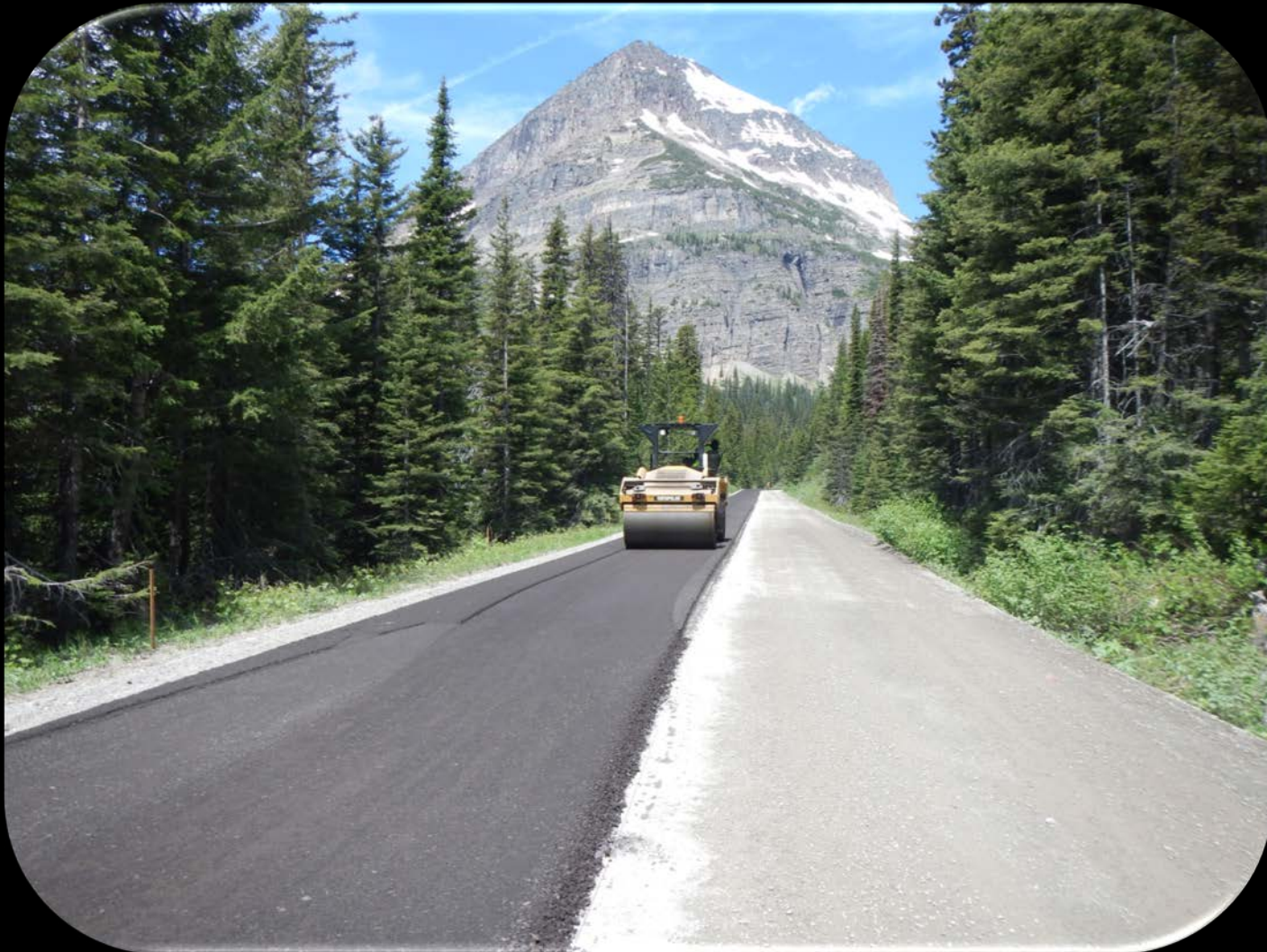


- Keep rollers back from paver
- Rapid compaction prevents efficient curing

LAYDOWN PROCESS



LAYDOWN PROCESS



- Initial breakdown with smooth vibratory double drum
- Pneumatic as Intermediate
- Finish with smooth drum to remove roller marks

FINAL SURFACE: PRIOR TO FOG



- Micro cracking is acceptable
- Traffic will aid in kneading together

LAYDOWN PROCESS



- When to fog
 - Product stability
- Using blotter
- Traffic control and timing

LAYDOWN PROCESS



- Fogged surface vs. open surface
- Cure times – minimum two hours after compaction

FINAL SURFACE



CONSTRUCTION INSPECTION

- Monitor cutting depth / milling operation
- Do not include any base material (C-I-R)
- Emulsified asphalt addition rate (approx. 3%)
 - Established at start as part of mix design
 - Adjustments may be necessary
 - Mix will look dry
- Lime or cement addition rate (1%)
- Pavement laydown – placement depth and width
- Compaction (Don't rush it!)
- Fog coat and blotter application

CONSTRUCTION CHALLENGES



CHALLENGES: RUTTING



CHALLENGES: RAVELING



PROJECT SELECTION





PROJECT SELECTION

- Estimated at approx. $\frac{3}{4}$ strength of HMA
- Provides opportunity to reuse existing materials
- Reduces pavement structure
- C-I-R needs reasonably consistent pavement depth. Approx $\frac{1}{2}$ " depth more than design
 - Do not include aggregate base with layer



PROJECT SELECTION: C-I-R OR CENTRAL PLANT RECYCLING

- Boring logs with depths of layers from subsurface investigation
- Project constraints / considerations
 - Adjusting grade
 - Sound existing structure with old pavement
 - Room for overlay
 - Excessive sub-excavation required
- Structural pavement analysis
- Sustainability concept

PROJECT SELECTION: ESTIMATION OF QUANTITIES

- In-place hot mix asphalt pavement = 150 pounds per cubic foot
 - In-place air voids approx. 5%
- C-I-R pavement = 135 pound per cubic foot
 - In-place air voids approx. 14%
 - No handling loss
- Central plant mixed
 - In-place air voids approx. 14%
 - Assume 5 to 10% handling and floor loss
- Approximately 10% increase in volume

PROJECT SELECTION



- Good candidate
 - End of service life
 - Minor patching
 - Fatigue cracking
 - 3 inch depth minimum

PROJECT SELECTION

- Poor candidate
 - Consistent recent crack seal
 - Less than 3 inches
 - Need to tie in to existing structures (C-I-R)



PROJECT SELECTION: BORING LOG EXAMPLE

FEDERAL HIGHWAY ADMINISTRATION VANCOUVER, WASHINGTON GEOTECHNICAL SECTION		6 in H-S AUGER 8 in H-S AUGER NQ CORE HQ CORE OTHER:		☐ BEGAN: 9/16/03 ☐ COMPLETED: 9/16/03 ☐ DRILL: Unknown ☐ DRILLER: Unknown WEATHER: Heavy snow	
BORING LOG (English Units)					
DEPTH (ft)	DESCRIPTION	GRAPHIC LOG	SAMPLE # SAMPLE	BLOW COUNT	▼ WATER CONTENT (%) PLASTIC LIMIT ——— LIQUID LIMIT ● SAMPLE PENETRATION RESISTANCE STANDARD BLOWS PER FOOT (140 lb mass, 30 in drop)
					0 20 40 60
0	LATITUDE (DEGREES): 48.67487800 LONGITUDE (DEGREES): -113.60747500 Asphalt.				
0.5	Red to gray, silty fine to coarse SAND, some fine to coarse gravel, some clay, subangular to angular fragments, damp (SM) (BASE).				
2.0	Red, fine to coarse GRAVEL, some fine to coarse sand, little silt, trace cobbles, subangular to angular fragments, damp (GP-GM). Hard drilling.				
3.0	Laboratory testing completed. Laboratory Control Number: W-08-0284-SO 42.4% Gravel, 47.3% Sand, 10.3% Silt GP-GM; Poorly graded gravel with silt and sand. Moisture at R Value is 131.8% at 300 psi. Boring completed at 3 feet.				

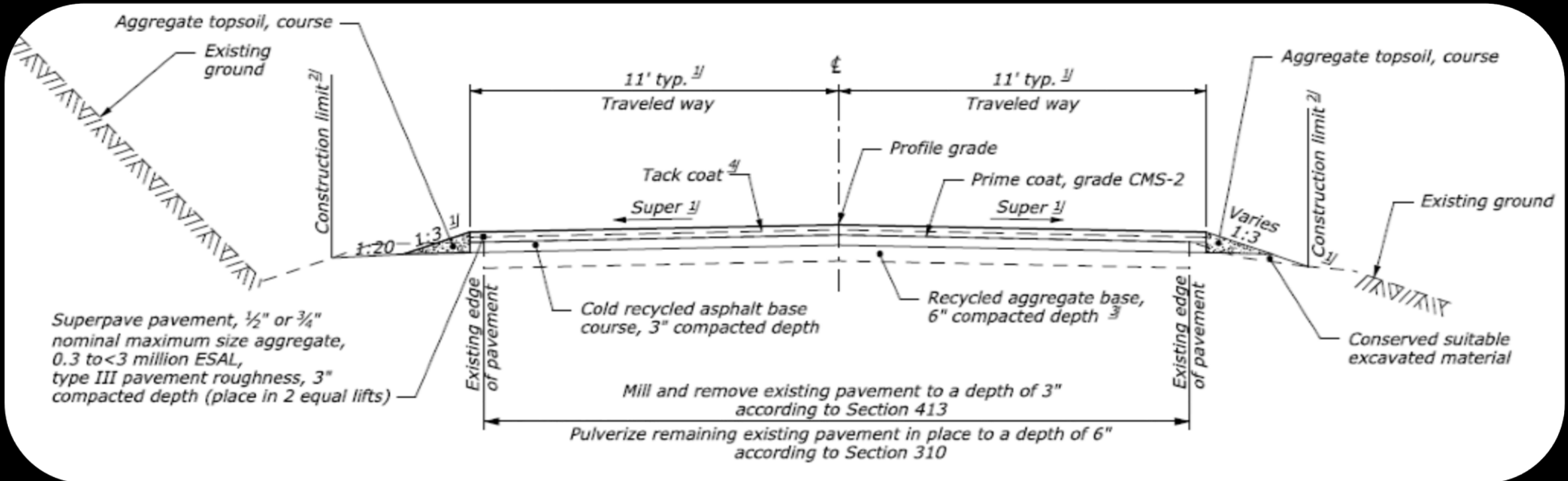
PROJECT SELECTION: BORING LOG DATA

Average Distance between Borings	2674 feet
Average Thickness of Pavement	6 inches
Controlling Thickness	3.6 inches

Boring No.	Station	Distance Between Borings (ft)	Pavement Depth (in)
SG03-37	1846+20	2580	6
SG03-38	1872+00	2780	9.6
SG03-39	1899+80	2590	8.4
SG03-40	1925+70	2680	6
SG03-41	1952+50	2680	6
SG03-42	1979+30	2700	6
SG03-43	2006+30	2655	7.2
SG03-44	2032+85	2685	6

Boring No.	Station	Distance Between Borings (ft)	Pavement Depth (in)
SG03-45	2059+70	2640	6
SG03-46	2086+10	2700	6
SG03-47	2113+10	2640	3.6
SG03-48	2139+50	2680	7.2
SG03-49	2166+30	2676	7.2
SG03-50	2193+06	2680	3.6
SG03-51	2219+86	2654	6
SG03-52	2246+40	2760	4.8
SG03-53	2274+00		6

PROJECT SELECTION: TYPICAL SECTION



CONCLUSIONS



- Utilizes existing materials
- Can be done in place or offsite
- Provides a flexible pavement layer
- Reduces pavement distress
- Decreases pavement structure thickness



THANK YOU!

Megan Chatfield, PE

Materials Engineer

Western Federal Lands
Highway Division

(360) 619-7586

Megan.Chatfield@dot.gov



Testing Fine Aggregates According to AASHTO T-84 and the CoreLok Device

PIs: Sunil Sharma & Emad Kassem

Graduate Research Assistant: Sandarva Sharma

ITD Project Manager: Mark Wheeler, ITD, Boise

October 25, 2018

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- Department of Civil and Env. Engineering
- ITD Technical Advisory Committee:
 - Chad Clawson
 - Bob Engelmann
 - Kyle Holman (FHWA)
 - Mike Santi
 - Mark Wheeler



Longitudinal



Transverse



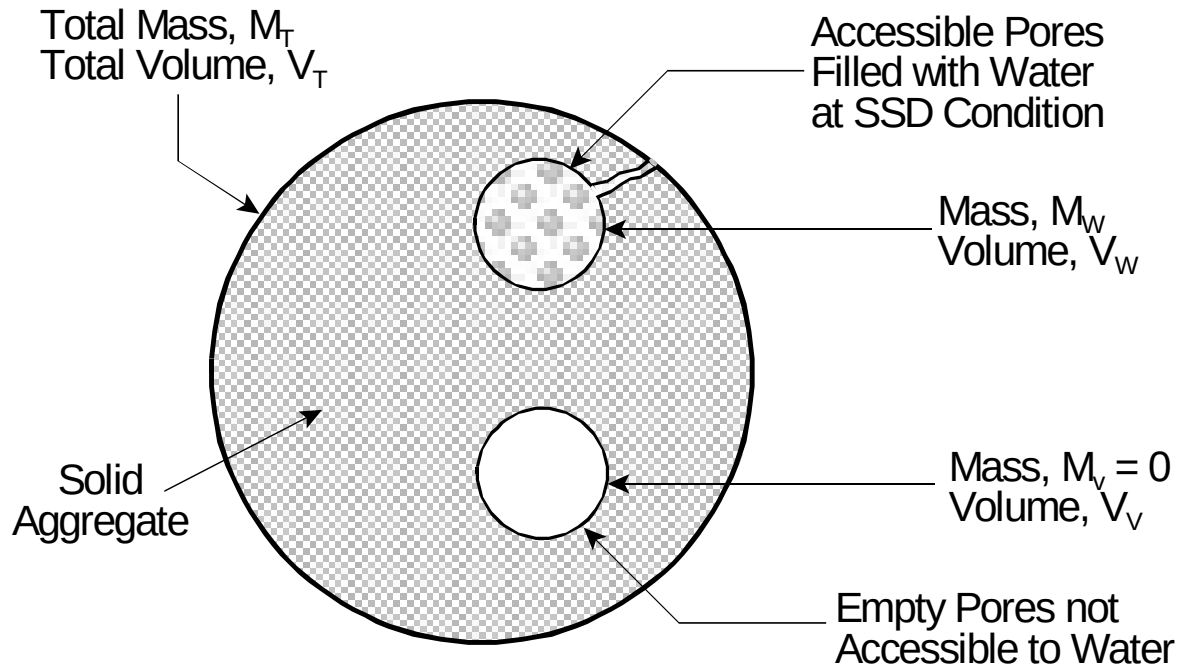
Raveling



Rutting

ASPHALT Mix Design

- Bulk Specific Gravity, G_{sb}
 - Need accurate value for HMA design
 - Used to calculate the percentage of voids in mineral aggregates
 - Determine amount of asphalt absorbed by the aggregates



Volume of Solid, $V_S = V_T - V_V - V_W$

Mass of Solid, $M_S = M_T - M_W$

Aggregate Particle & Voids

Apparent SG	$G_{sa} = \frac{M_T}{V_S}$
Bulk Dry SG	$G_{sb,Dry} = \frac{M_T - M_W}{V_T}$
Bulk SSD SG	$G_{sb,SSD} = \frac{M_T}{V_T}$
Absorption	$Abs = \frac{M_W}{M_T - M_W} \times 100\%$



Fine Aggregates, < #4:

- AASHTO T-84, and
- Idaho IT-144
(CoreLok Method)



AASHTO T-84 Method

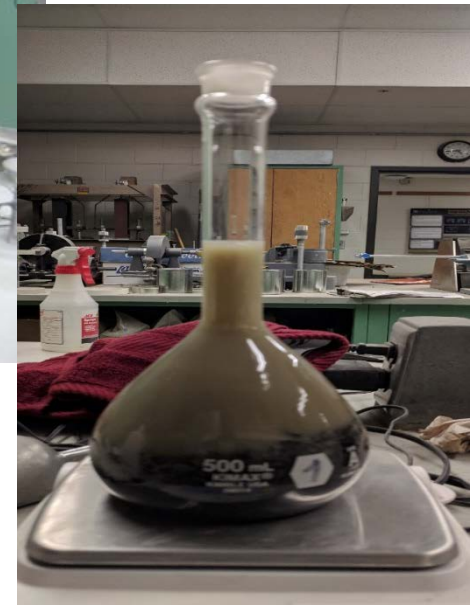
- Soaking period – 15 to 19 hours
- Samples starts at 6% water content
- Keep drying until SSD condition
- Several attempts

