ALDOT's PG3 Cape Seal Project

(Scrub Seal and Micro Surfacing)

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National Center for Pavement Preservation

MICHIGAN STATE UNIVERSITY

Best Practices for *Micro-Surfacing* Applications

MICHIGAN STATE UNIVERSITY

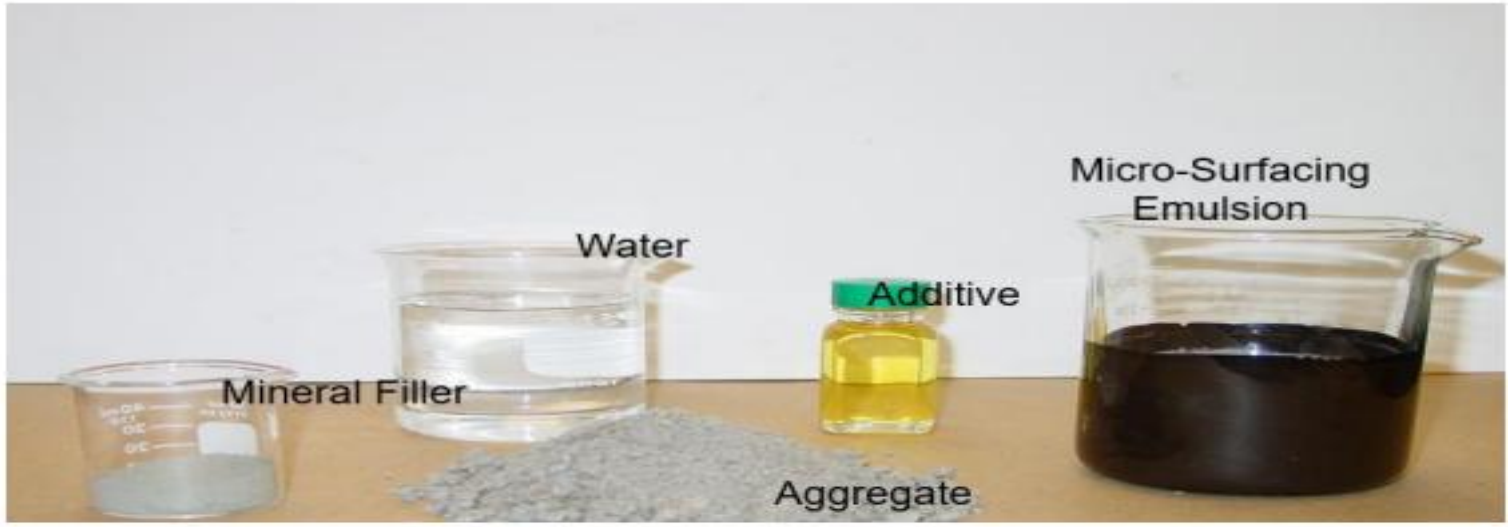
Micro Best Practices

1st Things First

What is *Micro-surfacing?*

What is *Micro-surfacing?*

- Micro surfacing is a chemical system. Each component has an important function in the system and when any component fails to meet the design parameters the system breaks down.
- Components Include:
  - Aggregate
  - Emulsion
  - Cement
  - Additives
  - Paver Calibration



What is *Micro-surfacing?*

- Laboratory designed mixture of asphalt emulsion, aggregate, mineral filler, water and other additives accurately proportioned, mixed and uniformly spread over a properly prepared surface.
- Type 2 and Type 3
- Mixed and spread in a mobile operation as thin wearing surface
- Mix design is required
- CQS-1HP (3% Polymer)

Micro Surfacing (CQS-1HP)

- Always Cationic
- Always Quick set
- Always Polymer modified
- Continuous paver or truck mount
- Two Gradations of aggregate (II & III)
- Faster Return to Traffic
- Night Work
- Stone stacking ability
- Can repair larger deviations

Table 7: Component Materials and Ranges for Microsurfacing

COMPONENT MATERIALS	SUGGESTED LIMITS
Residual Asphalt	5.5 – 10.5% by dry weight of aggregate
Mineral Filler	0.0 - 3.0% (Based on dry weight of aggregate)
Polymer Content	Minimum of 3.0% solids based on bitumen weight content
Additives	As needed
Water	As required to produce proper mix consistency

After ISSA A105 (2020)

Table 9: Application Rates for Microsurfacing

AGGEGATE TYPE	LOCATION	SUGGESTED APPLICATION RATE
Type II	Urban and Residential Streets Airport Runways Scratch or Leveling Course	10 - 20 lb./yd2 (5.4 - 10.8 kg/m2) As Required
Type III	Primary and Interstate Routes Wheel Ruts Scratch or Leveling Course	15 - 30 lb./yd2 (8.1 - 16.3 kg/m2) As Required (See Appendix B) As Required

After ISSA A143 (2020)

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After ISSA A143 (2020)

Benefits of Micro-Surfacing

- Extending Pavement Service Life
- Decreasing Pavement Permeability
- Improving Surface Friction
- Correcting Moderate Bleeding/flushing (in Chip Seals)
- Leveling and Rut Filling (Type III)

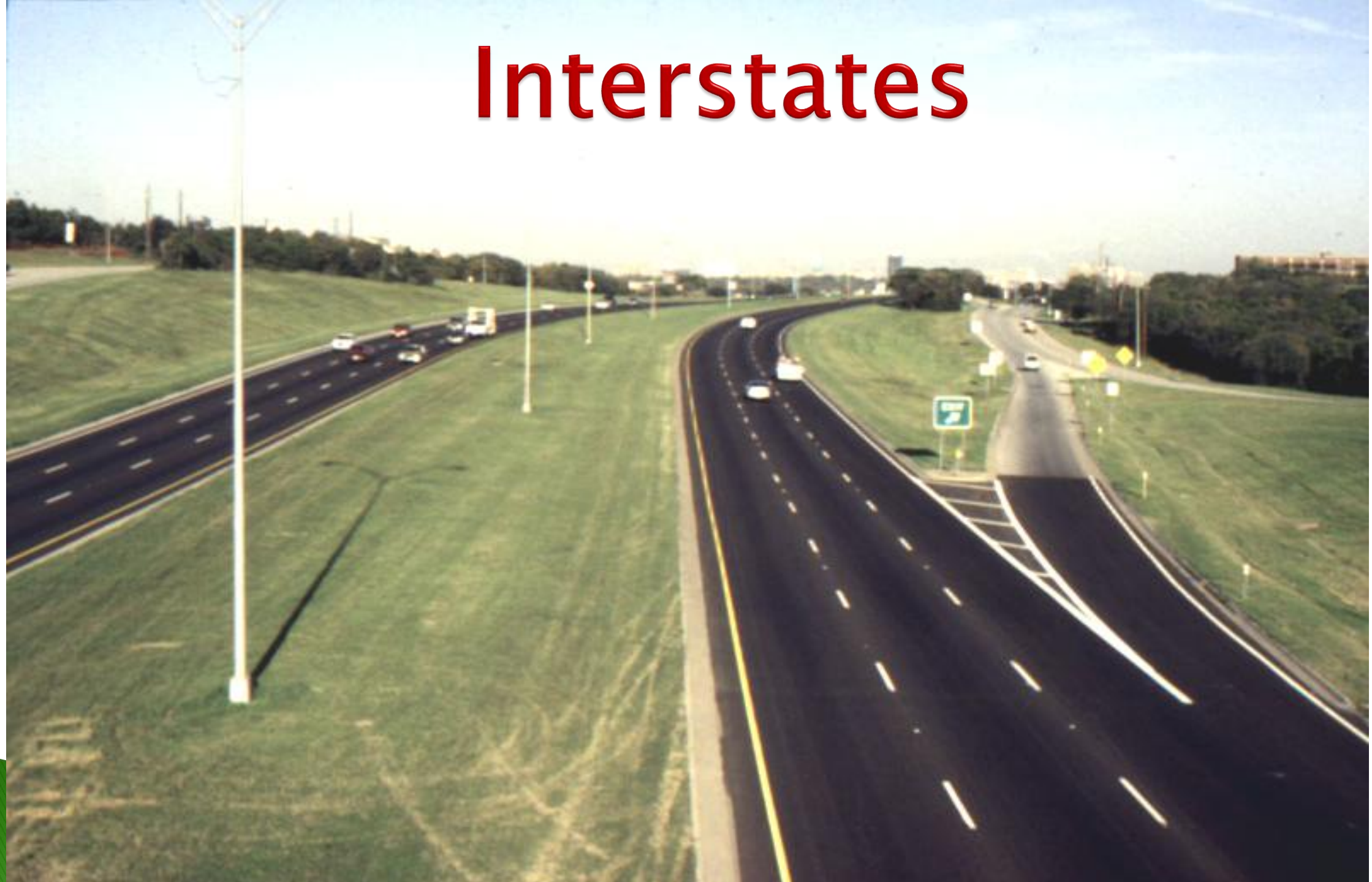
Where Can Micro Be Used?

