62nd Annual Idaho Asphalt Conference
University of Idaho, Moscow, Idaho
October 27, 2022

Conference Program

Wednesday, October 26, 2022

4:00 pm	***Registration opens***
5 -7:00 pm	***Icebreaker in Exhibit Hall – Sponsored by Western States Equipment / Caterpillar***

Thursday, October 27, 2022

7:00 am	***Registration opens – Continental Breakfast in Exhibit Room***
8:00 am	***Opening Comments*** Dr. Emad Kassem, PE, Associate Professor, University of Idaho
8:15 am	***Welcome Note*** Dr. Suzanna Long, Dean of College of Engineering, University of Idaho

Morning Session

Presiding: Dave Johnson, P.E.
The Asphalt Institute

8:30 am	***High Polymer Thick Mat*** Howard Anderson, P.E. Utah Department of Transportation
9:30 am	***Stone Matrix Asphalt Construction and Performance*** Jared Dastrup, P.E. Utah Department of Transportation
10:15 am	**Break**
10:40 am	***Innovative Pavement Preservation Strategies for Municipalities*** Tom Kirkman City of Pocatello
11:20 am	***Full Depth Reclamation – Montana DOT Experience*** Miles Yerger, P.E. Montana Department of Transportation
Noon – 1:45 pm	**Lunch and Expo**

Afternoon Session

Presiding: John Arambarri, P.E.
Idaho Transportation Department

1:45 pm	***Compaction of Asphalt Mixtures, State of Practice*** Dave Johnson, P.E. The Asphalt Institute
2:20 pm	***Void Reducing Asphalt Membrane*** Tim Zahrn, P.E Asphalt Materials
3:00 pm	**Break**
3:15 pm	***Asphalt Emulsion Nomenclature*** Codrin Daranga Ergon Asphalt & Emulsions
4:00 pm	***Asphalt Auto Extractor*** Dr. Buzz Powell, P.E. National Center for Asphalt Technology
4:45 pm	**Adjourn**

Speakers of the 62nd Idaho Asphalt Conference, Oct. 27, 2022

From left to right: Codrin Daranga, Dave Johnson, Howard Anderson, Jared Dastrup, Tom Kirkman, Emad Kassem, John Arambarri, Buzz Powell, Miles Yerger, Tim Zahrn, and Muhammad Zubery.

62nd Idaho Asphalt Conference – October 26 – 27, 2022 – Moscow, Idaho
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High Polymer, Thick Lift, Low Void Pavement

Howard Anderson, P.E.
Utah State Asphalt Engineer

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October 27, 2022

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Highly-Modified, Thick-Lift Demonstration Project in Utah

Rocky Mountain Asphalt User Producer Group Meeting
October 13, 2021

2

Past Experience With Highly Modified and/or Thick Lifts

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- South Carolina
  - Limited information on the mix
  - Believed to be highly modified
  - Single-lift at 7.9 inched
  - Consistent densities ~95%
- NCAT
  - South Carolina sponsored
  - Highly Modified
  - 5.75-inch, 12.5 mm mixture
  - Consistent densities through the lift of ~95%
  - Great performance
- Utah
  - Past laboratory work
    - Hamburg driven
    - Typical 12.5 mm mix
    - Multiple samples up to 6.8% binder
    - 40,000 passes
    - No Hamburg failures (<10 mm)
  - Two secondary highways
    - Simply substituted binder into the mix design
    - Constructed in 2017
    - Typical lift thicknesses
    - Excellent performance

3

The Binder Specification

Table 10

PG76-34 Highly Modified		
Original Binder		
Dynamic Shear Rheometer, AASHTO T 315	@ 76° C, G*, kPa	1.30 Min.
	@ 76° C, phase angle, degrees	70. 0 Max.
Rotational Viscometer, AASHTO T 316	@ 135° C, Pa.s	3 Max.
Flash Point, AASHTO T 48	°C	260 Min.
RTFO Residue, AASHTO T 240		
Dynamic Shear Rheometer, AASHTO T 315	@ 76° C, G*/sinδ, kPa	2.20 Min.
Elastic Recovery, AASHTO T 301 mod (a)	%	90 Min.
PAV Residue, 20 hours, 2.10 MPa, 100 °C, AASHTO R 28		
Dynamic Shear Rheometer, AASHTO T 315	@ 25° C, kPa	5,000 Max.
Bending Beam Rheometer, AASHTO T 313	@ -24° C, S, MPa	300 Max. 150 Min.
	@ -24° C, m-value	0.300 Min.
Delta Tc from additional BBR test, ASTM D7643	@ -30° C	-1.0 Min.

(a) Modify paragraph 4.5 as follows: Stop the ductilometer after 20 cm has been reached and within 2 seconds. Sever the specimen at its center with a pair of scissors.

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Highly Modified Asphalt Materials

WASHTO Conference
April 4, 2016
Salt Lake City, Utah

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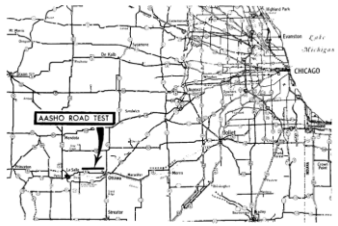
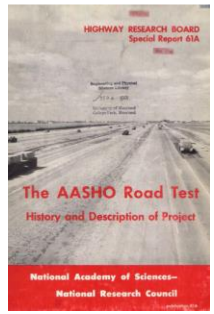
AASHO Road Test
Ottawa, Illinois Constructed 1956-58





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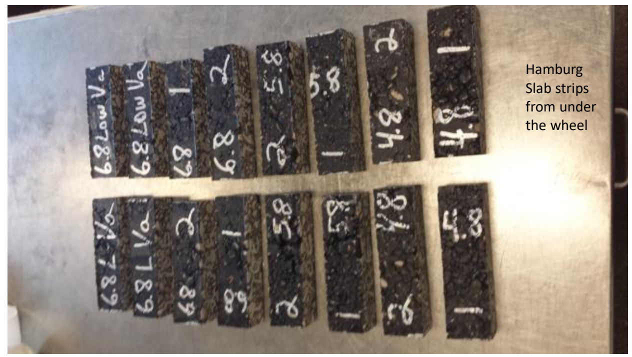
Hamburg Test
Showing load cell out put

7



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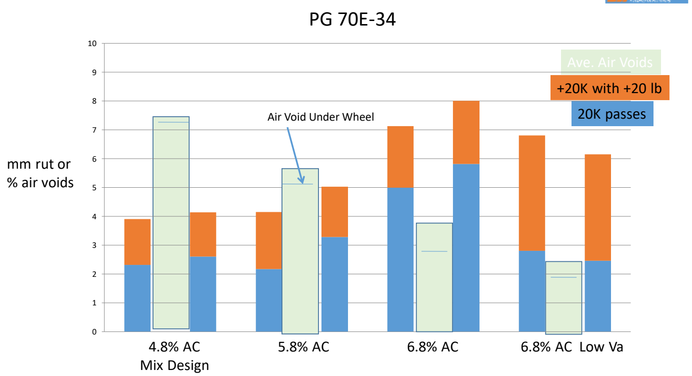
Hamburg Test



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Hamburg Test Data

PG 70E-34

	%AC	Air Voids/Rut Void	20,000	+(20,000 + 20 lb)	Total Rut, mm
Slab 1	4.8	7.3/7.2	2.32	1.59	3.91
Slab 2	4.8	7.8/7.8	2.6	1.54	4.14
Slab 1	5.8	5.5/4.7	2.17	1.98	4.15
Slab 2	5.8	5.9/5.9	3.28	1.75	5.03
Slab 1	6.8	3.8/3.0	5	2.13	7.13
Slab 2	6.8	3.9/2.7	5.82	2.19	8.01
Slab 1 Low Va	6.8	2.3/1.8	2.8	4.01	6.81
Slab 2 Low Va	6.8	2.8/2.2	2.46	3.69	6.15

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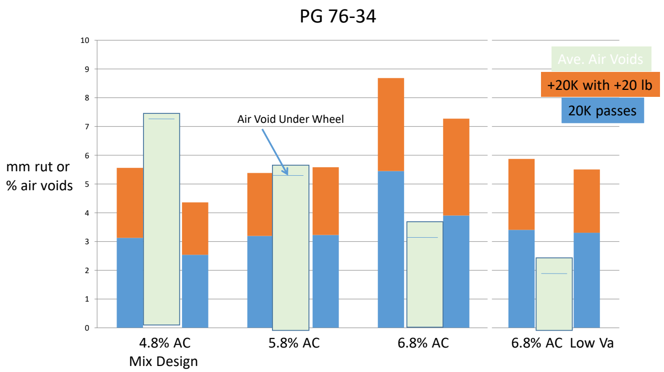
Hamburg Test



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Hamburg Test Data

PG 76-34

	%AC	Air Voids/Rut Void	20,000	+ (20,000 + 20 lb)	Total Rut, mm
Slab 1	4.8	7.4/7.1	3.13	2.43	5.56
Slab 2	4.8	7.6/7.7	2.54	1.82	4.36
Slab 1	5.8	5.8/5.0	3.19	2.2	5.39
Slab 2	5.8	5.7/5.8	3.23	2.36	5.59
Slab 1	6.8	3.6/3.2	5.45	3.24	8.69
Slab 2	6.8	3.8/3.0	3.91	3.37	7.28
Slab 1 Low Va	6.8	2.3/1.9	3.41	2.46	5.87
Slab 2 Low Va	6.8	2.6/1.6	3.31	2.2	5.51

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Project Location

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- Port of Entry on I-80 Near Wendover, UT
- High Truck Volume (51%), AADT 7,900
- 2-2.5 Million ESALs/year
- Very Hot in the Summer
- LTPPBind = PG64-28 (98% reliability)

Project Location

Google Maps

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Project Scope

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- Mill and Inlay 6.0 Inches of PCC
- ~330 Ton Project
- Highly Modified Binder
- Dense-Graded Mixture
- Construct in a Single Lift
- ~2-Hour One-Way Haul

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Notable Design Requirements

- PG 76-34
  - 110-degree useful temperature interval!
  - Highly modified
- Mix Design Requirements
  - 50 gyrations
  - 12.5 mm NMAS
  - 1.0 – 1.5% air voids
  - VMA 15.0 – 17.0
  - VFA 90 – 95%
  - 0.3% maximum draindown
  - 15% RAP maximum
- Proprietary PG 76-34 from Peak/Idaho Asphalt
- Mix Design Properties
  - 1% Air Voids (0.1% at 75 gyrations)
  - VMA = 15.3
  - VFA = 93.3%
  - 6% Total Asphalt
    - 5.33% Virgin
    - 0.67% RAP Binder
  - 0% Naturals
  - Incorporated Evotherm as a Compaction Aid

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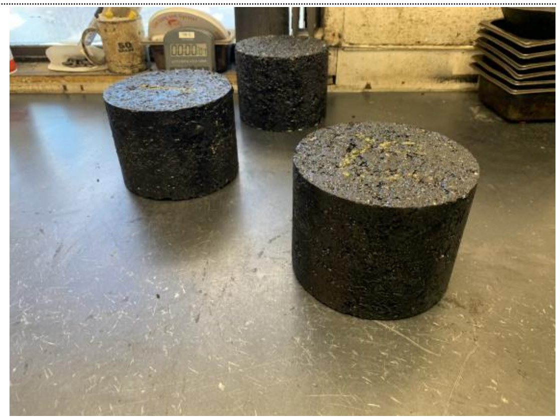
Superpave Specimens



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Hamburg Wheel Tracking Requirements

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- Slab Air Voids → 3.5 – 4.5% (6.5 – 7.5%)
- Water Bath Temperature
  - 50°C – first 20,000 passes
  - 54°C – second 20,000 passes
- Wheel Loading = 158 pounds
- Maximum Rut Depth at 20,000 Passes = 7.0 mm (10.0 mm)
- Maximum Rut Depth at 40,000 Passes = 10.0 mm

- **Approximately 3.9 mm after 20,000 Passes**
- **Approximately 6.1 mm after 40,000 Passes**

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Hamburg Graphs

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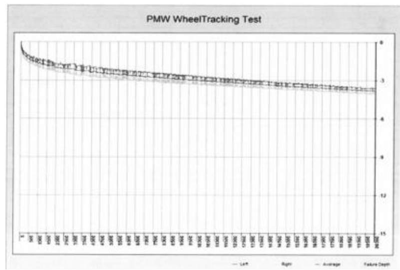
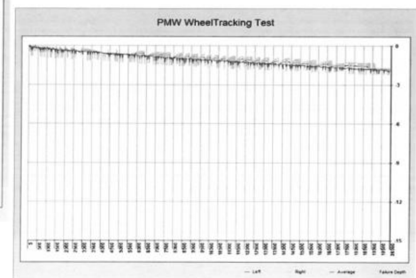


First 20,000 Passes



Second 20,000 Passes – same specimen

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Key Players

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Howard Anderson, UDOT

Craig Fabrizio, Staker Parsons

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Test Strip Construction

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- At Staker-Parson's Beck Street Facility
- Aggregate base vs. Portland cement concrete
- Virtually no haul vs. 2+ hours

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Test Strip Construction

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Test Strip Construction

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Test Strip Construction

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Test Strip Lessons Learned

- Density of 97% or more was easily achieved
- Regular rolling equipment and procedures followed
- Feeding while placing such a large volume of mix was achieved
- Mix was stable even with roller overhang
- No significant issues encountered

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Western Section Coming Off I-80

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Eastern Section Off the Scale

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Paving Operations

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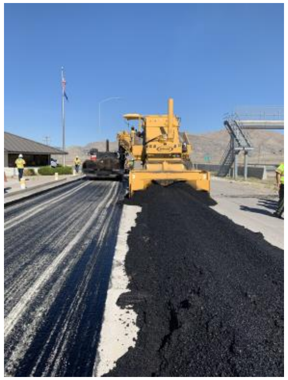

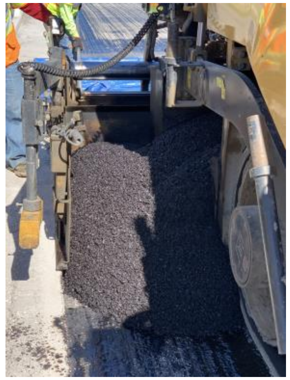

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Paving Operations

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Paving Operations

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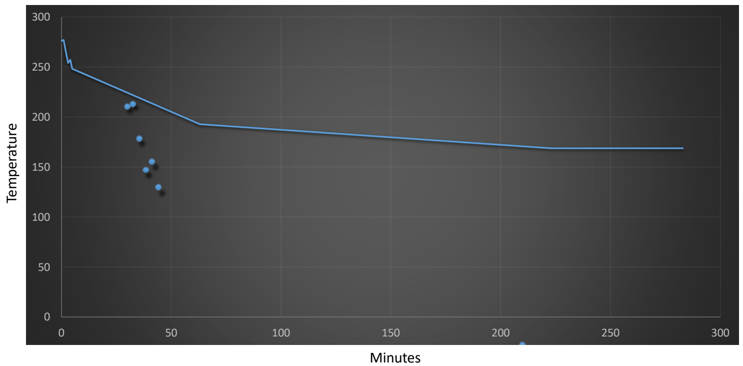
Time vs. Temperature



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Density Results

Core	Total Thickness	Top Half Density	Bottom Half Density
1	6.27 inches	97.9%	98.0%
2	6.27 inches	97.8%	94.4%
3	6.1 Inches	97.2%	92.8%
4	6.1 Inches	97.3%	97.6%

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Lessons Learned

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- Highly modified asphalt can be successfully constructed even with a 2+ hour haul
- High densities were easily achieved
- Initial performance has been spectacular

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I-80
POE Test
Section

5 months
Later

34

Early Post Traffic Performance

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- Exceptional early performance
  - 17 days of 100+°F since opening to traffic
  - Nearly 500,000 commercial trucks
  - **No discernable movement**

Courtesy of UDOT

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Skid Testing Results

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- British Pendulum Test (AASHTO T-278)
- Existing Pavement
  - **41** average skid number
- New Pavement
  - **53** average skid number

Courtesy of NCAT

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UDOT Experimenting With New Asphalt Paving Method

By Joe Walker | June 9, 2021 | Categories: Uncategorized |

UDOT is experimenting with a unique asphalt paving method that, if successful, will significantly minimize traffic impacts during construction and increase the life and durability of the pavement.

The new method requires a highly modified asphalt binder, PG 76-34 and allows crews to pave up to 6-inches or more in one lift. It is believed the oil will make the asphalt pavement stronger and last longer. Being able to pave the full depth in one lift will cut paving time by as much as one-half, reducing construction impacts on the traveling public.

The pavement, when placed in a thick lift, takes longer to cool down and the temperature needs to be monitored prior to opening to traffic. This may allow us to pave this HMA after our normal construction season ends.

The test on this new paving method is being conducted at UDOT's Wendover Port of Entry. "It's a pretty harsh environment for pavement out there," said Howard Anderson, our State Asphalt Engineer, who has been working on this experiment for some time.

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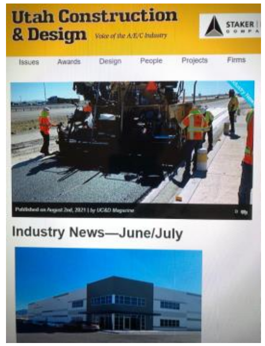

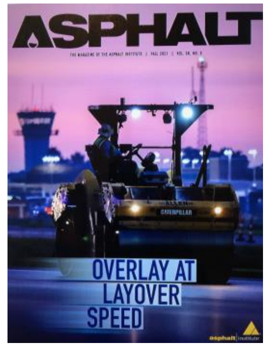

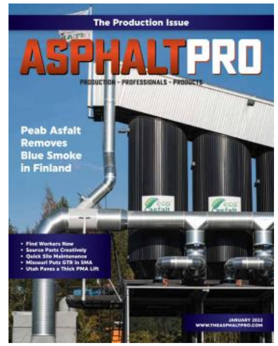

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The POE Weigh Scales have been rebuilt

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- This picture and the following were taken June 23, 2022.
- Surface is dirty with PCC dust. No visible distress, or cracking or rutting.