AASHTO T-84 – Takes up to 3 days

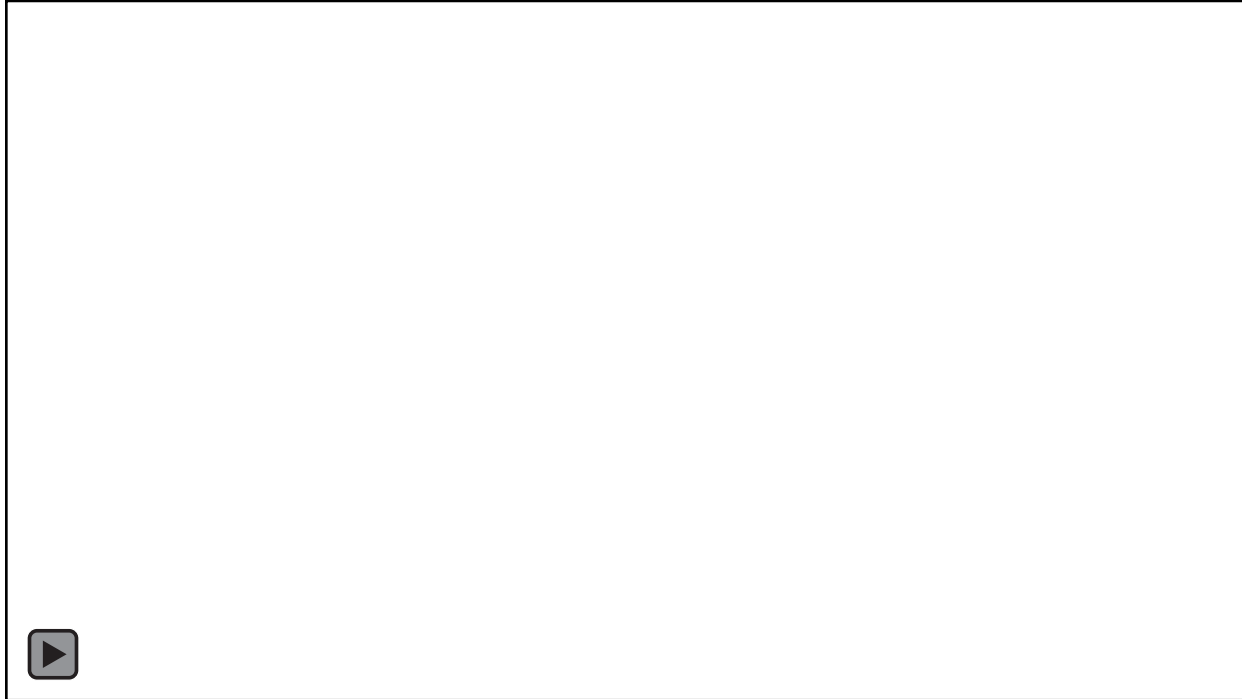


AASHTO T-84

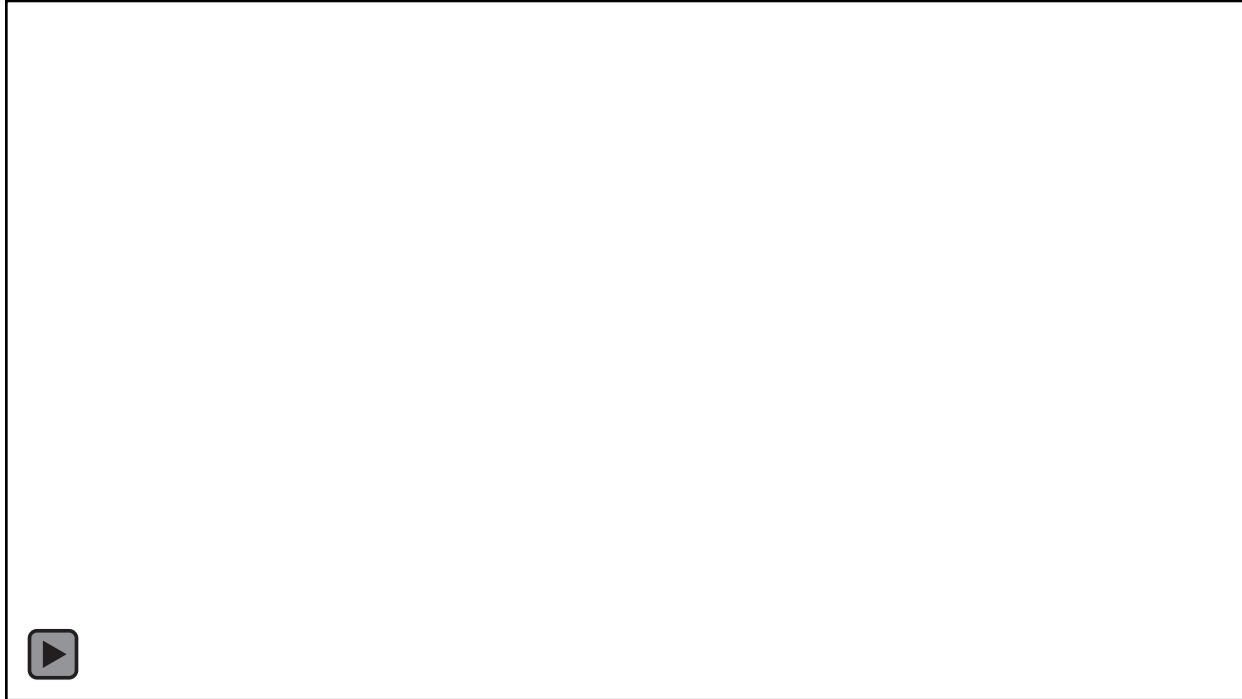
- Sample soaking and drying
- Cone test and SSD
- Agitation and de-airing



Drying of Samples

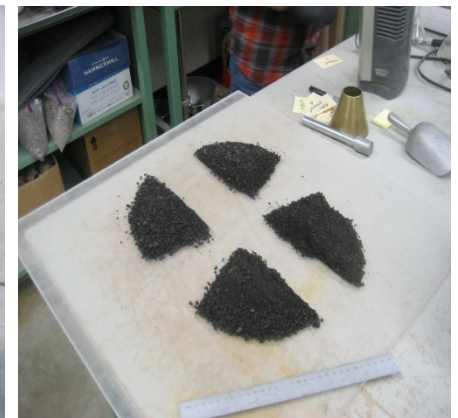


Cone Test



- Preparing cone
- SSD Condition
- Looking for dime shape on cone

Very subjective



- 25 drops
- Drop height = 5mm
- SSD condition
 - Start of raveling
 - Dime size
- Quartering
- De-airing



VARIABILITY

- SSD Condition
 - Start of raveling
 - Dime size
- Agitation and de-airing wait time (20 minutes or 16 hours)
- Sample weight equilibrium after drying in oven
- Tamper drop height
- Water temperature - maintained at constant $23 \pm 1.7^{\circ}\text{C}$
- Flask Size (500 mL or 1000 mL)



Limitations of AASHTO T-84

- Determining the saturated-surface dry (SSD) conditions may vary from one operator to another
- Requires a *long time* (including soaking time)
- Angular fine aggregates with rough surface may not readily slump at SSD conditions
- Alternative method that is quick, reliable, portable, and provides repeatable results is needed!

CoreLok Testing – Step 1



CoreLok Chamber

Placing bag with
sample into
vacuum chamber



Determine “Gsa”

CoreLok Testing – Step 2



Metal pycnometer



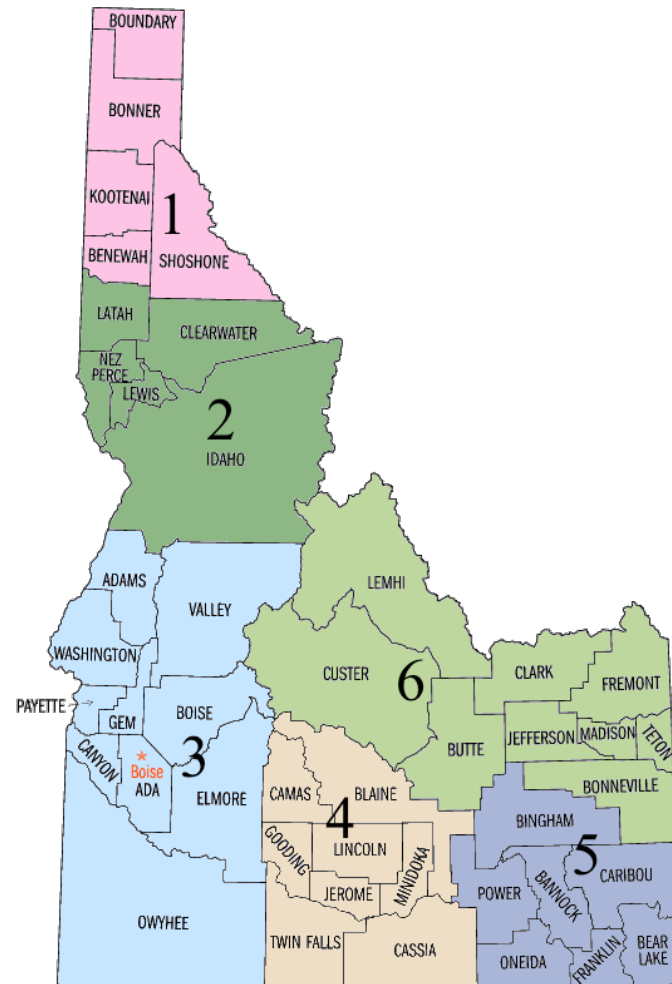
Determine “Gsb”,
Followed by final SGs
through a correlation

Objectives

- Perform T-84 and IT-144 tests
- Find correlation between tests for typical Idaho aggregates

Samples

- Representative samples selected
- 70-80 kg samples per aggregate source
- Samples from 5 out 6 ITD Districts
- **22 Aggregate Samples**



Sample preparation

1. Initial Drying
2. Splitting
3. Sieving to remove plus #4
4. Washed to remove minus #200
5. Washed samples dried
6. Split to testing size
 - 2 kg for IT-144
 - 1.5 kg for T-84

ITD-District	Samples
1	3
2	4
3	4
5	4
6	7
Total	22

Aggregate Testing

Initial Testing at UI

1. Training and Evaluation at ITD Lab in Boise
2. Round Robin Experiment
 - UI, ALLWEST, STRATA
 - 5 aggregate samples from 4 different districts

Conclusions

- Results were comparable and very close
- Agreed with ITD to follow similar procedure for further testing

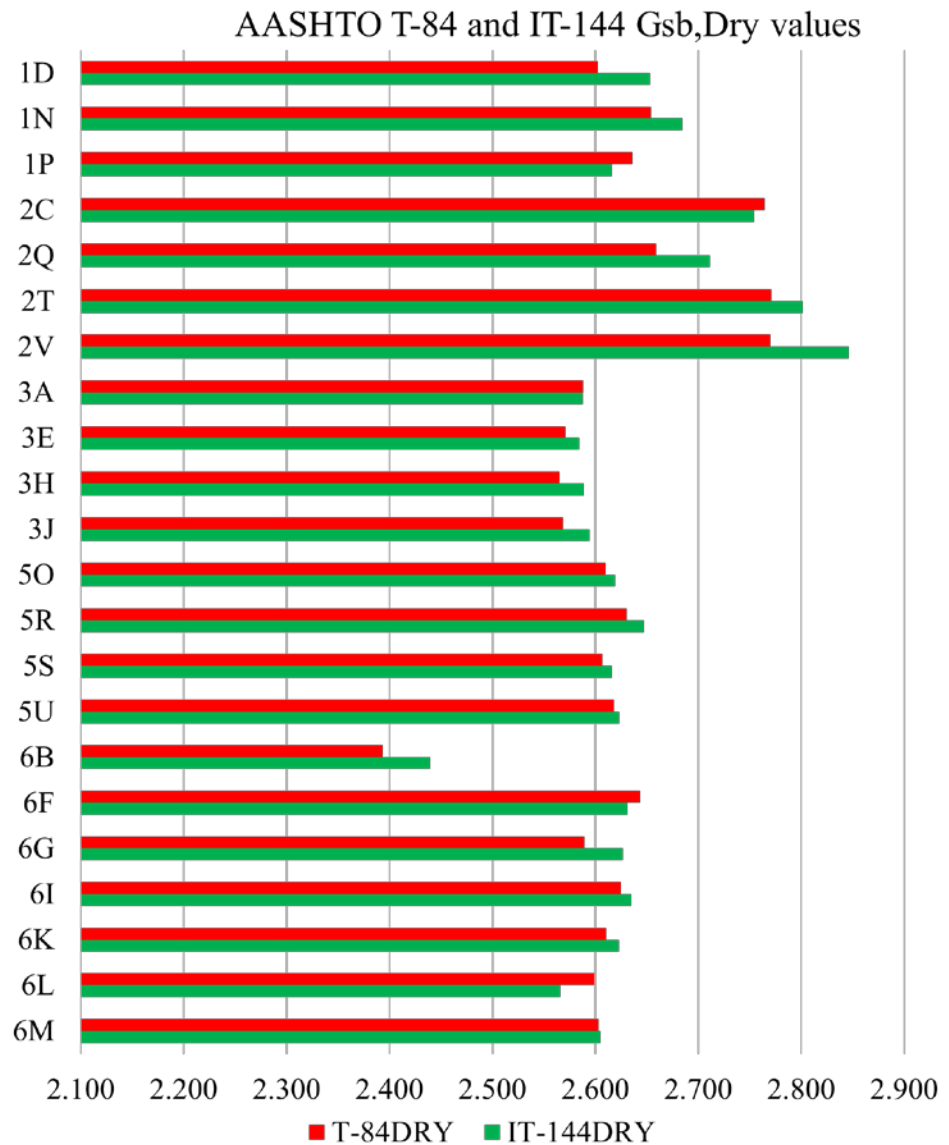
Aggregate Testing & Results

Test by	Number of Tests	
	AASHTO T-84	IT-144
UI	68	65
ALLWEST	21	21
STRATA	1	1
ITD	8	8

Difference between the two tests:

- Limit of 0.015 adopted for SGs
- Extra tests performed for greater D2S

Some Results



Some Results

Paired t-test

- Statistical difference between results from two test methods
- Results significantly different for all SGs and Absorption

Simple Regression Analysis

- One dependent variable
- One independent variable

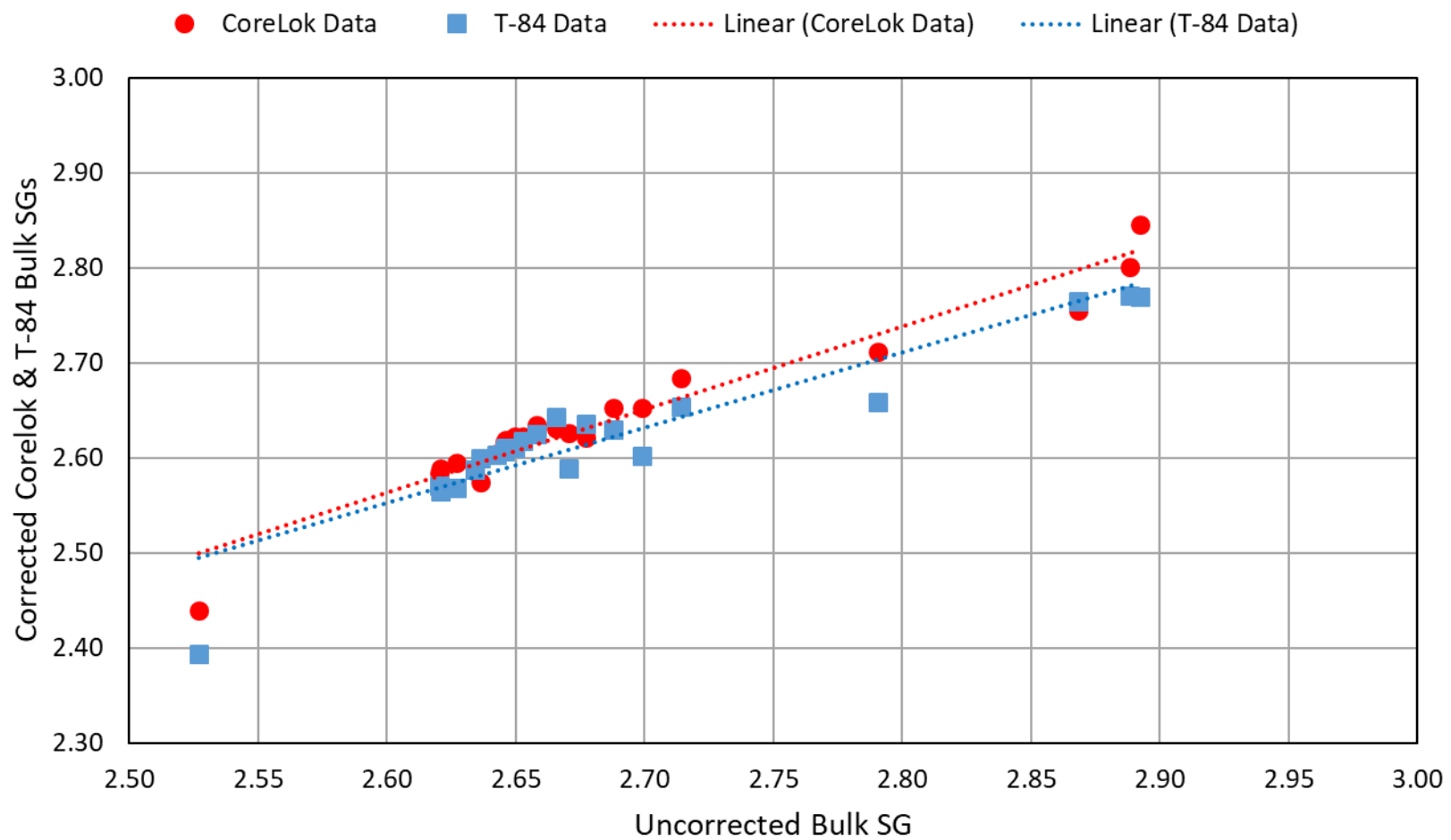
Multiple Regression Analysis

- One dependent variable
- Two or more independent variable

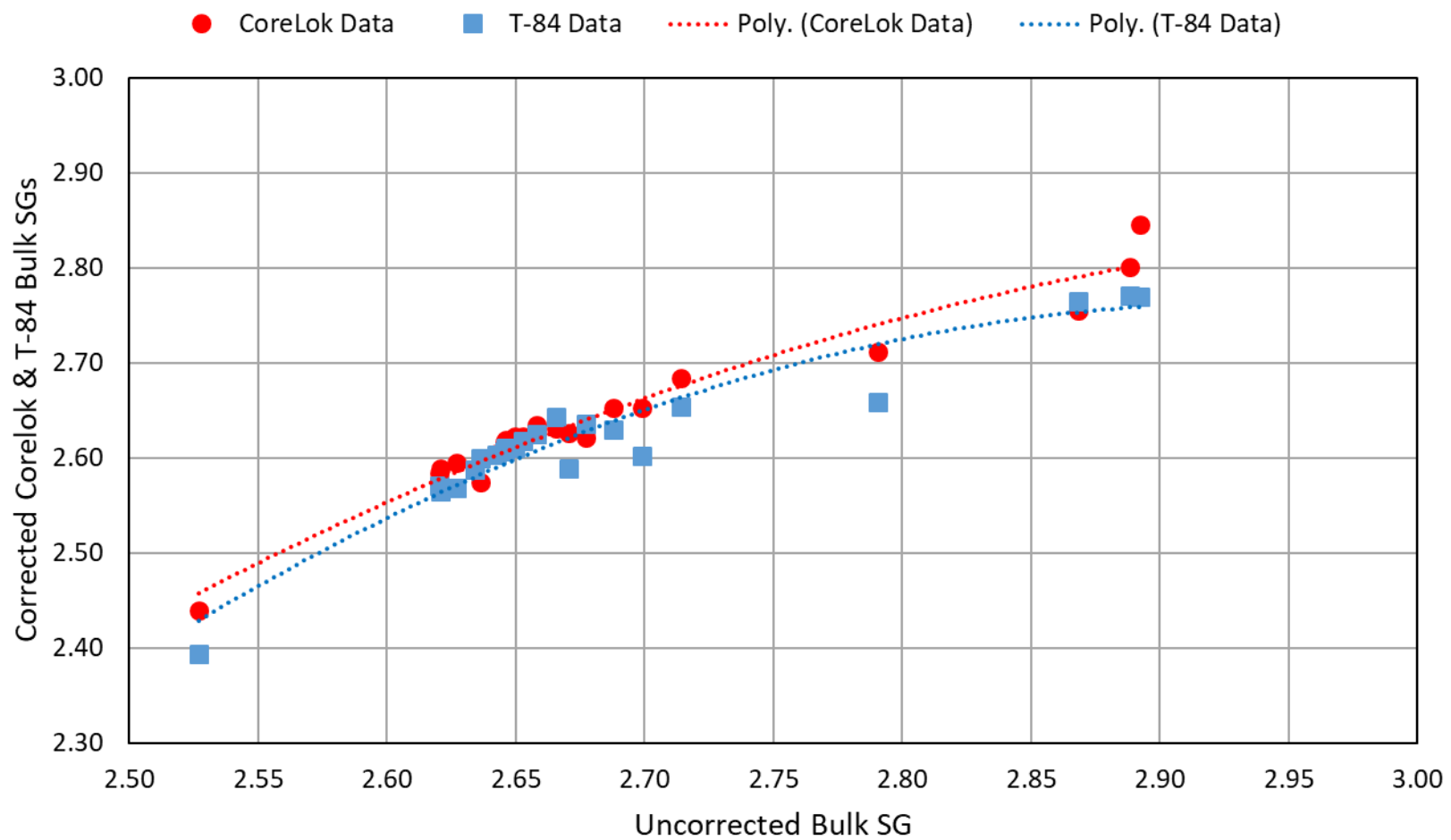
Final Objectives

- Investigate the currently programmed equation in the AggPlus software for calculating absorption, and hence Gsb
- Recommend a “better” equation for Idaho aggregates
- Recommend use of IT-144
- (retire the AASHTO T-84 method)

Comparison of Bulk SG Values



Comparison of Bulk SG Values



Thank You
Questions?