Airports

Airports

Expressways

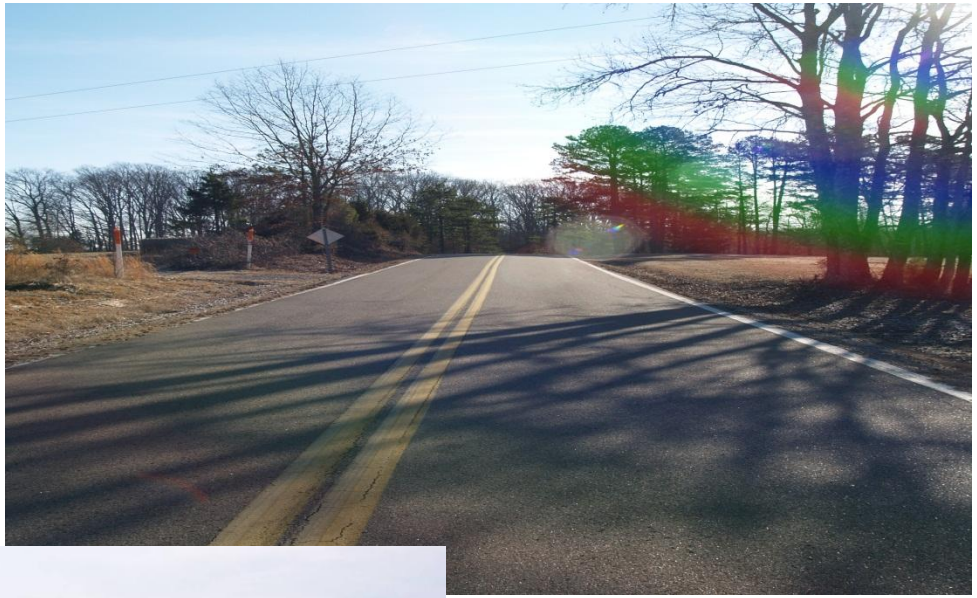
Interstates



Shoulders

Good Candidates for Slurry Systems?

Good Candidates for Slurry Systems



What is *Micro-surfacing?*

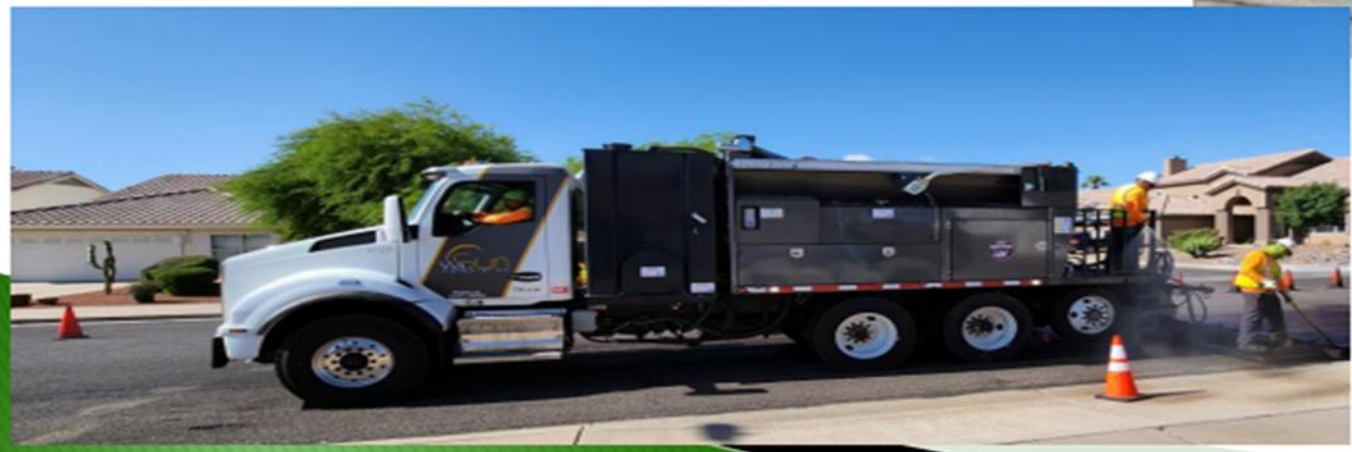
How is it applied to the roadway?

