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North Dakota Asphalt Conference

Future of Micro Surfacing

Tim O'Connell

Ingevity Technical Representative
April 11 2018

Micro Surfacing Innovations Improvements

Changes being driven by Northern Tier States

- Climate appropriate base asphalt

Industry driven innovation

- Evaluation and design methods for surface treatments

MICROSURFACING

- **Emulsion-based surface treatment for road maintenance**
  - Mixture of aggregate, asphalt emulsion (containing a polymer), mineral filler, chemical additives, and water
- **Application areas**
  - High-speed, high-traffic volume roads
  - Airport runways
  - Rut-filling operations
- **Applied in thin layers**
  - 3/8 inch to 5/8 inch for normal treatments
  - 1.5 inch for rut-filling applications

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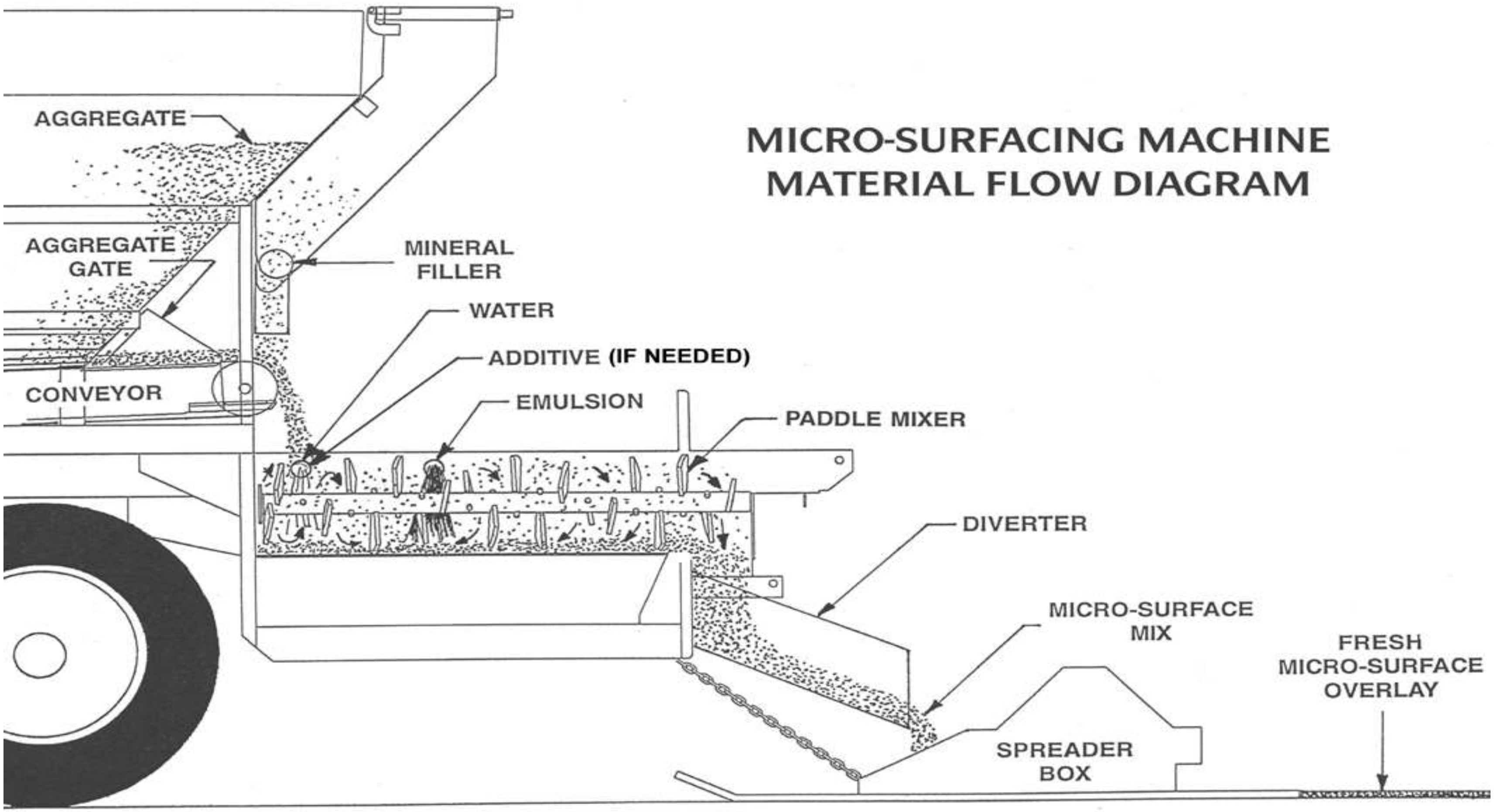
In Micro Surfacing water and chemistry take the place of heat to place an asphalt mix

- Aggregate and Binder are combined on the micro surfacing paver
- All the materials are at **near ambient** temperature:
  - Aggregate
  - Asphalt Emulsion
  - Additives

Micro Surfacing Paver



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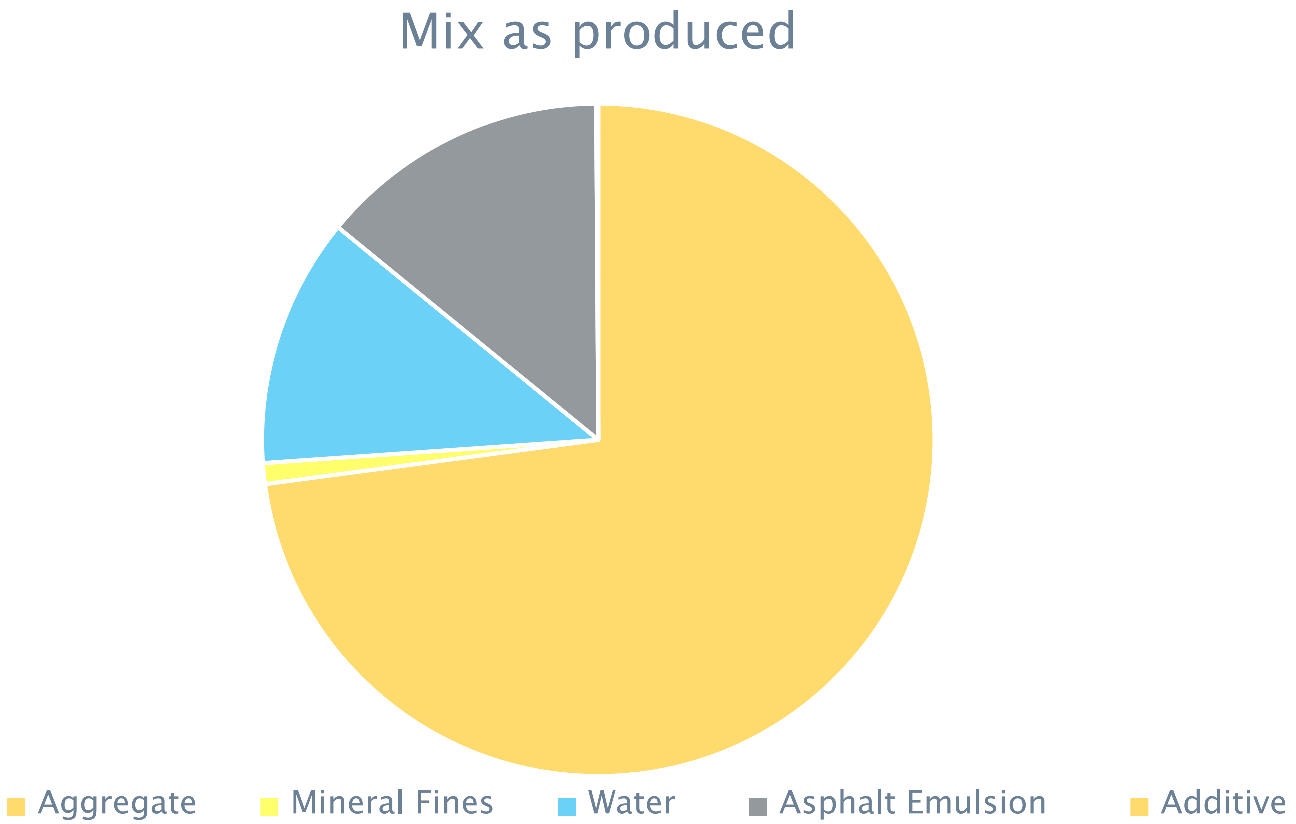
Micro surfacing Components



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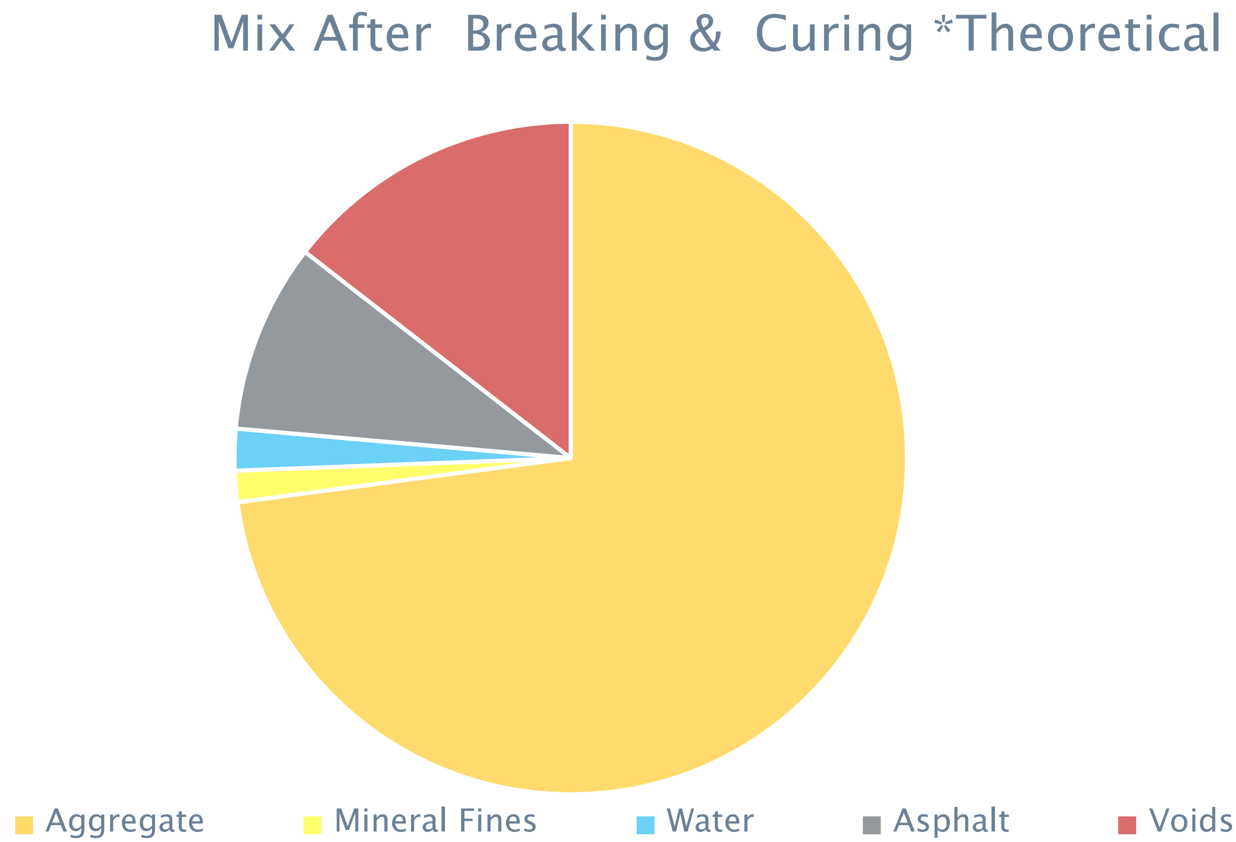
Micro surfacing Components