**NCHRP Project 20-05
Synthesis Topic 48-02
Tack Coat Specifications, Materials,
and Construction Practices**

**Danny Gierhart, P.E.
Dave Johnson, P.E.
Principal Investigators**

What Exactly Is a Synthesis?

- **A report that assembles and disseminates information on a topic of current highway practice.**
- **Prepared by a consultant who has expertise in the topic area, with assistance provided by a technical panel.**

Asphalt Institute's Expertise



Tack Coat Best Practices

FHWA Cooperative Agreement Subtask

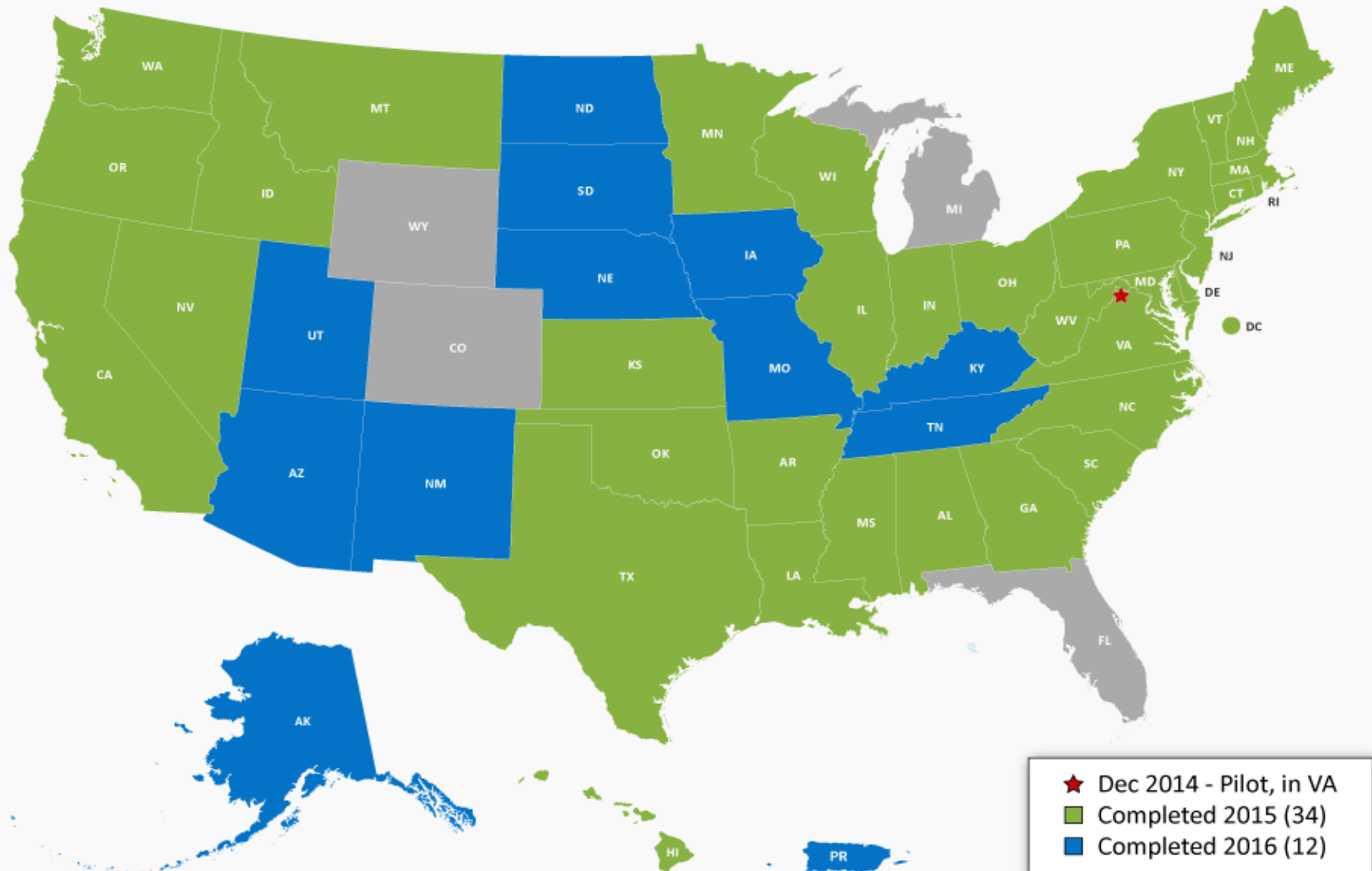
(Longitudinal Joints
Intelligent Compaction)



Tack Coat Workshops, 2015-2016



Reach: 2700 Attendees through 47 workshops, plus additional 3100 with 35 presentations



TechBrief

The Asphalt Pavement Technology Program is an integrated, national effort to improve the long-term performance and cost effectiveness of asphalt pavements. Managed by the Federal Highway Administration through partnerships with state highway agencies, industry and academia the program's primary goals are to reduce congestion, improve safety, and foster technology innovation. The program was established to develop and implement guidelines, methods, procedures and other tools for use in asphalt pavement materials selection, mixture design, testing, construction and quality control.



U.S. Department of Transportation
Federal Highway Administration

Office of Asset Management,
Pavements, and Construction

FHWA-HIF-16-017

April 2016

Tack Coat Best Practices

This Technical Brief provides an overview of tack coats and their vital role bonding multiple asphalt layers into one monolithic system. Poor tack coat techniques result in compromised bonding of the asphalt layers. This leads to pavement distresses. Possible slippage cracking and delamination are associated with poor bonding. Additionally, poor bonding can lead to structural distresses, namely fatigue cracking and potholes. Often this lack of sufficient bonding is not recognized as the source of failures.

Introduction

A key, but sometimes overlooked, component of an asphalt pavement is the bond strength between asphalt pavement layers. Tack coat is a sprayed application of an asphalt binder upon an existing asphalt or Portland cement concrete pavement prior to an overlay, or between layers of new asphalt concrete. This thin membrane of asphalt binder provides the glue between the layers, creating a monolithic structure which performs as a unit as opposed to unbound, independent, layers. When properly built, a pavement will provide the desired characteristics for its users, while meeting the needs of an agency for an economical, environmentally friendly and sustainable material.

Poor bonding of a pavement surface layer is a direct result of inadequate tack coat practices resulting in slippage and shoving of the pavement, as seen in Figure 1. This type of failure is most frequently seen in locations where braking or acceleration is common, such as intersections. Other distresses can also be made related to poor tack coat bonding, most notably pavement fatigue cracking.

Synthesis Project Time Line

- 12-Month Effort
 - Began in November 2016
 - Ends October 2017
- Survey
 - January – April 2017
 - 50 States
 - 7 Providences
 - Follow-up Interviews
- 1st Draft Report
 - May 19, 2017
- Panel Comments and Meeting
 - June 1, 2017
- 2nd Draft Report
 - July/August 2017
- Final Report
 - October 2017
- Publication
 - May 2018

Work Plan

- Literature Review
 - Specifications
 - Research
 - Testing
- Survey
 - US DOTs
 - Canadian Ministries
- Follow-Up Interviews
- Report

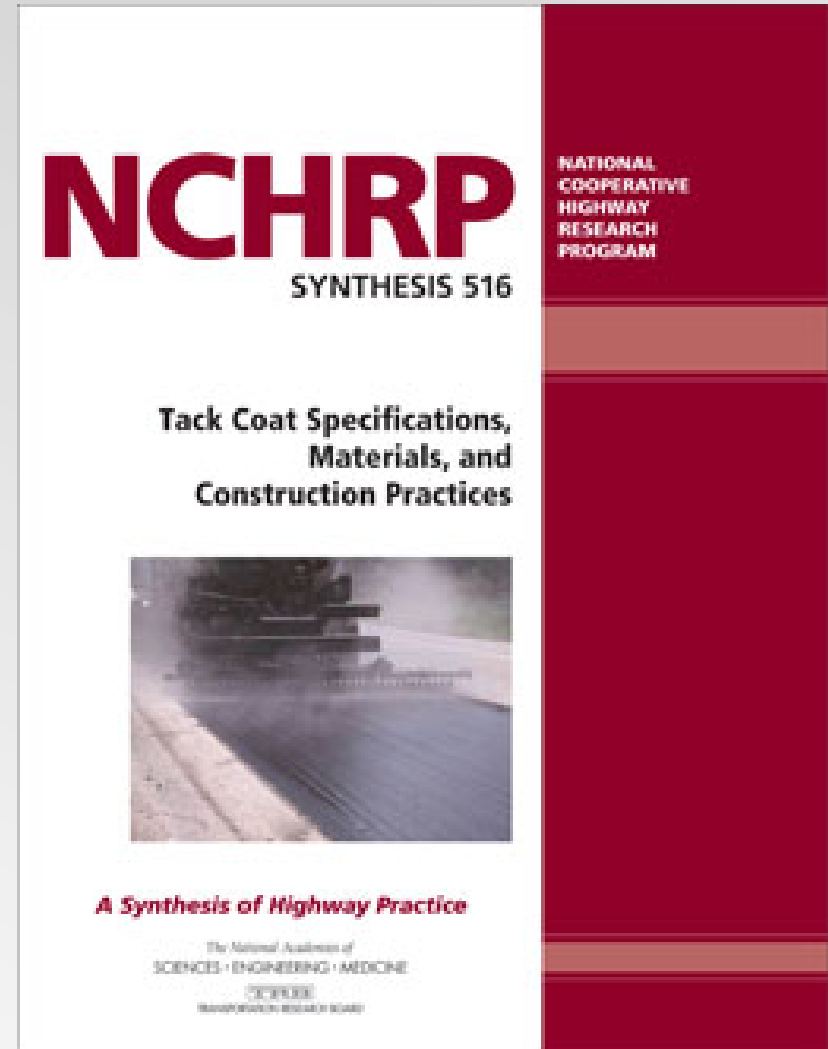


How not to use a Distributor Truck



Sections of the Synthesis 516

- Introduction
- Literature Review
- Survey Results
- Case Examples
- Conclusions
- Appendices



- Importance of Tack Coats
- Tack Coat Definitions
- Tack Coat Specifications
- Tack Coat Materials/Products
- Tack Coat Construction Practices
- Testing and Acceptance of Tack Coats

Importance of Tack Coats

- discusses reasons why a good tack coat is important
- reviews typical pavement distresses that occur as result of poor bonding between pavement layers
- examines probable reasons why poor bonding results in the reported distress

Tack Coat Definitions

- ***Undiluted Emulsion*** - an emulsion which consists primarily of a paving grade asphalt binder, water, and an emulsifying agent.
- ***Diluted Emulsion*** - an emulsion with additional water added to it. The most common dilution rate is 1:1 (one part undiluted emulsion and one part additional water).
- ***Residual Asphalt*** - the remaining asphalt after an emulsion has set, typically 57-70 percent of the undiluted emulsion.
- ***Tack Coat Break*** - the moment when water separates enough from the asphalt to show 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 broken.

Tack Coat Specifications

- discusses ways agencies have specified issues related to tack coats
- provides information about:
 - methods of material acceptance
 - how tack is paid for by agencies
 - tack coat material dilution
 - tack coat application rates

Tack Coat Materials/Products

- provides information on materials specified by agencies for the use as tack coats.
- includes basic information about emulsions, cutbacks and asphalt binders, which ones are specified as tack coat material, and why
- includes information about reduced-tracking materials and their usage
- discusses temperatures at which materials are applied, and how agencies choose what they believe to be the best product for their use

Tack Coat Construction Practices

- provides detailed findings on agencies' and contractors' best practices regarding the application of tack coat in the construction phase
- discusses:
 - material storage and transport
 - equipment inspection and calibration
 - handling issues
 - surface preparation
 - effects of environmental factors
 - longitudinal joint surfaces
 - vehicle tracking of tack coat

Testing and Acceptance of Tack Coats

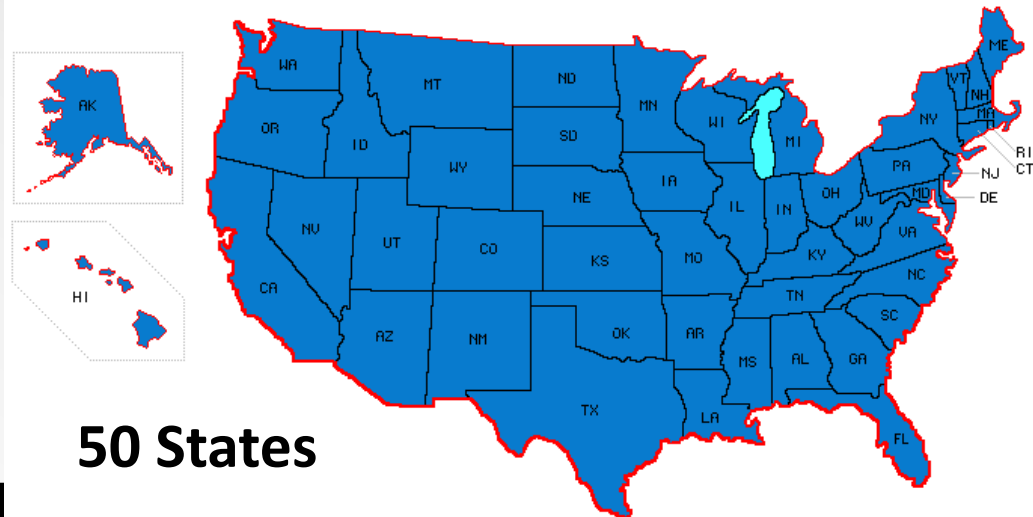
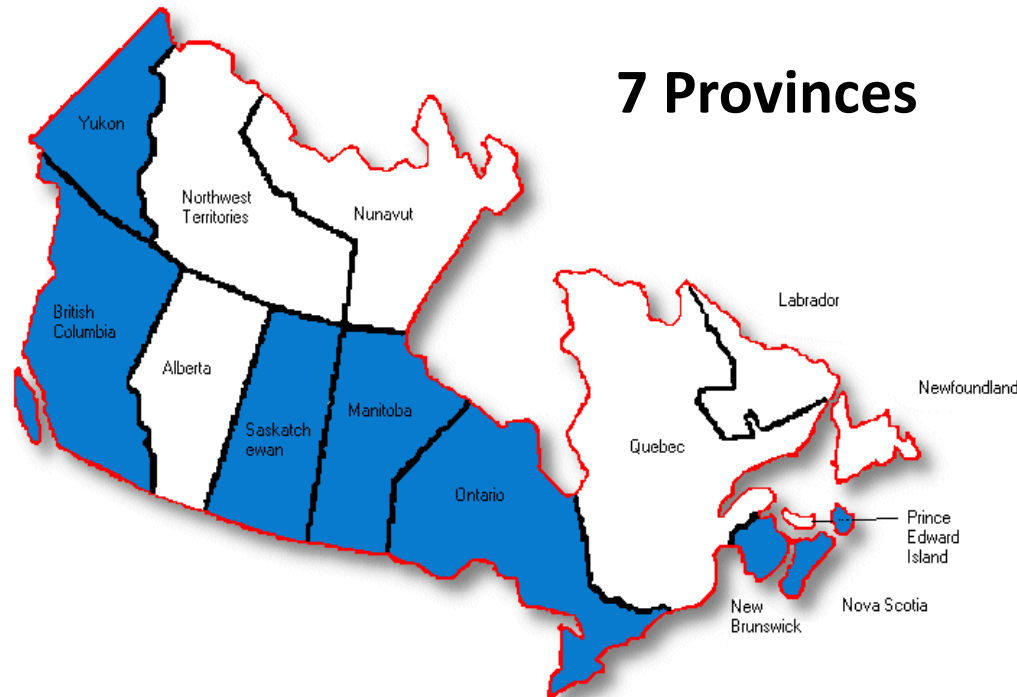
- tack coat quality assurance (QA) processes
- discusses:
 - whether tack coat material acceptance is based on field sampling or source sampling
 - what types of tests agencies specify for acceptance of tack coats
 - how agencies verify that the appropriate rate and surface coverage of tack coat is achieved.

Survey - excellent response rate

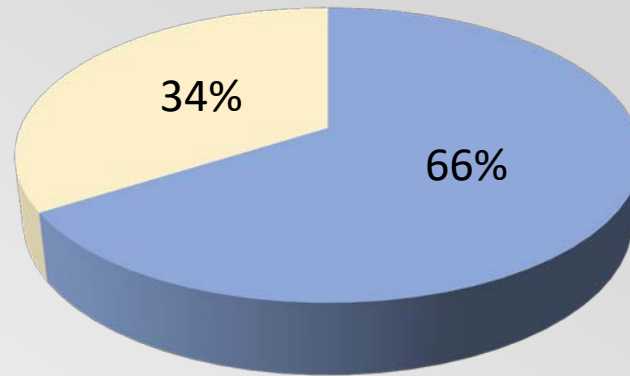


45 Questions

- Tack Coat Payment Specs
 - 2 questions
- Tack Coat Materials
 - 4 questions
- Tack Coat Application
 - 28 questions
- Tack Coat Evaluation
 - 9 questions
- Other Questions
 - 2 questions



How is tack paid for?