EQUIPMENT

EQUIPMENT

Micro-surfacing is applied with a *Slurry Paver*

Truck Mount Pavers




MACK

Truck Mount Operations

Truck Mount Pavers

Advantages

- Flexibility
- Smaller Crew
- Fast Travel Speed Between Jobs or Streets
- Maneuverability *

Disadvantages

- Transverse Joints every 1500 ft. (+/-)
- Heavy Axle Loading
- Expensive equipment spends ¾ of its life driving to and from Stockpile.
- Operator does not have control of forward speed.
- Maneuverability *

Continuous Paver

Continuous Paver– Video

Continuous Paver

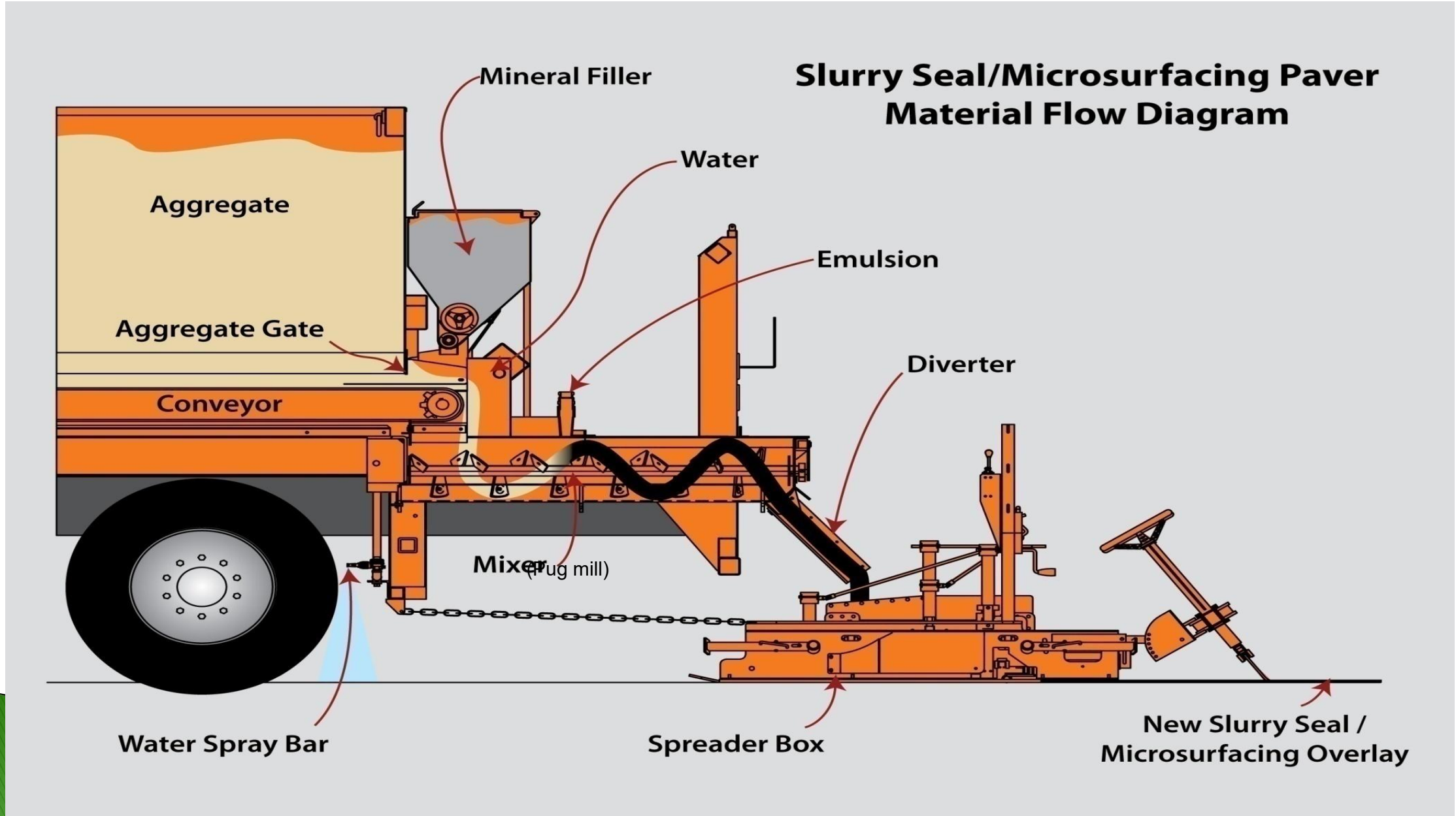
Advantages

- Fewer Transverse Joints
- Operator has control of forward speed.
- More Miles Per Day
- Left and Right Drivers Stations
- Inexpensive Haul Trucks*
- One Calibration per job

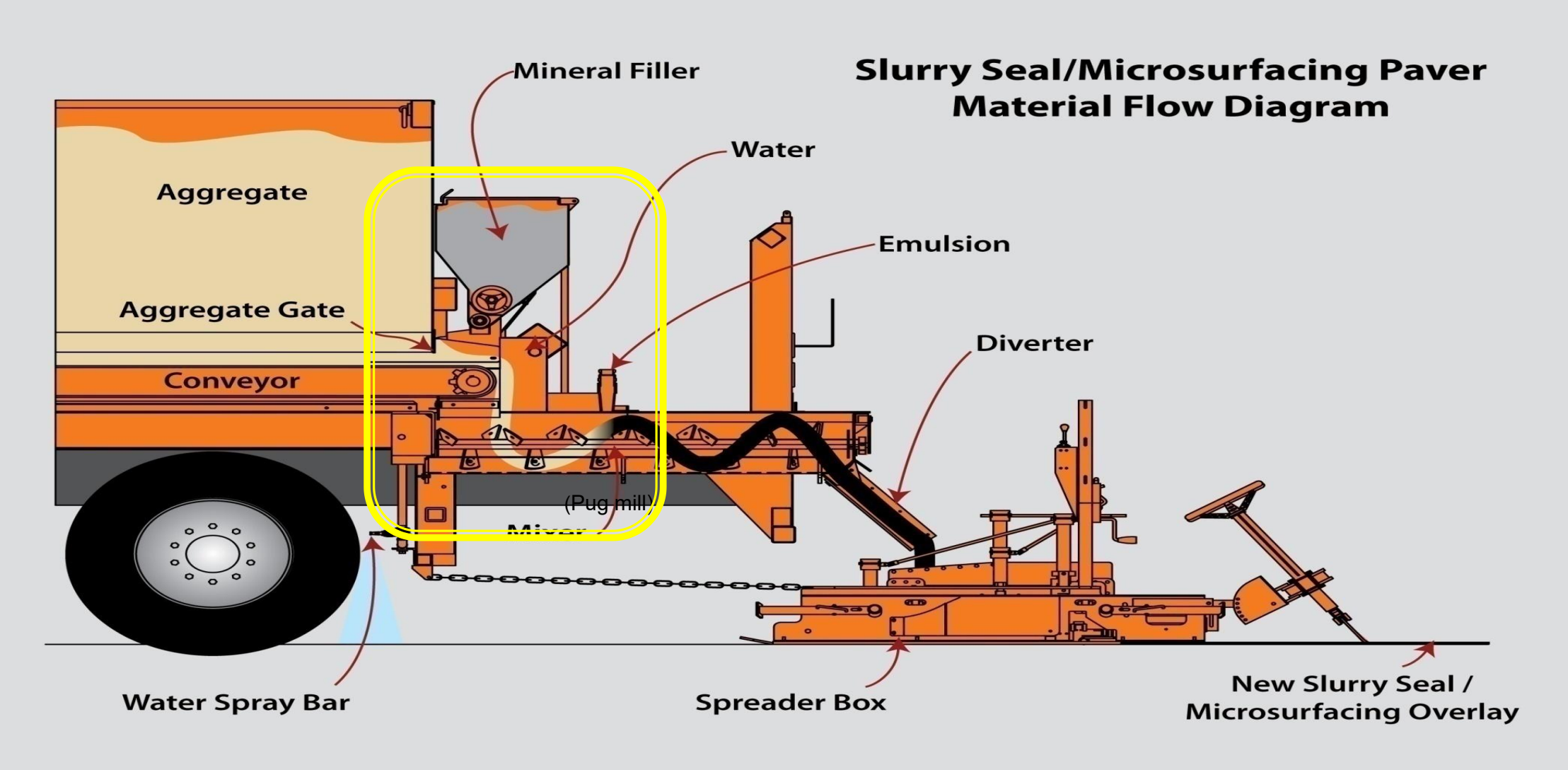
Disadvantages

- Paver breaks, you're done!
- Travel Speed – need Lowboy
- Additional Crewmembers
- One Paver One Job