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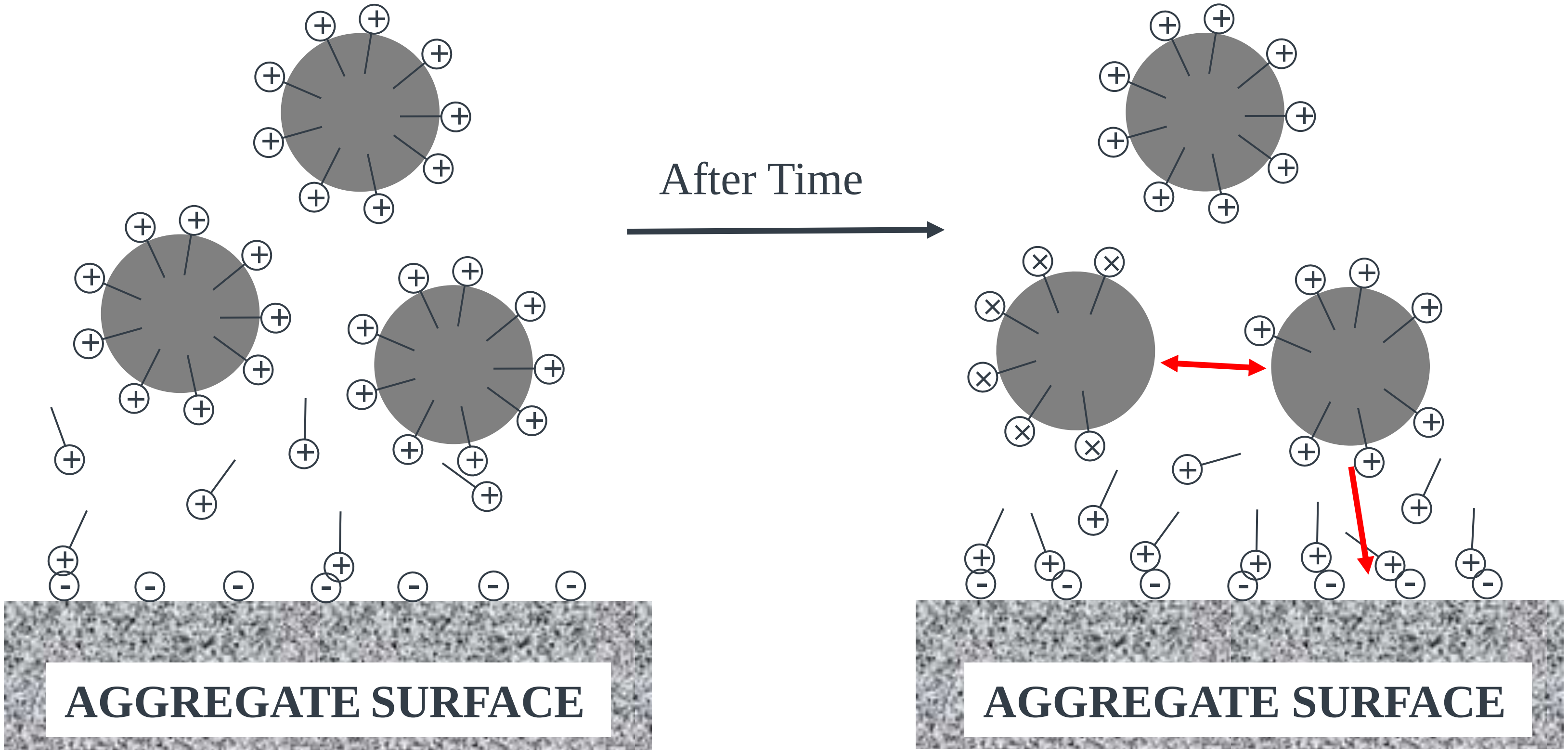
EMULSION-AGGREGATE MIXING



Equilibrium between interfacial and bulk emulsifier concentrations upset by introduction of charged aggregate.

Adhesion of emulsifier to aggregate surface causes a decrease in bulk and interfacial concentrations. Droplets begin to flocculate.

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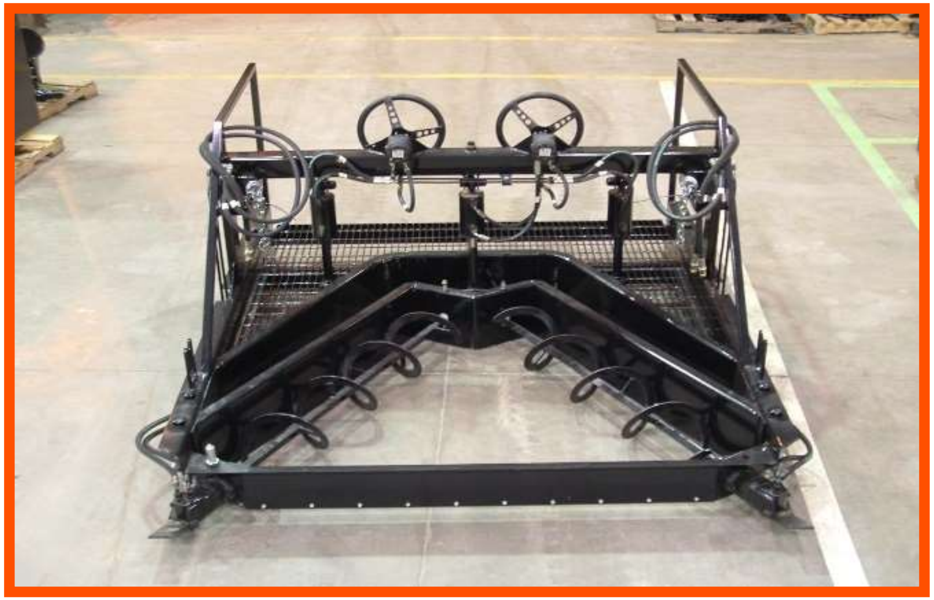
- Micro Surfacing –
  - Ruts in excess of ½” should be filled with a rut box

Rut Box

- 5 or 6 feet widths
- With augers
- V shaped screed
  - Channels larger aggregate into deeper parts of the rut
  - Feathers edges
  - Over-crowns rut to compensate for traffic compaction



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Rut Filling

Rut Filled

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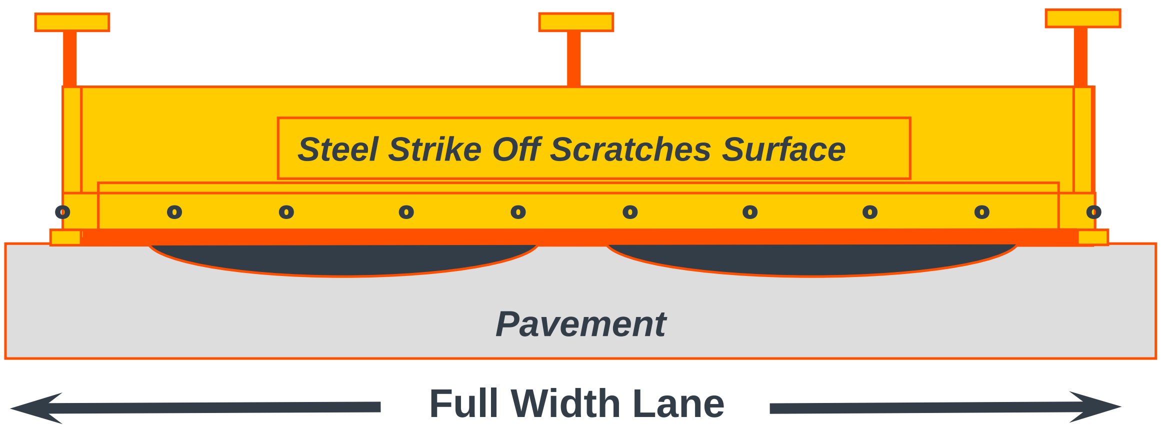
Slurry Seal vs. Micro

TEST	SLURRY SEAL	MICRO-SURFACING
Sand Equivalent	45% minimum	65% minimum
Mix Time	180 seconds minimum	120 seconds minimum
WTAT, 1 Hour Soak	75 g/ft^2	50 g/ft^2
WTAT, 6 Day Soak	Not required	75 g/ft^2
Lateral Displacement	Not required	5% maximum

Scratch Course

- Leveling (Scratch) Course
  - Ruts < ½” may be filled with scratch course



The scratch coat is generally 6” less than the width of the lane.

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Full Width Spreader Box

- Variable width 9 to 15 feet
- Rubber strike-off for surface
- Steel or Stiff Rubber for Level-up

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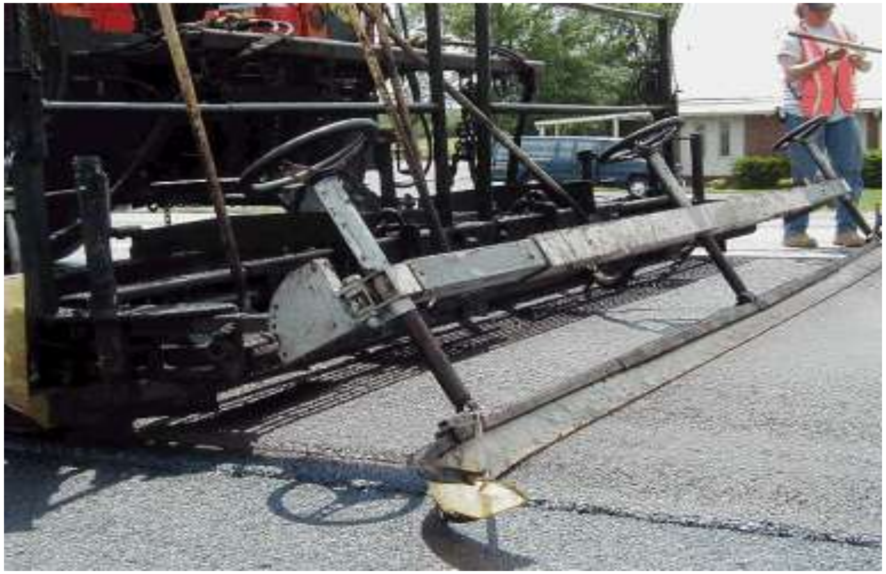
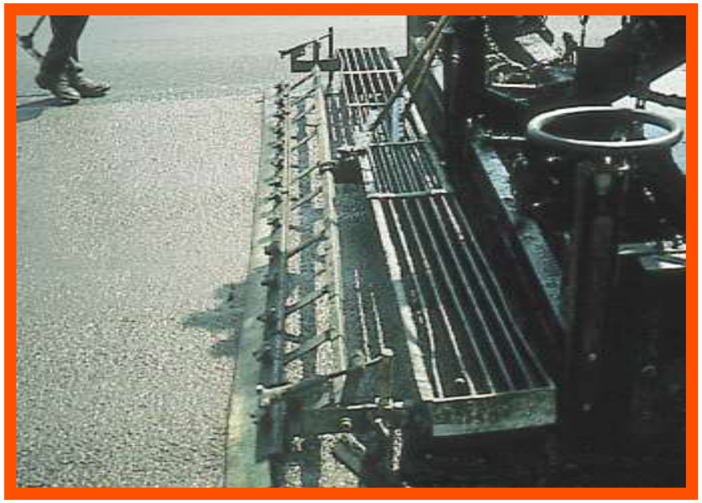
- Secondary strike-off
  - Used to achieve desired
  - texture
    - Burlap drag
    - Rubber strike-off