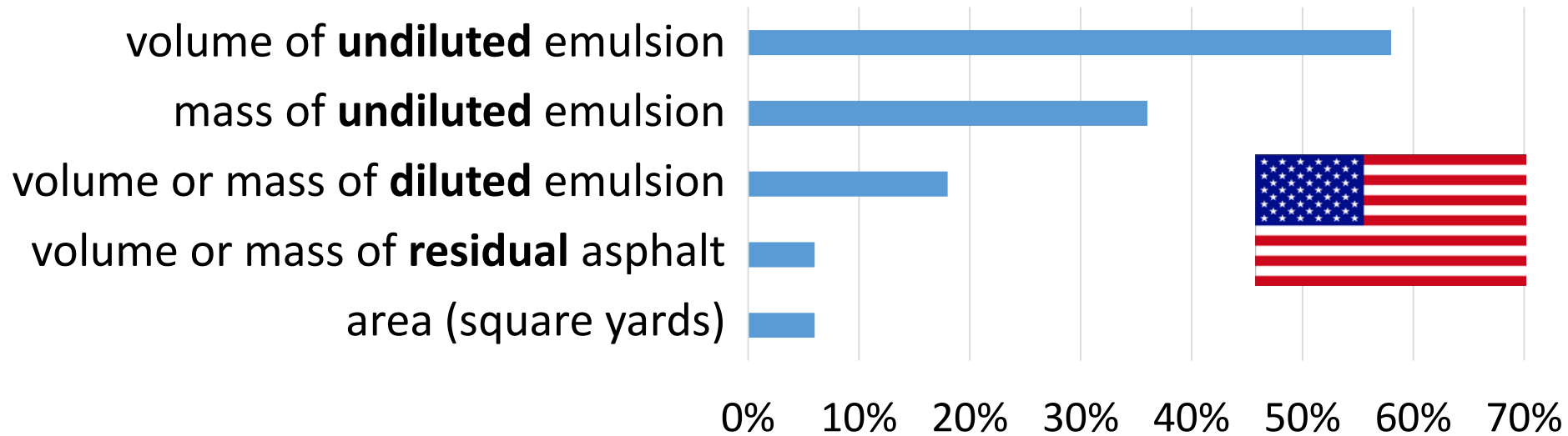


- Individual Pay Item
- Incidental to Paving

Why is this important?

Little incentive for sufficient tack application if not a direct pay item

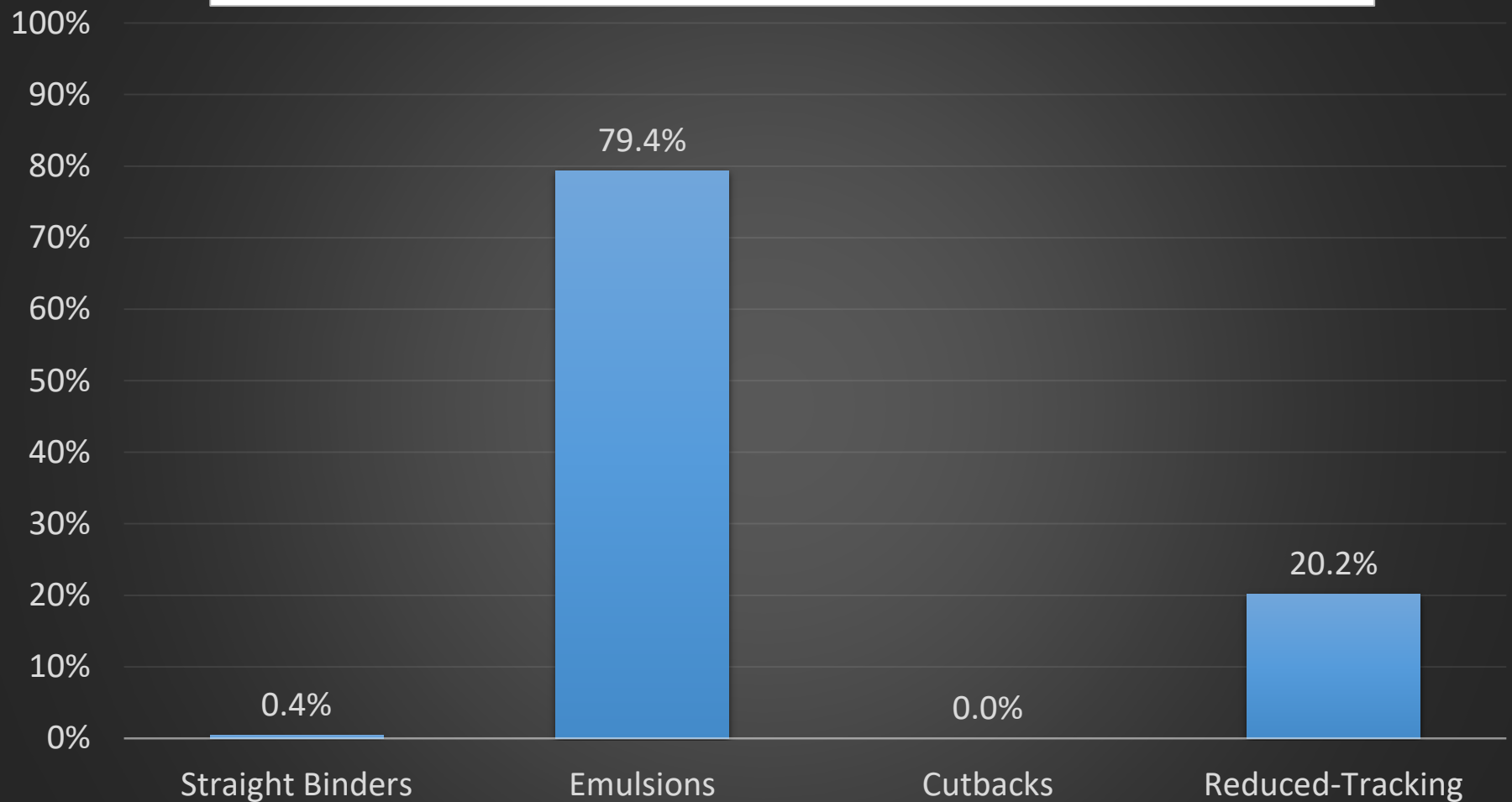
* How is tack measured for pay ?



* Some states pay by more than one method, so %'s do not add up to 100



**Synthesis Survey Results:
Percentage of Tack Coat Materials Used in the U.S.**





Top 5 Emulsions Used

1. CSS-1h	(52%)
2. Non-standard*	(48%)
3. SS-1h	(46%)
4. SS-1	(36%)
5. CSS-1	(28%)

* *Non-standard means that a state has come up with its own nomenclature for an emulsion, outside those specified in **AASHTO M 140** (Anionic Emulsions), **M 208** (Cationic Emulsions), or **M 316** (Polymer-Modified Cationic Emulsions)*
Examples: SS-1hp, CRS-2h, EBL

1. NTSS-1hm (24%)

Others specified (all by less than 3% of the states)

CBC-1H

CBC-1HT

EM-50-TT

E-Tac

NTCQS-HH

NTCQS-1HM

NTCRS-1HM

NTCRS-1HSP

NTHAP

NTT

PATT

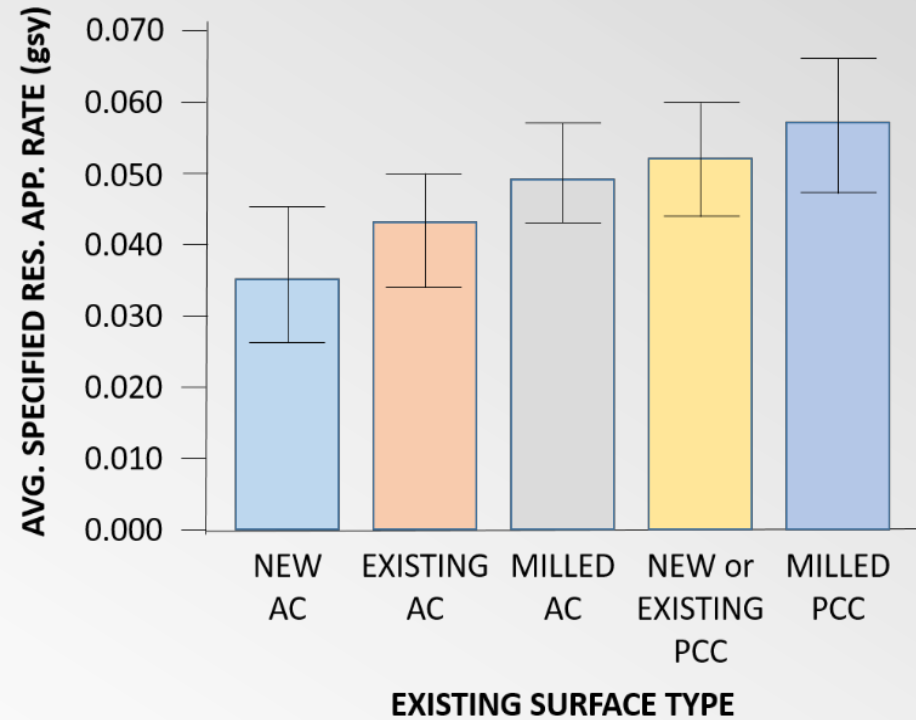
UltraFuse

UltraTack

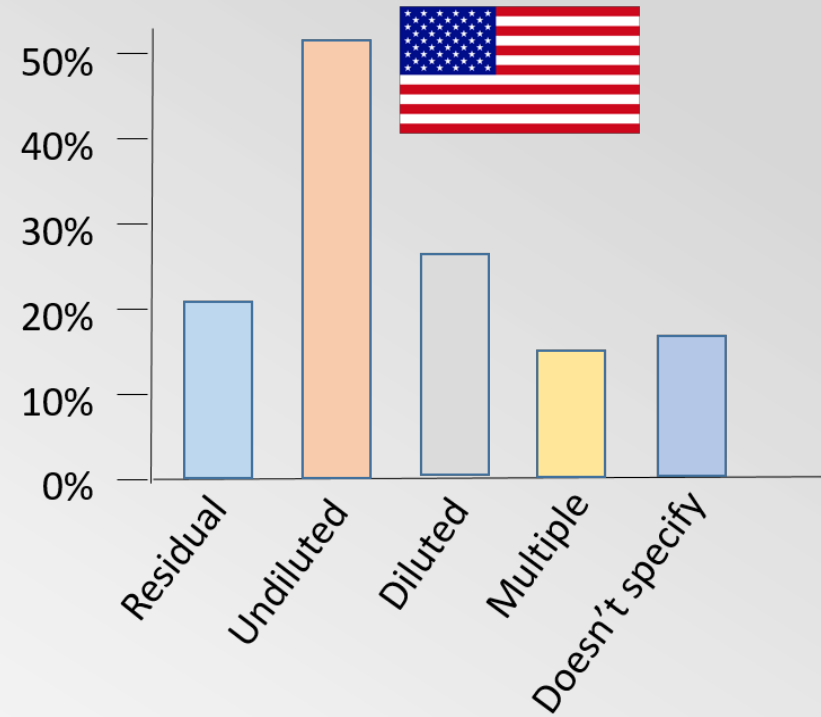
“Non-tracking tacks are designed to improve the pavement performance by avoiding the tracking problems associated with traditional tacks. This material is typically manufactured to harden quickly and adhere minimally to tires. When a hot lift of asphalt is subsequently placed over the tack, the hardened tack is reactivated by the heat, and bonds the new overlay with the existing surface.”

(Seo, 2016)

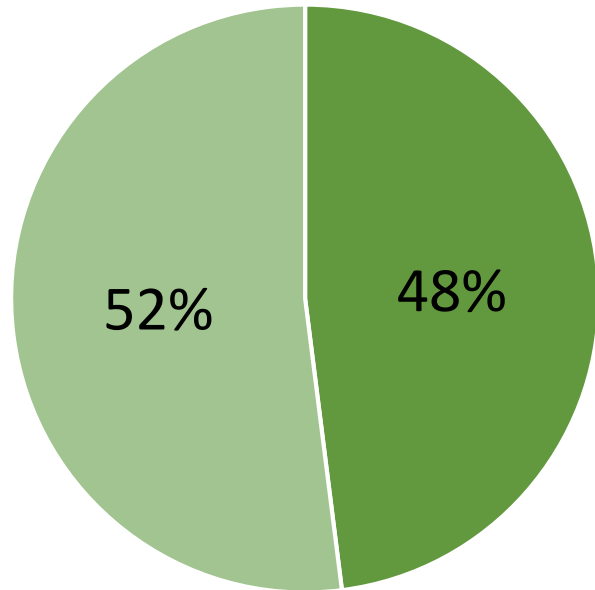
AVERAGE SPECIFIED RESIDUAL BINDER APPLICATION RATE AND RANGES FOR VARIOUS SURFACE TYPES



APP. RATE SPECIFIED BY:



Is Dilution of Emulsified Tack Allowed?

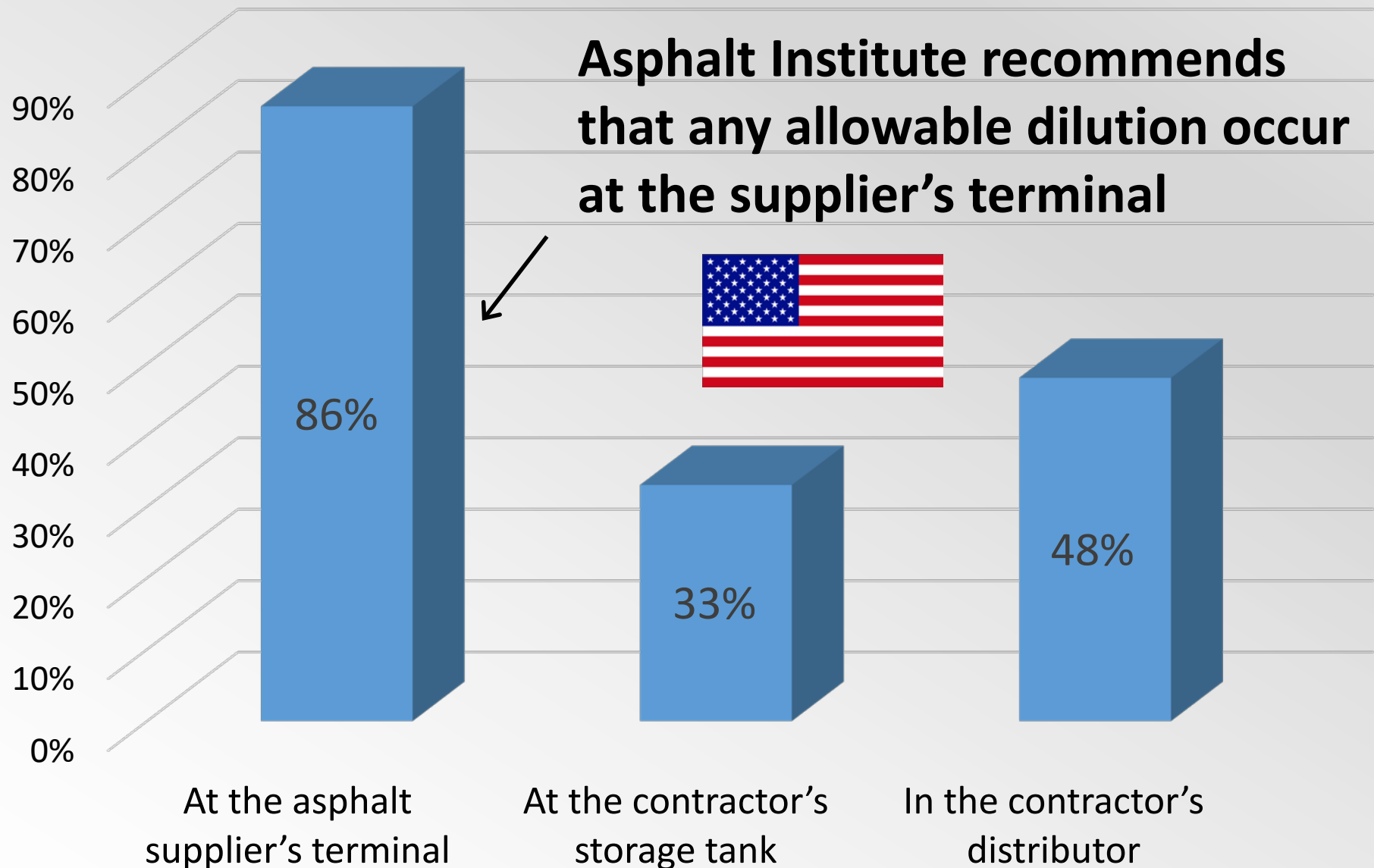


- Dilution Allowed 48% (24/50)
- Dilution Not Allowed 52% (26/50)

Dilution Recommendations

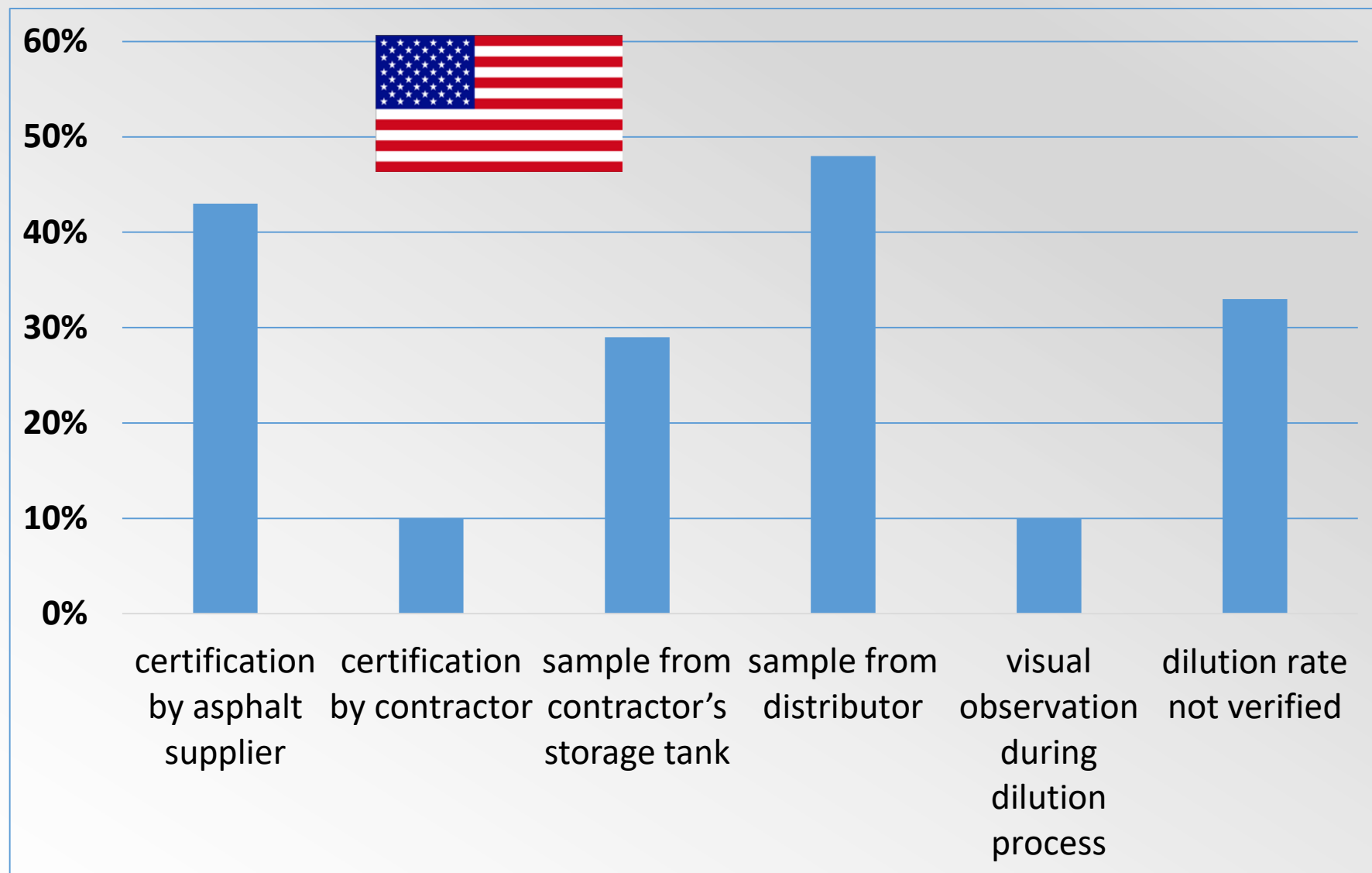
- Verify dilution amount
- Dilution cannot be used to “stretch” tack
- Residual value is key

Where is Dilution Allowed?