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The POE Weigh Scales have been rebuilt

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UDOT

40

The POE Weigh Scales have been rebuilt

Cost Considerations:

- First project was $150 per ton. This is with a small quantity, long haul and an experimental feature.
- Expect costs to end up similar to SMA or less with experience.
  - The aggregate gradation is cheaper than SMA
  - Binder content is less than SMA, but more expensive
  - No mineral filler
  - No fibers to add
  - QC and QA testing is less than SMA
  - Production is higher
  - The cost for high polymer binder is expected to come down a little with experience

Other Benefits:

- UDOT and the Contractor also have time savings
  - One lift to pave, compact and test
  - Savings in traffic control costs
  - User costs are reduced
  - No tack coat needed
  - Stronger more durable pavement - density, binder grade, content
  - Real potential to expand paving season

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Further Discussion:

- Maintenance of Traffic:
  - Cool down time is expected to be one day longer
  - The edge will be thicker, protect from traffic
  - Shorter construction time may be safer for workers and public
- Smoothness
  - One less opportunity to improve the ride
  - A high density material can be ground
  - Can add surface coarse
- Higher volume of material to produce and truck

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PCCP Test Section on I-15

- This same mix (2216 tons) was placed on all 5 lanes of I-15 northbound near parish lane in early May of this year. Average density of 97.3%, Ave thickness of 2.97 inches. Ave binder 5.94%, Ave VMA 15.7
- This 3 inch lift was placed directly over very poor PCCP that had only crack sealing done prior to the overlay.
- The PG 76-34 low void mix was placed near also new 3 inch PG 64-34 Superpave mix (1347 tons) for comparison.
- We have excellent performance so far.

45

Future UDOT Usage

- PG 76-34 Low Void Mix
  - Multiple thin-lift installations around Salt Lake City, bids close this week. Bridge decks are being planned.
  - 13 mile project on SR 196 to I-80 just came in yesterday at $103/mix ton.
- Thick Lift, PG 76-34 Low Void Mix
  - Potential 6 inch lift placed on PCCP on I-15
  - I-15 Ramps and SR 6 Intersection

https://www.visitsaltlake.com/

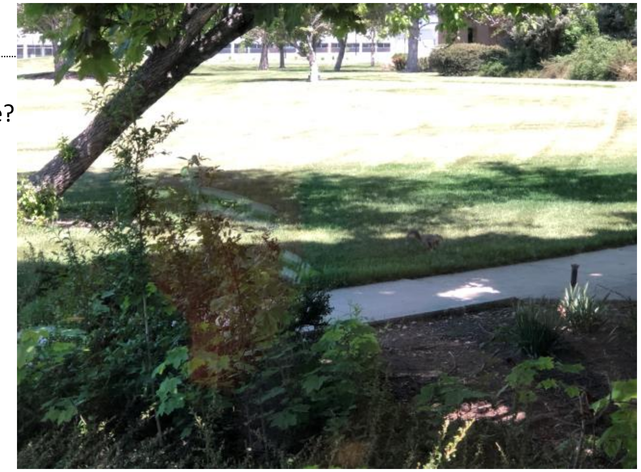
46

Acknowledgments

- Lonnie Marchant, Clinton Martin, Robert Stewart, Region 2
- Dave Johnson, Asphalt Institute
- Clark Allen, Dave Thomas, Mike Evans, Central Labs
- Reed Ryan, UAPA

47

What do you see?



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Questions or Comments:

asphalt institute

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UDOT STONE MATRIX ASPHALT (SMA) CONSTRUCTION AND PERFORMANCE

- History of SMA use in Utah
- Where we use SMA
- SMA Specification
- Important things to watch

1

HISTORY

First SMA project in 2003 on I-70 by Salina. Project was 4" Rotomill, 2.5" HMA, 1.5" SMA.

AADT 6558

42.72 % Trucks

Preservation:

Chip seal in 2013

Micro Surface planned 2025.

Ride 93

Fatigue Cracking 100

Rutting 76

Environmental Cracking 95

2

HISTORY

Since 2003 SMA has been used on all roads both high and low volume.

Right now 1455 miles 5047 surface areas of road top surface is SMA

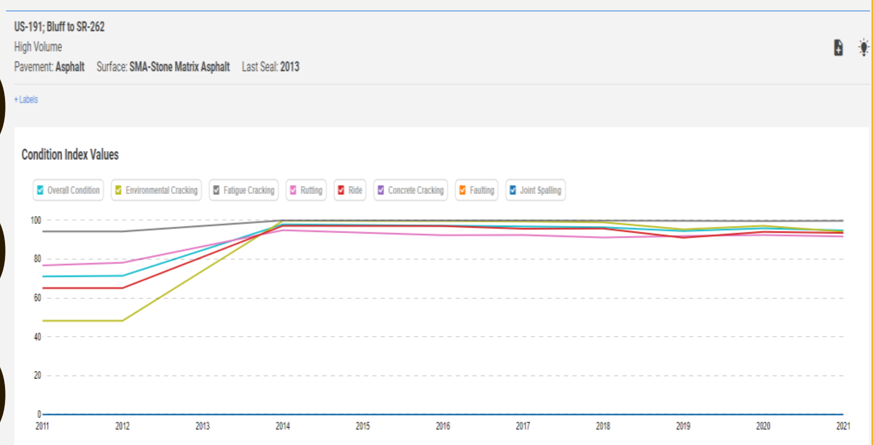
Does not include SMA sections that have been chipped, micro surfaced, or overlayed.

Average environmental cracking index 89

Average rutting index 88

3

Lane Level / 1.5" SMA overlay



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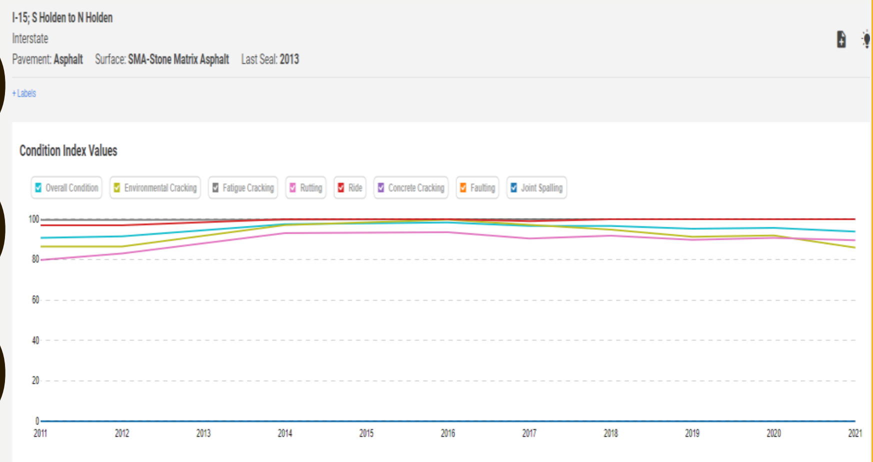
1.5" Rotomill / 1.5" SMA overlay



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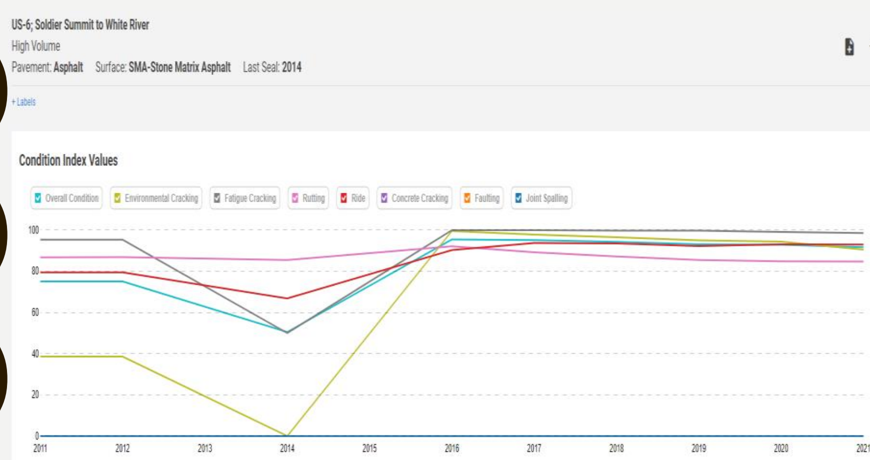
3" Rotomill / 1.5" HMA / 1.5" SMA overlay



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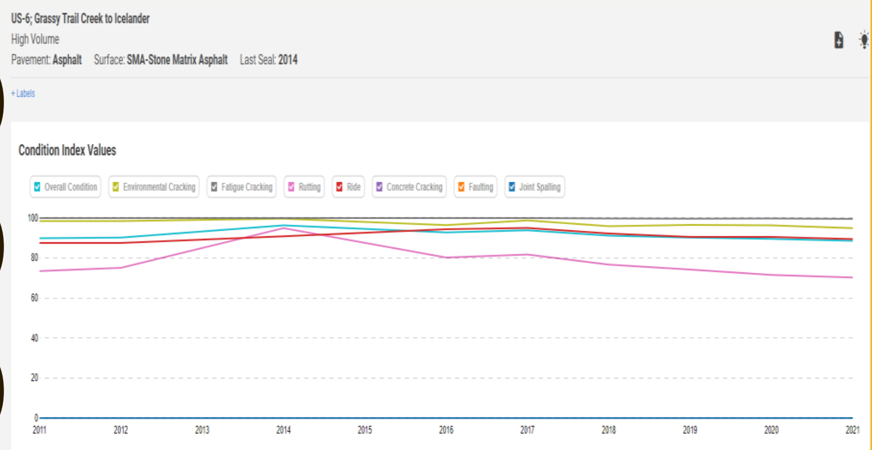
1.5” Rotomill / 1.5” SMA overlay



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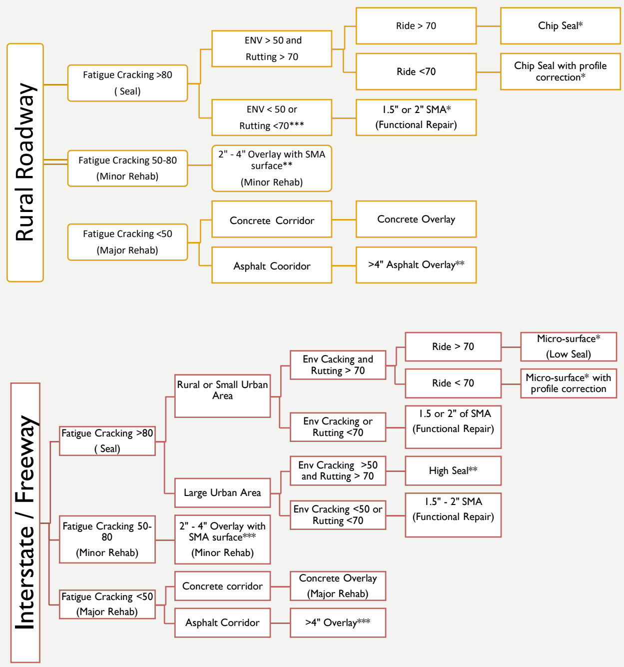
WHERE IS SMA USED

- Usually 1.5” to 2” thick for the wearing surface
- High Volume Roads
- Low Volume Roads
- Urban Roads
- Rural Roads
- Reconstruction Projects
- Preservation Projects
- To Help Solve Rutting Problems
- In Place of an HMA Chip Seal
- To Seal the Road
- To Slow Down Cracking Problems
- To Improve Friction

8



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SMA SPECIFICATION

02744S Stone Matrix Asphalt (SMA)

Has been adjusted several times

Last major change 2019

Changed to closer match the HMA specification

Fixed problems with low oil content

Now in the process of combining our HMA and SMA Materials Manual of Instruction

960 Volumetric Mix Design and Verification

962 Guidelines for Stone Matrix Asphalt (SMA) Mix Design and Verification

10

SPECIFICATION HIGHLIGHTS

Table 5	Aggregate Properties – SMA	
Test Method	Test No.	Specification
One Fractured Face	AASHTO T 335	100% minimum
Two Fractured Face	AASHTO T 335	90% minimum
Fine Aggregate Angularity	AASHTO T 304	45 minimum
Flakiness Index	UDOT MOI 933 (Based on 3/8 inch sieve and above)	17% maximum
L.A. Wear	AASHTO T 96	28% maximum
Sand Equivalent	AASHTO T 176 (Pre-wet method)	60 minimum
Plasticity Index (Does not apply to Mineral Filler)	AASHTO T 89 and T 90	0 maximum
Unit Weight	AASHTO T 19	75 lb/cu. ft. minimum
Polishing	AASHTO T 278 and T 279	31 min.
Soundness (sodium sulfate)	AASHTO T 104	10% maximum loss with five cycles
Clay Lumps and Friable Particles	AASHTO T 112	2% maximum
Natural Fines	N/A	0% maximum

Control Sieve Size	½ inch	$^3/_8$ inch
¾ inch	100	100
½ inch	90 - 100	100
$^3/_8$ inch	45 - 78	90 - 100
No. 4	20 - 28	26 - 50
No. 8	16 - 24	20 - 28
No. 16	13 - 21	13 - 21
No. 30	12 - 18	12 - 18
No. 50	12 - 15	12 - 15
No. 200	8 - 10	8 - 10

11

Table 9

SPECIFICATION HIGHLIGHTS

- Asphalt Binder PG 70-28
- Design Gyrations 75

Minimum Asphalt Binder Content	
Combined Aggregate Bulk Specific Gravity Including Lime G_{sb}	Minimum Asphalt Binder Content %*
2.375 - 2.424	6.8
2.425 - 2.474	6.7
2.475 - 2.524	6.6
2.525 - 2.574	6.5
2.575 - 2.624	6.3
2.625 - 2.674	6.2
2.675 - 2.724	6.1
> 2.724	6.0
* Percent of total mix.	

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Table 9

SPECIFICATION HIGHLIGHTS

Mix Design Requirements	
SMA design mixing and compaction temperatures	Provided by the approved mix design
Voids in Mineral Aggregate (VMA) AASHTO R 46, using G_{sb}. Equation based on percent of total mix.	17.5% minimum
Air voids at N_{design}	3.5%
Voids In Course Aggregate (Stone Matrix Asphalt Mix Design)	$VCA_{MIX} < VCA_{DRC}$
Hamburg Wheel Tracker	< 10.00 mm at 20,000 Cycles
Draindown (AASHTO T 305)	0.30 max.

- Additives / Stabilizers
- Hydrated Lime
- Stabilizing additive: Mineral Fiber or Cellulose Fiber
- Mineral Filler: Consists of finely divided mineral matter such as rock dust, slag dust, hydrated lime, hydraulic cement, fly ash, or other suitable mineral matter. Free flowing and free of lumps.

Table 7Sieve Size	Percent Passing
No. 30	100
No. 50	95 – 100
No. 200	55 – 100
No. 450	40 max.

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IMPORTANT THINGS TO WATCH

Oil content and VMA 17.5 minimum if they are not high then we have had cracking problems

Compaction target 94%, 9 ton minimum roller, stay close to the lay-down machine, full pneumatic tire rollers not permitted,

Joint compaction

Does not fix sub grade problems

Access and side road radius not ease but constructible

Added cost because of high oil and no RAP

High quality material equals high quality product

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UDOT STONE MATRIX ASPHALT (SMA) CONSTRUCTION AND PERFORMANCE
• Questions?

15

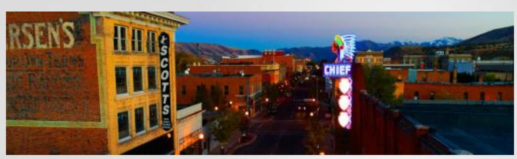
City of Pocatello

Pavement Management

1

OVERVIEW

- History
- Strategy
- Treatments
- Coordinated Efforts
- Outcomes



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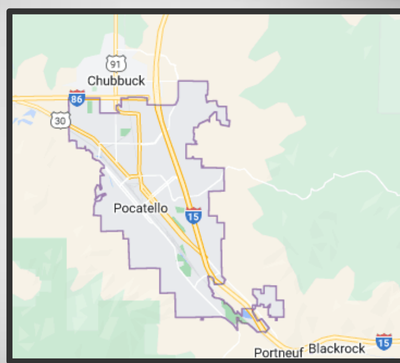
CITY OF POCATELLO DEMOGRAPHICS

- Population = 57,000
- Terrain – Hills and Valleys
- Hot Summers/Harsh Winters
- Maintain approximately 268 Centerline Miles



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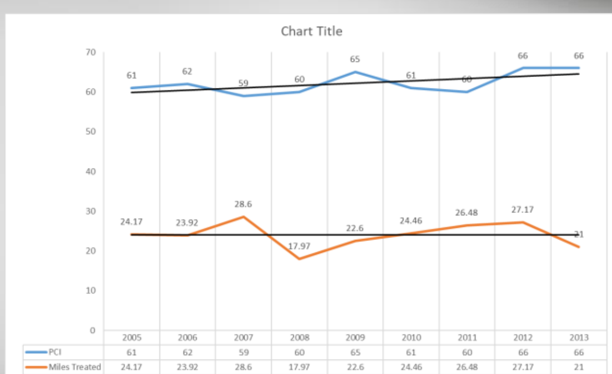
HISTORY OF PAVEMENT MANAGEMENT

- **2005 – 2013**
  - Annual Budget Allocation = $1,000,000
  - Limited Asset Management Plan
  - Subjective Analysis
  - Averaged 24 Miles Treated Per Year
    - Road treated every 11 years
  - Added 5 PCI points in 8 years
    - Averaged 0.63 PCI points per year



4

STRATEGY

- **Collect Objective Data**
  - Modern Technology
    - Takes human factors out of the equation
  - Windshield Survey Factors
    - Fatigue
    - Subjectivity
- **Develop a Plan**
  - Study Data
    - Current methodology was unreliable
    - Budget remained flat - from 2005-2022
      - $1,000,000 per year
    - Determined we need to increase our road miles treated
      - Target was to treat 35-40 miles per year
        - » Road need treated every 7 years
- **Implement a Plan**
  - How To Treat 10-15 More Miles Per Year With The Same Money
    - How Do We Do That?
      - Realized conventional thinking wasn't going to solve our problem
      - Determined we would have to get creative in our tactics and treatments