Application Equipment



Paver Types
Mechanical vs Electronic

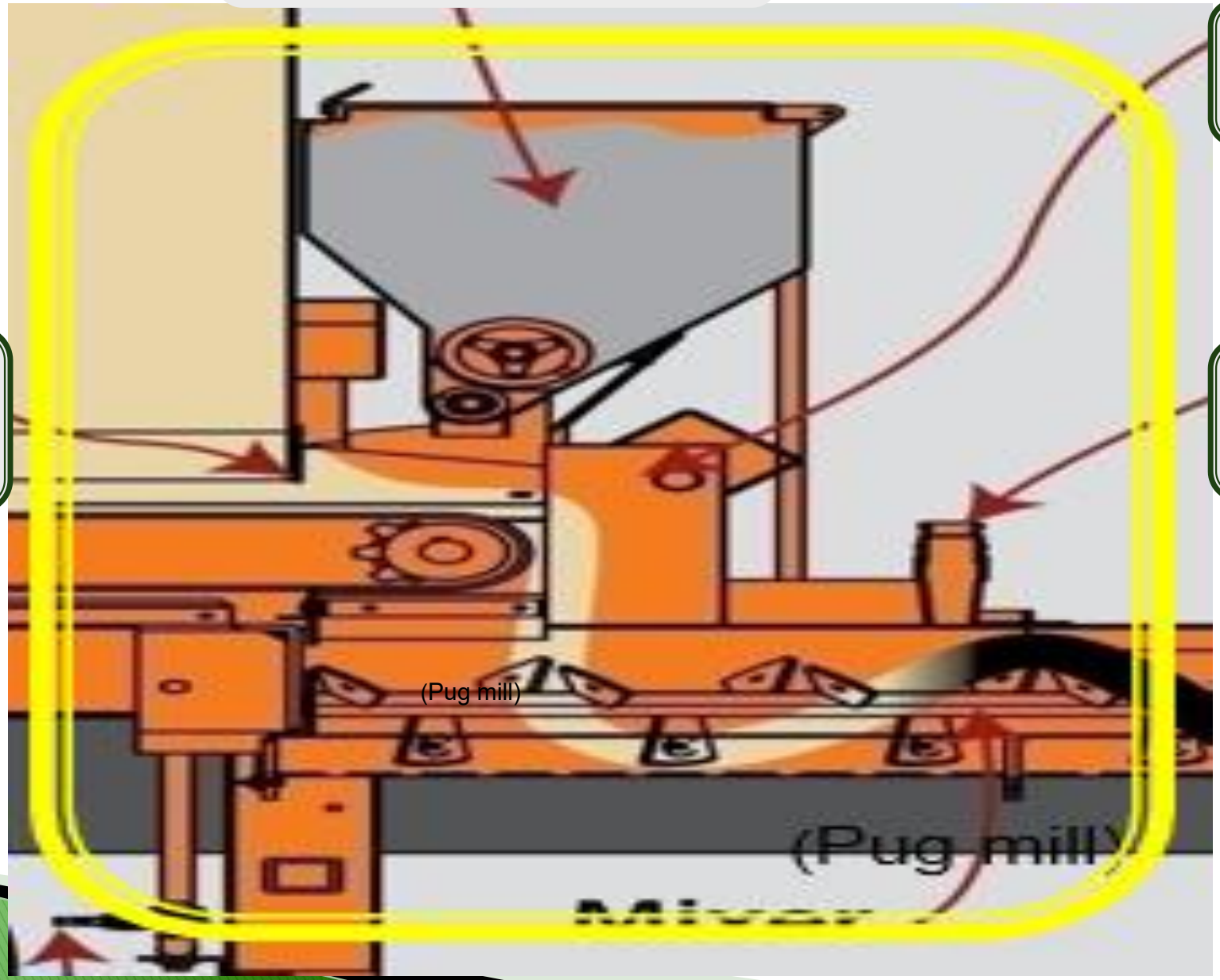


Mineral Filler

Water

Aggregate

Emulsion



Paver Types

Mechanical –Air / Hydraulic

- A mechanical paver uses a Jackshaft to power the emulsion pump and aggregate belt.
- Jackshaft keeps the aggregate belt and the emulsion pump in the same ratio.
- Hydraulic systems are operated by air switches.

Electronic – Electric over Hydraulic

- An electronic paver uses computer controlled hydraulic motors to separately power the aggregate belt and emulsion pump.
- The computer maintains the ratio of the aggregate and emulsion.

Mechanical Mix Control

Electronic over Hydraulic

Paver Types

Mechanical –Air / Hydraulic

- Mechanical paver has an adjustable aggregate gate that controls emulsion content.
- Paver is calibrated using air or electronic counter which count revolutions of the aggregate belt and emulsion pump.

Electronic – Electric over Hydraulic

- Electronic paver has a fixed aggregate gate.
- Emulsion content is controlled by the computer controller.
- Controller checks and adjusts speed of various motors to keep mix ratios constant.