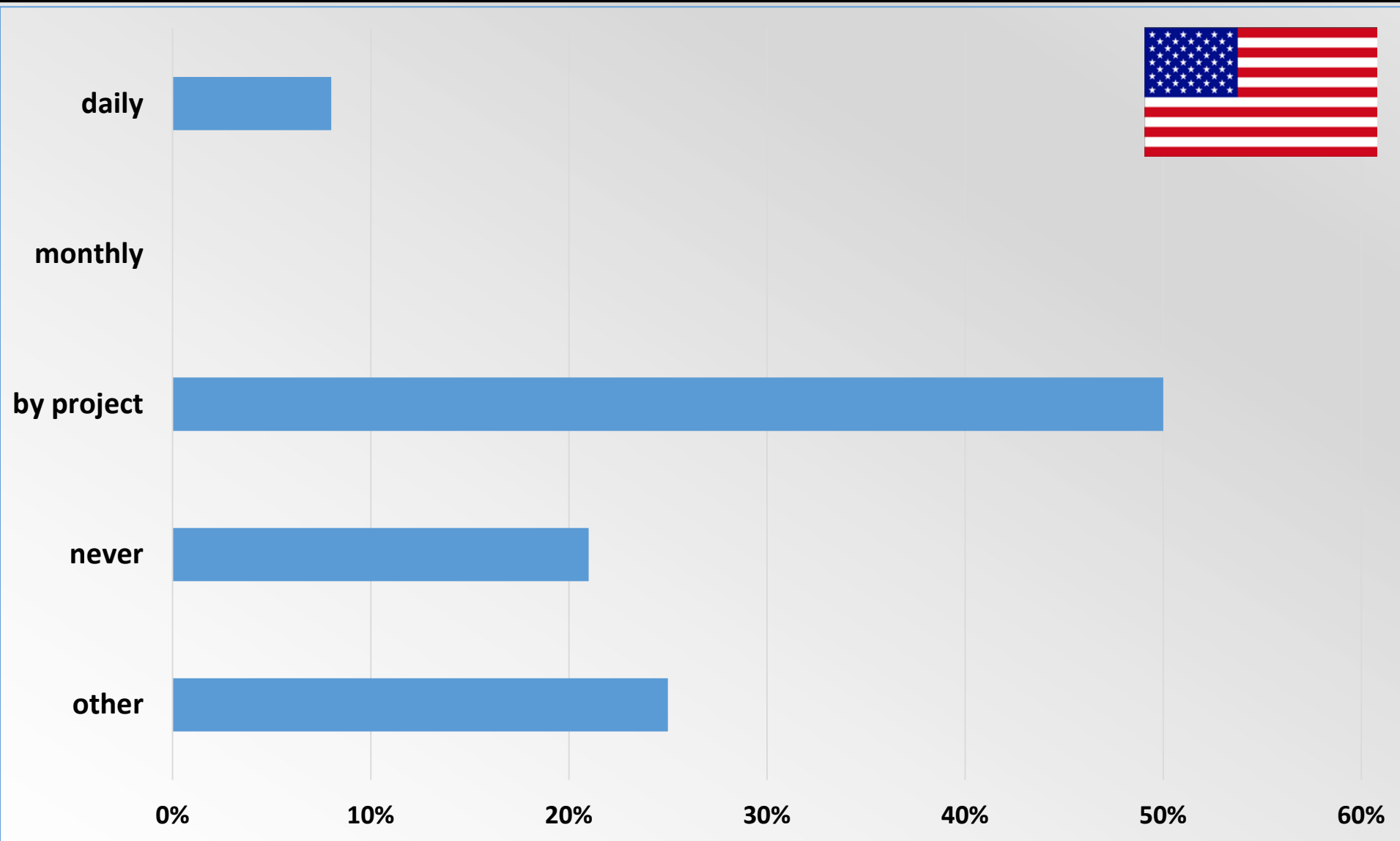




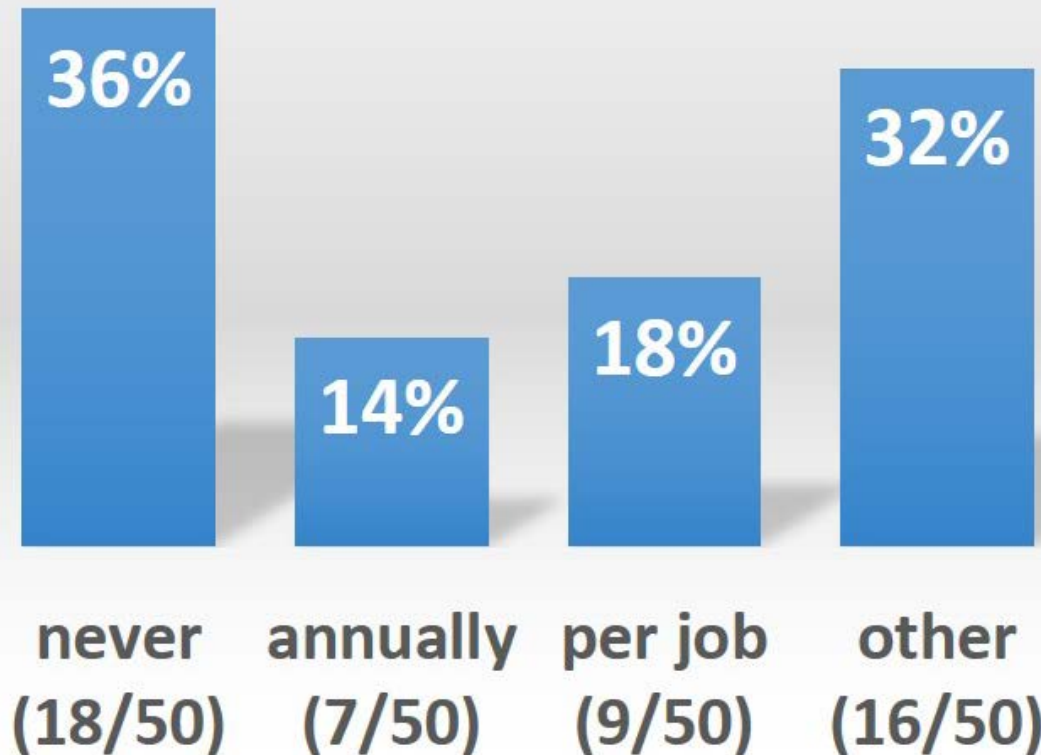
Dilution verification method(s) allowed?



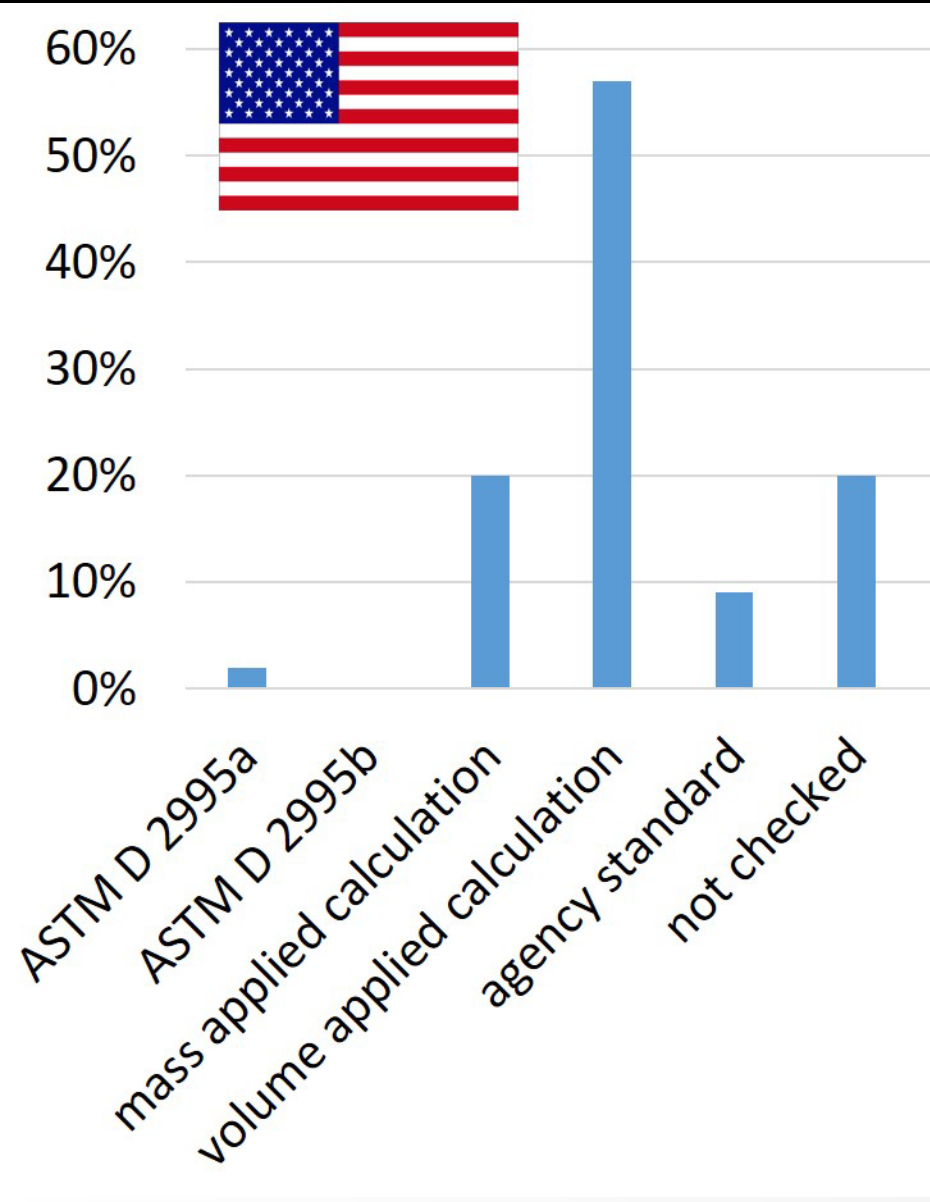
How often is dilution checked?



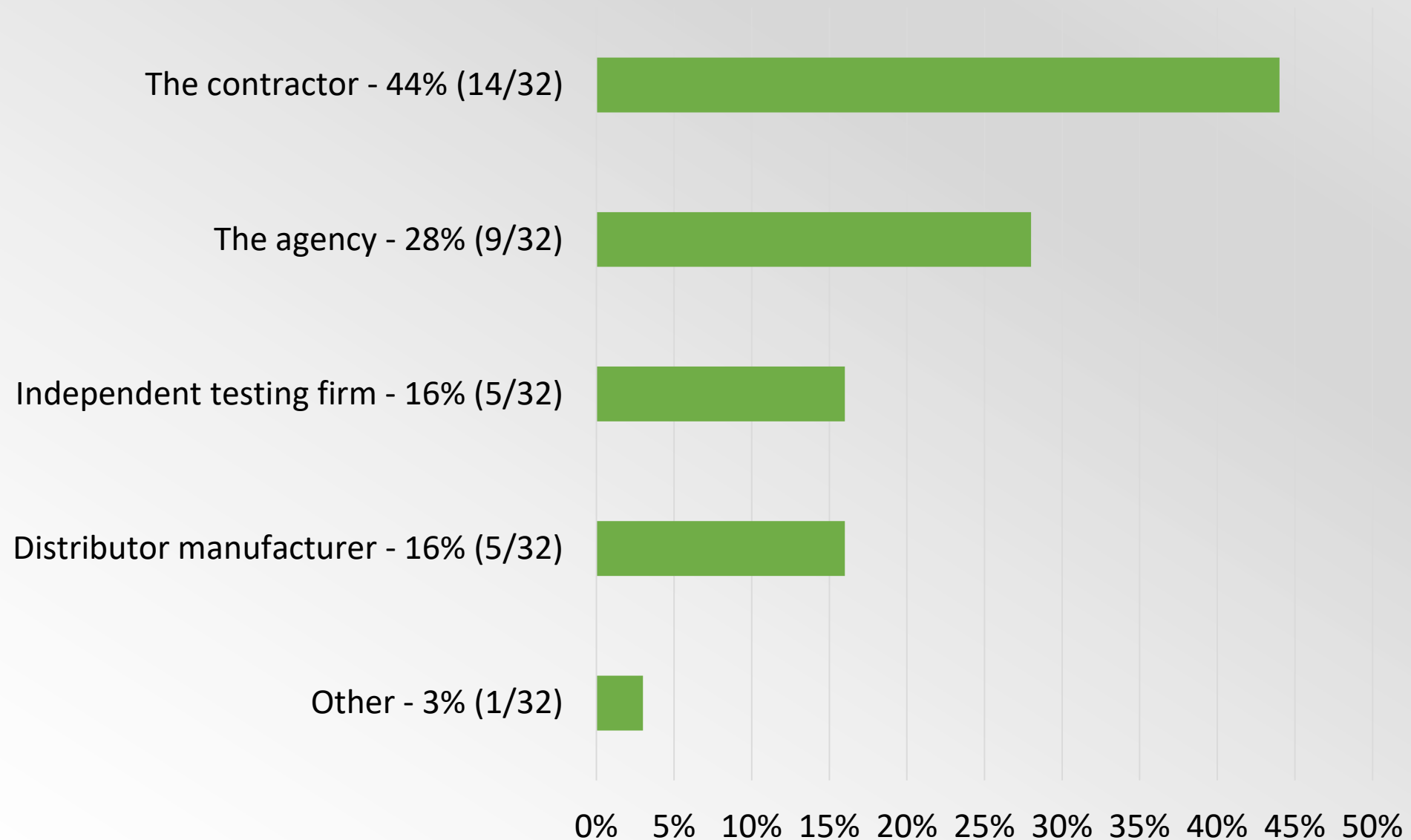
Distributor Calibration-How often?



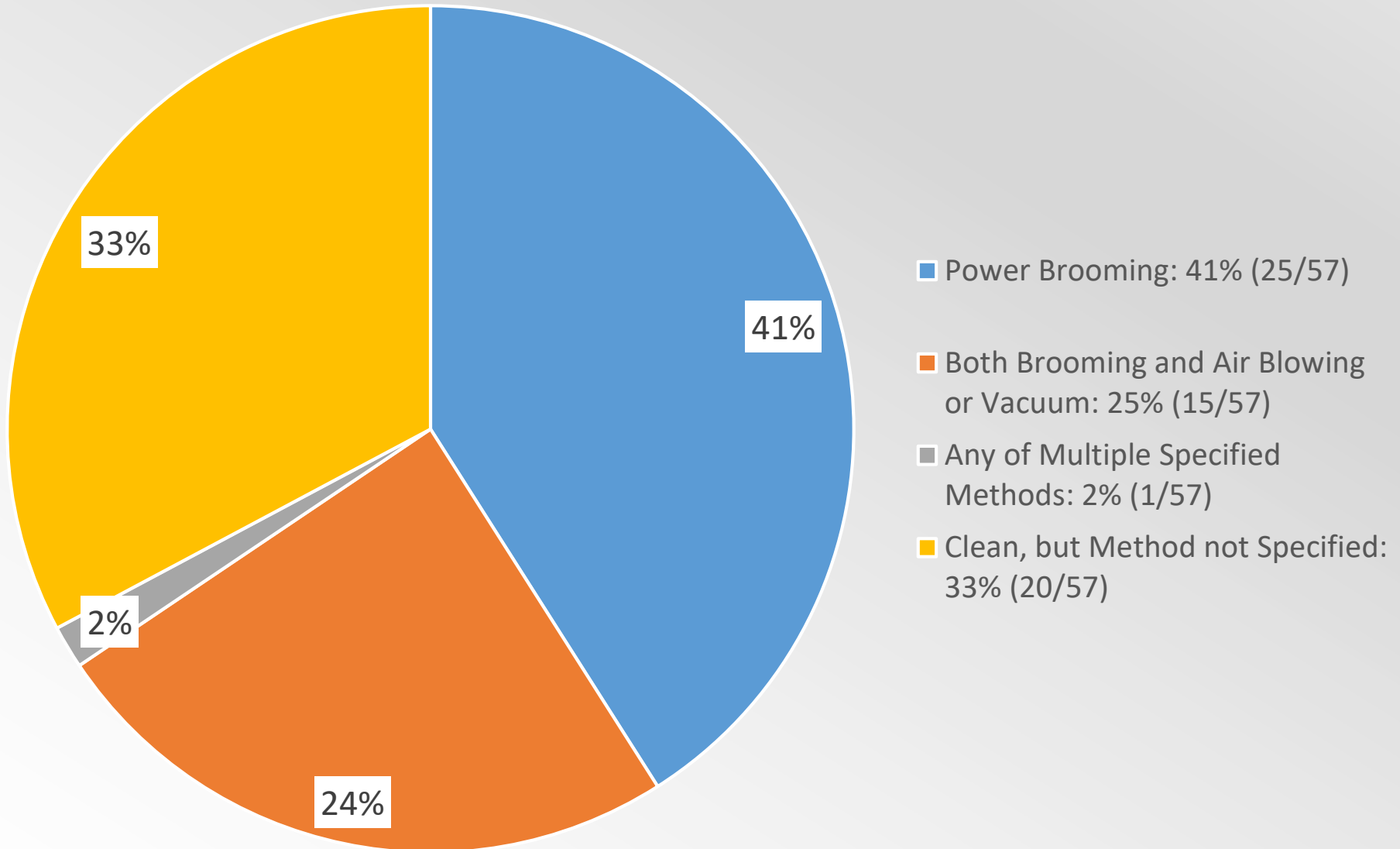
Distributor Calibration-Method?