5

COLLECT OBJECTIVE DATA

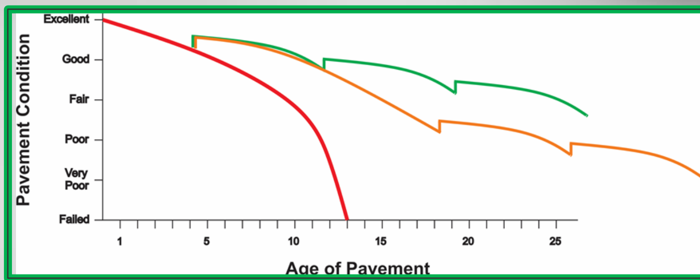
Pavement Condition Index	
100 - 86	Very Good
85 - 76	Good
75 - 56	Fair
55 - 41	Marginal
40 - 25	Poor
25 - 0	Very Poor

- **Asset Management Program**
  - Pavement Management Analysis
    - Performed by Third-party
      - Modern technology
      - PCI ratings
  - Perform Annual Modeling – EAM/Lucity
    - Strategic Parameters Set
      - Types of treatments
      - Budget allocations
        - » **%** based
        - » $$ based

6

DEVELOP A PLAN

- **Deterioration Graph**
  - Sometimes Its Difficult To Adhere To
    - Political influence
    - Complaints
- **Preventative Maintenance Is Key**
  - Keep Good Roads Good!
- **Kicking The Can Has Benefits**
  - Deplete every bit of life



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IMPLEMENTING THE PLAN

- **Invested In Manpower And Equipment**
  - Manpower
    - Hire qualified employees
    - Extensive operator training
  - Equipment
    - Asphalt Paver
    - Asphalt Cold Planer
    - Asphalt Distributor Truck
    - Oil Tanker

Old Ways

New Ways

8

PAVEMENT TREATMENTS
Preventative

- **Crack Seal**
  - Underutilized Treatment
  - When Utilized, Over-applied
  - Proper Techniques
    - Clean cracks
    - Proper temperature
      - Material
      - Ambient
  - Needs To Be Done Every Year

9

PAVEMENT TREATMENTS
Preventative

- **FOG SEAL**
  - Minimum Of 10% Of Budget Allocation
  - Most Under-rated Treatment
  - Research Good Products & Suppliers
    - Rejuvenators
    - Rejuvenators with latex
    - Seal-coats
  - Determine What Works Best In Your Area
  - 4 Years Of Life Extension
  - PCI Of 77 And Above

*Deplete Every Ounce Of Life Out Of Every Road
*Kicking The Can
*Forget About This Road For 4 Years And Move On To Others

10

PAVEMENT TREATMENTS
Restorative

- **Chip Seal**
  - Excellent treatment, cost prohibitive in urban environment
    - Sweeping
    - Flushing
    - Multiple closures
    - Moving vehicles
- **Micro Seal**
  - Game Changer
  - One-time closure
  - Added Fiber
- **Cape Seal**
  - Chip/Micro

⟺

- **PREPPING**
  - Scrub Patch
    - Improve IRI
  - Correct drainage
    - Keep base dry
  - Repair Base Failures
    - Replace base and patch back
  - Profile Mill
    - Grade averaging
  - ADA Ramps

*Deplete Every Ounce Of Life Out Of Every Road
*Kicking The Can
*Forget About This Road For 4-5 Years And Move On To Others

11

PAVEMENT TREATMENTS
Restorative

- **Thin Overlay**
  - Profile Mill 1/10th of Asphalt, Reapply 1/10th of Asphalt
  - ½' Aggregate Asphalt
  - Correct Data Imperative
  - Base Defects Are Usually Visual
    - Proof roll with pneumatic
    - Repair base failure
    - Correct Drainage
- **Thick Overlay**
  - Profile Mill 2-3"
  - ½" To ¾" Aggregate, Depending On Traffic Volumes
  - Proof Roll With Pneumatic Roller
  - Repair Base Failures
  - Correct Drainage
  - Reapply 2-3"

*Have Depleted Every Ounce Of Life Out Of The Road
*We Are No Longer Kicking The Can

12

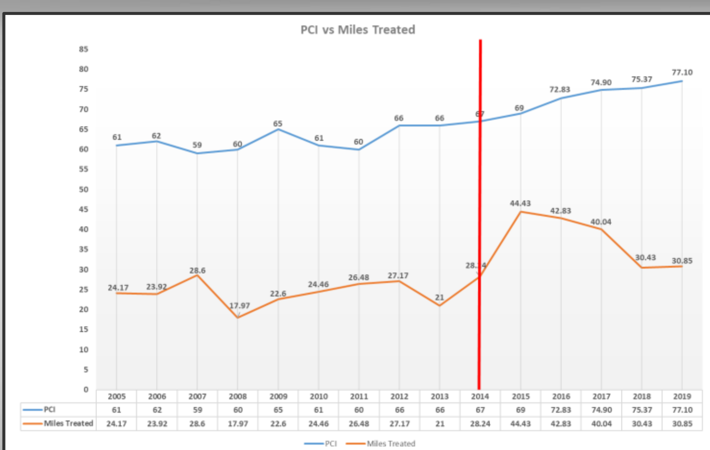
COORDINATED EFFORTS

- Coordinate Pavement Management Data With Local Utilities Data
  - Pavement Model Vs. Water Dept. Replacement Plan
    - Determine cost sharing between departments
  - Pavement Model vs. Other Utilities
    - Utility Coordination Committee
      - Meet monthly
      - Change plans as needed

*Street Department Gets A New Road
*Utility Department Gets A Budget-friendly Pave Job

13

OUTCOMES

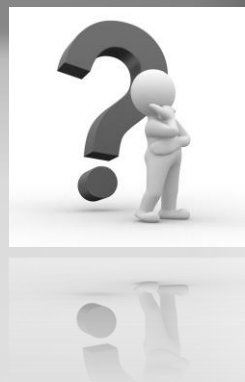


	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
PCI	61	62	59	60	65	61	60	66	66	67	69	72.83	74.90	75.37	77.10
Miles Treated	24.17	23.92	28.6	17.97	22.6	24.46	26.48	27.17	21	28.24	44.43	42.83	40.04	30.43	30.85

- **2014 – 2019**
  - Annual Budget Allocation = $1,000,000
    - Do more with less
  - Data Driven Strategies
    - Accurate data
    - Keep good roads good!
    - 7 -Year Strategy – based on lane miles
  - Outcome
    - Road network condition 77.1
      - +10 PCI in 5 years
        - 2 PCI points per year

14

Questions?



15

Pulverization: The Montana Experience

Miles Yerger, PE

MONTANA
Department of Transportation

1

Topics

- Our Reasons
- Investigation Procedure
- Calculations
- Specifications
- Project Example

2

Guidelines for Nomination and Development of Pavement Projects

GUIDELINES FOR NOMINATION AND DEVELOPMENT OF PAVEMENT PROJECTS
(CORRECTIVE MAINTENANCE TO RECONSTRUCTION)

MONTANA DEPARTMENT OF TRANSPORTATION
MONTANA DIVISION, FEDERAL HIGHWAY ADMINISTRATION

Joint Agreement

This agreement constitutes a commitment by the Montana Department of Transportation (MDT) and the Montana Division of the Federal Highway Administration (FHWA) to provide guidelines to nominate and develop projects consistent with criteria for projects in different funding and roadway treatment categories. This agreement supplements the Department's geometric design standards in the categories of corrective maintenance, pavement preservation, minor and major rehabilitation, and reconstruction. It also establishes guidelines for federal aid participation. This agreement provides guidelines for all state maintenance, state construction, and federal aid projects. Projects that fall within the parameters of this agreement will be considered eligible for federal aid by the Division. Projects that do not meet one or more of the parameters can still be considered for federal aid, but further review will be necessary in accordance with the Stewardship and Oversight Agreement on the National Highway System (NHS); by MDT on non-NHS routes (normally funded by the Surface Transportation Program (STP); or the project may be a state-funded project. All projects will receive the appropriate level of environmental documentation as required by NEPA and MEPA.

Mike Tooley
Director
Montana Department of Transportation

Kevin McLaury
Division Administrator
Federal Highway Administration

Barb Skelton
Chair
Montana Transportation Commission

12/14/17
Date

MONTANA MDT DEPARTMENT OF TRANSPORTATION

U.S. Department of Transportation Federal Highway Administration

3

Major Rehabilitation

Major Rehabilitation
Major rehabilitation improves pavement structure, typically exposing base gravel. These projects may include grading and/or widening. The intent of these projects is to rehabilitate the existing pavement structure through an engineered approach that considers the observed pavement distress, the in-place material, and roadway geometrics. Milling operations may expose base gravel which can then be treated or modified. New right-of-way and utility relocation may be required to improve geometrics, to flatten slopes and enhance safety. Reconstruction work should be limited to less than 25% of the project length.

Appropriate soil survey work, subsurface analysis, traffic data and crash data must be collected. The preliminary surfacing recommendation for a 20-year design life will be used. The data collection and engineering required to determine the level of rehabilitation should take six to nine months. Additional development time for a major rehabilitation should be three to four years, given the probable inclusion of other features.

Major rehabilitation treatments include:

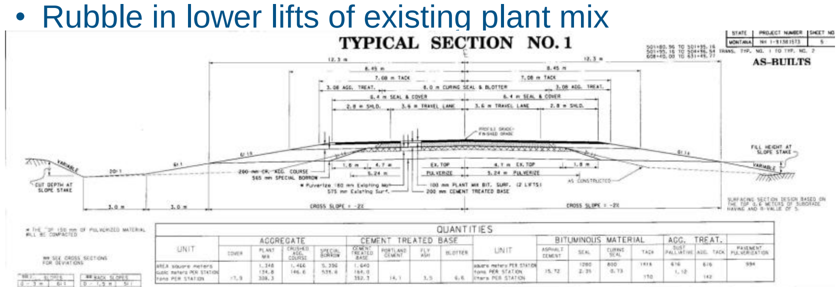
- Overlay > 0.3 ft
- Full depth reclamation
- Pulverize w/overlay
- Grading beyond the surfacing section and/or widening
- Exposure of base gravel
- CCPR > 0.3 ft
- Crack and seat w/overlay
- Concrete overlay unbonded or bonded

Hazard Mitigation:
A Safety Engineering review or crash analysis is required. Safety Engineering crash analysis recommendations should be included with the project. Crash analysis recommendations that are not included should be documented in the Scope of Work report with supporting justification. Features to mitigate correctable hazards identified by the design team may be included. Consider project scope, schedule, cost-effectiveness and benefit-cost when evaluating hazard mitigation features.

4

Reasons for Pulverization

- Recycling/aggregate availability
- Increased Material Costs
- Reduction in Fuel usage when compared to reconstruction
- Allows for use of CTPB when necessary
- Rubble in lower lifts of existing plant mix



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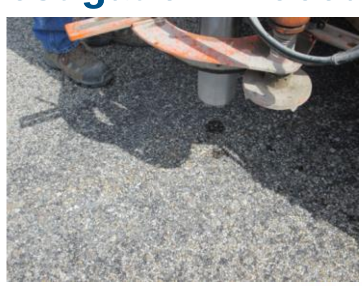
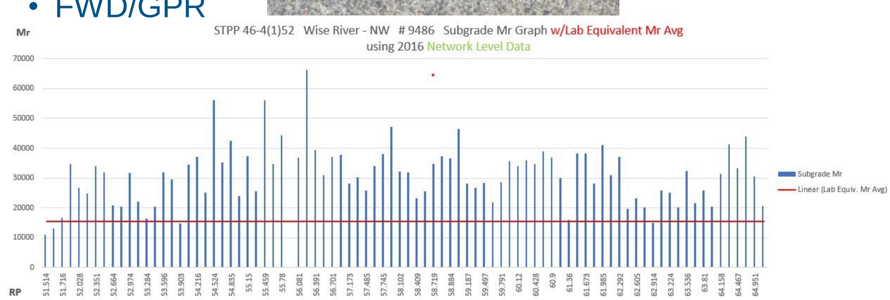
Investigation Procedure

- Traffic
- Distress
- Coring
- DCP
- FWD/GPR





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Calculations

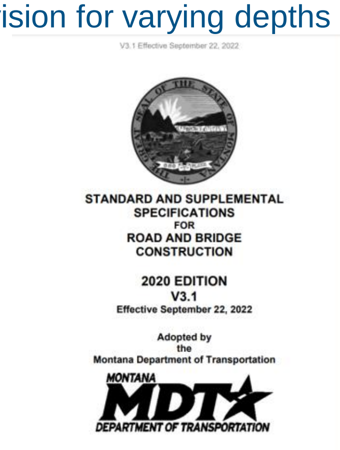
- AASHTO 93
- Calculation spreadsheets

Virgin Materials	Coefficient per in.	Existing Materials	Coefficient per in.
PMS (All Grades)	0.41	PMS (All Grades)[2]	0.20 - 0.33
Crushed Aggregate Course (CAC)	0.14	Crushed Aggregate Course (CAC)	0.12
PMS / CAC Mixture (pulverized, pugmilled, or mixed in-place)	0.12	PMS / CAC Mixture (pulverized, pugmilled, or mixed in-place)	0.12
Cement Treated Base (CTB)	0.20	Cement Treated Base (CTB)	0.18 #
CTB Pulverized	0.16	CTB Pulverized	0.14 #
Cold Recycled Asphalt (CIR)/(CCPR)	0.30	Cold Recycled Asphalt (CIR)/(CCPR)	0.20
Subbase Material[1]	0.07 - 0.10	Special Borrow	0.07

7

Specifications

- Section 302 and 304 of the Standard Specifications
- Special Provision for varying depths along project


V3.1 Effective September 22, 2022

STANDARD AND SUPPLEMENTAL SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION

2020 EDITION
V3.1
Effective September 22, 2022

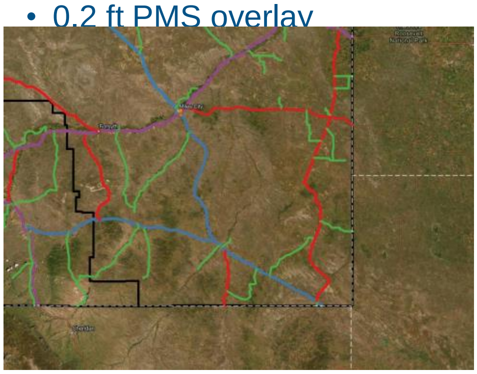
Adopted by the Montana Department of Transportation

MONTANA MDT DEPARTMENT OF TRANSPORTATION

8

Project Example

- P-323 between RP 50.82 and RP 69.03
- "Emergency Project" administered by Maintenance
- 0.2 ft mill, 0.6 ft pulverization with 6% cement
- 0.2 ft PMS overlay



Questions?

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MONTANA
Department of Transportation

@montanadot @mtdot YouTube /montanadot @mdtroadreport

Compaction of Asphalt Mixtures, State of Practice

Dave Johnson, P.E.
Senior Reginal Engineer, Asphalt Institute
Billings, Montana

1

Importance of Compaction

"Compaction is the single most important factor that affects pavement performance in terms of durability, fatigue life, resistance to deformation, strength and moisture damage." – C. S. Hughes, NCHRP Synthesis 152, *Compaction of Asphalt Pavement*, (1989)

"The amount of air voids in an asphalt mixture is probably the single most important factor that affects performance throughout the life of an asphalt pavement. The voids are primarily controlled by asphalt content, compactive effort during construction, and additional compaction under traffic." – E. R. Brown, NCAT Report No. 90-03, *Density of Asphalt Concrete—How Much is Needed?* (1990)

2

Introduction to Compaction

asphalt institute

- Compaction is the final step in the construction process of an asphalt pavement
- Compaction is the process by which the freshly placed asphalt mat is compressed (or densified) to reduce the in-place air voids in the mat.
- During the compaction process, aggregate particles in the mat are reoriented closer together and locked into place to provide a strong skeleton for the asphalt mixture with increased shear strength providing resistance to permanent deformation (rutting) and cracking.