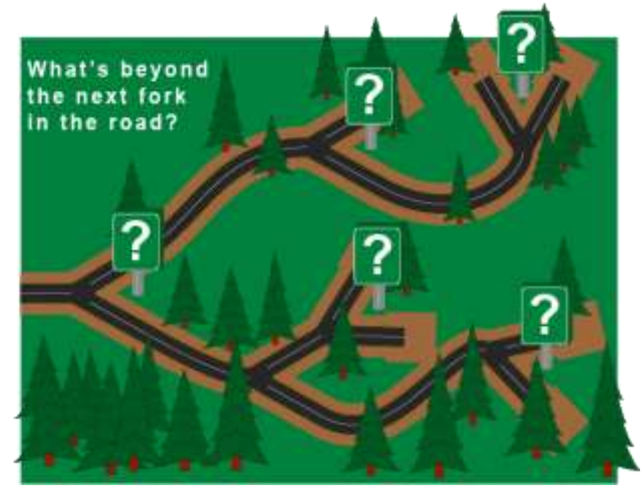


Surface Texture Adjustment with Strikeoff

Textured wearing surface

Micro Surfacing Decision-Making…Driven by Project/Agency Performance Objectives

- Climate
- Traffic
- Time Constraints
- Existing Pavement Condition
- Base Stiffness
- Polymer & Additive Option
- Surface Texture Needs
- Design & Performance Testing
- Field Acceptance



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International Slurry Seal Association (ISSA) Strategic Plan Goals and Timeline

- Slurry Seal Guideline Objectives

  Polymer-Modified Slurry Seal Guideline (Goal: June 2018)
- Inspector's Manual (Goal: April 2018)
- ISSA TB Revisions (Goal: September 2018)
- Micro Surfacing Guideline Revisions (Goal: Q1 2019)

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Micro Surfacing Future Changes / Improvements

- Base AC Grade
  - Move to a climate specific Super Pave Binder
- High Performance Specification
  - Design Methods
  - Test equipment
  - Materials

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The Future of Micro Surfacing
Materials

- Standard Micro Surfacing Base Asphalt
  - Normally **PG 64-22** (effectively a PG 58-28) when placed under micro surfacing condition construction process.
- Additional Grades being trialed in northern states
  - PG 58-28 (PG 52-34 as placed)
  - PG XX-34 (PG XX-40 as placed)
  - Note: All above are before addition of latex or polymer. Polymer raises top end 1 to 2 grades

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The Future of Micro Surfacing
Materials

- When you make an emulsion mix or surface treatment the binder is not subjected to the heat / oxygen in the hot mix plant.
  - CQS ~ 100 to 120 F on delivery / application
  - CRS ~ 150 to 190 F on delivery / application
- Since SHRP Superpave PG binders are tested in the lab by subjecting them to a simulated hot mix and thin film heat aging they end up “harder” than what will be on the road using an emulsion mix.

The Future of Micro Surfacing Materials

Performance Grades							
Max. Design Temp.	PG 46	PG 52	PG 58	PG 64	PG 70	PG 76	PG 82
Min. Design Temp.	-34 -40 -46	-10 -16 -22 -28 -34 -40 -46	-16 -22 -28 -34 -40	-10 -16 -22 -28 -34 -40	-10 -16 -22 -28 -34 -40	-10 -16 -22 -28 -34	-10 -16 -22 -28 -34
Original							
≥230 °C	**Flash Point**						
≤ 3 Pa-s @ 135 °C	**Rotational Viscosity**						
≥ 1.00 kPa	**DSR G*/sin δ** (Dynamic Shear Rheometer)						
	46	52	58	64	70	76	82
(Rolling Thin Film Oven) RTFO, Mass Change ≤ 1.00%							
≥ 2.20 kPa	**DSR G*/sin δ** (Dynamic Shear Rheometer)						
	46	52	58	64	70	76	82
(Pressure Aging Vessel) PAV							
20 hours, 2.10 MPa	90	90	100	100	100(110)	100(110)	100(110)
≤ 5000 kPa	**DSR G*sin δ** (Dynamic Shear Rheometer)				Intermediate Temp. = [(Max. + Min.)/2] + 4		
	10 7 4	25 22 19 16 13 10 7	25 22 19 16 13	31 28 25 22 19 16	34 31 28 25 22 19	37 34 31 28 25	40 37 34 31 28
S ≤ 300 MPa m ≥ 0.300	**BBR S (creep stiffness) & m-value** (Bending Beam Rheometer)						
	-24 -30 -36	0 -6 -12 -18 -24 -30 -36	-6 -12 -18 -24 -30	0 -6 -12 -18 -24 -30	0 -6 -12 -18 -24 -30	0 -6 -12 -18 -24	0 -6 -12 -18 -24
If BBR m-value ≥ 0.300 and creep stiffness is between 300 and 600, the Direct Tension failure strain requirement can be used in lieu of the creep stiffness requirement.							
ε_f ≥ 1.00%	**DTT** (Direct Tension Tester)						
	-24 -30 -36	0 -6 -12 -18 -24 -30 -36	-6 -12 -18 -24 -30	0 -6 -12 -18 -24 -30	0 -6 -12 -18 -24 -30	0 -6 -12 -18 -24	0 -6 -12 -18 -24

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The Future of Micro Surfacing
Materials

Performance Grades

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Original

≥230 °C	**Flash Point**						
≤ 3 Pa-s @ 135 °C	**Rotational Viscosity**						
≥ 1.00 kPa	**DSR G*/sin δ** (Dynamic Shear Rheometer)						
	46	52	58	64	70	76	82

In emulsion on the original DSR, FP & RV Values are relevant to what end up on the road

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The Future of Micro Surfacing
Materials & Mix Design – Softer Base

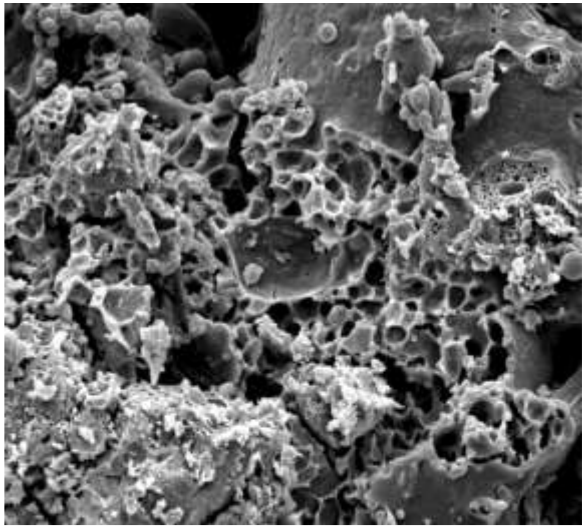
Field application ahead of fully proven mix design methodology.

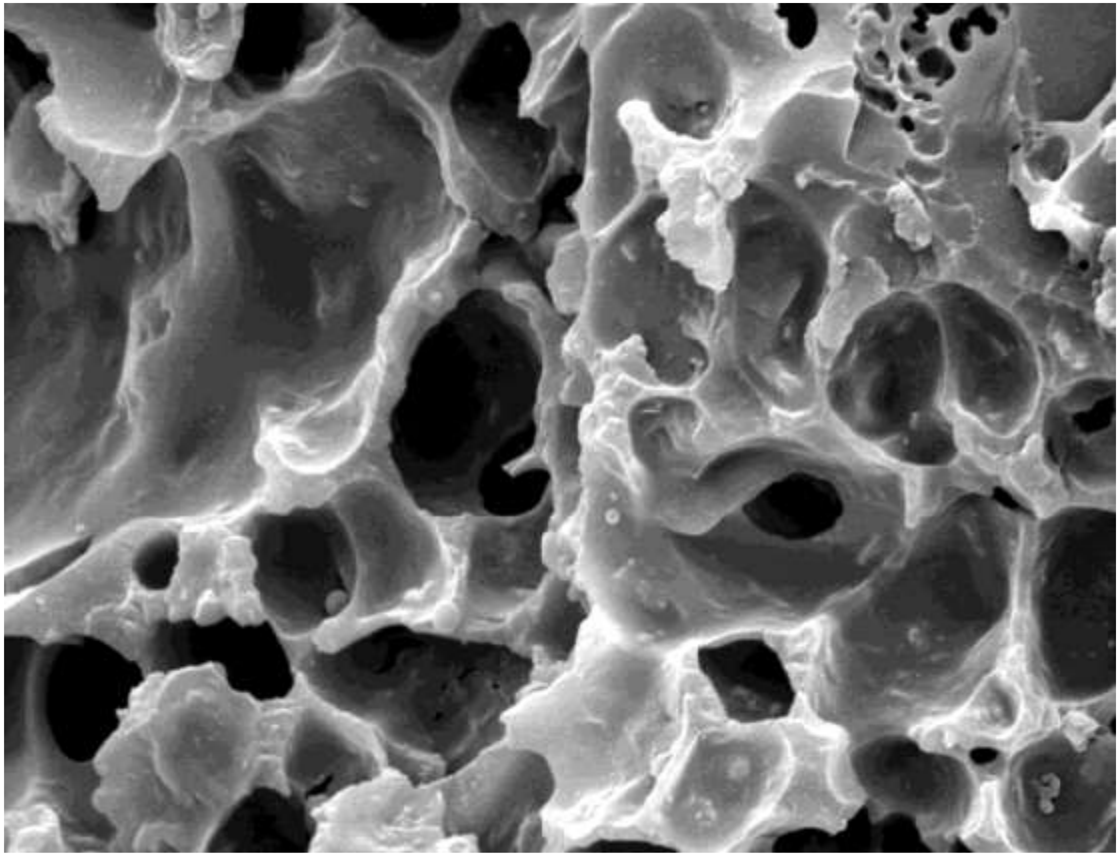
- Emulsion Distillation residue yields different test values when made with PG 58-28 or softer. (Penetration & Softening Point)
  - Latex / Polymers react and differently
- Micro surfacing mix design tests produce different numbers. (Wet Track Abrasion Tests and Loaded Wheel Tests.