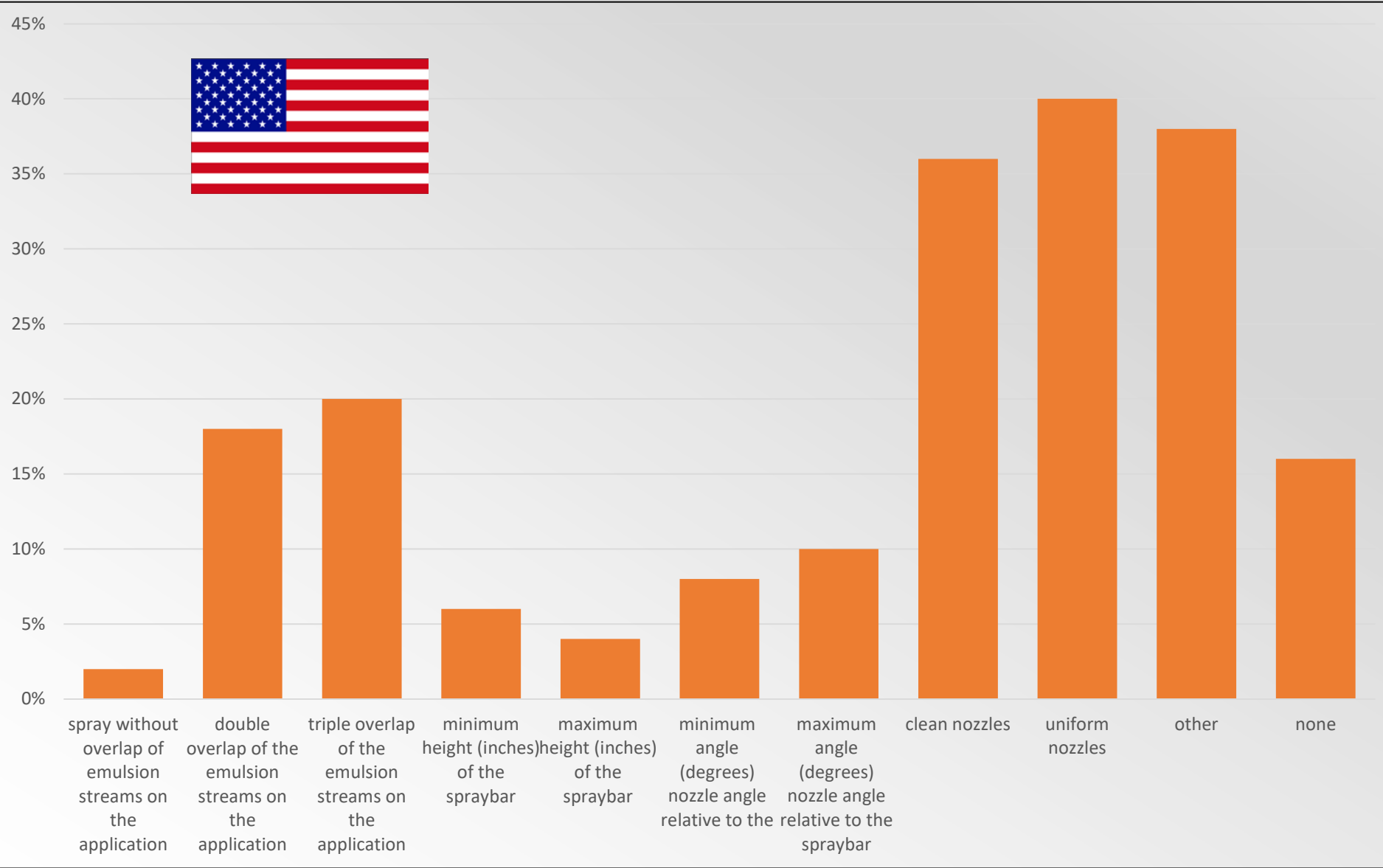
Who performs the calibration?



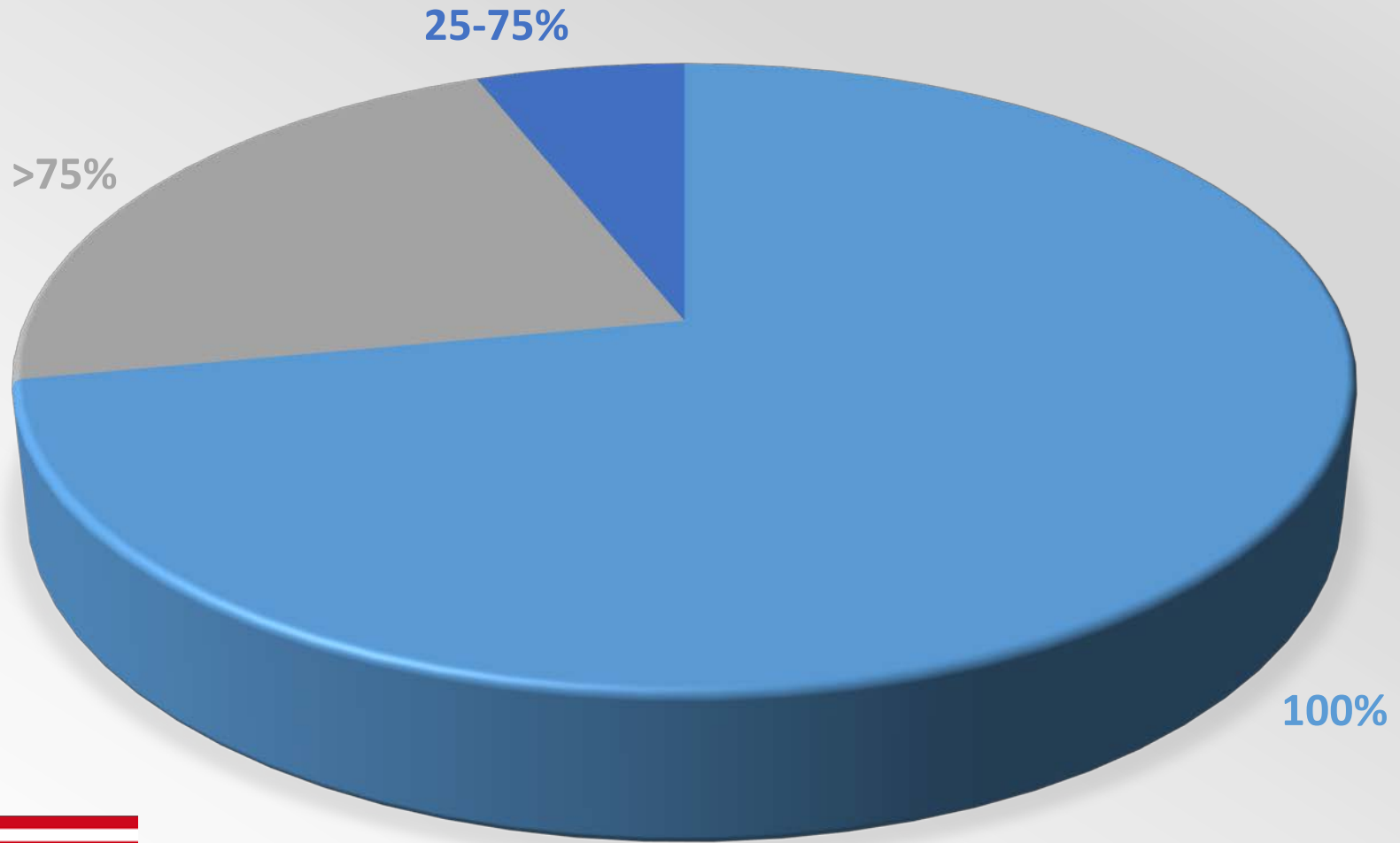
Surface Cleaning Methods



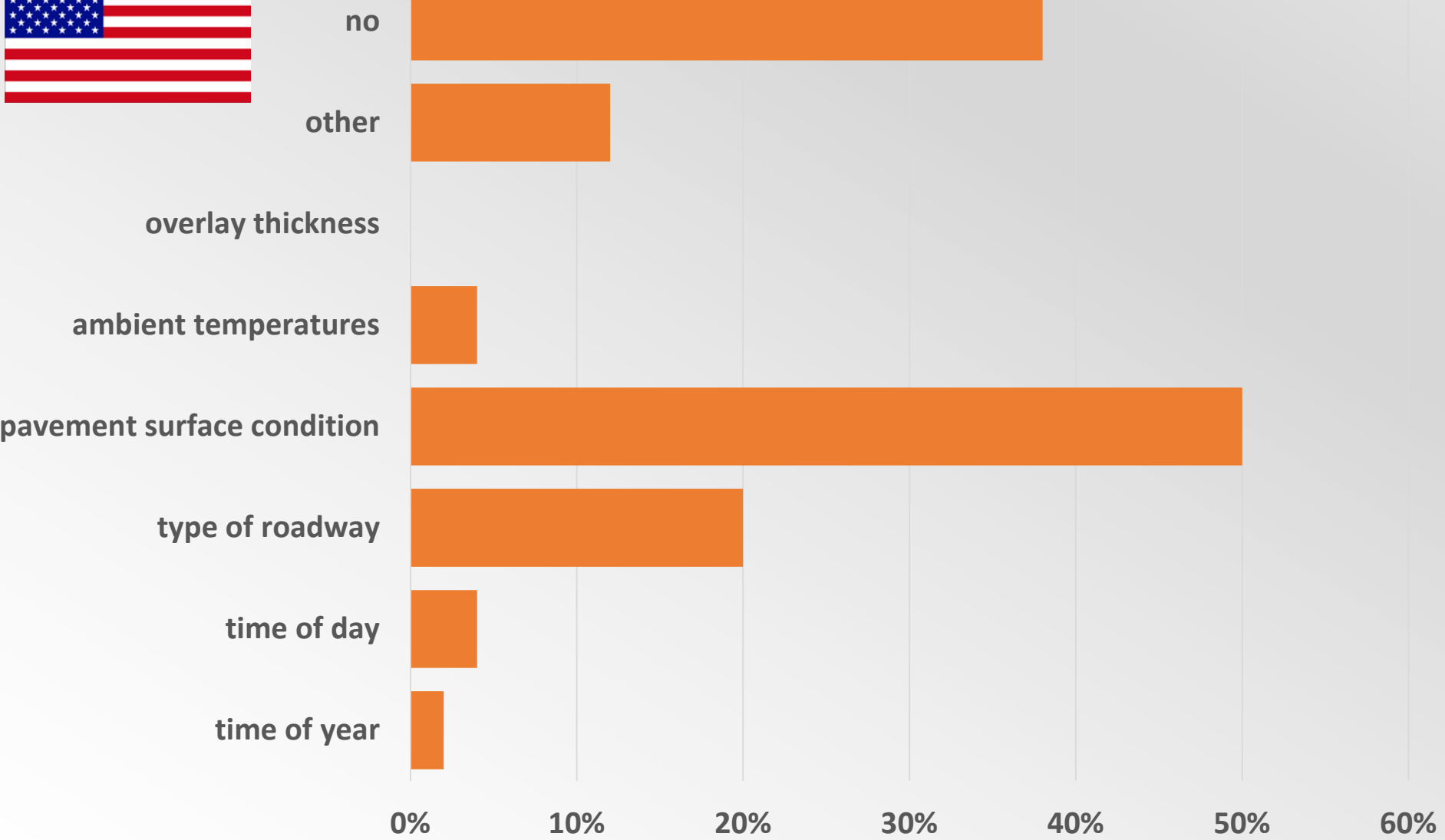
Which of the following are specified by your agency for spray application of tack coat materials?



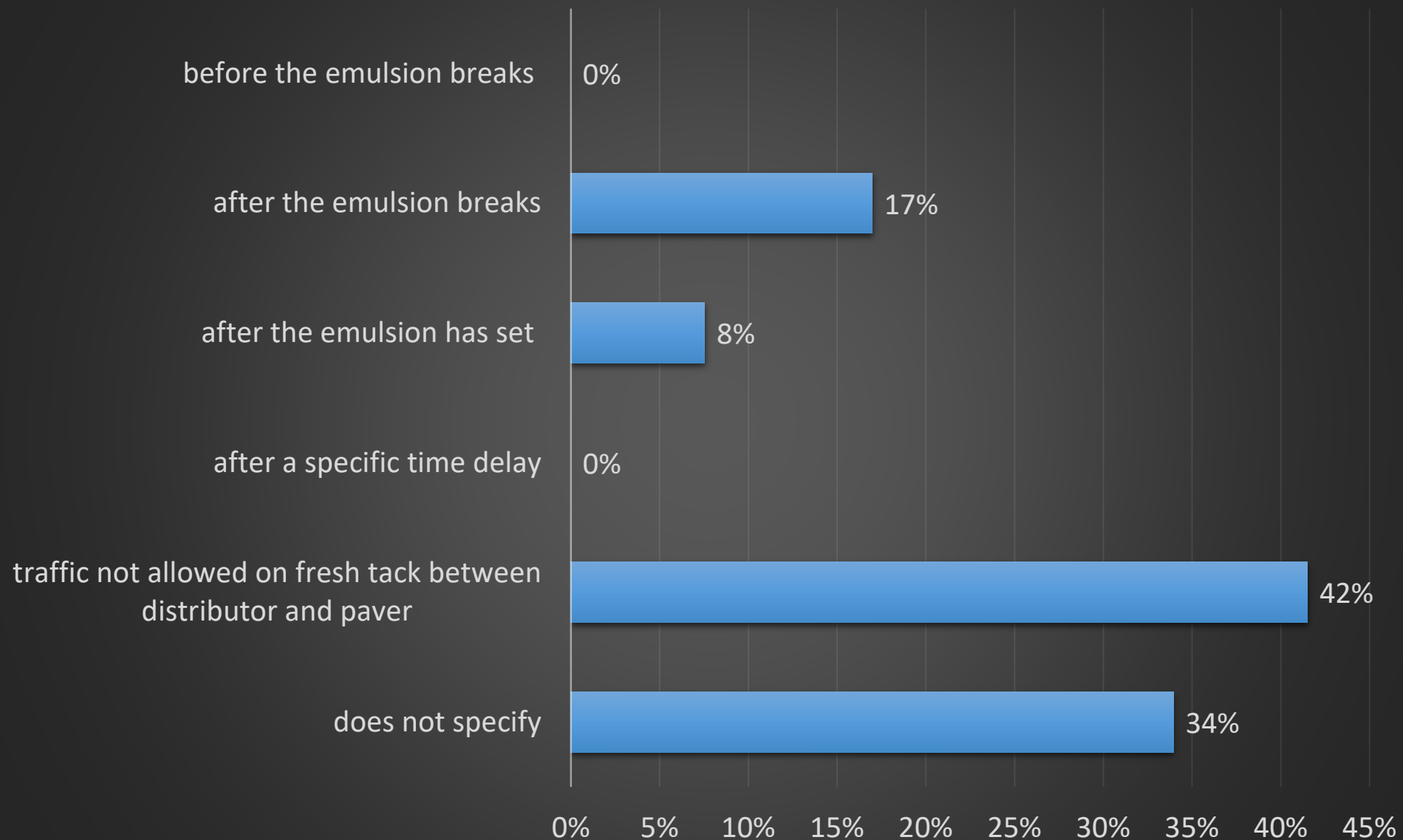
Percent of Surfaces Tacked



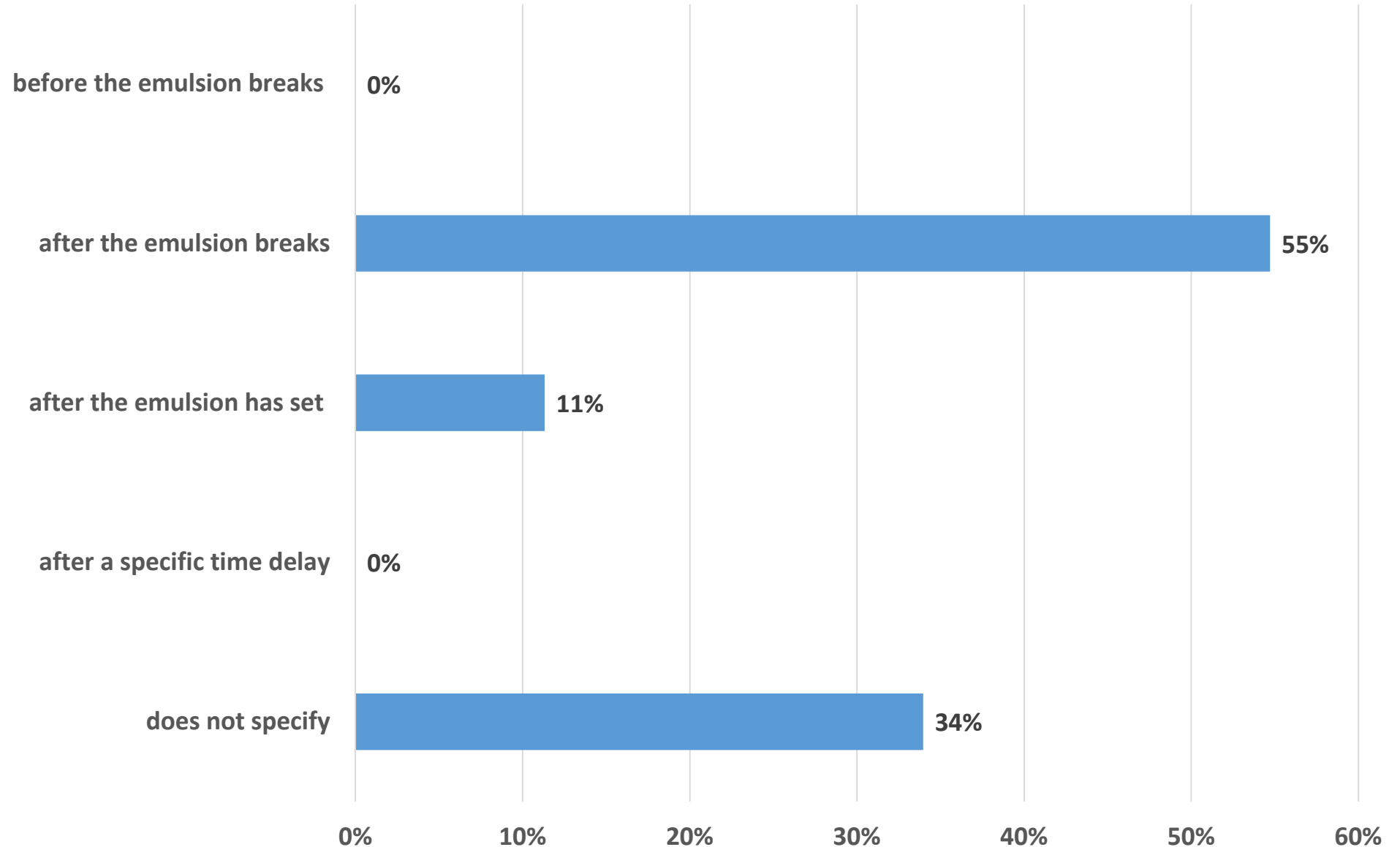
Do any of the following conditions cause the specified residual asphalt tack coat application rate to change?