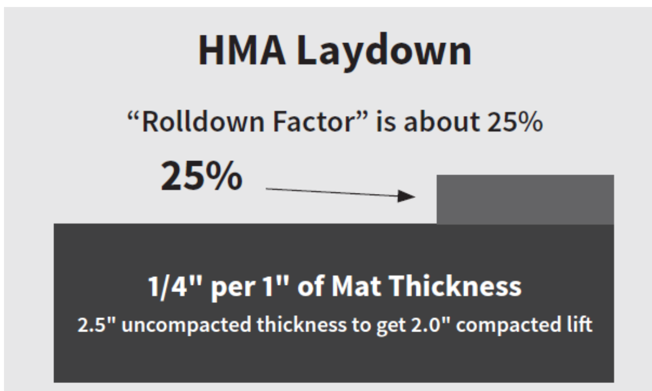
MS-22
Section 9.1

3

Introduction to Compaction

asphalt institute

- The primary goals of the compaction process are to:
  - consolidate the mat
  - increase in-place density, which reduces in-place air voids
  - smooth out the asphalt pavement



Going forward, we will use the terms **density** and **air voids**. It is understood that we are referring to in-place density and in-place air voids

MS-22
Figure 8.23

4

Current Technologies that Influence Compaction…

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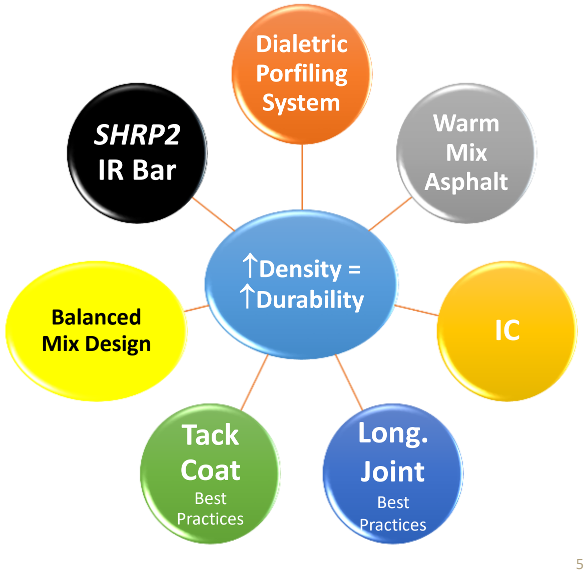

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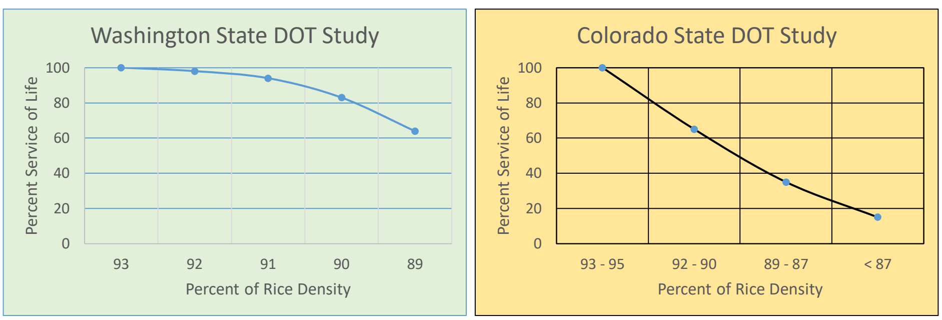
Density vs. Loss of Pavement Service Life

asphalt institute



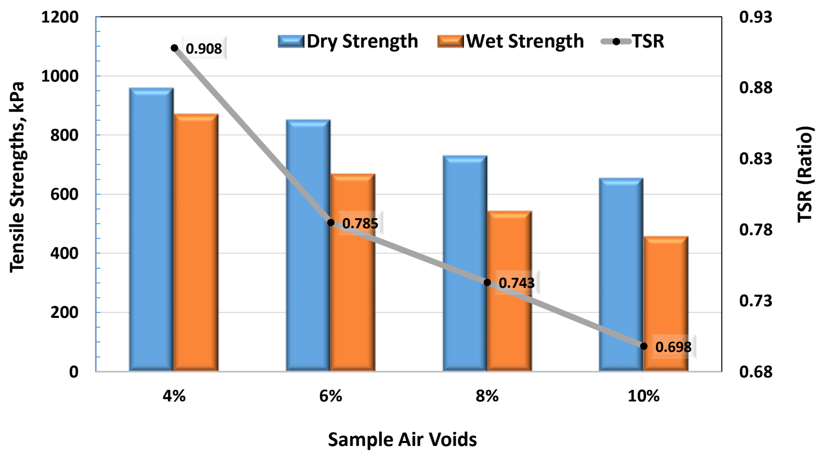
Thicker Pavements — TRR 1217, 1989

Typical Pavements — CDOT 2013-4, 2013

For both thicker and thinner, reduced in-place density at the time of construction results in significant loss of Service Life!

6

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



7

Asphalt Institute Research

7

NCAT Report 16-02 (2016)

Literature Review on connecting in-place density to performance

- 5 studies cited for fatigue life
- 7 studies cited for rutting
- “A **1% decrease in air voids** was estimated to improve the fatigue performance of asphalt pavements between 8.2 and 43.8%, to improve the rutting resistance by 7.3 to 66.3%, and to **extend the service life by conservatively 10%**.”

8

Research on Critical Air Void Level for Impermeability

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"…to ensure that permeability is not a problem, the in-place air voids should be between 6 and 7 percent or lower. This appears to be true for a wide range of mixtures regardless of NMAS and grading." – NCHRP 531

9

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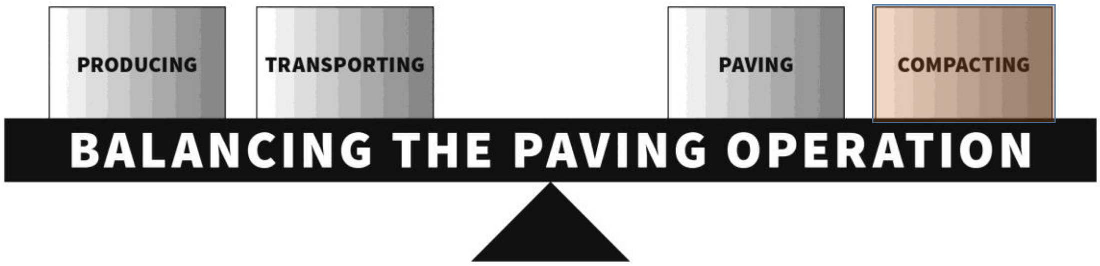
Getting Compaction

10



What is a balanced paving operation?

The synchronized balance of the four phases of asphalt paving to provide continuous paving operations. The four phases are mixture production, mixture hauling, paving operations, and compaction.

11

Factors in Affecting Compaction

- Base Condition
- Lift Thickness vs. NMAS
- Laydown Temperature
- Ambient Conditions
- Cooling Rates
- Balancing Production Through Compaction
- Paver Operations

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General Mechanics of Compaction

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- The mechanics of compaction involve three main forces that can have a major impact on the compaction process:
  - Compressive force of the rollers
  - Resistive forces within the mixture
  - Supporting forces exerted by the stable surface below the mat (subgrade, aggregate base or the existing pavement)
- Optimum conditions for compaction of the asphalt mat will be achieved when:
  - Asphalt mat is stable enough at compaction temperatures to be densified without excessive movement
  - Underlying materials adequately support the compactive forces being applied by the rollers

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Importance of Underlying Support

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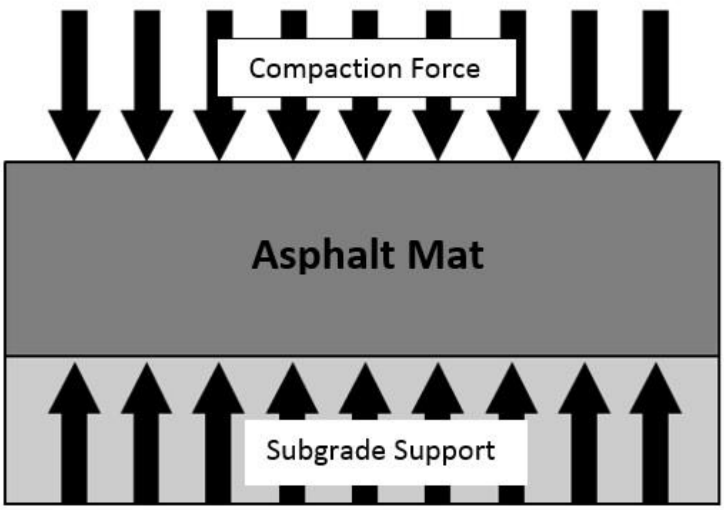

MS-22
Figure 9.2

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Subgrade & Base Support

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

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Lift Thickness' Effect on Compaction

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- Aggregates need room to densify
- Too thin vs. NMAS leads to:
  - Roller bridging
  - Aggregate lockup
  - Aggregate breakage
  - **Compaction Difficulties**
- NCHRP Report 531 (2004)
  - Fine Graded Mix—**Minimum** Thickness = 3 X NMAS
  - Coarse Graded Mix—**Minimum** Thickness = 4 X NMAS
  - SMA Mix—**Minimum** Thickness = 4 X NMAS

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The Temperature Effect

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- Charles F. Parker (1959)
  - 275°F – standard temperature – reference air voids
  - 200°F – doubled the air voids
  - 150°F – quadrupled the air voids
- Kim A. Willoughby, et.al. (2001)
  - Mix temperature differentials
  - ≤ 25°F – generally consistent air voids
  - ≥ 25°F – greater air void spread
    - Pneumatic rollers reduced spread
    - End dumps showed a greater spread
- Robert Schmitt, et.al. (2009)
  - Most important factor in achieving density

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Mat Temperature

- Compacting asphalt in the correct temperature range is critically important
- Temperatures must be neither too hot nor too cold
- Optimum compaction temperatures vary depending on many factors
  - Start compaction: 310 – 280°F
  - Stop compaction: 180 – 175°F
  - WMA will lower these ranges depending on the technology

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Environmental Factors and Compaction

Several factors come into play regarding how fast the mix cools onsite, affecting time available for compaction:

- Ambient air temperature
- Temperature of the existing surface
- Wind speed
- Lift thickness
- Mix temperature
- Solar Radiation

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Material Cooling

- Thicker = More Time for Compaction
- Free tools for estimating compaction time
  - PaveCool—single lift (generation 1)
    - PC
    - iOs App
    - Google App
  - MultiCool—multiple lifts (generation 2)
    - PC
    - Google App
    - Mobile Web

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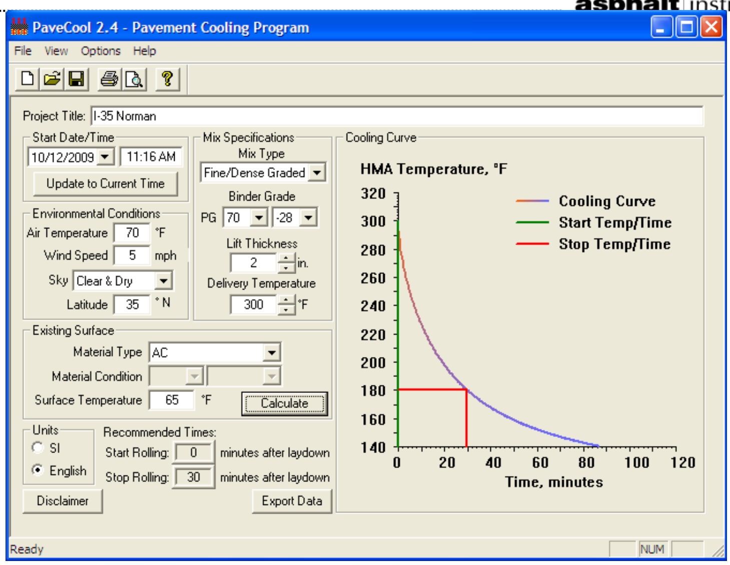
PaveCool Example

- Key Inputs
  - Temperature
    - Air
    - Base
    - Mix Delivery
  - Wind Speed
  - Lift Thickness



- Output
  - Cooling Curve
  - Estimated Compaction Time

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PaveCool Example

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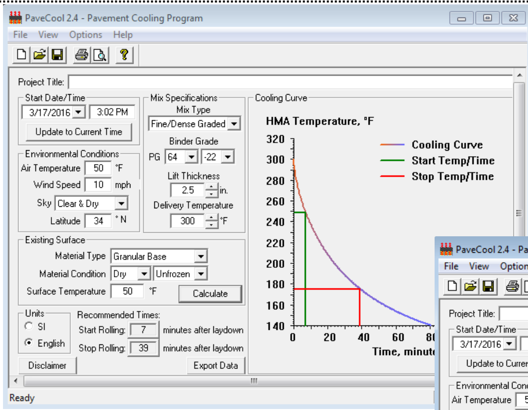
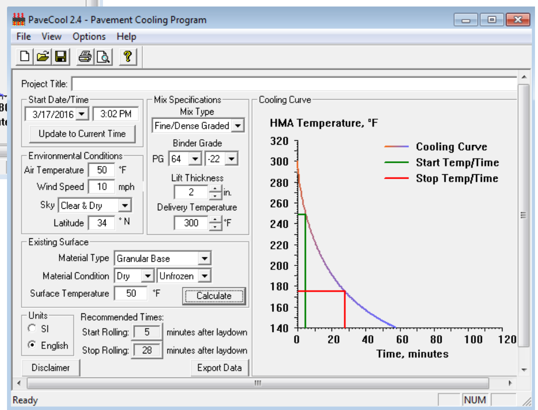


2.5 Inch Lift

50°F Air, Surface Temp

Mix Delivery temp - 300°F

39 minutes to complete compaction operations



2 Inch Lift

50°F Air, Surface Temp

Mix Delivery temp - 300°F

28 minutes to complete compaction operations

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Forces of Compaction and Roller Types

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Balanced Roller Vibration

- Optimum compaction occurs when all forces are accepted by the asphalt layer
- Balance between forces of compaction and the asphalt layer

Courtesy Caterpillar

25

Drum Bouncing

Courtesy Caterpillar

- **When using vibratory rollers:**
  - Forces out of balance create drum bounce
  - Inefficient operation
  - Solve bouncing:
    - - change speed
    - - lower amplitude
    - - higher frequency
    - - one drum static
    - - both drums static

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Roller Equipment

- Forces of Compaction
- Roller Type
  - Steel Drum
    - Static
    - Vibratory
  - Pneumatic
  - Newer Technology
    - Vibratory Pneumatic
    - Oscillatory Steel Drum

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Forces of Compaction

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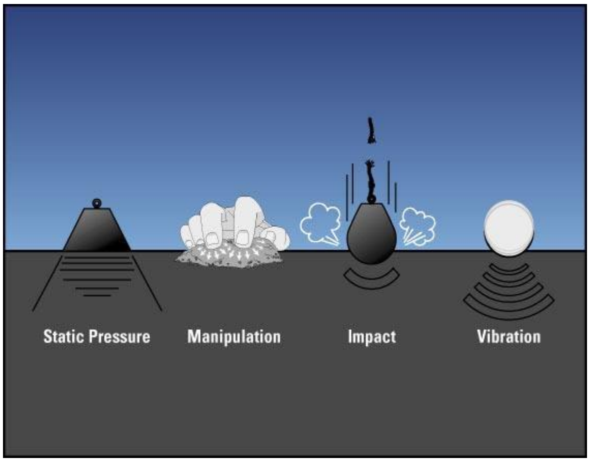

Compaction forces

- Low force
  - Static pressure
  - Manipulation
- Higher forces
  - Impact
  - Vibration

Effect of Roller Type, Size, Passes

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Roller type and size affects:

- Magnitude of the load
- Manner the load is imparted to the pavement

Number of passes:

- Increases the density
- To optimum point after a number of passes
  - Lowers compaction
  - If continued, damages mat

Roller Types

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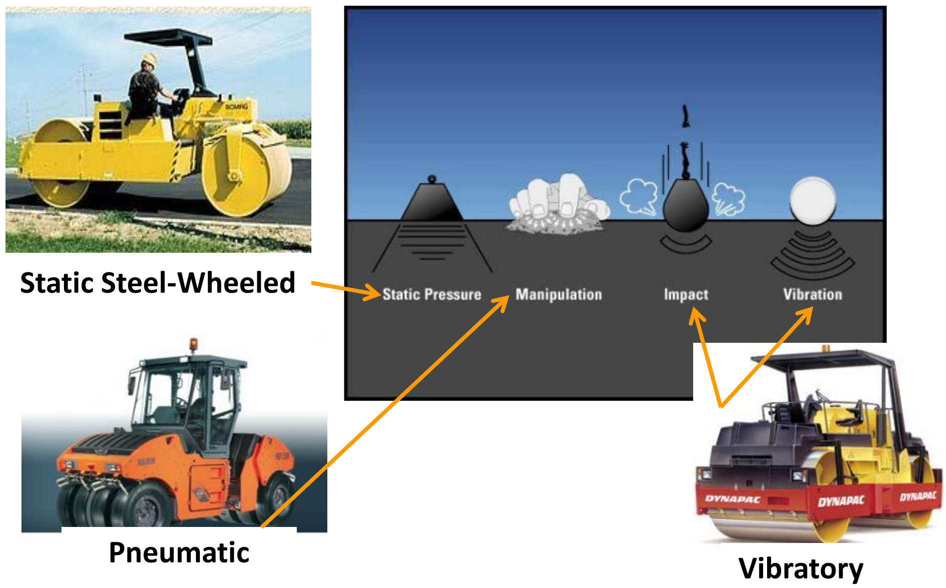

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Pneumatic Rollers

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- Reorients particles through kneading action
- Tire pressures:
  - ~80 psi (cold) for compaction
  - ~50 psi (cold) for finish rolling
  - Range of tire pressures not to exceed 10 psi
- Used as Intermediate or as Breakdown Roller
- Tires must be hot to avoid pickup
- Tires must be smooth - no tread
- Not used for PFC mixes or SMA

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Pneumatic Rubber Tired Rollers

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

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Vibratory Rollers

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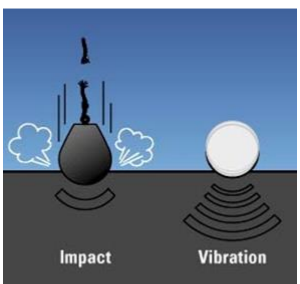

- Commonly used for initial (breakdown) rolling
- 8-18.5 tons, 57-84 in wide ("heavy" rollers)
  - 50-200 lbs/linear inch (PLI)
- Frequency: 2700-4200 impacts/min.
- Amplitude: 0.016-0.032 in.
  - For thin overlays (≤ 2 in.) use low amplitude or static mode
- Operate to attain at least 10 impacts/ft
  - 2-4 mph

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Drum Impacts per Foot

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Frequency	2 MPH	3 MPH	4 MPH	5 MPH
2000 vpm	11.36	7.58	5.68	4.55
2200 vpm	12.50	8.33	6.25	5.00
2400 vpm	13.64	9.09	6.82	5.45
2600 vpm	14.77	9.84	7.39	5.91
2800 vpm	15.91	10.61	7.95	6.36
3000 vpm	17.05	11.36	8.52	6.82
3200 vpm	18.18	12.12	9.09	7.27
3400 vpm	19.32	12.88	9.66	7.72
3600 vpm	20.45	13.64	10.22	8.18
3800 vpm	21.59	14.39	10.80	8.63
4000 vpm	22.72	15.16	11.36	9.10

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Other Compaction Technologies

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- In addition to the standard roller types, there are a number of innovative and new compaction technologies now available
  - Oscillatory rollers
  - Combination rollers
  - Vibratory pneumatic (rubber) tire rollers

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Oscillatory Rollers

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- Oscillatory rollers are typically equipped with an oscillating drum and vibratory drum
- The oscillatory drum generates Compactive force based on:
  - Weight of the roller
  - Tangential dynamic force from offset spinning eccentric weights
- Can be used effectively in both intermediate and breakdown
- Tangential Compactive force is desirable in scenarios where:
  - Vertical force is not practical
  - Compaction at lower cessation temperatures are desired

Courtesy Hamm Wirtgen

MS-22
Section 9.6.1

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Combination Rollers

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- Combination rollers are rollers that are equipped with both a steel drum and pneumatic (rubber) tires
- Advantages of “combi” rollers
  - Desirable qualities of both vibratory and rubber tire in a single roller
  - Provide rapid density increases from vibratory drum
  - Kneading action that both densifies mat and provides a tight finish from rubber tires

Courtesy Volvo

MS-22
Section 9.6.2

38

Vibratory Rubber Tire Rollers

- Vibratory pneumatic (rubber) tire rollers are rubber tire rollers that are equipped with vibration amplitude and frequency
- Advantages of vibratory rubber tire rollers
  - Advantages of both rubber tire and vibratory rollers in a single roller
  - Kneading action that densifies mat and provides a tight finish from rubber tires
  - Rapid density increases from dynamic forces generated by the vibratory drum
  - Avoid bridging at cold joints

Courtesy Sakai America

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Section 9.6.3

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Roller Operations & Roller Procedures

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Compaction Variables at the Roller

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- Roller Patters
  - Sequencing
  - Passes—A roller passing over one point in the may one time
  - Roller Speed
- Rolling Zone
- General Rolling Operations

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Traditional Roller Operations Sequencing

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- Breakdown Rolling
- Intermediate Rolling
- Finish Rolling

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Pattern Decisions

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- How many passes?
- How to be sure mix is rolled at correct temperature?
- How fast to roll?