The Future of Micro Surfacing
Materials

- Modifiers
  - Pre-modified asphalt base
  - Latex modified emulsion
  - Fibers in mix

Polymer and Latex Modification of Micro Surfacing





Courtesy of BASF

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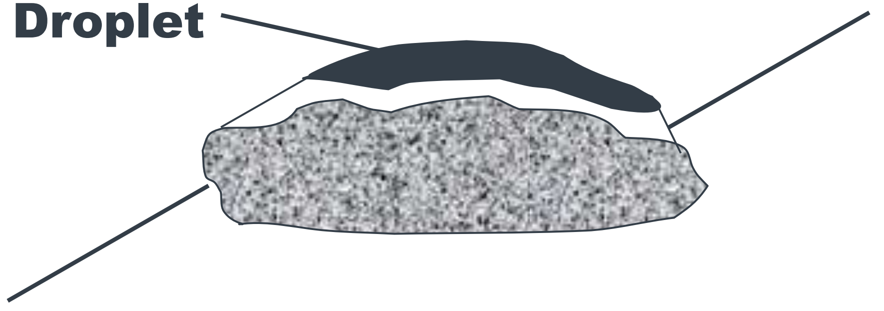
UTILITY OF LATEX

- Improve adhesion of asphalt to aggregate



- Improve asphalt elasticity in the finished material for stability in the summer and flexibility in the winter

Types of Fiber

Glass

Polyester

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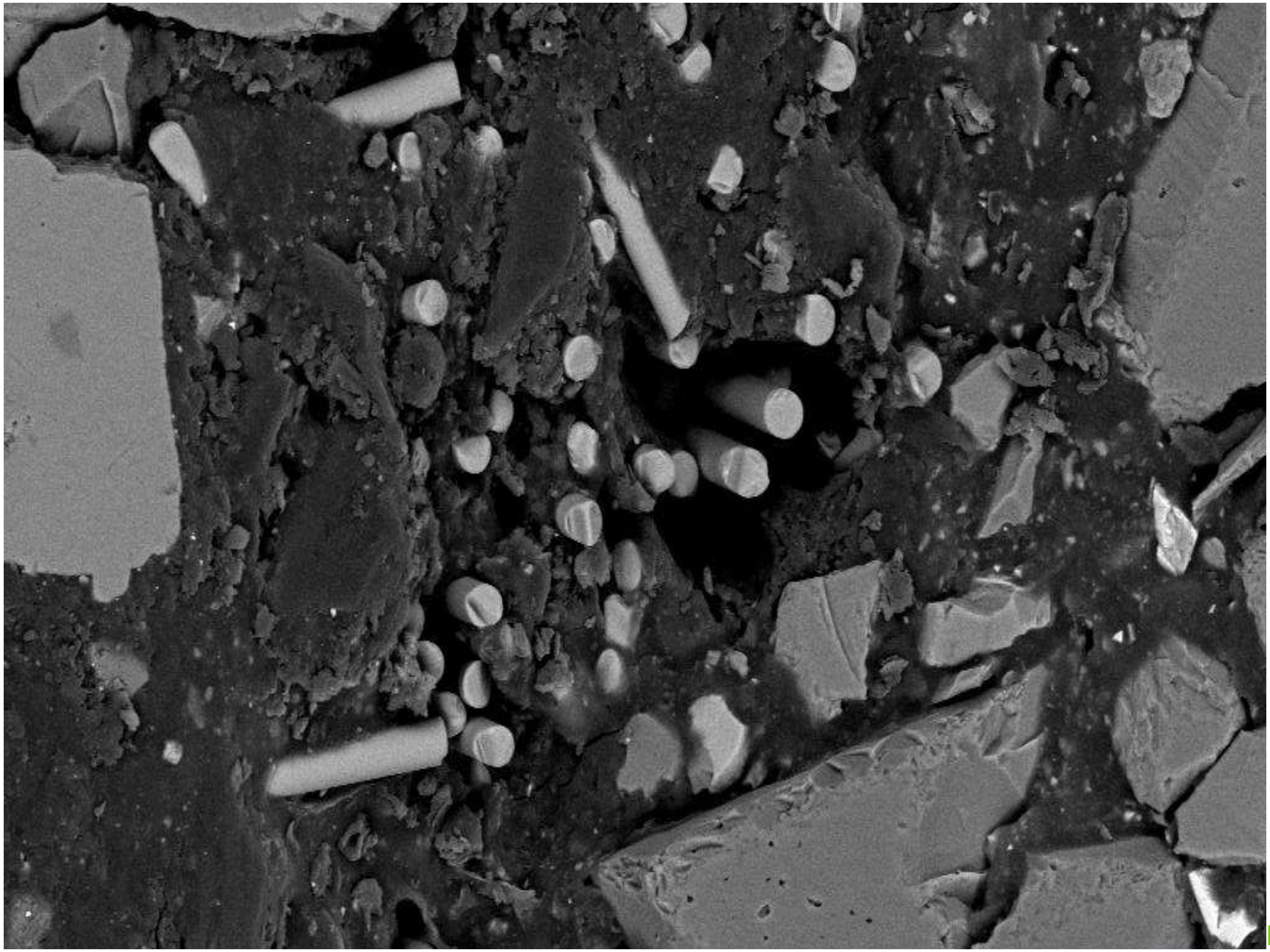
Fiber Modified
Slurry & Micro Surfacing



Durability

Fiber Dispersion

% of Binder

Aggregate gradation

Polymer

Crack Resistance

✓ Fiber Dispersion

✓ Soft Binder

✓ % of Binder

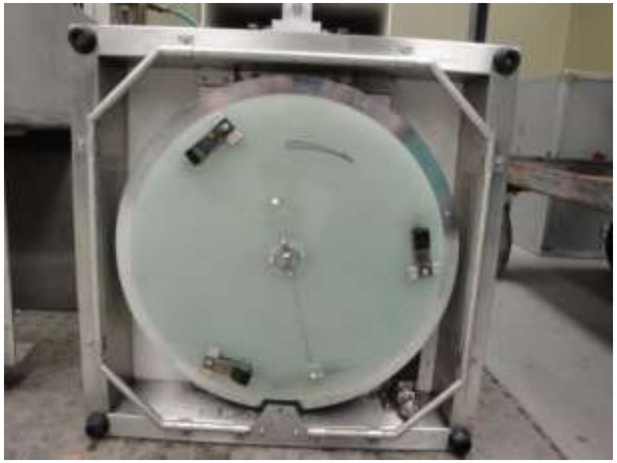
✓ Aggregate gradation

✓ Polymer

y

Looking
Friction and Texture

Dynamic Friction Tester (DFT)



Circular Track Meter (CTM)

Micro Surfacing Mix Testing for Surface Texture and Dynamic Friction Tests

9.5 mm S4 Oklahoma DOT mix (hot plant produced)

Slab prep

Reheat mix

Compact slab

Slabs were used “as is” from the compactor

19” X 15” X 2”

Slab before treatment

- Typical slab after removal from compactor

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Slurry & Micro Preparation

Texture

AMES Texture Meter was run before loading into the 3WP

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Wear testing of Surface Treatements

Three Wheel Polisher in action on CRS-2LM

Note: Water spray on surface when in motion

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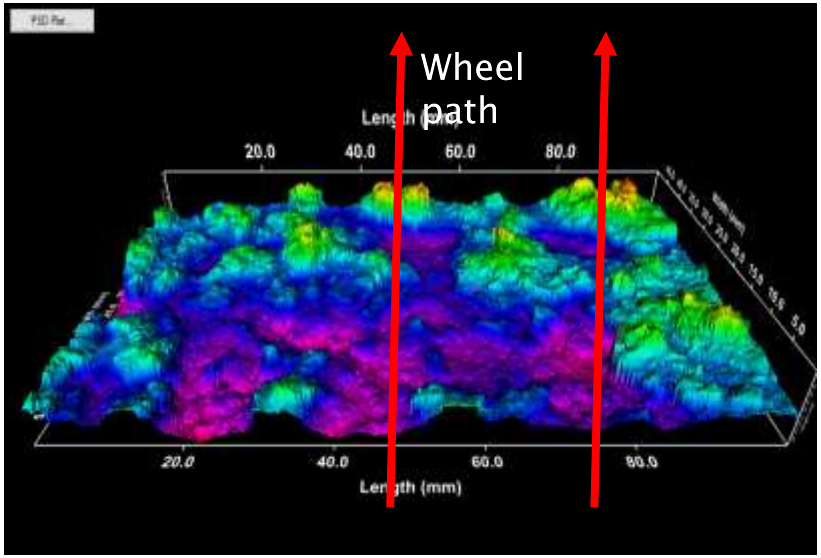
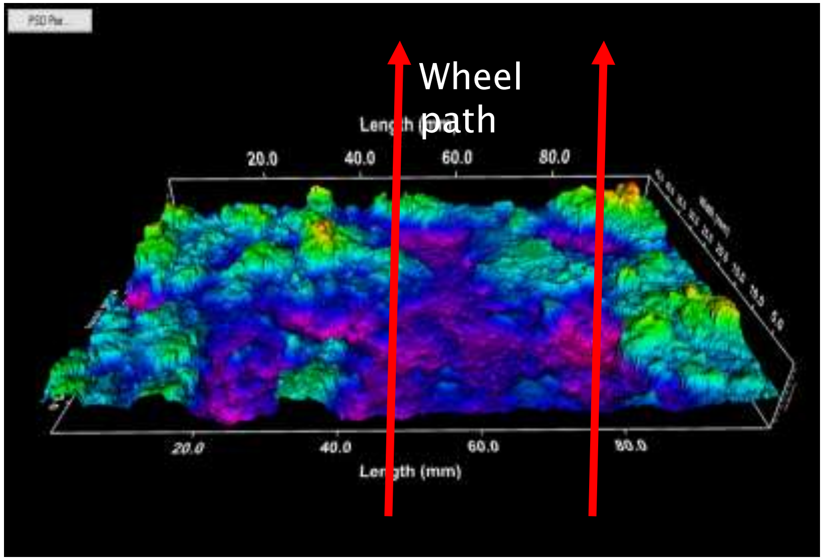
AMES Texture