Monitoring and Mix-Control Systems

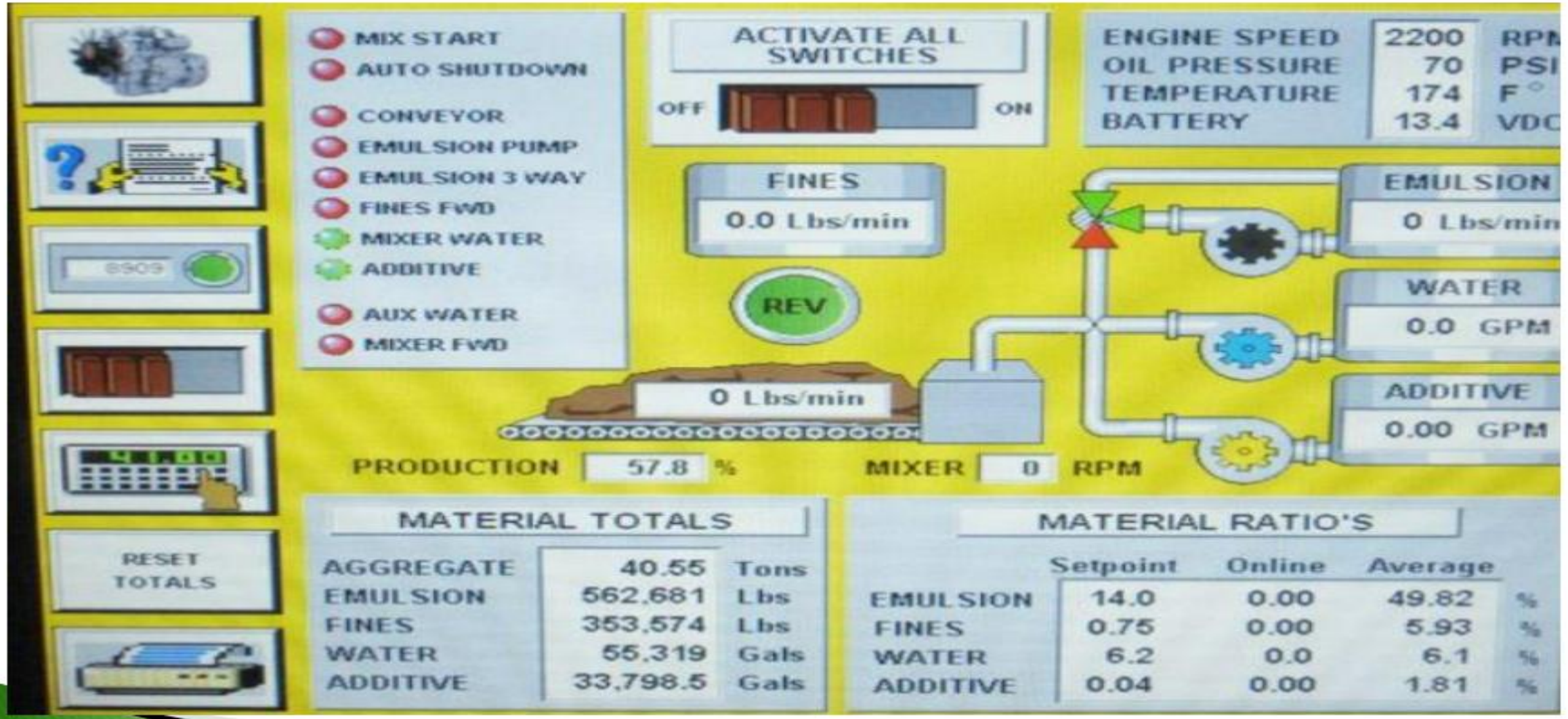
Monitoring Systems

- Electronically captures information from counters.
- Visual and Printed Reports showing:
  - Quantities
  - Emulsion Percentage
  - Cement Percentage
  - S.Y. Applied

Computer Mix Control

- Operator inputs mix design and desired production rate into computer.
- Computer controls speed of conveyor and liquid pumps to maintain mix design.
- Computer adjusts to production changes to keep outputs in mix design.
- Tracks Distance and Width covered to calculate application rate.

Electronic Mix Control



Application Equipment

EQUIPMENT

403.04 Equipment.

(a) General.

All equipment, tools, and machines used in the performance of this work shall be approved by the Engineer. No work shall be attempted with equipment that is malfunctioning. The Engineer may order that the work be discontinued if sufficient equipment and tools are not in use to place the materials satisfactorily.

(b) Mixing Equipment.

The paving mixture shall be mixed by a self-propelled Micro-Surfacing mixing machine which shall be a front feed continuous flow mixing unit *able to accurately deliver and proportion the aggregate, emulsified asphalt, mineral filler, field control additives and water to a* revolving multi-blade, twin shafted mixer and discharge the mixed product uniformly on a continuous flow basis.

Continuous Run Machine

Truck Mounted Unit

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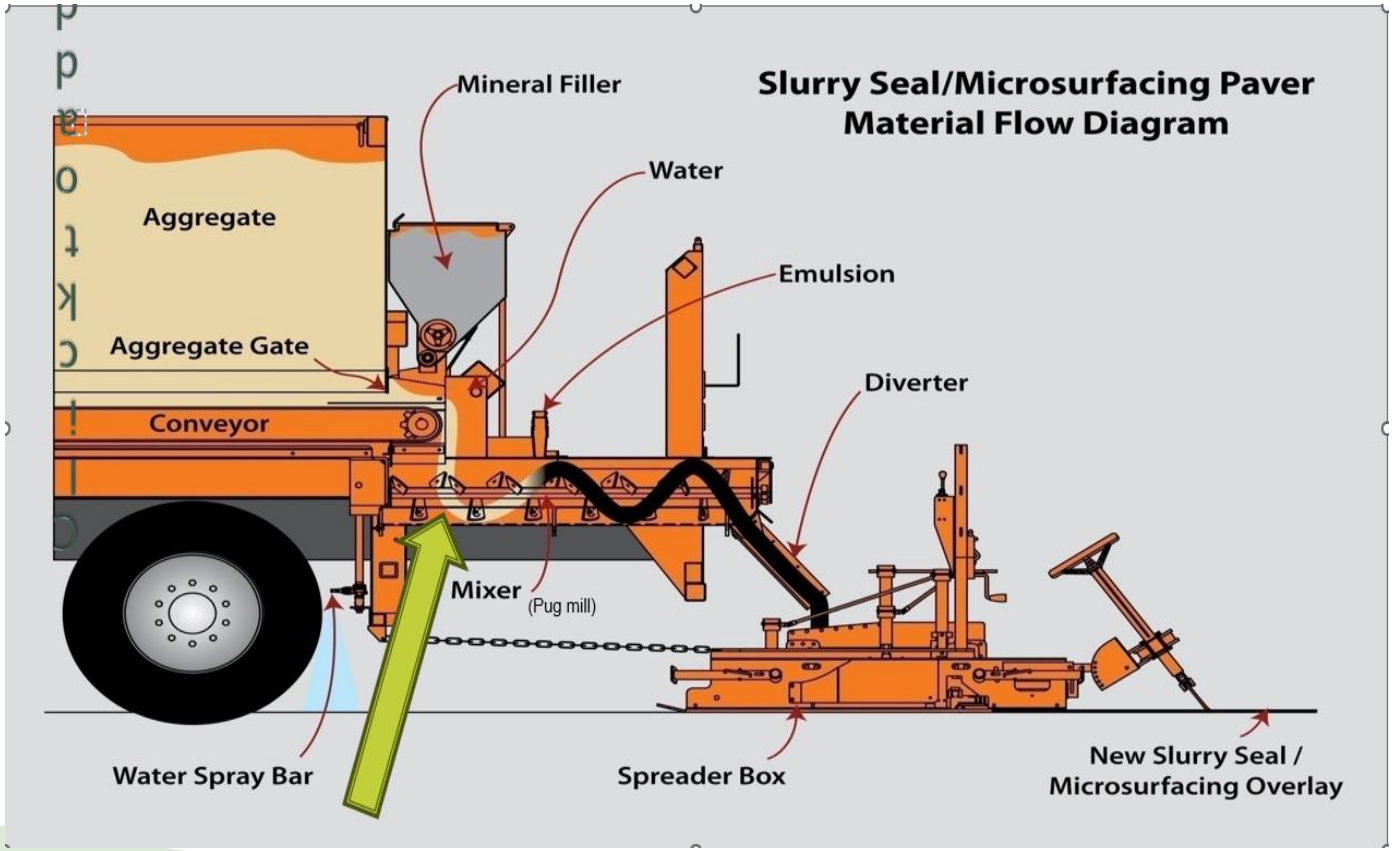