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Establishing Breakdown Rolling Pattern

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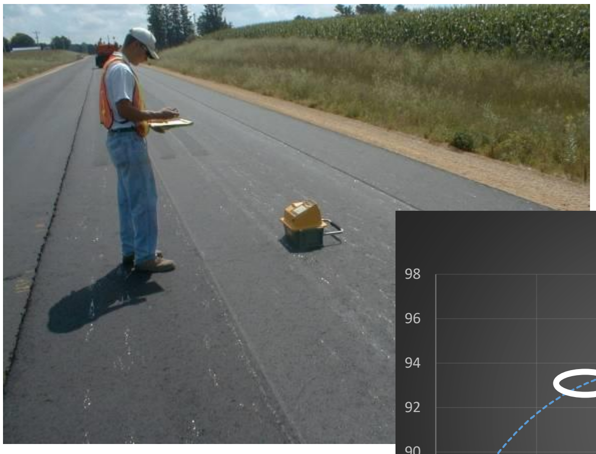
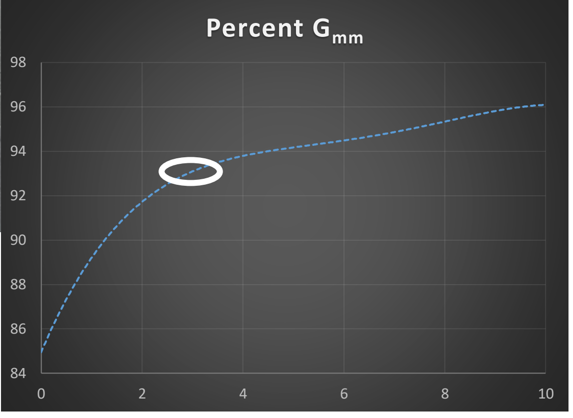


Goal: 93.5% G_{mm}



Select: 3 Passes (Intermediate will get the rest of the density)

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Rolling Pattern

- Speed and lap pattern for each roller
- Number of passes for each roller
  - One trip across a point on the mat
  - Set minimum temperature each roller finishes

IMPORTANT:

- Paver speed must not exceed compaction!!!
- Paver makes single pass
- Roller pattern requires 3-7 passes

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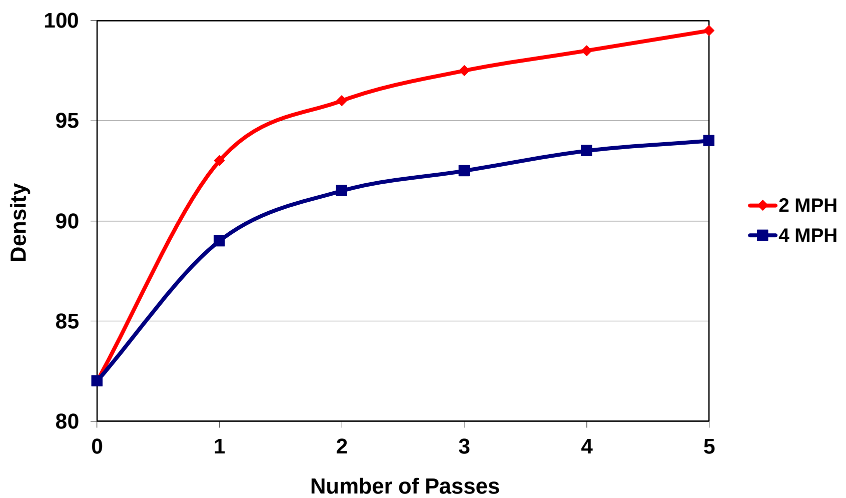
Roller Speed is Critical – **SPEED KILLS DENSITY!!**



Slower = More Compaction/Pass

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Breakdown Rolling

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- First roller behind paver
- Gets most of density
- Begin at highest temperature without huge mat distortion
- May have to work very close to paver for some mixes
- May be performed with two coordinated rollers

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Breakdown Rolling

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- Historically 3-wheel steel
- D/D vibratory most common
- Vibration most productive during breakdown
- Pneumatics
  - Used on base courses
  - Leveling courses
    - Forces mix into cracks
    - Compacts without bridging minor ruts
  - Can leave marks – may be harder to roll out

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Echelon Vibratory Rollers

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Intermediate Rolling

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- Final step in getting density and initial smoothness
- Mat hot enough to allow aggregate movement
- Mat already close to final density
- Too much force will fracture aggregate
- Typical roller type:
  - Traditionally pneumatic
  - Vibratory at low amplitude and/or static mode

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Pneumatic Roller

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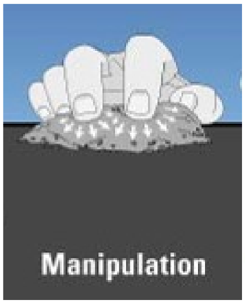

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Finish Rolling

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Main purpose
- Minimal compaction
- Smoothness
- Removal of any marks
- Once smooth, stop rolling

Typical roller types:
- Tandem steel-wheel
- Pneumatic w/lower pressure
- Vibratory static mode only

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General Rolling Procedures

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For best results

- Roll at highest temperature without excessive displacement
- Stay close to paver
- Monitor weather
- Keep up but not too fast
  - Slower paver speed
  - Not faster roller speed

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General Rolling Procedures

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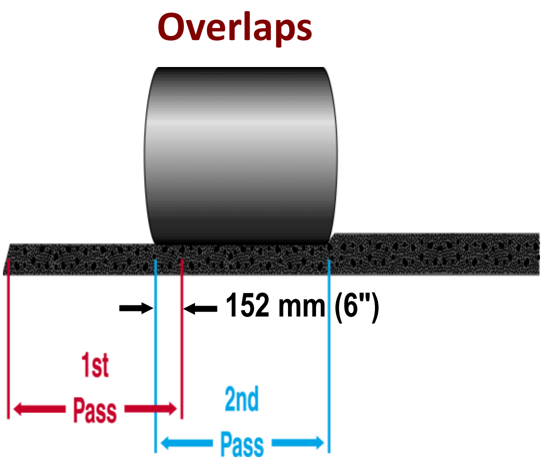

- 6” overlap assures uniform compaction
- Include overlap selecting drum width
- Roller should cover mat in no more than 3 passes

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General Rolling Procedures

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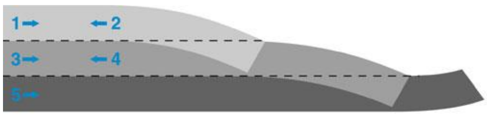

Reversing

Reversing Directions

- Avoid straight stops
- Turn toward center of mat
- Don’t turn drum while stopped
- Next pass should roll out any marks created by reversing

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Compact the Mat While It Is Hot!

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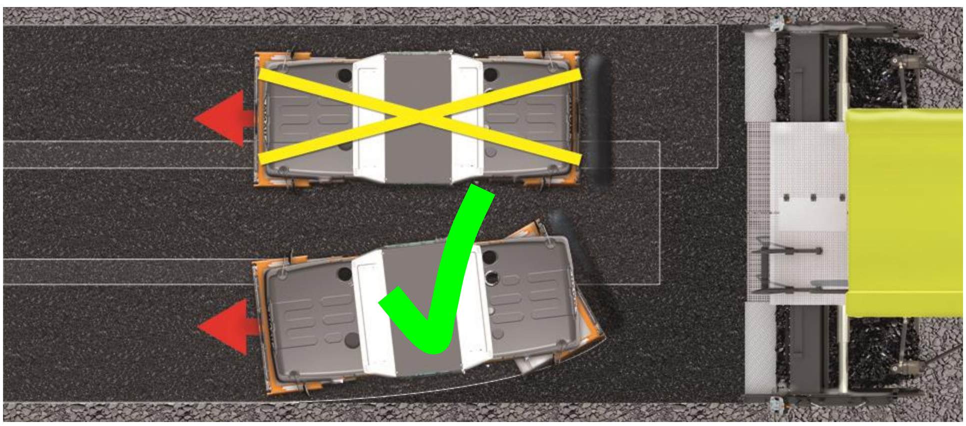

Stay Close to the Paver with Breakdown Rollers.

Always Stop and Reverse Directions at an Angle!

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General Rolling Procedures

"Birdbath" from roller stopping on hot mat

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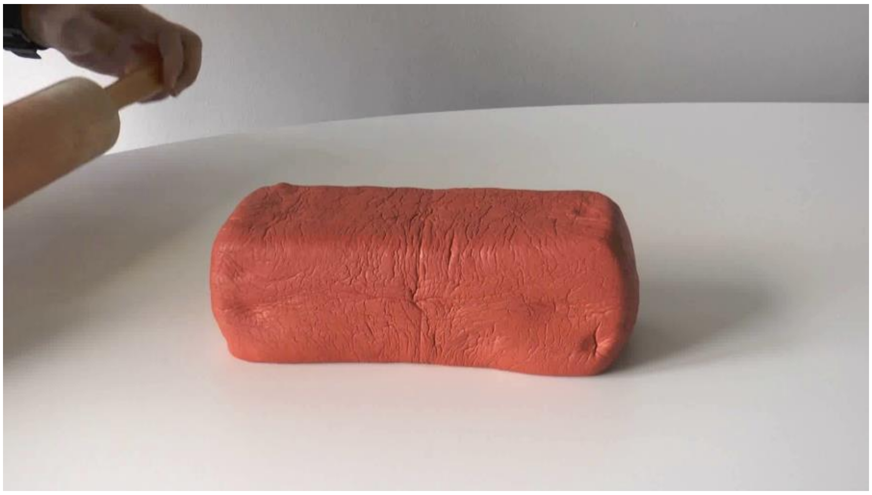
Why Rollers Need to Turn to Stop



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Summary of "Good Practice"

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- Compact mat when it is hot!
- Conduct a density control strip at the beginning of the project
  - Determine optimum roller pattern
  - Stick with roller pattern throughout project unless something changes in the conditions
- Reverse directions properly
  - Turn into stops
  - Do not turn while standing
- Do not stop roller on hot mat
- Use proper technique when compacting longitudinal joints

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Questions?

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JBAND®
The Bottom-Up Joint Solution

Improving HMA Pavements with a Void Reducing Asphalt Membrane

Timothy C. Zahrn, P.E.
Asphalt Materials, Inc.

Idaho Asphalt Conference
October 27, 2022

1

Topics to be Covered

- **Problem**: Longitudinal Joints Failures
- **Solution**: VRAM
  Void Reducing Asphalt Membrane
  - Intro and terminology
  - Concept and Performance History
  - Application
  - Special Provisions
  - Research
  - Idaho SH 55 Project
  - Three Pillars of Sustainability

2

3

How difficult is it to find pavements like these?

4 Improving HMA Pavements with a Void Reducing Asphalt Membrane

JBAND

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Rumble Strips / Corrugations

- Being used on an increasing basis for safety
- Placed in the weakest area of the pavement, centerline joint or outside edge of paving creating early failure
- Water settles in rumble strips

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Longitudinal Construction Joints

- **Issues**
  - Cannot achieve the same density at the joint as in the mat
  - Water and air intrusion due to permeability accelerates damage
- **Longitudinal construction joints**
  - Commonly, the first area requiring maintenance on a pavement

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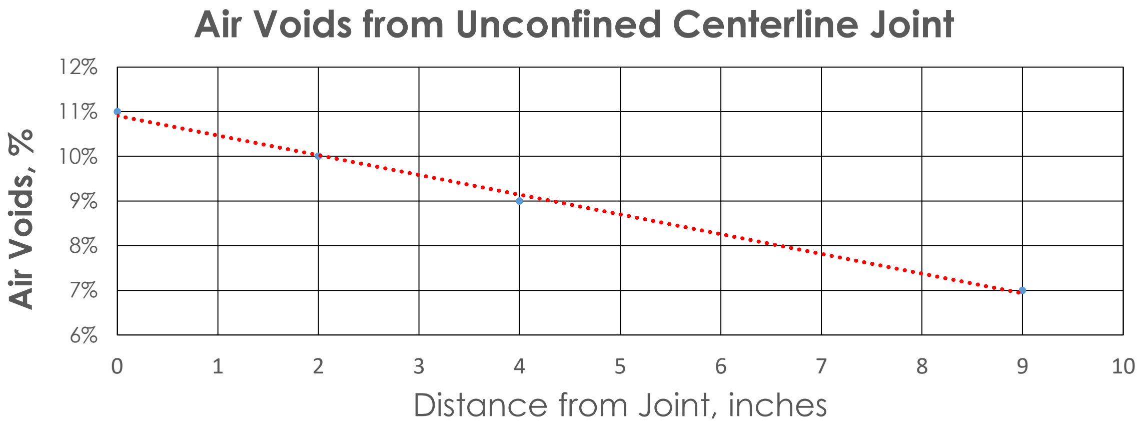
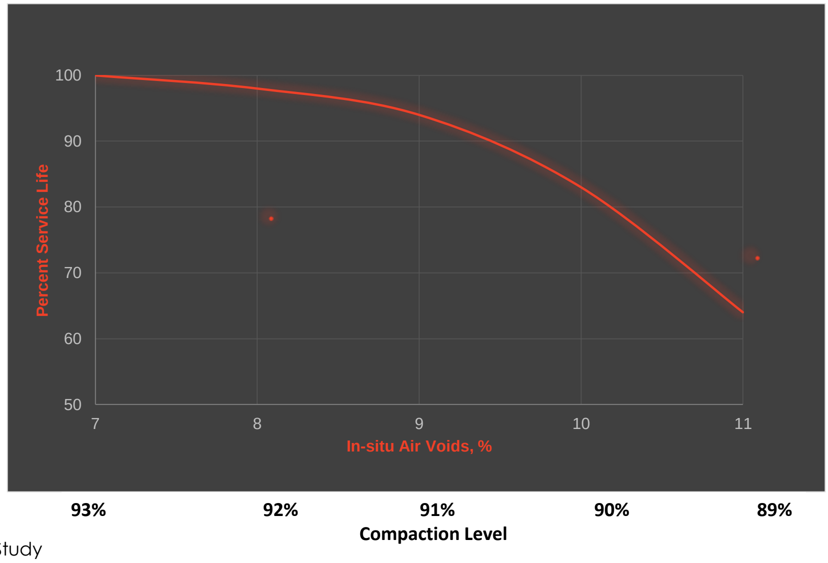
Air Voids from Joint Towards Center of Lane



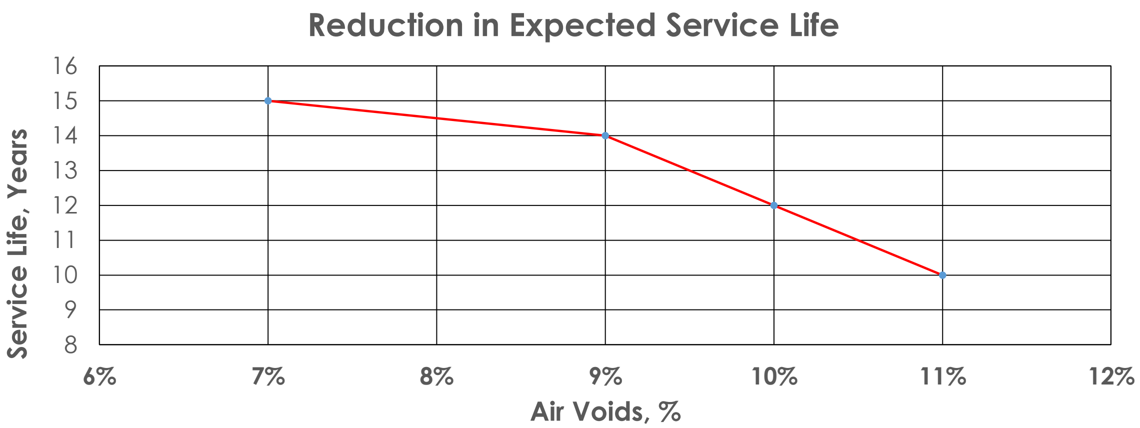
Centerline going towards interior of mat ⟶

Why do joints fail early?



*Washington State DOT Study
"Effect of In-Place Voids on Service Life"

Effect of Air Voids on Pavement Service Life



If the center of the mat is at 7% voids or less, but the joint is at 11% voids, the joint fails 5 years earlier than the rest of the pavement.