Micro surfacing texture
Before 3wp wear



Micro surfacing texture
After 8000 wear cycles



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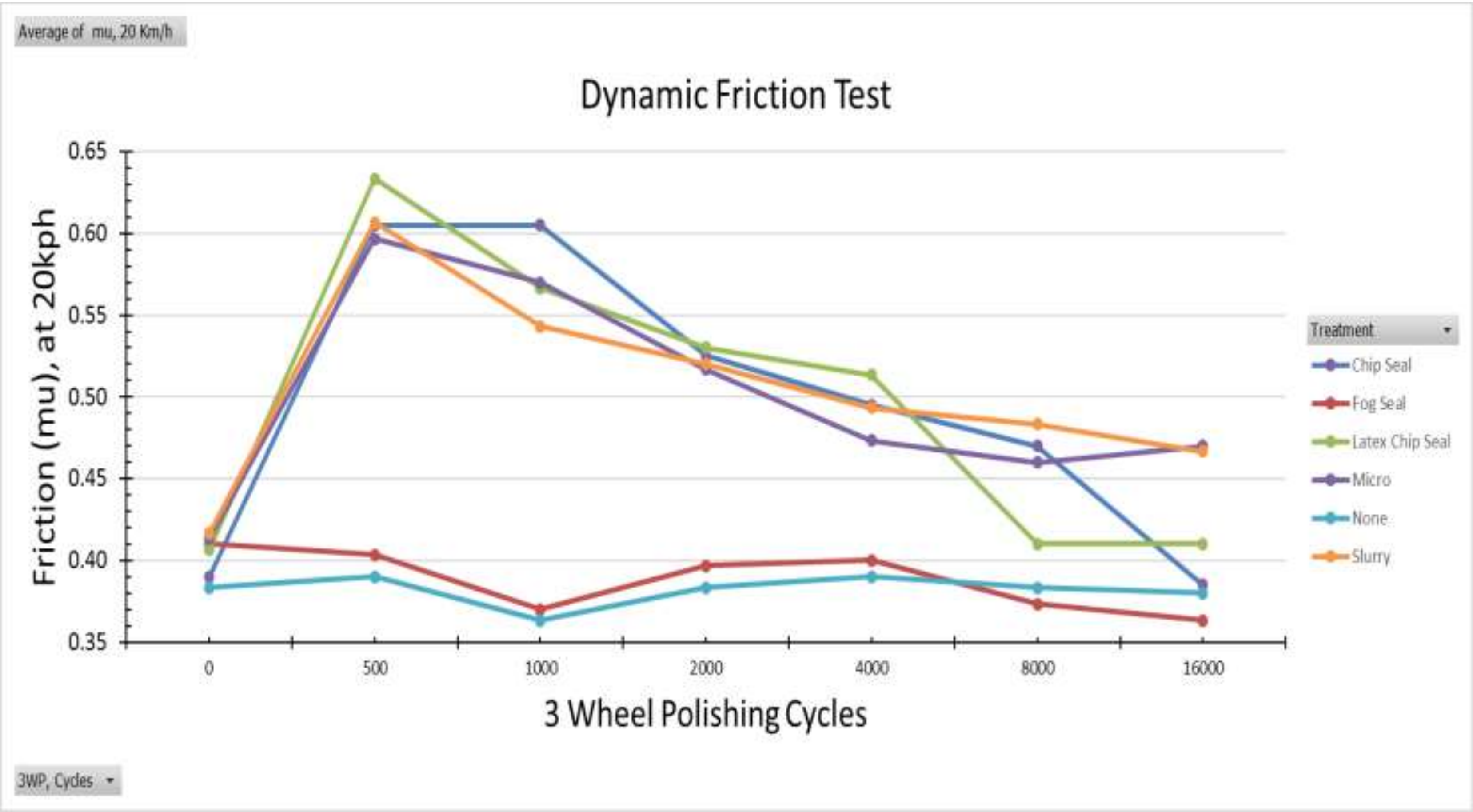
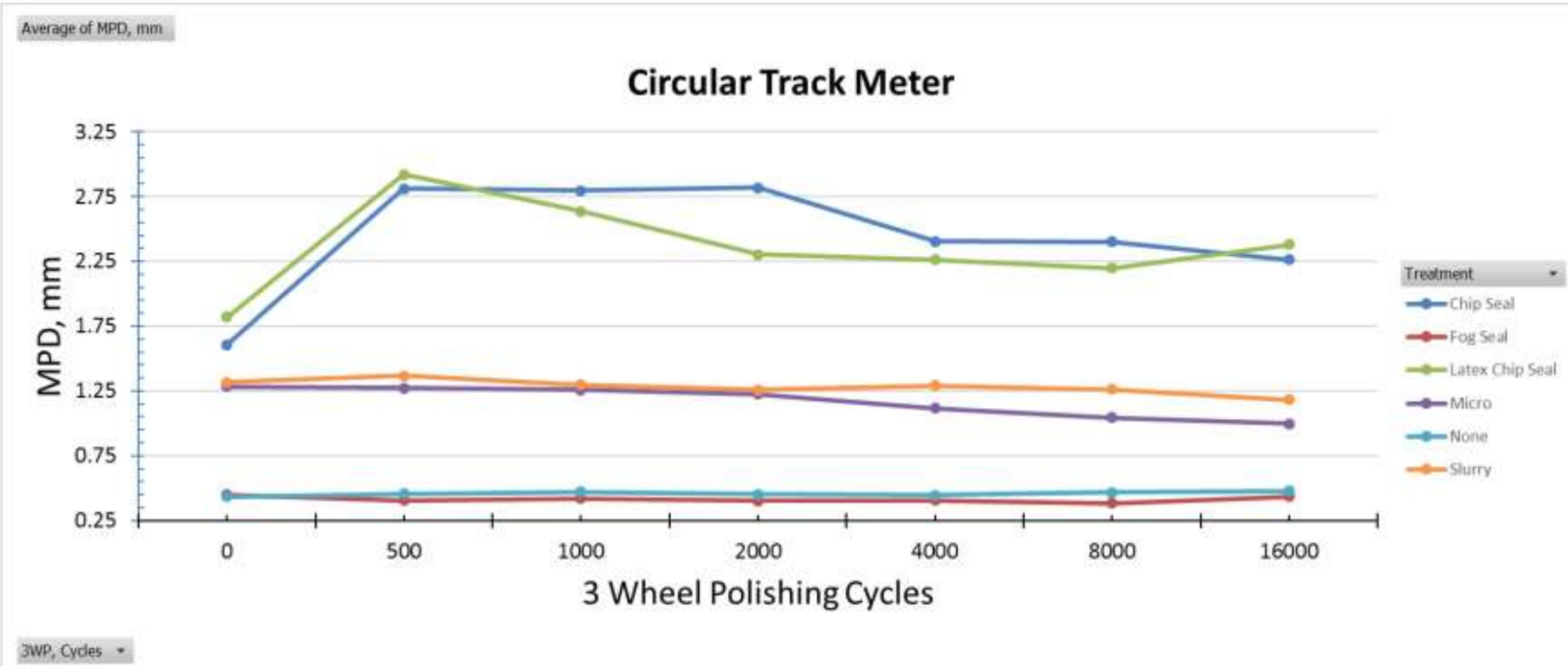
Friction


Average of mu, 20 Km/h
Dynamic Friction Test
Friction (mu), at 20kph
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0
500
1000
2000
4000
8000
16000
3 Wheel Polishing Cycles
Treatment
Chip Seal
Fog Seal
Latex Chip Seal
Micro
None
Slurry
3WP, Cycles

Texture



Average of MPD, mm
Circular Track Meter
3.25
2.75
2.25
1.75
1.25
0.75
0.25
MPD, mm
0
500
1000
2000
4000
8000
16000
3 Wheel Polishing Cycles
Treatment
Chip Seal
Fog Seal
Latex Chip Seal
Micro
None
Slurry
3WP, Cycles

Observations

Sample Preparation

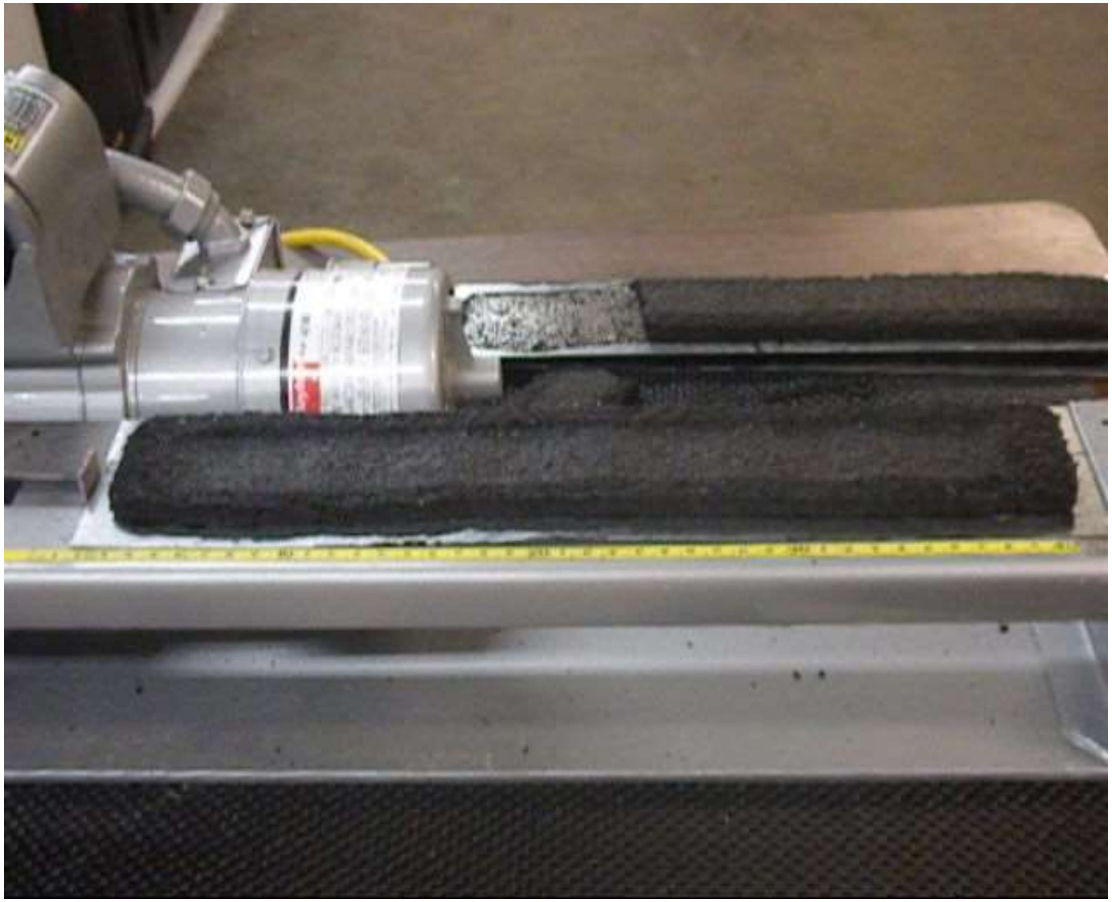
- Samples did not represent aged or distressed asphalt surfaces
- Fog, Slurry & Micro samples produced reasonably close to field
- Chip (CRS-2, CRS-2LM) samples did not replicate field
  - Required additional rolling
  - Traffic effects not replicated for embedment

3 Wheel Polisher

- 3WP intended to evaluate resistance to aggregate polishing
- 3WP use on Fog, Slurry & Micro reasonably replicated field distress
- 3WP use on chip seals needs additional work to replicate field distress
  - Experienced excess chip loss
  - Chip contributed to rapid surface degradation