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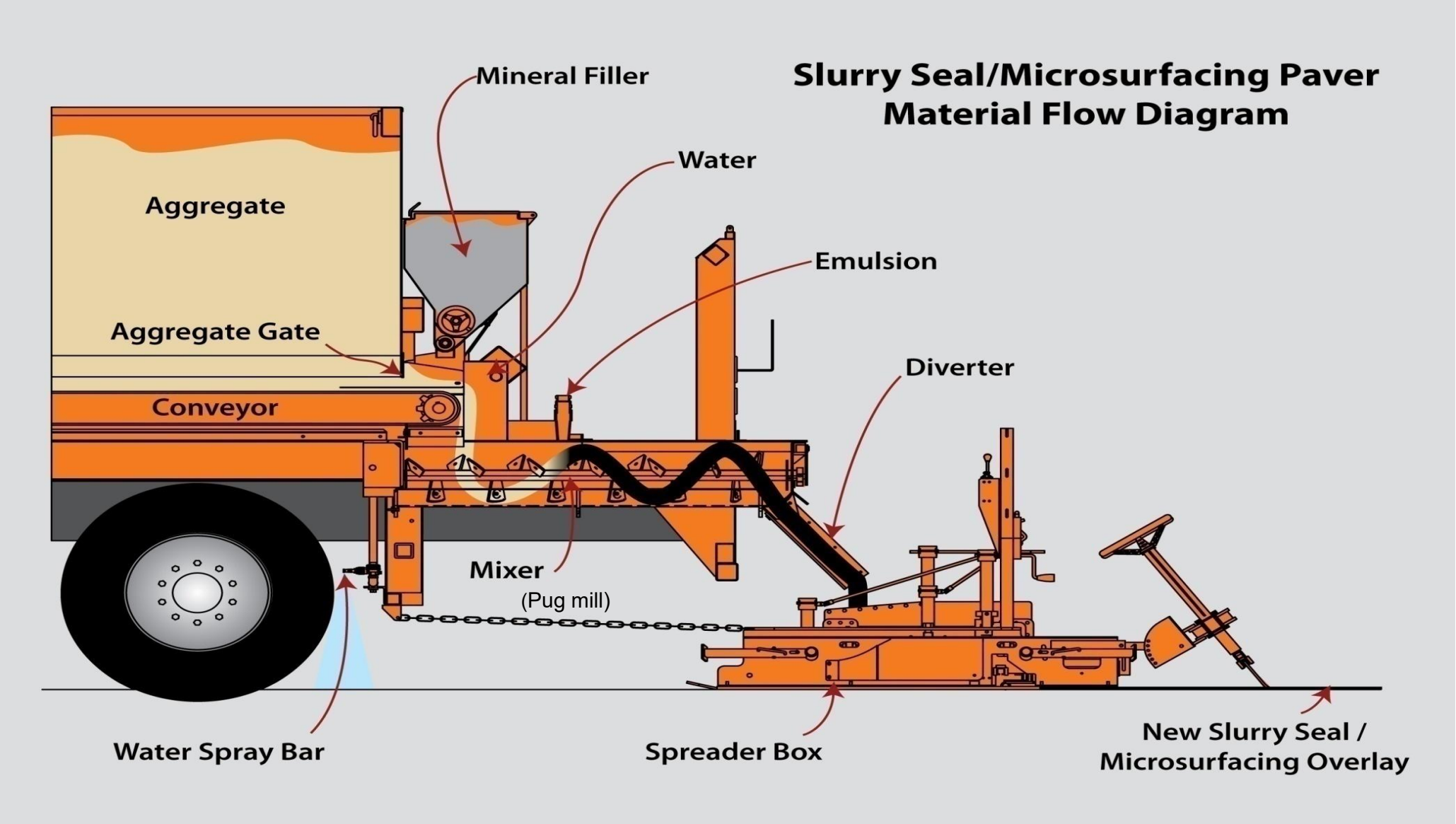
Additionally, the mixing machine shall be equipped with dual side driving stations of original equipment manufacturers design that will assist in proper alignment when applying mixture.

A spray bar shall be provided to completely wet the aggregate entering the pugmill with additive (if used) and water.

Application Equipment



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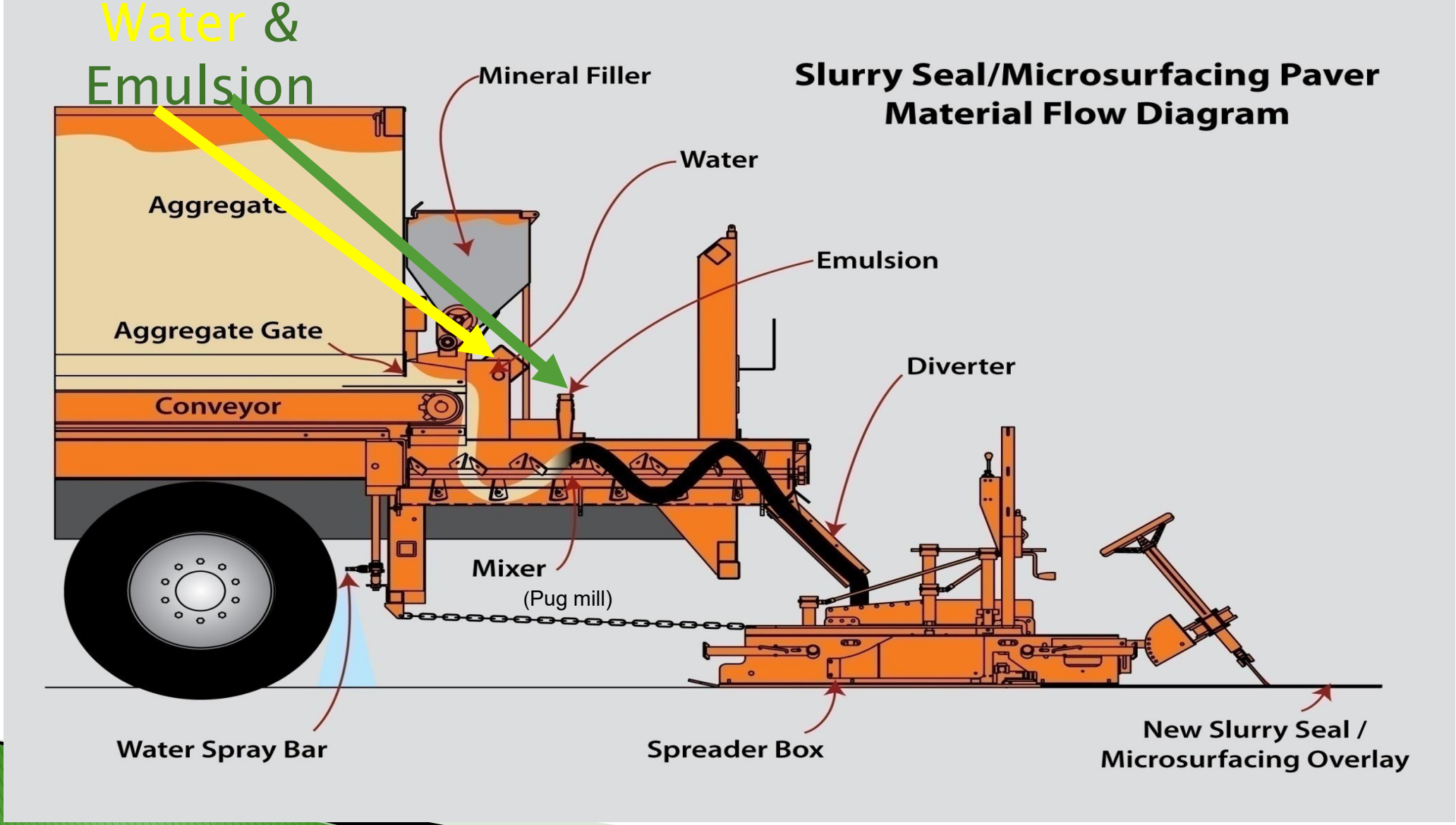