Longitudinal Construction Joints Traditional Methods

Mechanical methods to improve joint performance

- Joint density requirements (typically target voids at 4" from joint to within 2% of center mat voids)
- Echelon paving (hot joint)
- Joint heater
- Notched wedge joint
- Cut off lower density unconfined edge
- Mill and inlay (confined)

11

Terminology

V R A M
Void Reducing Asphalt Membrane

The Product Category

L J S
Longitudinal Joint Sealant
(Illinois Terminology)

Asphalt Materials, Inc.
Trade Name

J-Band®

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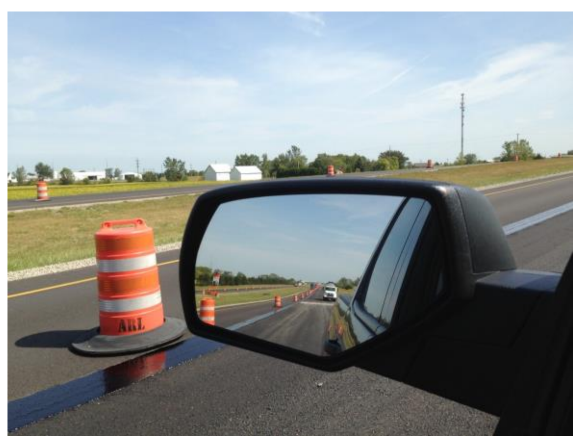
Longitudinal Joint Improvement Plan

- Early 2000's timeframe
- Illinois DOT recognized need for better joint performance
- Failure mechanism
  - **PERMEABILITY**
- **Concept:** Fill a portion of the voids with an asphalt product from bottom up, a Void Reducing Asphalt Membrane (**VRAM**)

LJS Performance History

- 9 IDOT LJS Experimental Test Sections Placed in 2002 – 2003
- Illinois DOT took cores for testing 3 of these in 2017
  - District 7 US-51 Elwin
  - District 1 US-50 Richton Park
  - District 2 IL-26 Cedarville



LJS Experimental Projects

IDOT US-51

CONTROL 15 YR OLD

VRAM SECTION 15 YR OLD

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LJS Experimental Projects

IDOT IL-50

CONTROL 14 YR OLD

VRAM SECTION 14 YR OLD

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LJS Experimental Projects

IDOT IL-26

CONTROL 14 YR OLD

VRAM SECTION 14 YR OLD

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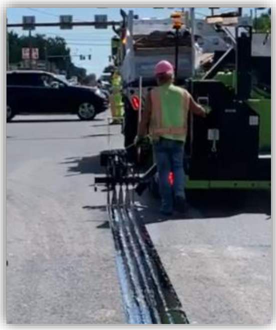
Void Reducing Asphalt Membrane (VRAM)

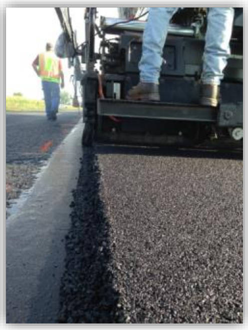
- Thick application of hot-applied, polymer-modified asphalt (~ 1 gal/sq yd for 1 ½” overlay)
- Application of an 18” band applied before paving in the location of the new longitudinal joint
- Fills voids and reduces water intrusion at joint from the bottom up
- Modifies the AC mix at the longitudinal joint
- Protects underlying pavement layers
- Materials approach to improving joint performance

VRAM Application



18” wide VRAM application or 9” wide mill and fill

Non-tracking < 30 min Based on cooling time



1st pass covering half VRAM width. Joint density testing not required within 1 ft from joint.

VRAM Application Methods

Placed by pressure distributor with mechanical agitation in tank

Manual strike off box fed from melting kettle

Tow behind melter applicator

Special Provision – Material properties

Test	Test Requirement	Test Method
Dynamic shear @ 88°C (unaged), G*/sin δ, kPa	1.00 min.	AASHTO T 315
Creep stiffness @ -18°C (unaged), Stiffness (S), MPa m-value	300 max. 0.300 min.	AASHTO T 313
Ash, %	1.0 – 4.0	AASHTO T 111
Elastic Recovery*, 100 mm elongation, cut immediately, 25°C, %	70 min.	ASTM D6084 Method A
Separation of Polymer, Difference in °C of the softening point (ring and ball)	3 max.	ASTM D7173

Special Provision – Rates by mix type and thickness

Coarse and fine-graded based on No. 8 sieve*

VRAM Application Table		
Coarse-Graded HMA Mixtures		
Overlay Thickness, in	**VRAM Width, in.**	**Application Rate, lb/ft**
1	18	1.15
1 ¼	18	1.31
1 ½	18	1.47
1 ¾	18	1.63
≥ 2	18	1.80
Fine-Graded HMA Mixtures		
Overlay Thickness, in	**VRAM Width, in.**	**Application Rate, lb/ft**
1	18	0.80
1 ¼	18	0.88
≥ 1 ½	18	0.95
SMA Mixtures/SuperPave 5 Mixtures		
Overlay Thickness, in	**VRAM Width, in.**	**Application Rate, lb/ft**
1 ½	18	1.26
1 ¾	18	1.38
≥ 2	18	1.51

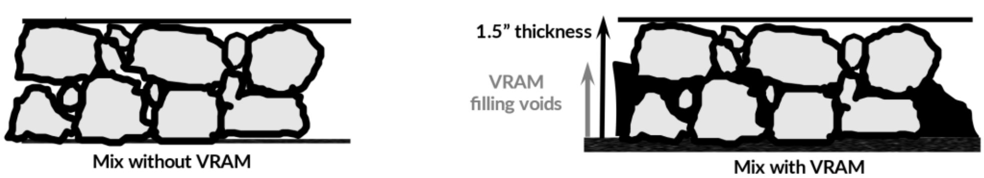
*No. 8 limits – 19-mm, 35% - 12.5-mm, 40% - 9.5-mm, 45%

Effect of VRAM on Voids and Asphalt at Joint

- The VRAM will migrate into the available air voids with heat and compaction
- Example HMA @ 6.0% AC, @ 1.5” thick/square yard = 9.9 lb of AC from mix
- VRAM @ 18” with VRAM weight per SY and total asphalt in joint area:

Mix type	VRAM rate, lb/ft	VRAM, lb/SY	Total asphalt in joint area, %
Coarse-graded	1.47	8.8	10.8
SMA/SP5	1.26	7.6	10.6
Fine-graded	0.95	5.7	9.6

- Finer mixes have less inter-connected voids than coarse-graded mixes



Cross Sectional View at Longitudinal Joint

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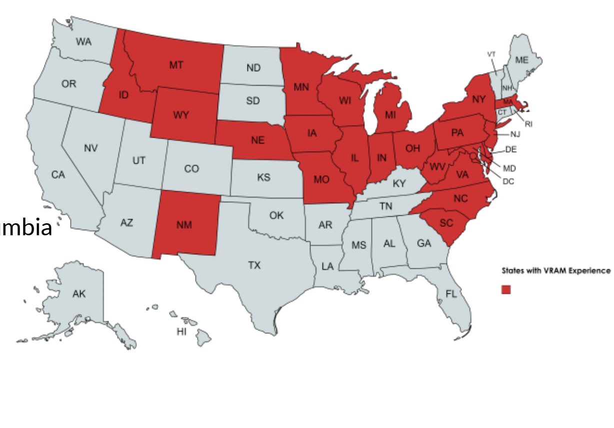
Current States* with VRAM Experience

- Illinois
- Indiana
- Ohio
- Iowa
- Michigan
- Missouri
- Wisconsin
- Minnesota
- Wyoming
- Montana
- Idaho
- New Jersey
- Pennsylvania
- Massachusetts
- Maryland
- Virginia
- Delaware
- South Carolina
- District of Columbia
- New York
- North Carolina
- West Virginia
- Nebraska
- New Mexico



Since 2002, VRAM has grown in popularity and is now found on roads across 23 states and the District of Columbia.

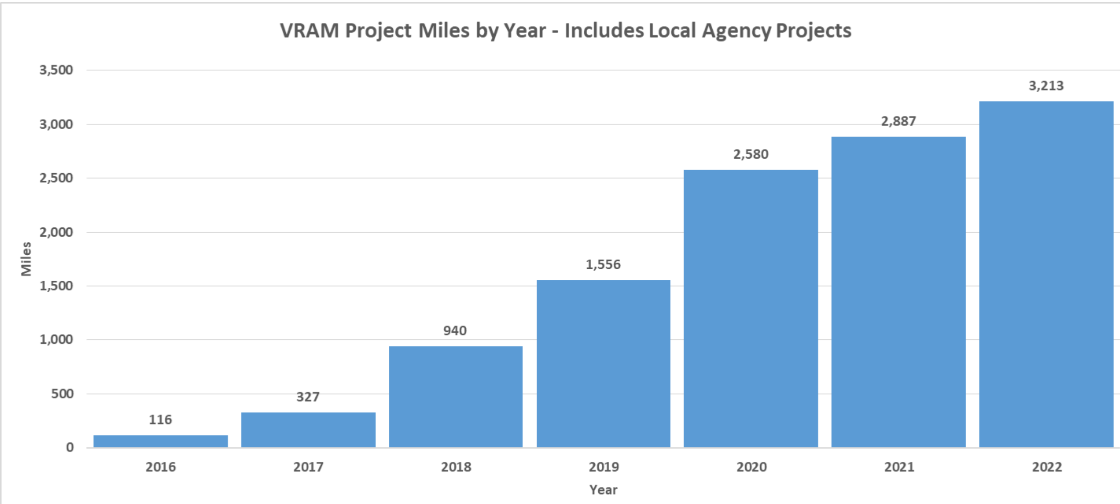
BAND

26 | Improving HMA Pavements with a Void Reducing Asphalt Membrane

26

Growth of VRAM

Snapshot taken August 2022



VRAM Performance History

9 IDOT VRAM experimental sections placed in **<u>2002 – 2003</u>** (oldest VRAM projects)

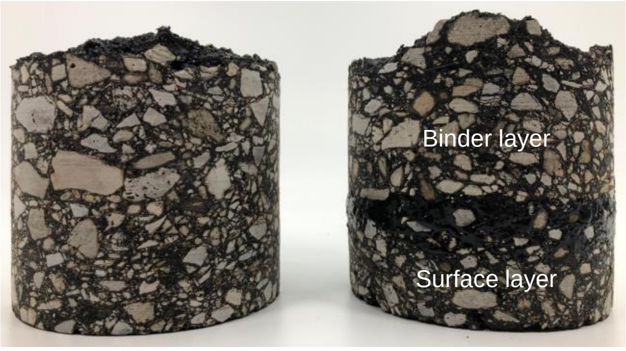
- IDOT research reports available
- Example - IL 50 Richton Park

VRAM

Control

IDOT Core Testing 14 Years After Service *(2017)*

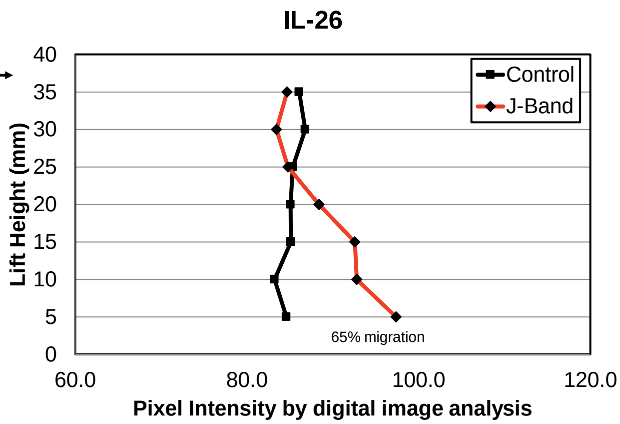
- Asphalt content
- Migration
- Laboratory permeability testing
- I-FIT flexibility index (FI) values



***Note**: No LJS on left, with LJS on right.*
Example, not from IDOT research sections.

IDOT core testing 14 years after service (2017)

- Asphalt content nearly double for VRAM cores
- Laboratory permeability testing (vertical flow)
  - Top half of all cores had nearly equal lab perm.
  - Bottom half
    - Control: 110 to 372 x 10^{-5} cm/sec
    - VRAM: zero
- I-FIT flexibility index (FI) values
  - Controls: 0.2 to 0.8
  - VRAM: 1.9 to 23
  - IDOT long-term aged lab FI ≥ 4.0



Testing VRAM & Control Conditions

- Comparing VRAM to a traditional method
  - Encouragement to have a control section on a VRAM project when first starting out
  - Annual performance review focusing on the joint area

Cores on or near the centerline joint

Good to Know	Must Know
Asphalt Content	Laboratory Permeability Testing (vertical flow)
Migration	Flexibility or Cracking Test

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mn DEPARTMENT OF TRANSPORTATION

Use of J-Band to Improve the Performance of the HMA Longitudinal Joint

Status: Complete
Report Date: 12/23/2020

Summary:

The density and air void content of asphalt mixtures affect the durability and performance of asphalt pavements. Pavement longitudinal joints typically have a lower density than the mat because they receive less compaction than the center section of the mat for various reasons. The higher air void percentages

- The use of VRAM reduces permeability and air void content, which reduces the intrusion of water into the pavement, indicating that good long-term pavement performance will be achieved
- Longitudinal cracking at the joints will be delayed relative to the control sections

Final Deliverables:

- Report #2020-33

Related Materials:

Project Personnel:
Principal Investigator: Christopher Williams
Co-Principal Investigator: Joseph Podolsky
Technical Liaison: Eddie Johnson
Project Coordinator: Elizabeth Klemann

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33

Idaho SH 55, July 2019

- Contractor: Idaho Materials & Construction
- Applied by Western States Asphalt
- 5,280-foot demo project West of Marsing in Owyhee County, ID, starting 500 ft. east of US-95 to 500 ft. east of Edison Road
- Planned application at 18” wide and 0.95 lb/ft (±10%) for the 3” fine graded surface course.
- West half from 500 ft. east of US-95 to 2,640 east has VRAM, east half control

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Idaho SH 55

35 Improving HMA Pavements with a Void Reducing Asphalt Membrane

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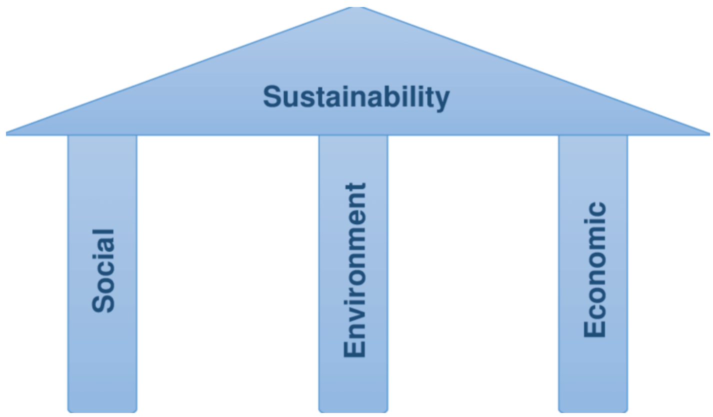
VRAM - Pillars of Sustainability



- ***Achieve Engineering goals while achieving Sustainability goals***

VRAM/J-Band - Environmental Pillar

- AMI partnered with ClimeCo to study the sustainability of J-Band
- ClimeCo is a sustainability, climate change, and environmental commodities firm
- Goal: Build on J-Band life-extension to quantify its sustainability benefits

What is a Life Cycle Assessment?

by: Gary Yoder and Jaskaran Sidhu | February 22, 2022

VRAM - Environmental Pillar

- GHG and air quality emissions estimated over the life cycle of the road: J-Band v. 3 alternatives
  - Longer life
  - Less maintenance
- Extraction, manufacturing, transport, application, and maintenance trips were quantified
- Quantified J-Band reduction in energy during construction and in maintenance compared to alternatives
- Final report is available on the ClimeCo Site
  - What is a Life Cycle Assessment
- To be presented at 2023 Transportation Research Board

What is a Life Cycle Assessment?