Flexural Tension Test

- 0.2% AR Glass Fiber
- LWT 1000 Cycles
- ½” Thick Mold
- Temp. 5c



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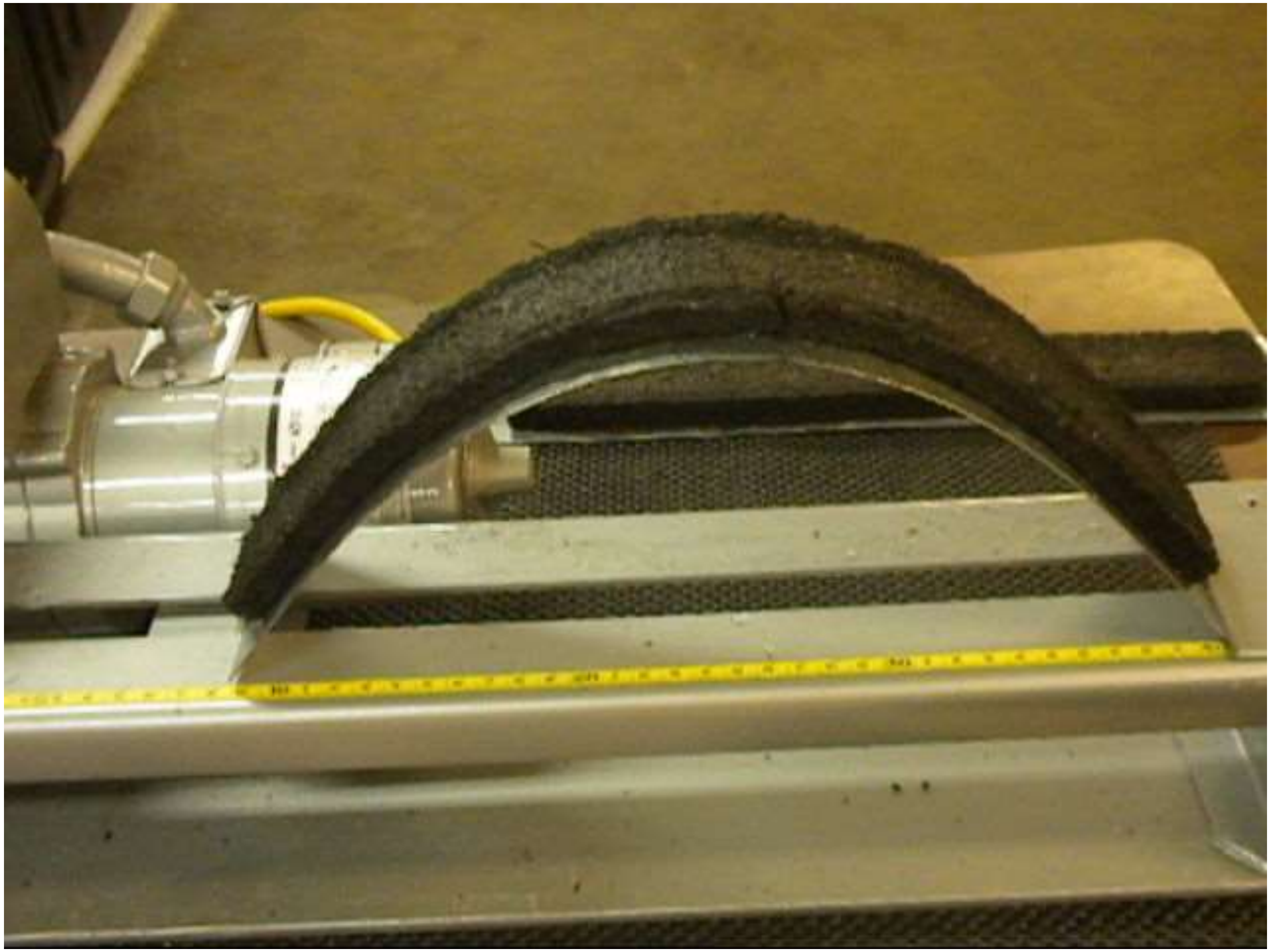
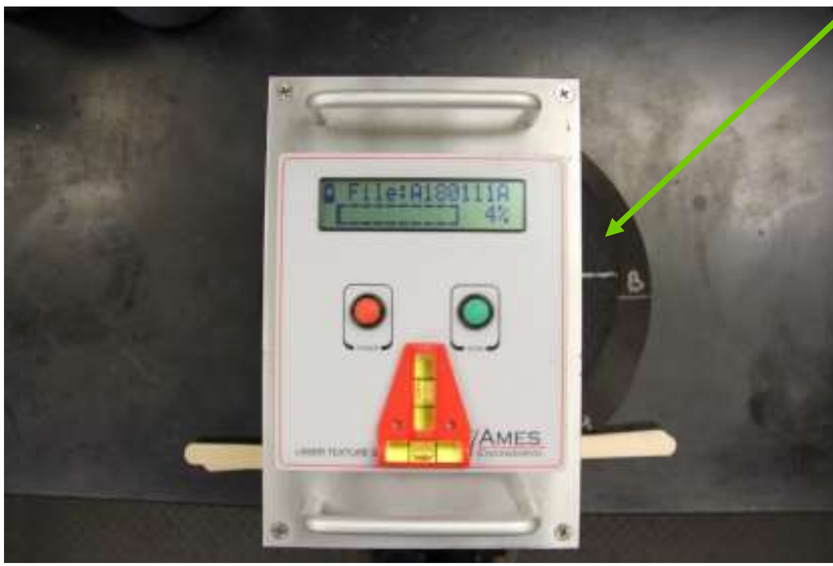
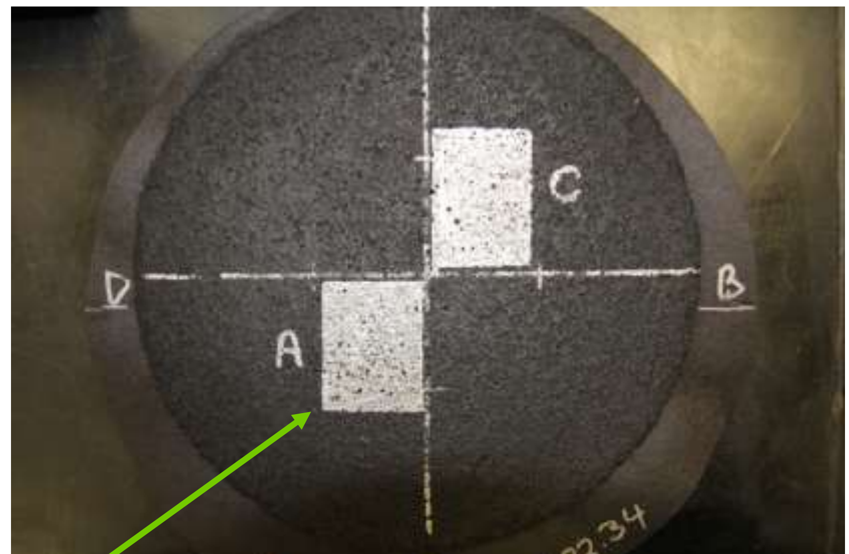
Flexural Tension Test



Measuring Surface Texture With Ames Engineering Surface Texture Scanner

WTAT Sample





Scanned Area

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Surface Texture Effect on Wet Track Abrasion Test Results

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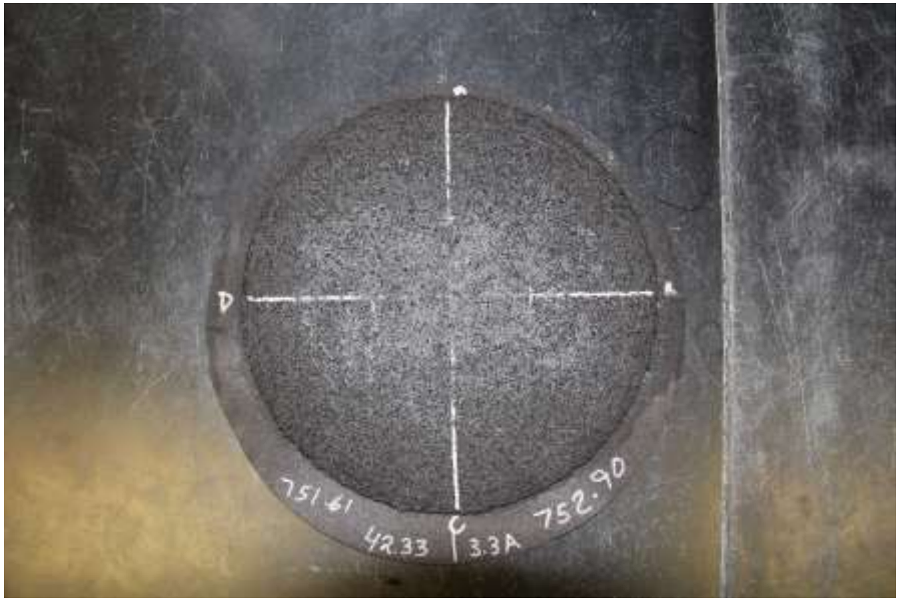
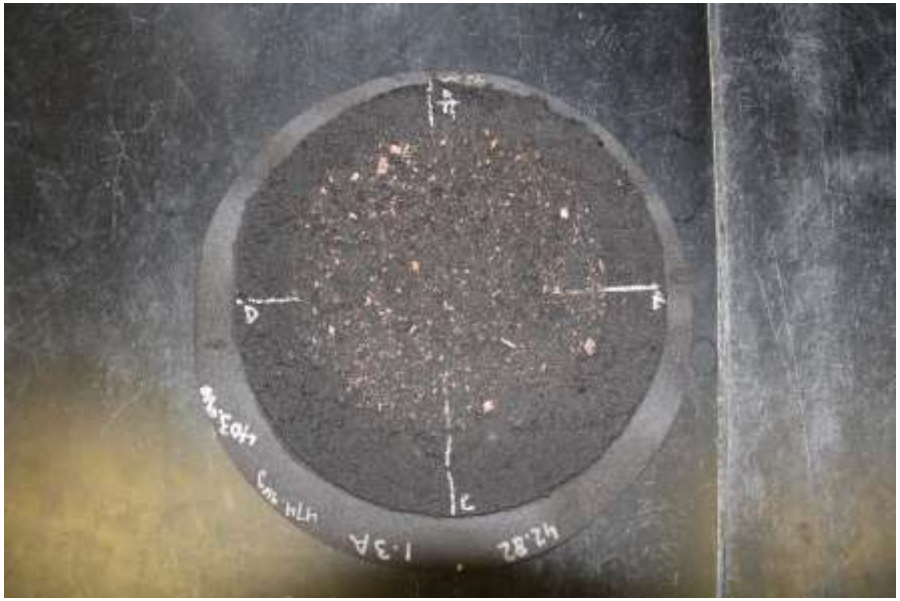
Surface Texture Appearance After WTAT Wear