Application Equipment

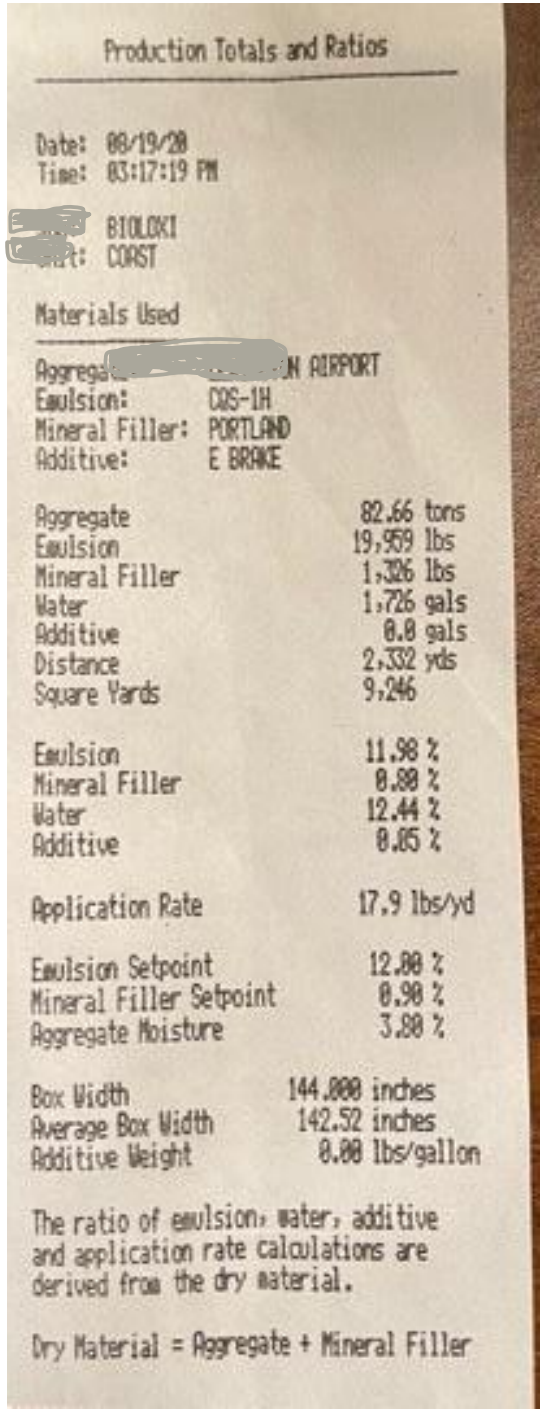
403.04 Equipment.

(b) Mixing Equipment.

The Contractor shall provide a computerized material monitoring system with integrated materials control devices that are readily accessible and positioned so the amount of each material used can be determined at any time. Each material control device shall be clearly marked and calibrated prior to mix application.

The mixer shall be equipped with a back-up electronic materials counter that is capable of recording running count totals for each material being monitored. The mixer shall have the capability to record and display the following information:

1. Individual sensor counts for emulsion, aggregate, mineral filler, water and additive;
2. Aggregate, emulsion, and mineral filler output in lbs. per minute;
3. Ground travel distance;
4. Spread rate in lbs. per square yard;
5. Percentages of emulsion, mineral filler, water, and additive;
6. Cumulative totals of aggregate, emulsion, mineral filler, water, and additive;
7. Scale factor for all materials.



Production Totals and Ratios

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[redacted] BIOLOKI
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Materials Used

Aggrega[redacted]N AIRPORT
Emulsion: QDS-1H
Mineral Filler: PORTLAND
Additive: E BRAKE

Aggregate	82.66 tons
Emulsion	19,959 lbs
Mineral Filler	1,326 lbs
Water	1,726 gals
Additive	0.0 gals
Distance	2,332 yds
Square Yards	9,246
Emulsion	11.98 %
Mineral Filler	0.80 %
Water	12.44 %
Additive	0.05 %
Application Rate	17.9 lbs/yd
Emulsion Setpoint	12.00 %
Mineral Filler Setpoint	0.90 %
Aggregate Moisture	3.00 %
Box Width	144.000 inches
Average Box Width	142.52 inches
Additive Weight	0.00 lbs/gallon

The ratio of emulsion, water, additive and application rate calculations are derived from the dry material.

Dry Material = Aggregate + Mineral Filler

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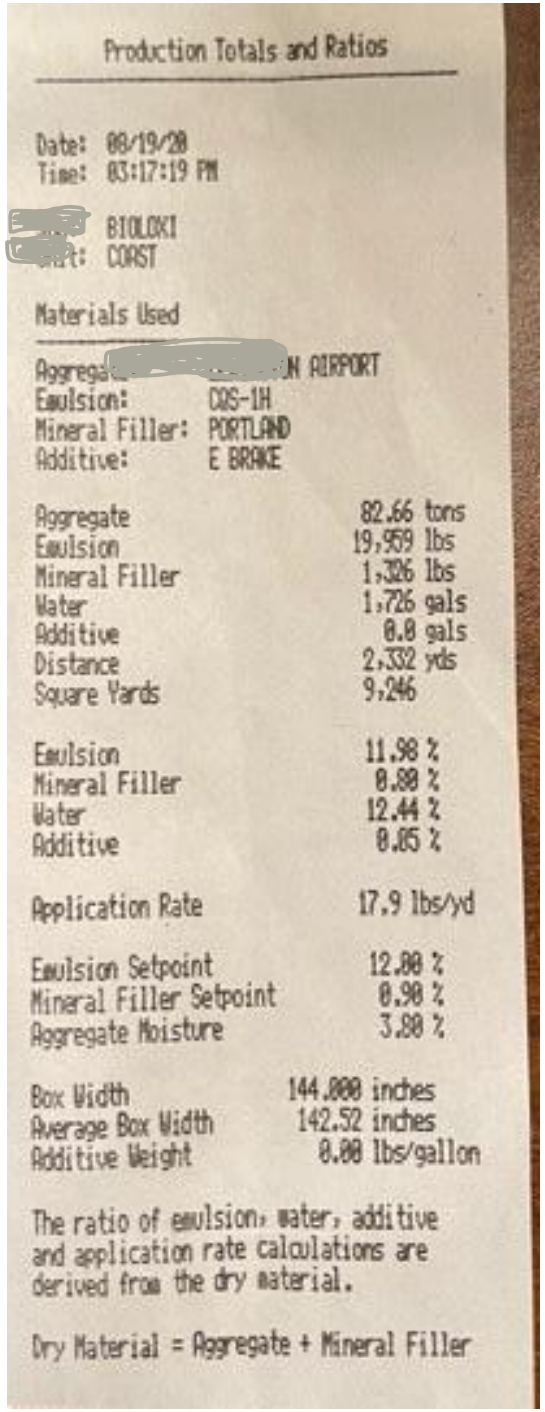

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403.04 Equipment.