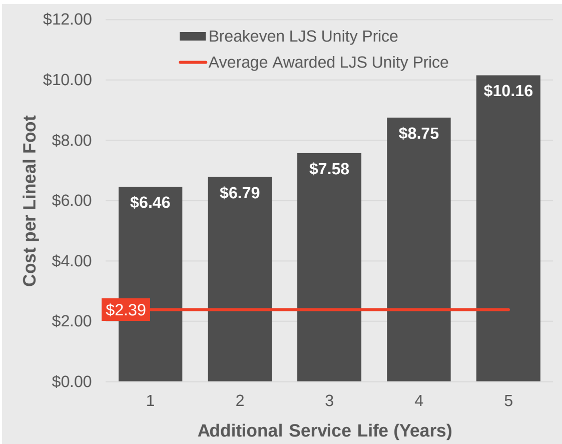
by: Gary Yoder and Jaskaran Sidhu | February 22, 2022

VRAM - Safety (Social) Pillar

- No density checks at the centerline during construction puts fewer workers at risk
- Rumble strips and distracted driving
- ClimeCo studied the reduction in maintenance for a road using J-Band, and calculated safety metrics
  - Far fewer injuries and fatalities using J-Band than alternatives in joint construction

VRAM - Economic Pillar

IDOT's ROI: 3-5 times the cost of LJS



IDOT VRAM Life Cycle Cost Analysis
2-lane roadway
15-year basis

IDOT expects VRAM to provide a life extension of 3-5 years

The benefit of this practice is 3-5 times the cost of the material, per IDOT

2021 TRB Paper Establishing Agency Value

Written with Illinois DOT – Accepted by Transportation Research Board

A Materials Approach to Improving Asphalt Pavement Longitudinal Joint Performance

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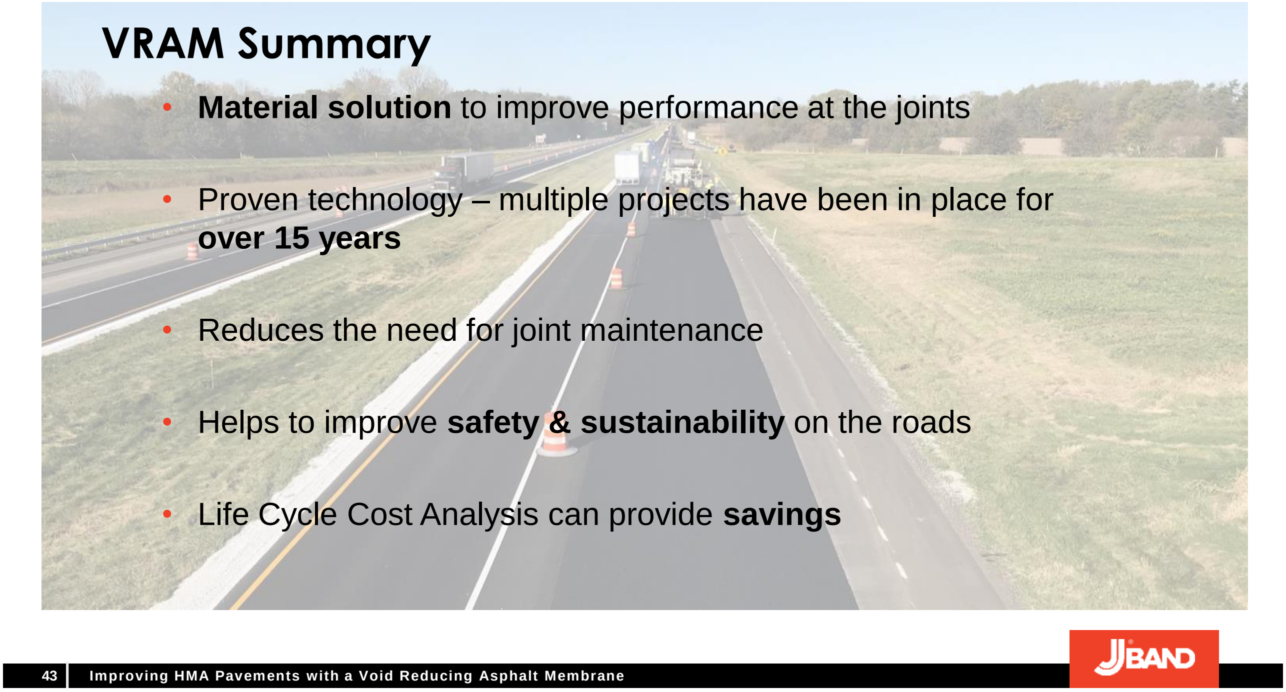
Word Count: 6327 words + 3 tables (250 words per table) = 7077 words

Submitted date July 29, 2020

ABSTRACT
Many states are looking for methods to improve longitudinal joint performance of their asphalt pavements since these joints often fail before the rest of the surface. With their inherently lower density, longitudinal joints fail by cracking, raveling and potholing because of the intrusion of air and water. Due to their longitudinal joint issues, and after trying several less-than-successful traditional solutions, the Illinois Department of Transportation (IDOT) developed a concept to seal the longitudinal joint region, but from the bottom up. Test sections were constructed in 2001 through 2003 to determine how a newly developed material, called longitudinal joint sealant (LJS), would improve joint performance. LJS is a highly-polymer-modified asphalt cement with fillers and is placed at the location of a longitudinal joint prior to paving. As mix is paved over it, the LJS melts and migrates up into voids in the low-density mix, making the mix impermeable to moisture while sealing the longitudinal joint itself. The IDOT test pavements were evaluated after twelve years and found to have longitudinal joints that exhibited significantly better performance than the control joint sections and were in similar or better condition than the rest of the pavement. Laboratory testing of cores showed decreased permeability and increased crack resistance of mix near joints with LJS as compared to similar mix without LJS. The life extension of the joint area is approximately three to five years, and the benefit is calculated to be three to five times the initial cost.
Keywords: Longitudinal joint, longitudinal joint sealant (LJS), void reducing asphalt membrane (VRAM)

TRB Paper is available upon request


VRAM Summary
• Material solution to improve performance at the joints
• Proven technology – multiple projects have been in place for over 15 years
• Reduces the need for joint maintenance
• Helps to improve safety & sustainability on the roads
• Life Cycle Cost Analysis can provide savings
43
Improving HMA Pavements with a Void Reducing Asphalt Membrane
JBAND

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Questions About VRAM?
For more information go to
https://www.thejointsolution.com
Tim Zahrn 217.494.3563
JBAND

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ASPHALT EMULSIONS:
NOMENCLATURE & WHAT MAKES THEM WORK

CODRIN DARANGA

PARAGON TECHNICAL SERVICES INC.

62ND ANNUAL IDAHO ASPHALT CONFERENCE OCTOBER 2022

1

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OVERVIEW

- What makes an emulsion?

2

OVERVIEW

- What makes an emulsion?
- What breaks an emulsion?

3

OVERVIEW

- What makes an emulsion?
- What breaks an emulsion?
- The answer to ALL your questions!

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OVERVIEW

- What makes an emulsion?
- Emulsion nomenclature
- Is rapid faster than quick?
- What breaks an emulsion?
- Break speed determining factors
- The answer to ALL your questions!
- Summary & conclusions

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EMULSIONS

Definition – *A suspension of small globules of one liquid dispersed in a second liquid with which the first will not mix*

- Consists of a dispersed phase and a continuous phase
  - Milk (fat in water)
  - Mayonnaise (fat in oil)
  - Butter (water in fat)

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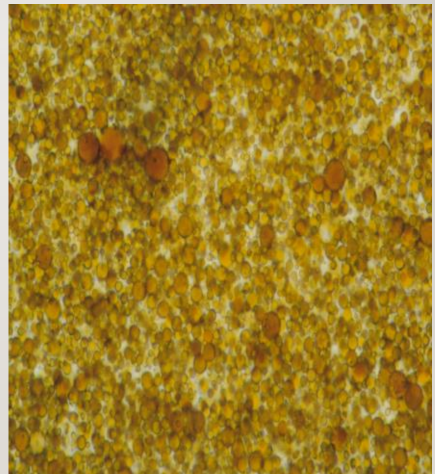
ASPHALT EMULSIONS

- A dispersion of asphalt in water
  - Water is the continuous phase
  - Asphalt is the non-continuous or dispersed phase



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•What makes an emulsion?

- **Necessary Components:**
  – Asphalt
  – Water
  – Surfactants – Emulsifying Agents
  – Mechanical Energy (Colloid Mill)
- **Other Common Components**
  – Additives
  – Modifiers or Polymers

8

WHAT MAKES AN EMULSION?

Emulsifiers, Surface active agents, or Surfactants

Definition--a substance capable of reducing the surface tension of a liquid in which it is dissolved

- Obviously, water and oil do not mix…
- Emulsifiers allow this to occur by altering the surface tension (hand soap)

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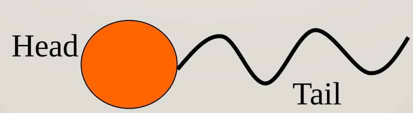
WHAT MAKES AN EMULSION?

Emulsifying Agents:

- Emulsifiers are chemical molecules that possess dual functionalities
  - Polar head, often electrically charged, which is hydrophilic, or "water loving"
  - Non-polar tail which is lipophillic, or "oil loving"



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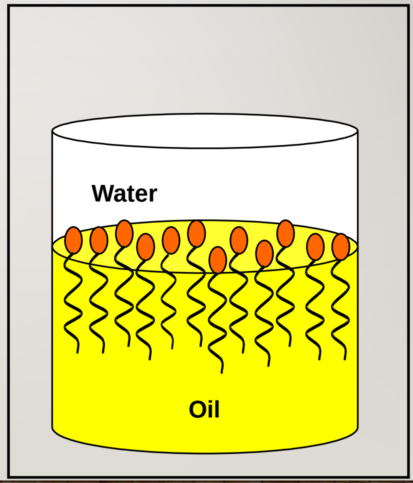
EMULSION COMPONENTS

Emulsifying Agents:

How do they Work?

- Emulsifier molecules adsorb at the interface between two liquids
- The head orientates towards more polar phase (water)
- The tail remains in the non-polar phase (oil)



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EMULSION COMPONENTS

Emulsifying Agents:

- As the key ingredient in suspending oil in water, emulsifiers greatly affect the performance and stability of the resulting emulsion
- The type of emulsion produced is controlled by the chemistry of the emulsifier
- Emulsifiers, and hence emulsions, are characterized by the head group of the molecule

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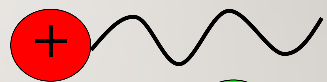
EMULSION COMPONENTS

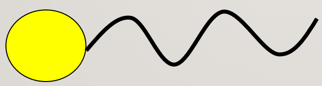
Emulsifying Agents:

- Cationic emulsifiers possess a positive charge on the head group



- Anionic emulsifiers possess a negative charge

- Nonionic emulsifiers do not possess a charge



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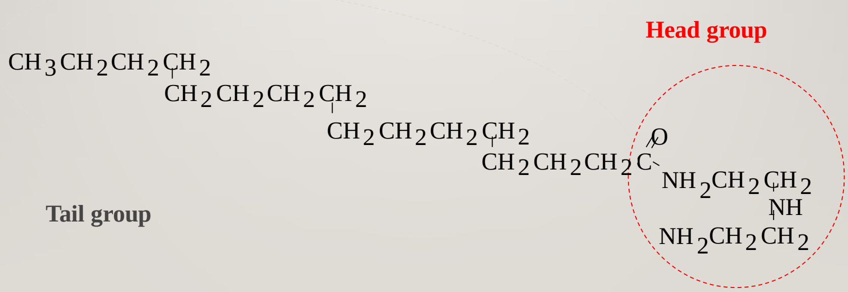
EMULSION COMPONENTS

Emulsifying Agents:

- Example of a cationic emulsifier



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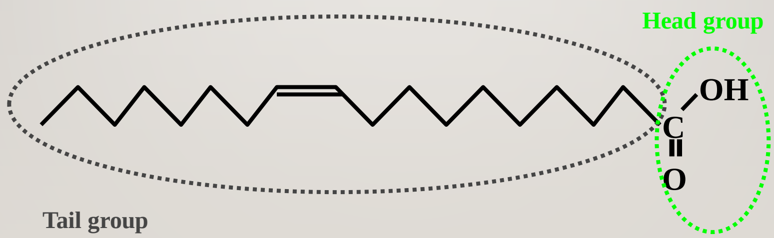
EMULSION COMPONENTS

Emulsifying Agents:

- Example of an anionic emulsifier



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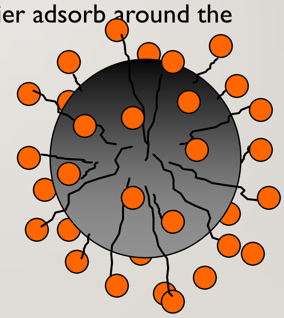
EMULSION COMPONENTS

Emulsifying Agents:

- For asphalt emulsions, the tails of the emulsifier adsorb around the asphalt droplet
- The head groups protrude on the outside of each droplet



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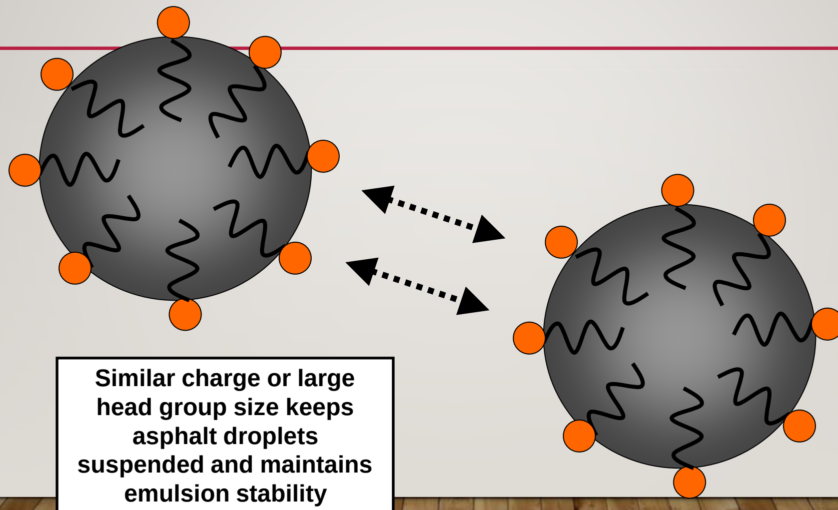
EMULSION COMPONENTS



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EMULSION NOMENCLATURE

Asphalt Emulsions are characterized with a systematic nomenclature, for example:

CHFRS-2hp

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EMULSION NOMENCLATURE

CHFRS-2hp

Charge of the Emulsion Droplets

- If the first letter is a C, the emulsion is cationic
- If a "C" is not present, the emulsion is anionic
- Though fairly rare in paving applications, nonionics are typically named like anionic emulsions

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EMULSION NOMENCLATURE

cHFRS-2hp

High Float

- "HF" indicates that the emulsion has High Float characteristics as indicated by the Float Test
- This high float characteristic provides a structured residue that aids in thicker aggregate films

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EMULSION NOMENCLATURE

CHFRS-2hp

Type of Emulsion

- Next emulsions are named by how quickly the asphalt droplets coalesce
  - "RS" designates a Rapid Setting Emulsion
  - "MS" Medium Set
  - "SS" Slow Set
  - "QS" Quick Set

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EMULSION NOMENCLATURE

CHFRS-2hp

Emulsion Viscosity

- Emulsions are further described by their viscosity range
  - "1" signifies lower viscosity
  - "2" signifies higher viscosity

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EMULSION NOMENCLATURE

CHFRS-2hp

Type of Asphalt

- A designation may follow the "1" or "2" that describes the type of asphalt used
  - "h" refers to a harder asphalt
  - "s" refers to a softer asphalt

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EMULSION NOMENCLATURE

CHFRS-2hp

Polymer Modification

- Polymer modified emulsions will often contain a letter at the end to signify that they are polymer modified
  - Most typically "P", but occasionally "L," "LM," and "S" are also used

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EMULSION NOMENCLATURE

Common Anionic Emulsions:

RS-2	**RS-2p**
MS-2	**MS-2h**
HFRS-2	**HFRS-2p**
HFMS-2	**SS-1**
SS-1h	**SS-1hlm**

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EMULSION NOMENCLATURE

Common Cationic Emulsions:

CRS-2	**CRS-2p**
CMS-2	**CMS-2s**
CSS-1	**CSS-1h**
CSS-1hp	**CQS-1hlm**
CQS-1h	**CHFRS-2p**

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IS RAPID FASTER THAN QUICK?

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TYPES OF EMULSIONS

Rapid Setting Emulsions:

- Emulsions designed to react and break quickly when in contact with roadway and aggregate
- Typically used in chip seal applications
- Rely mostly on a chemical break to revert to asphalt

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TYPES OF EMULSIONS

Medium Setting Emulsions:

- Often called "mixing grade" emulsions
- These emulsions have increased stability to allow for better aggregate coating in mixing applications
- Often contain solvents to create stock-pile type mixes
- Rely primarily on evaporation for breaking

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TYPES OF EMULSIONS

Slow Setting Emulsions:

- Emulsions formulated for stability and/or extended mix times
- Rely on evaporation for breaking
- Often used in tack coats, fog seals, and aggregate pre-coating

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TYPES OF EMULSIONS

Quick Setting Emulsions:

- Emulsions formulated for specific use in Slurry Seal applications
- Specialized chemistry to allow for mixing with aggregate, but also quick breaking behavior
- Relies primarily on a chemical break

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TYPES OF EMULSIONS

Micro-Surfacing Emulsion:

- Emulsions formulated for specific use in Micro-Surfacing
- The emulsion is carefully formulated to allow for mixing with aggregate, but also maintains quick setting behavior
- Often called CSS, but relies on a chemical break and is fast setting in the system

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WHAT MAKES AN EMULSION BREAK?

HOW DOES AN EMULSION BREAK?