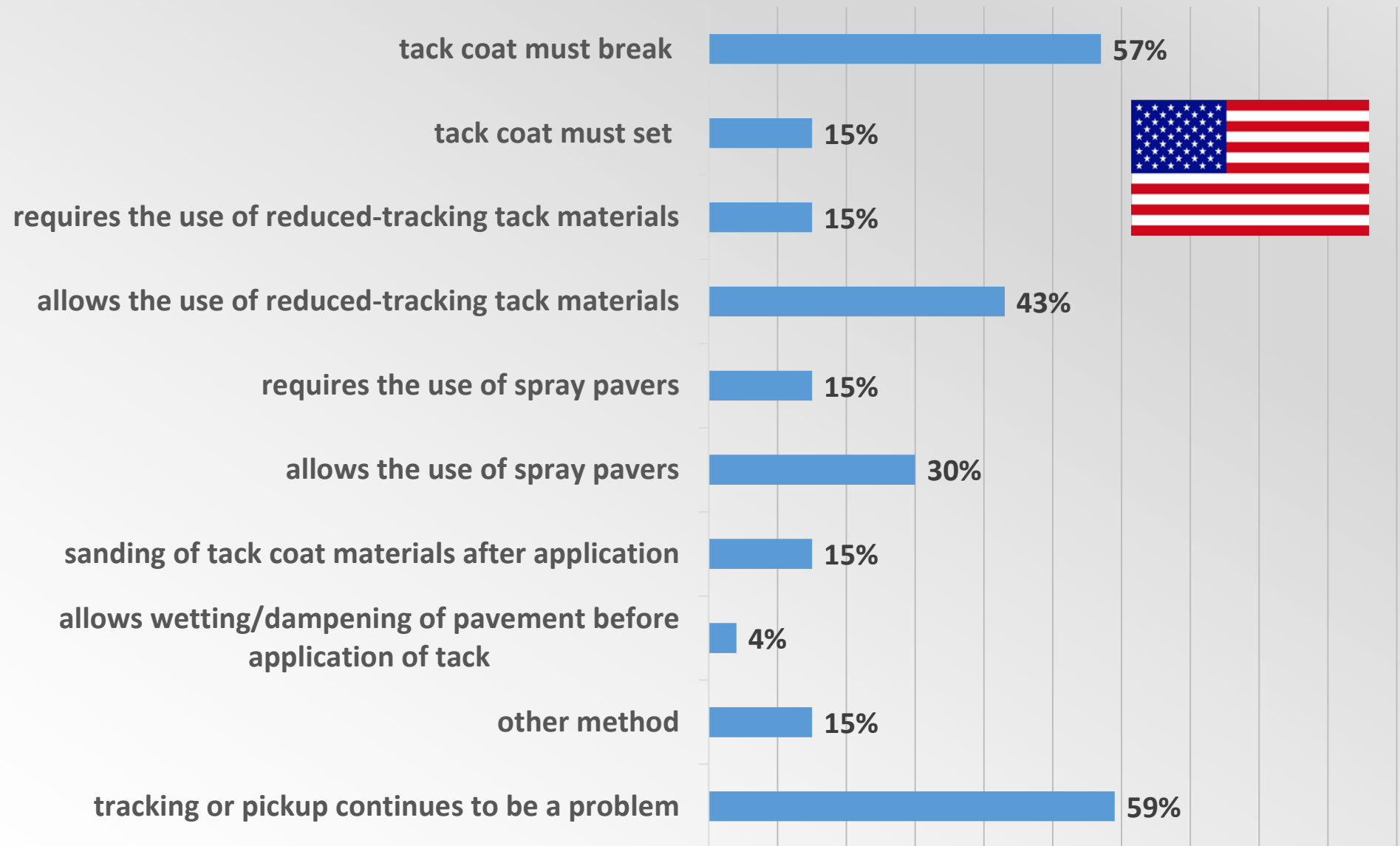
When is traffic allowed on the tack coat?



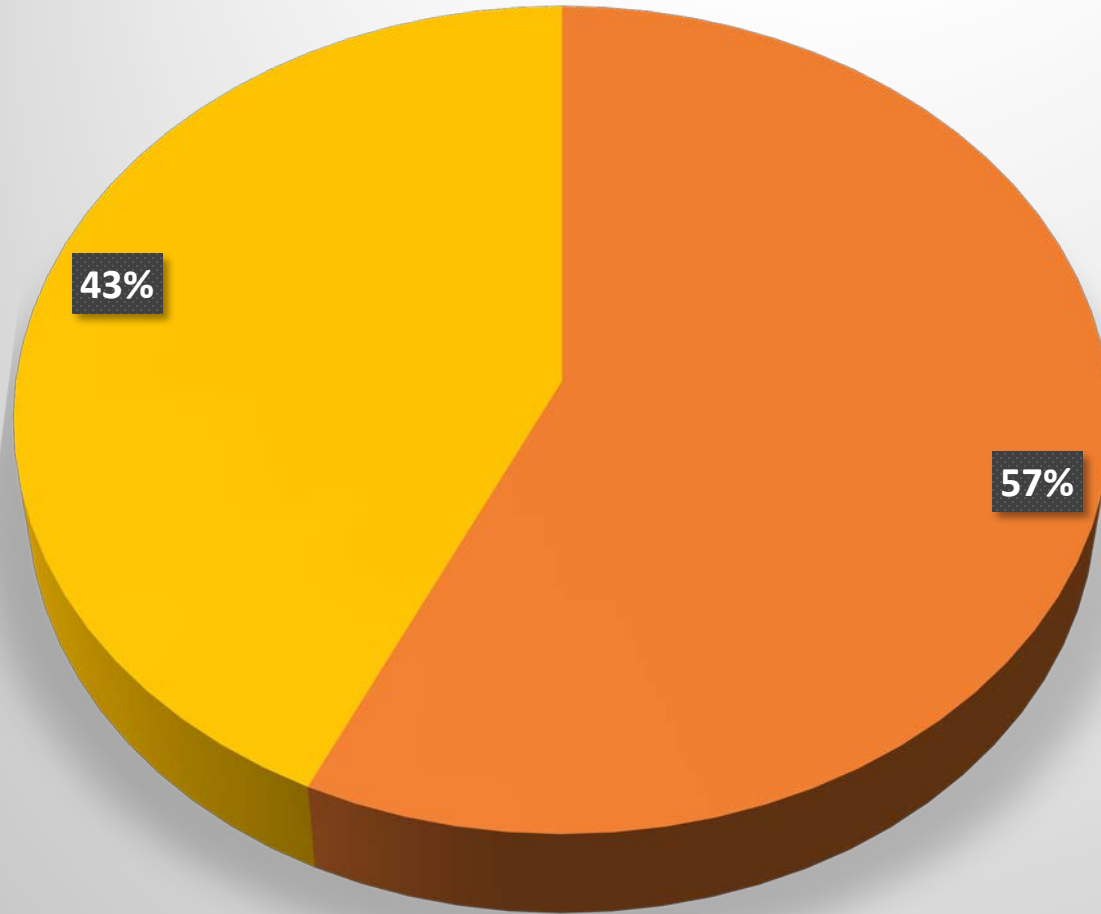
When is the paver allowed on the tack coat?



Methods Used to Minimize Tracking



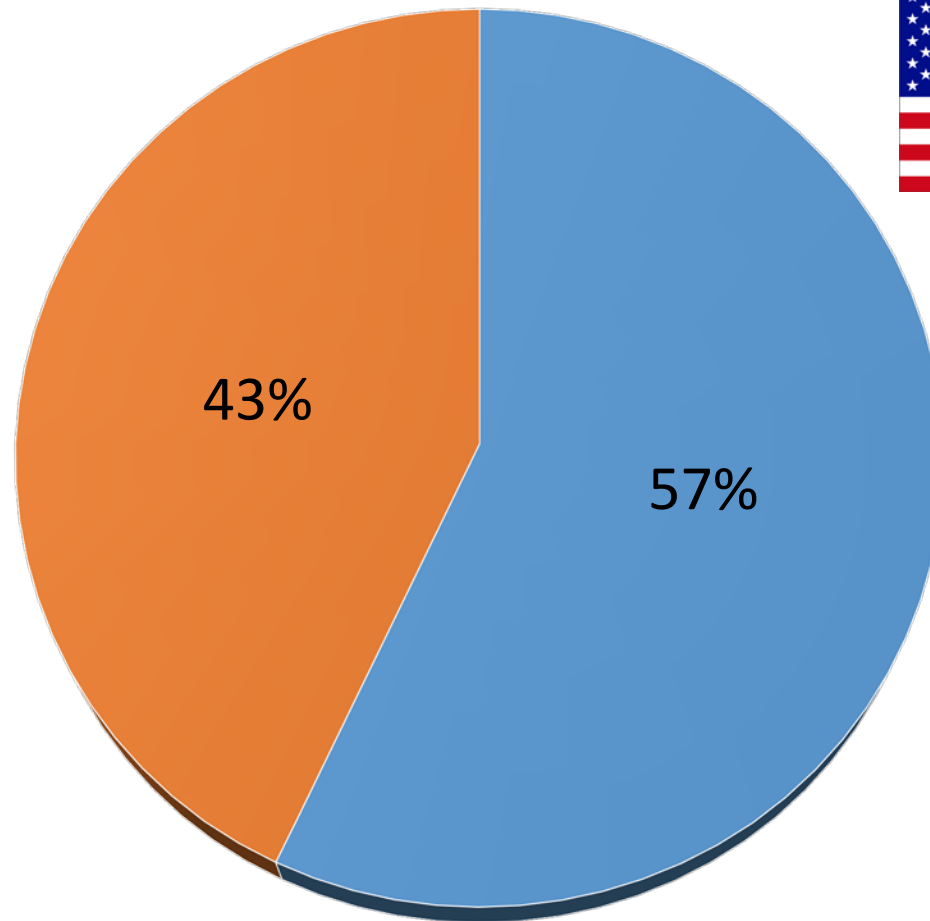
Are spray pavers allowed?



- Spray Pavers Allowed
- Spray Pavers Not Allowed

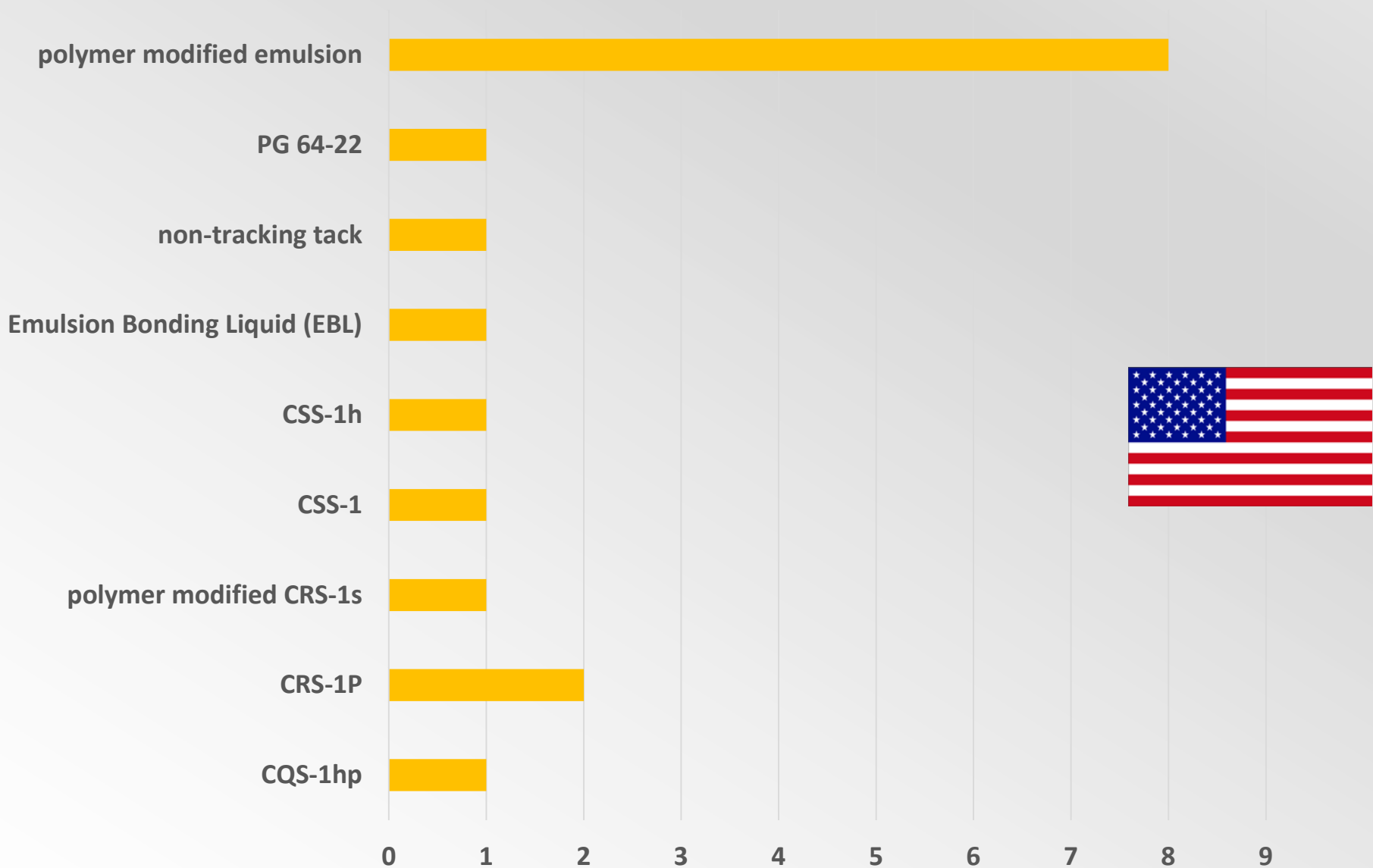


Are different tack materials used with spray pavers?

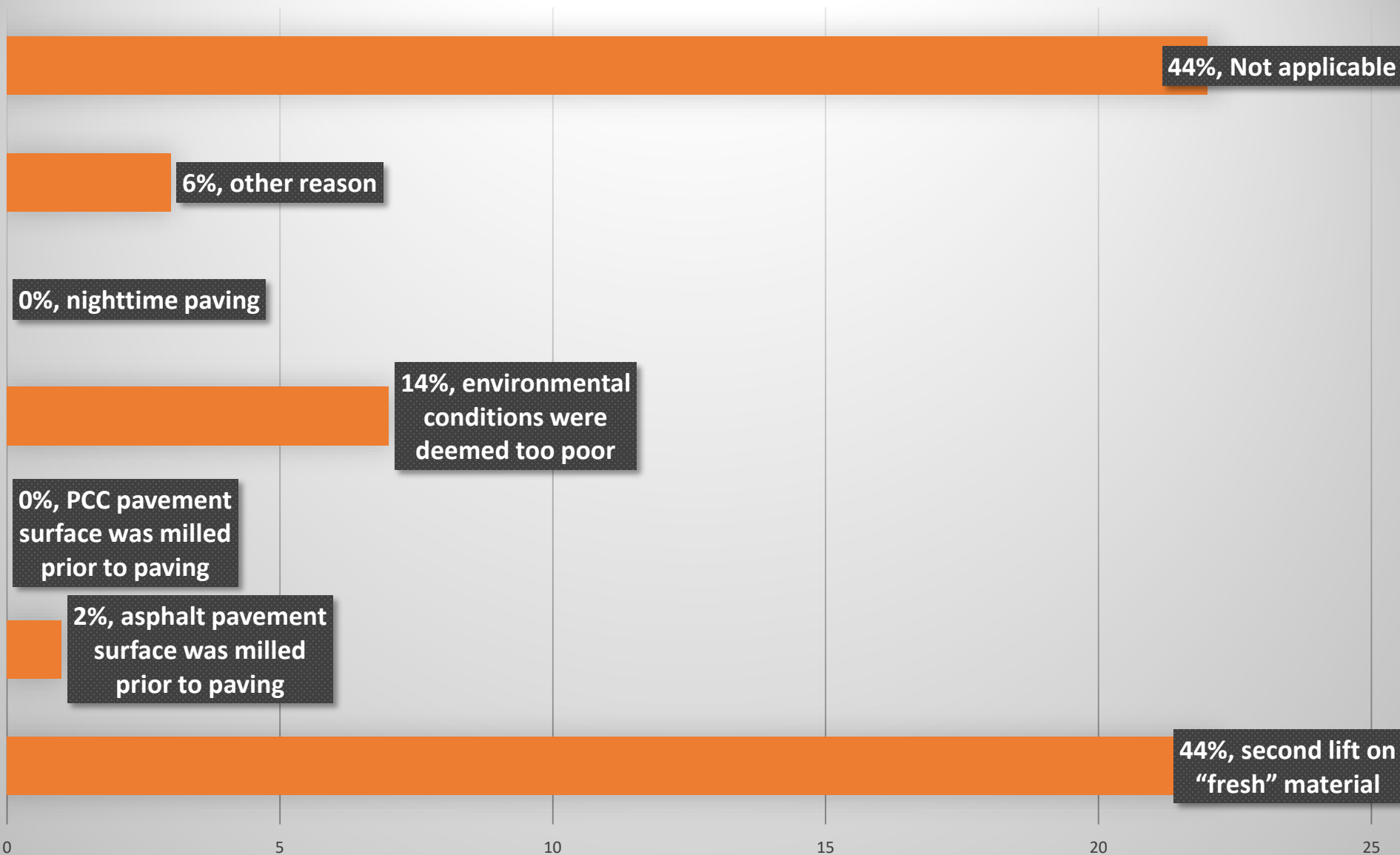


- different tack coat material used (16/28)
- same tack coat material used (12/28)

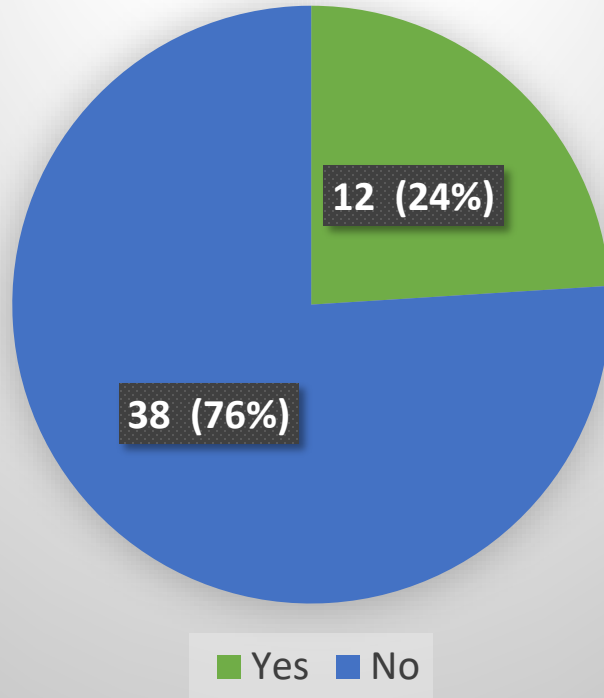
What materials do you use with spray pavers?