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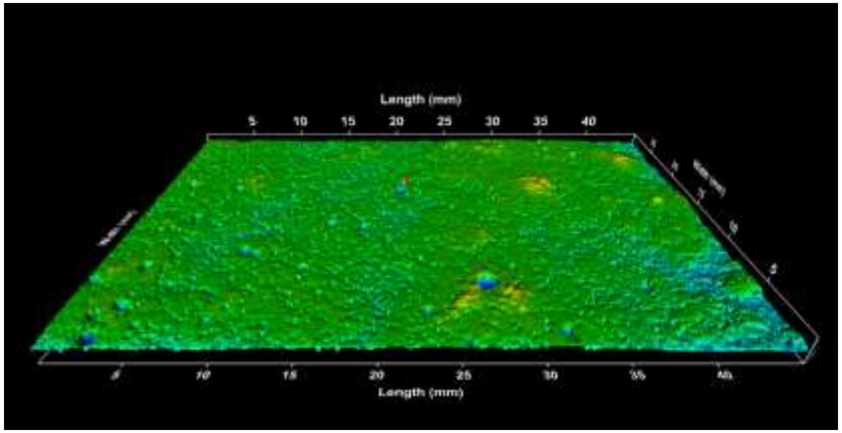
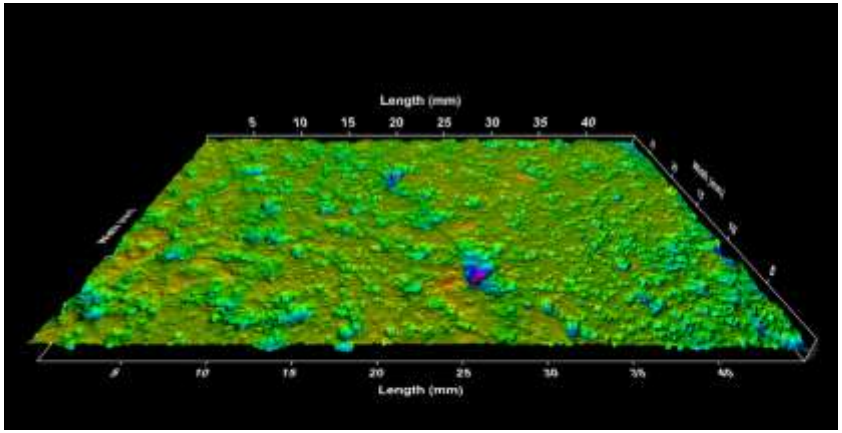
Before and After Low Surface Area & WTAT Loss





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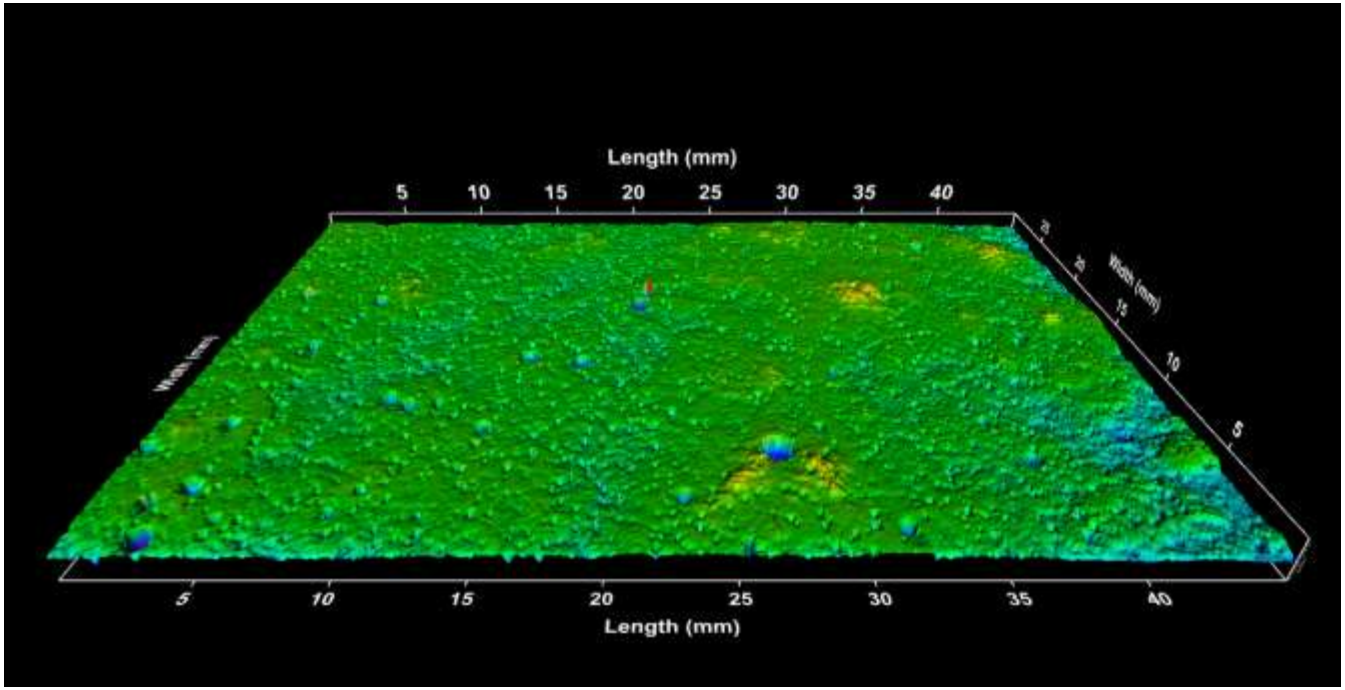
Before WTAT soak low surface area & WTAT loss



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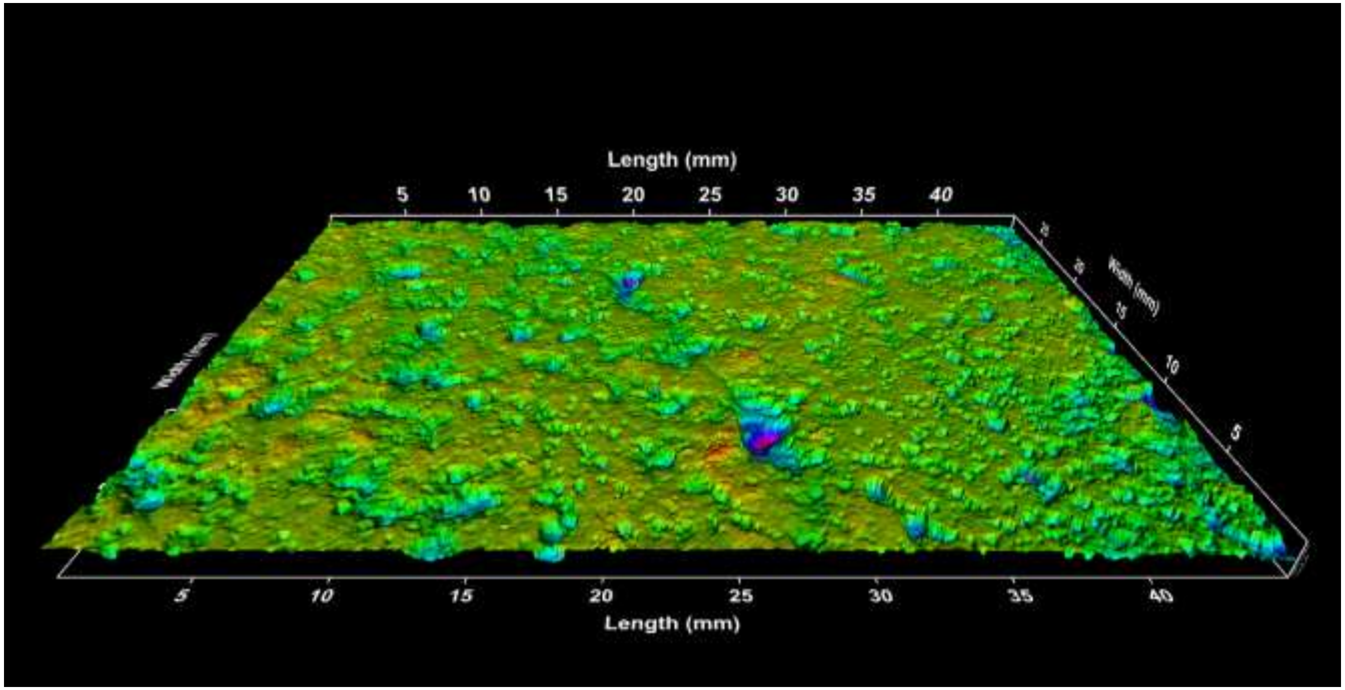
After WTAT wear low surface area WTAT loss