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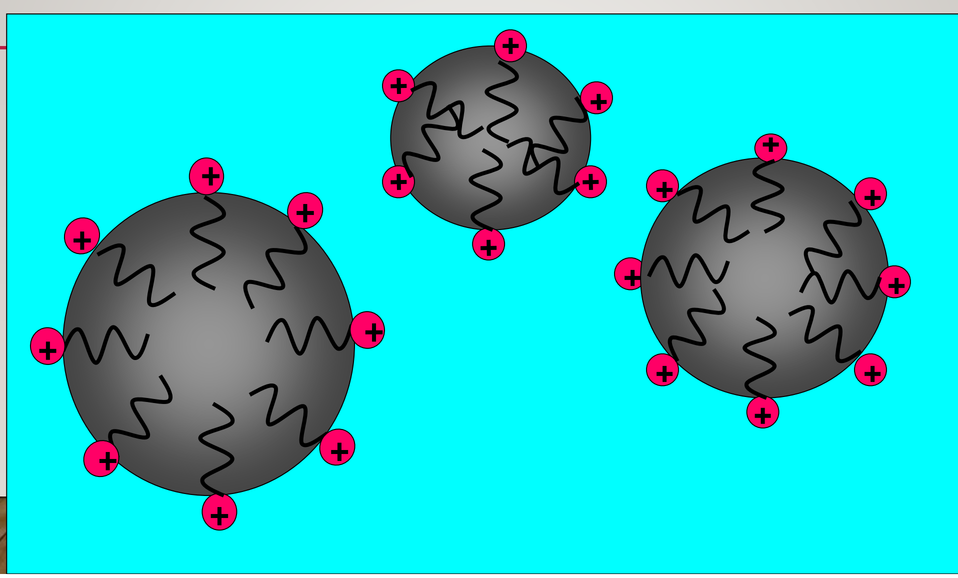
INITIAL CONDITION



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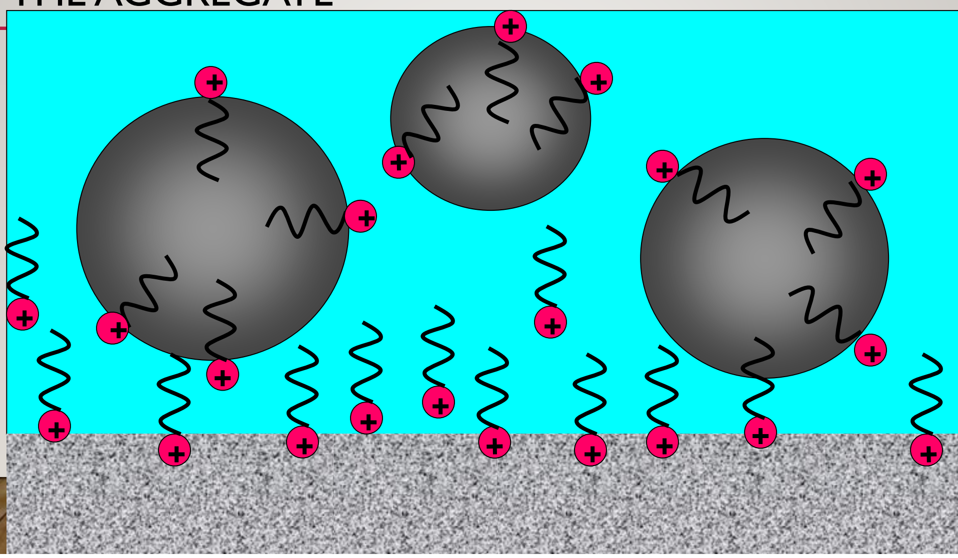
SURFACTANT WETS THE AGGREGATE



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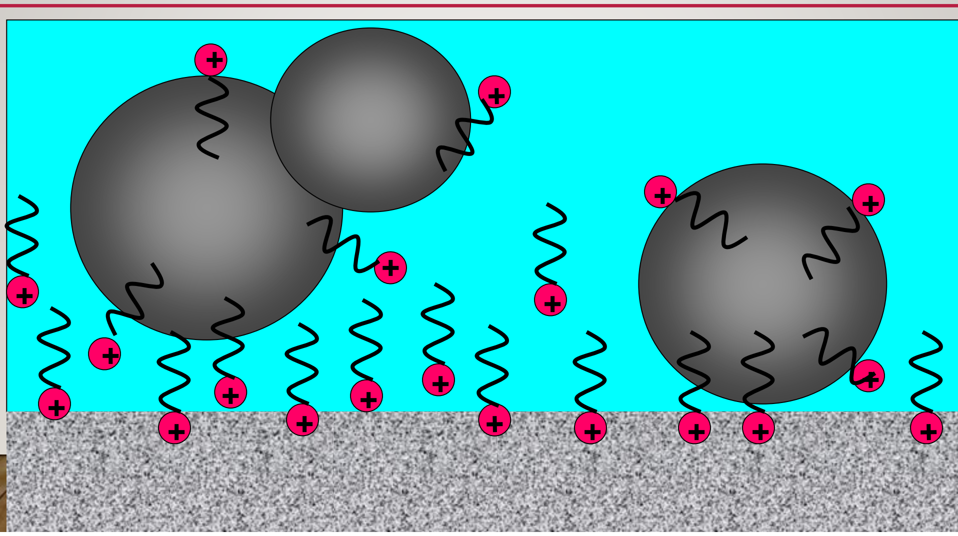
ASPHALT DROPLETS ARE DESTABILIZED



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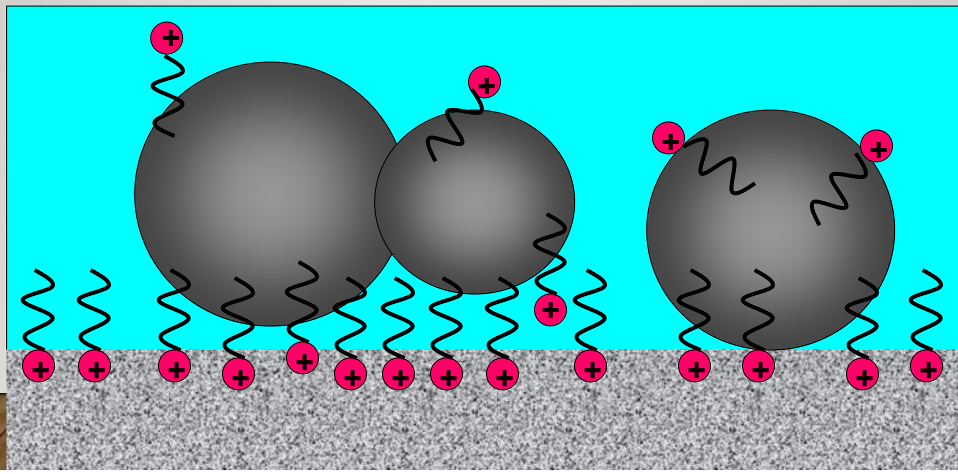
AGGREGATE BECOMING "OIL WET"



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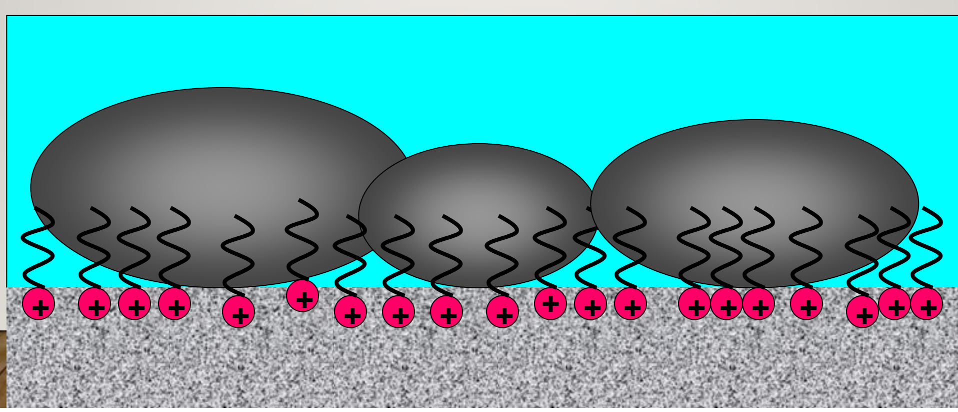
ASPHALT DROPLETS WET AGGREGATE AND BEGIN TO FLOCCULATE



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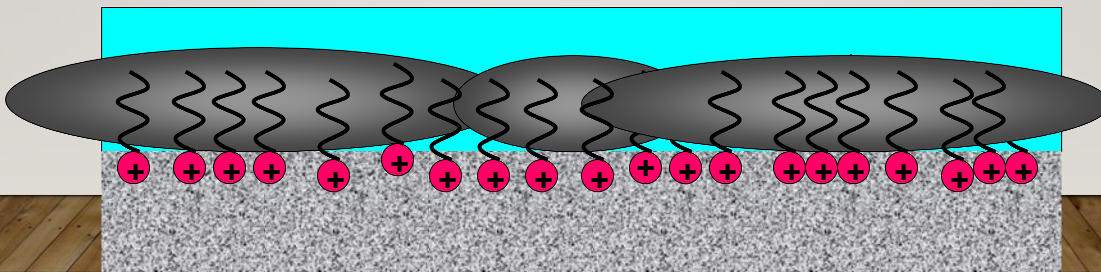
ASPHALT DROPLETS BEGIN TO COALESCE, GAINING MECHANICAL STRENGTH



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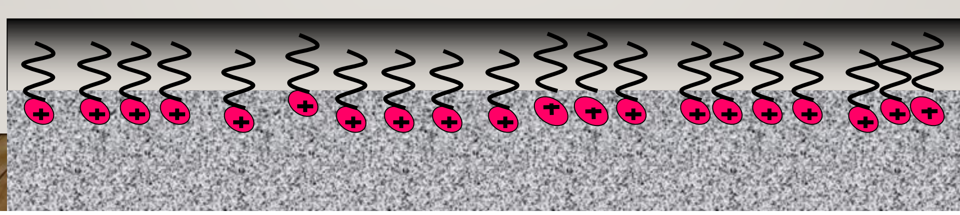
ASPHALT FILM FORMS WITH THE SURFACTANT REMAINING AS AN ADHESION PROMOTER



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BREAK SPEED DETERMINING FACTORS

BREAK SPEED DETERMINING FACTORS

- Emulsifier type (chemistry)
- Solution chemistry (pH, salt content, etc.)
- Ambient conditions
  - Temperature
  - Relative humidity
  - Wind conditions
- Surface condition (old/new, cracked/smooth, dry/wet)
- Application rate and uniformity
- Construction variables (application temperature, shear and temperature history of the emulsion, application equipment, etc.)

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THE ANSWER TO ALL YOUR QUESTIONS

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THE ANSWER TO ALL YOUR QUESTIONS

IT DEPENDS!

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WHAT ABOUT VERY RAPID SET EMULSIONS?

- Essentially rapid set emulsions engineered to be stable at lower emulsifier content.

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HEAD SCRATCHER:

- The fastest breaking emulsion known to **me** is a slow set emulsion
  - Breaking mechanism/speed not driven by emulsifier
  - Emulsifier still needed for emulsion stability
  - Nature of base binder drives speed of breaking
  - Can be very slow in cold humid conditions
  - Hard asphalt based non-tracking type tack coats and bond coats

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SUMMARY AND CONCLUSIONS

- The rapid, medium, slow, and quick designations refer to the type and dosage of emulsifier which, as a general rule, do control the speed of breaking
- In practice it is the "speed determining process" that controls the breaking speed of an emulsion. It can be temperature, humidity, emulsifier type and content, emulsion base chemistry, soap chemistry, pH and so on.

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QUESTIONS?

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1

Content

- Background
- NCAT experience
- Independent studies
- Industry feedback
- Takeaways

National Center for Asphalt Technology NCAT at AUBURN UNIVERSITY

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Background

- Historical harsh solvent extractions
- Nuclear AC and bio-solvents
- NCAT ignition furnace/method
- Correction factor for AC, gradation
- Variability with specific aggregates
- Harsh solvent benefit without the risk?

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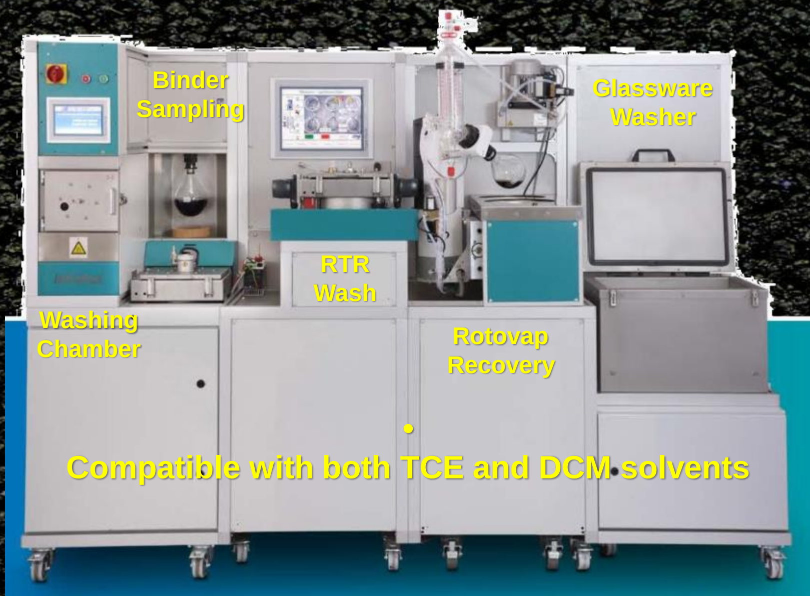
InfraTest Modular Asphalt Analyzer "Cube"



- Compatible with both TCE and DCM solvents

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Purchase Options

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NCAT Experience

- Loaner unit production testing (1 year)
- Positive assessment of comparison trials
- 10/day (AC and dried aggregates)
- Reduced fumes w/ closed system, but
- Walk-in hood needed for rotovap
- Reduced solvent demand with repetitive recycling
- Return on investment in NCAT's nonprofit business.

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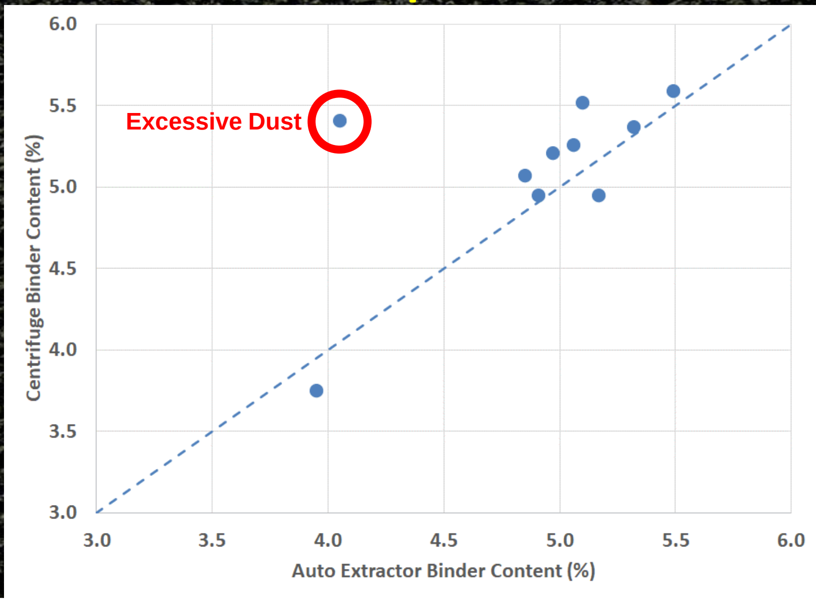
NCAT Experience



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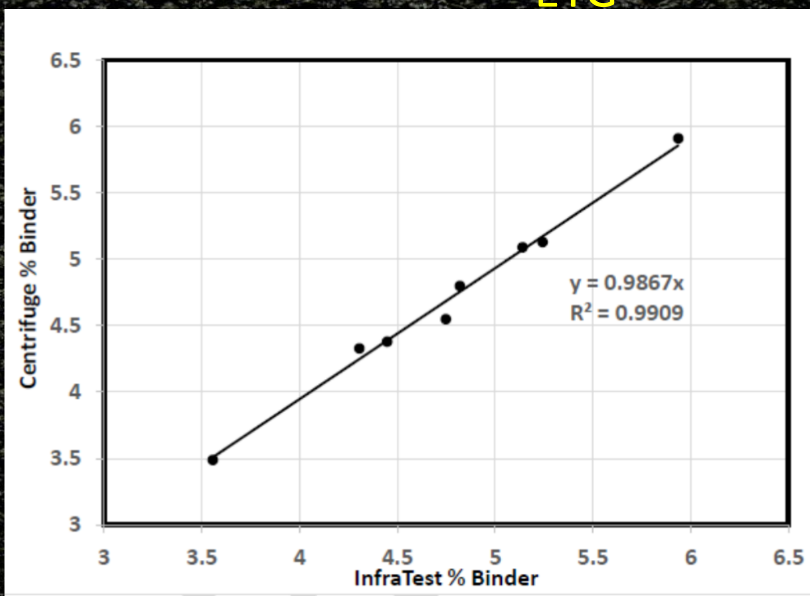
IOWA DOT$_{ETG}$



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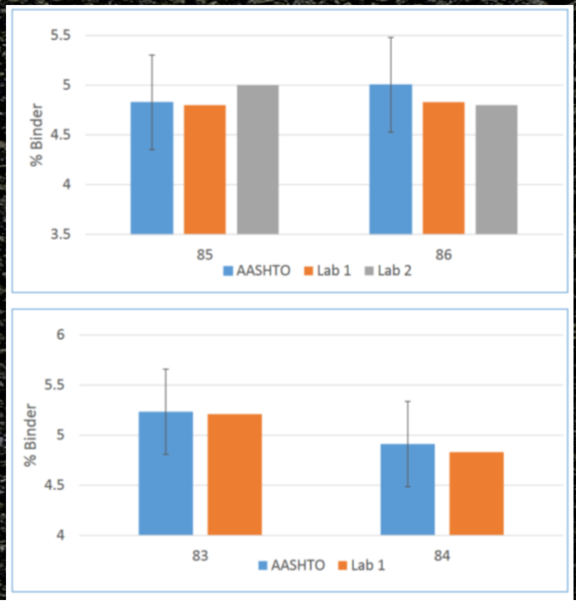
AASHTO Binder Content PSP_{ETG}



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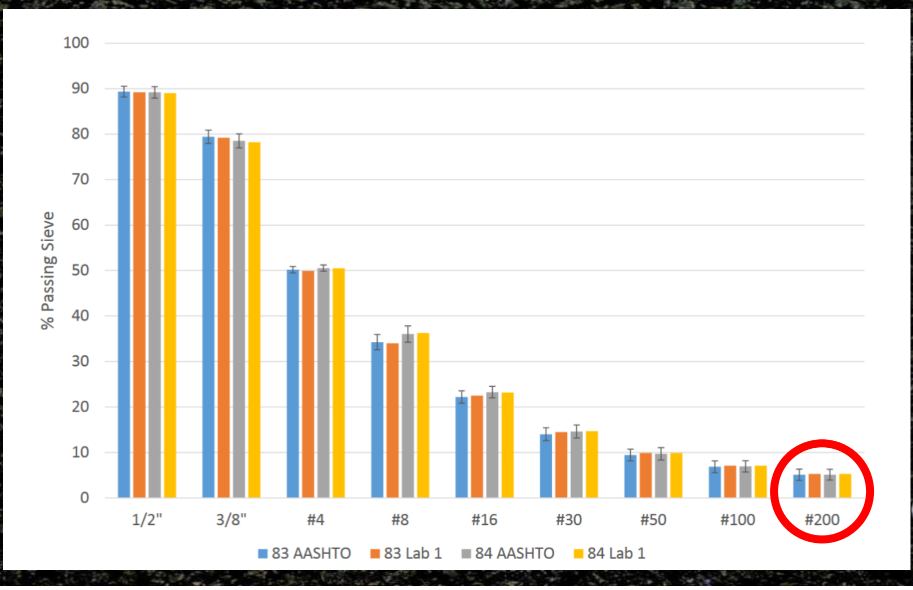
AASHTO Gradation PSP_{ETG}



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Industry Feedback

- Unanimously positive feedback
- User interface for real time controls
- AC and dried aggregates in 1 hour
- Faster turnaround than an ignition furnace
- Dry shake of uncoated aggregates
- Decision via worker safety & bottom line
- 400V 8.5 kW, 3PH 50/60hz custom transformer (provided)
- 230V 5kW water cooling unit (~$10k).

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Takeaways

- Technology works
- Contractors approve
- Startup costs are high
- Worker safety benefits
- Reduced testing time.

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