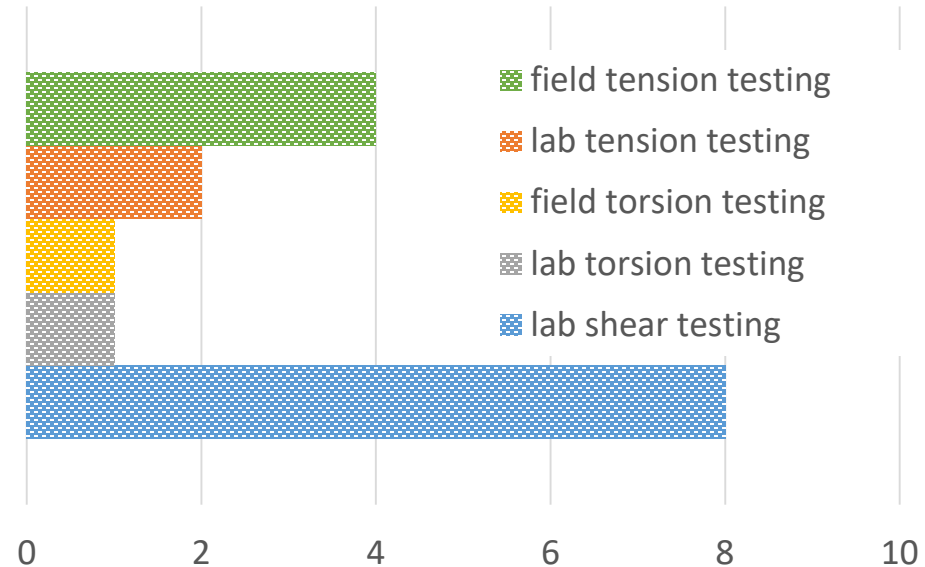
What conditions can lead to tack being waived?



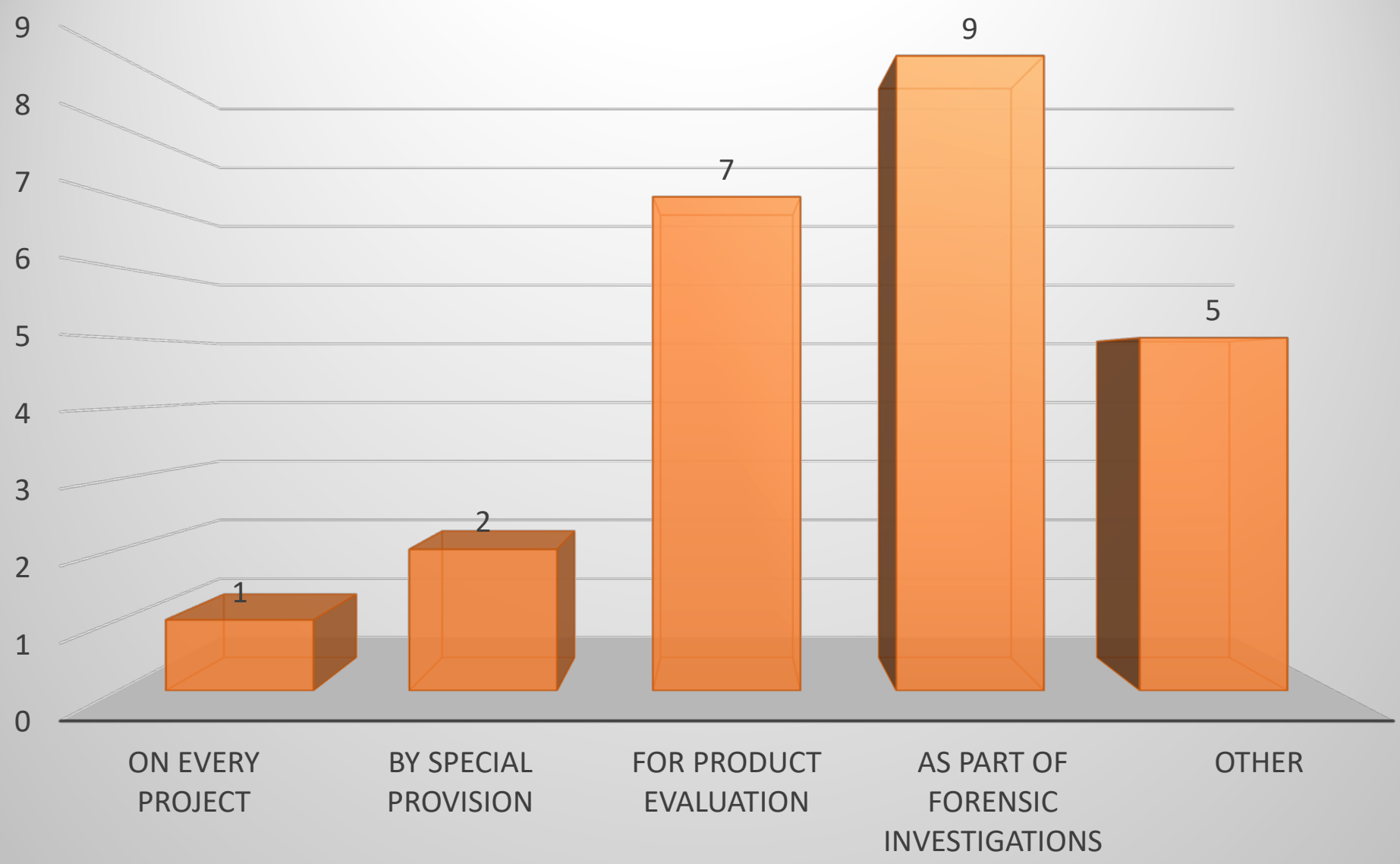
Bond Strength Testing?



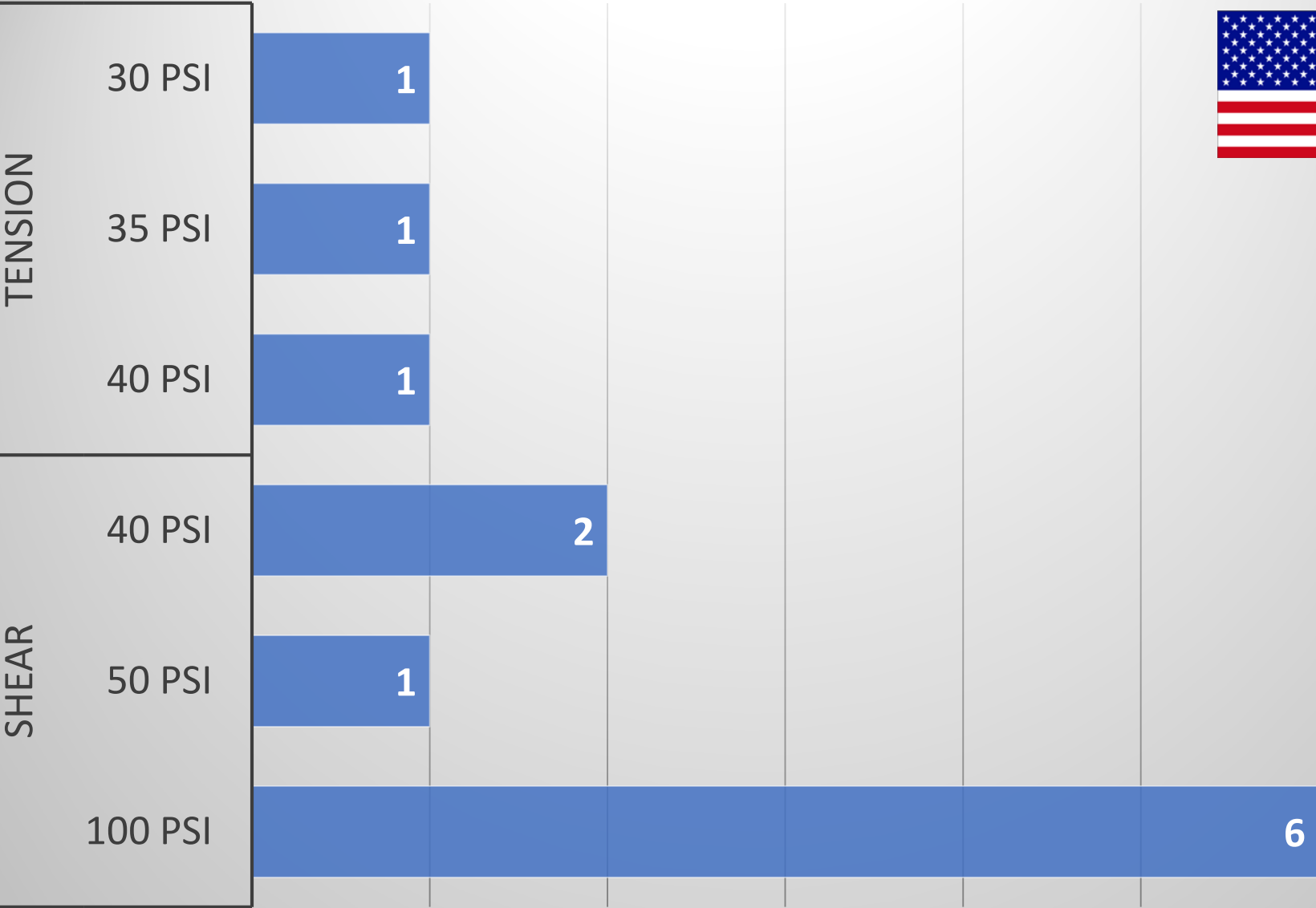
Testing style?



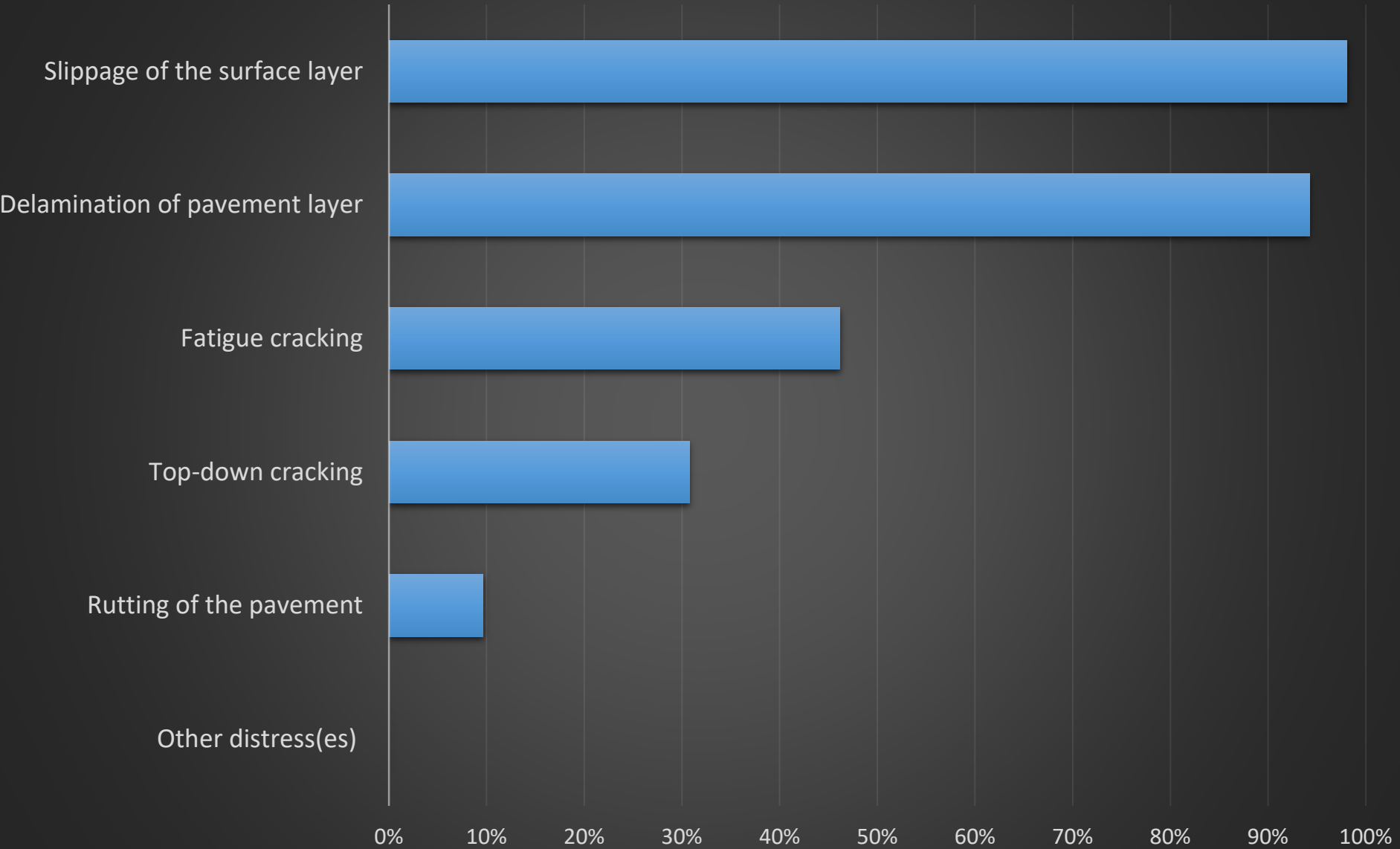
When does your agency perform interface bond testing?



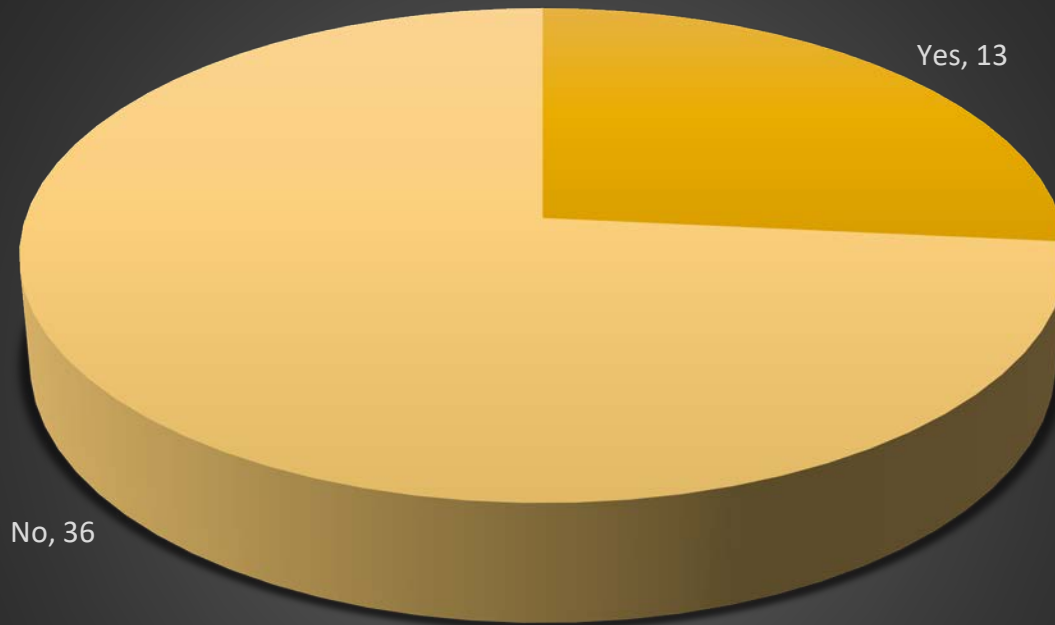
What is your minimum bond strength requirement?



Pavement failure types cited by agencies as potentially caused by poor bond strength.



Does your agency require any tests on tack coat?



No, 36

Yes, 13

■ Yes ■ No

Most common?

Standard emulsion tests.

Case Examples

- presents the results of in-depth communication with three states (KS, TX, WV) which were identified as candidates for further study
- information is presented regarding:
 - their histories with interface bond testing
 - a summary of their testing methods
 - discussion of how the implementation of additional focus on tack coats has progressed and been received in their state.



- Survey Questions
- Summary of Survey Results
- Tack Coat Training Manual From NCHRP Report 712
- Kansas DOT Bond Strength Specs and Best Management Checklists
- Louisiana DOTD Tack Coat Inspector Checklists

Questions?