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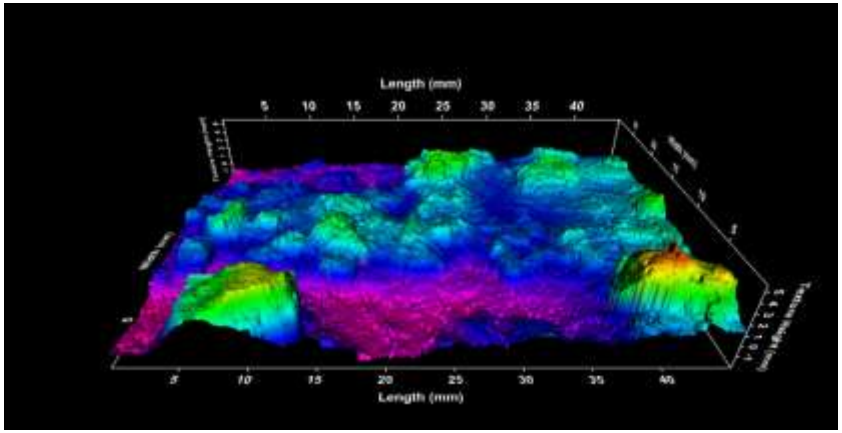
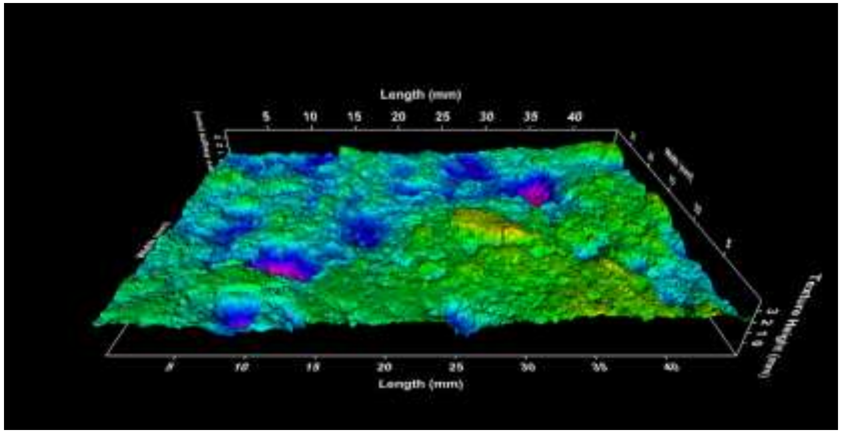
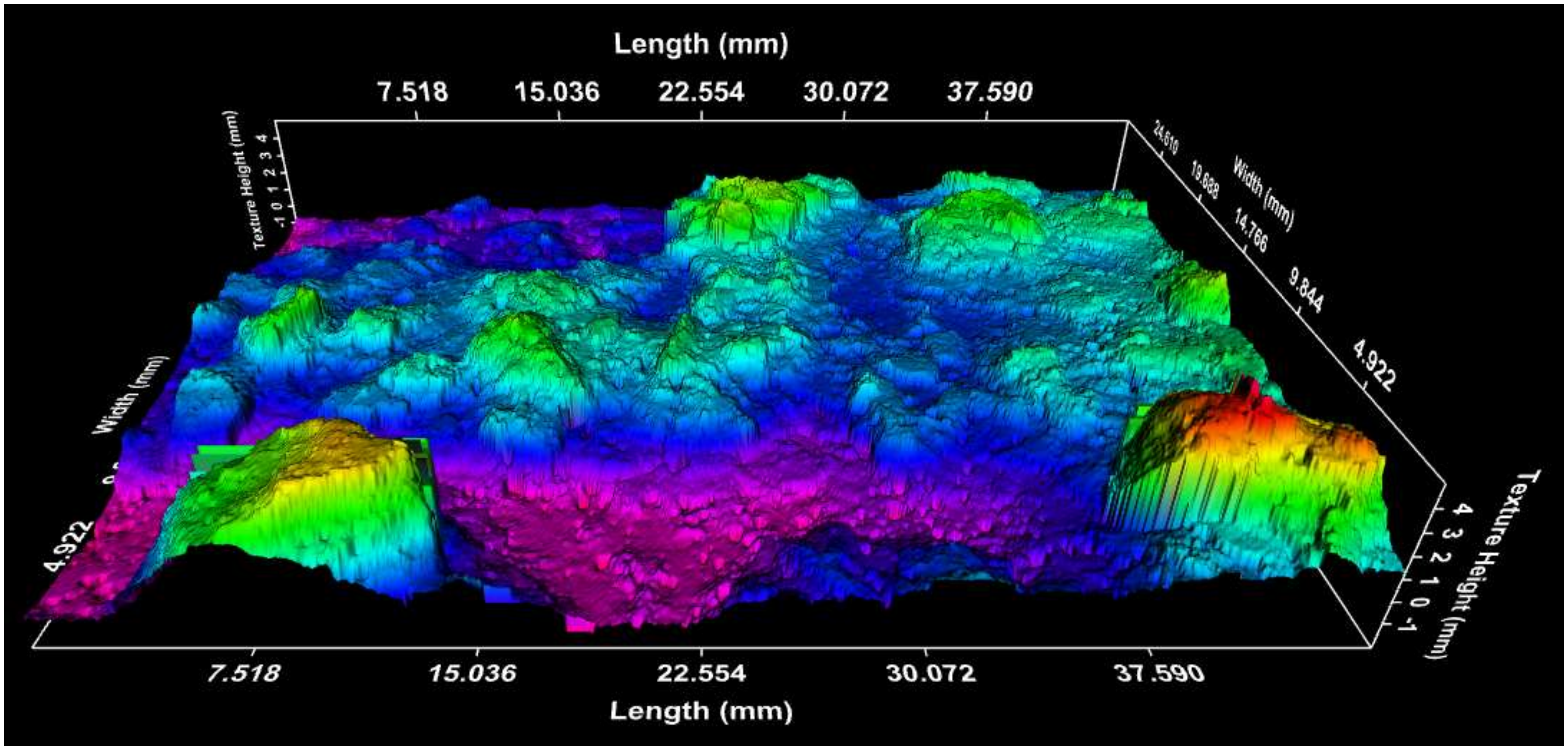
Before and After High Surface Texture High WTAT Loss





High Surface Texture WTAT Scan before soak and wear



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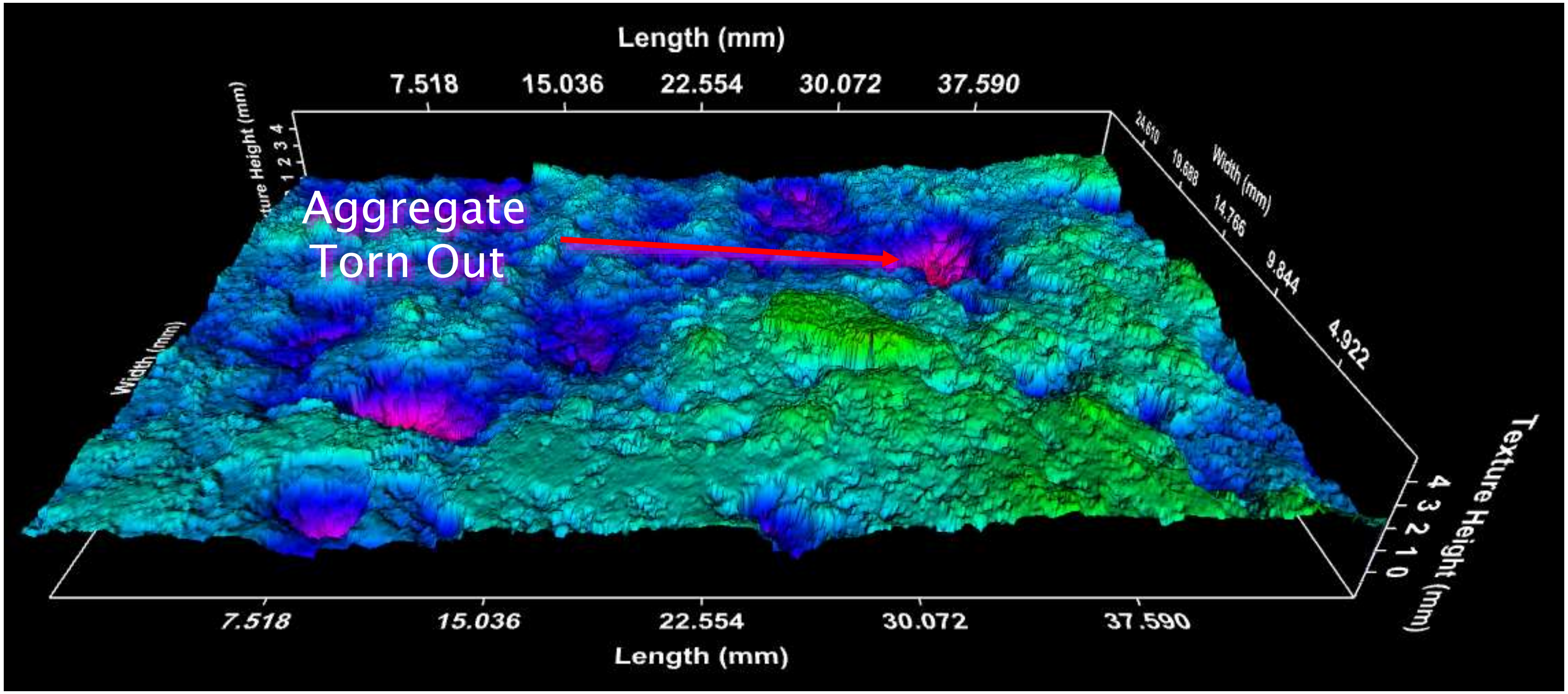
High Surface Texture WTAT Scan After Soak and Wear



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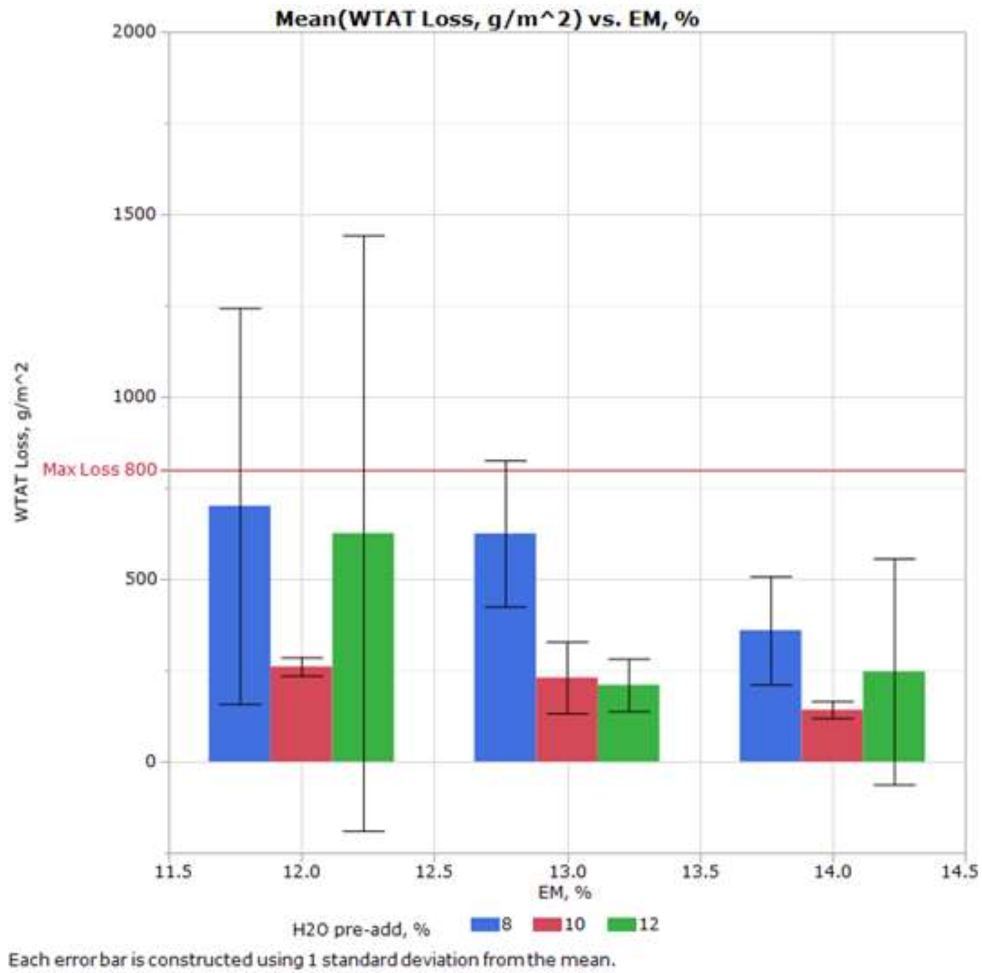
WTAT Loss Vs EM, %



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Effect Summary (WTAT Only)

Effect Summary

Source	LogWorth	PValue	
Chem load, %*EM, %	10.610	0.00000	
Gradation*H2O pre-add, %	7.570	0.00000	
Chem load, %(1.2,1.8)	7.501	0.00000	^
Strike off S to S	6.998	0.00000	
EM, %(12,14)	6.070	0.00000	^
Template Thicness*EM, %	4.562	0.00003	
Strike off	2.724	0.00189	
Strike off*Chem load, %	2.289	0.00514	
Template Thicness	1.778	0.01667	^
Gradation	1.720	0.01904	^
H2O pre-add, %(8,12)	1.176	0.06670	^

The Future of Micro Surfacing

- Challenge assumptions
- Borrow from the overall asphalt industry.

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Future of Micro Surfacing –

Update Industry Source Material & Documentation

Evaluate / Revise Test Methods and Specifications