(b) Mixing Equipment.

The Contractor shall calibrate the mixing machine for each material type with a minimum of 3 tests. The mixing machine shall be calibrated every time a material component is changed. Additional calibrations may be required during production as directed by the Engineer.

Additional requirements:

1. Water Pressure System. The mixing machine shall be equipped with a water pressure system and nozzle type spray bar to provide a water spray ahead of and outside the spreader box when required.
2. Proportioning Devices. Individual volume or weight controls for proportioning each material to be added to the mix shall be provided and properly marked. These proportioning devices shall be used in materials calibration and for determination of materials output at any time. Each mixing unit shall be calibrated prior to commencement of the work.
3. Emulsion Pump. The emulsion pump shall be a heated, positive displacement type pump.

Application Equipment

403.04 Equipment.

(c) Spreading Equipment.

Application Equipment

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The Micro-Surfacing mixture shall be spread uniformly by means of a hydraulically adjustable type spreader box with a positive screed adjustment and equipped to expand as necessary for varying pavement widths attached to the mixer, equipped with ribbon flighted augers to agitate and spread the materials throughout the box. These augers shall be designed to maintain sufficient turbulence in the mixture to prevent the material from setting-up in the box or causing buildup and lumps. A front seal s hall be provided to ensure no loss of the mixture at the road contact surface. The rear seal shall act as a final strike-off and shall be adjustable. The spreader shall be maintained to prevent the loss of the paving mixture in surfacing super-elevated curves. The spreader box and rear strike-off shall be 193 SECTION 403 MICRO-SURFACING SEAL COAT designed and operated so that a uniform consistency is achieved to produce a free flow of material to the rear strike-off without causing skips, lumps, or tears in the finished surface.

Spreader Boxes

- Slurry Box
  - Slurry Only
  - No Augers
  - Front Auger
  - Dual Augers
- Hydraulic Spreader Box – Dual Augers
  - Slurry or Micro
  - Stop to Adjust Width
- Variable Width Spreader Box–Dual Augers
  - Slurry or Micro
  - Adjustable on the Go
- Rut Box

Slurry Box

Spreader Box Operation

Application Equipment

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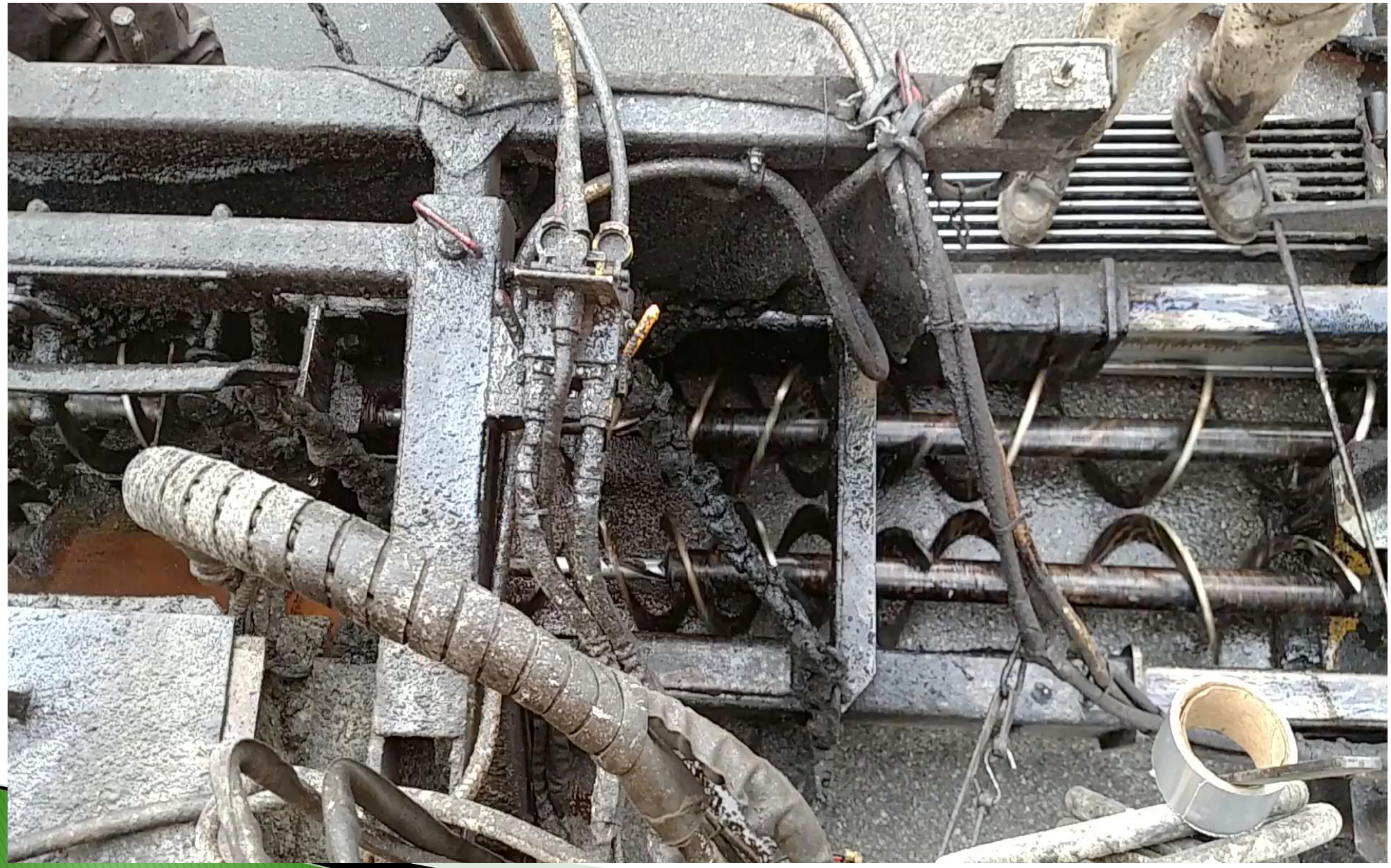

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Variable Width Spreader Box

Application Equipment

Application

Application Equipment

403.04 Equipment.

(d) Rut-Filling Equipment.

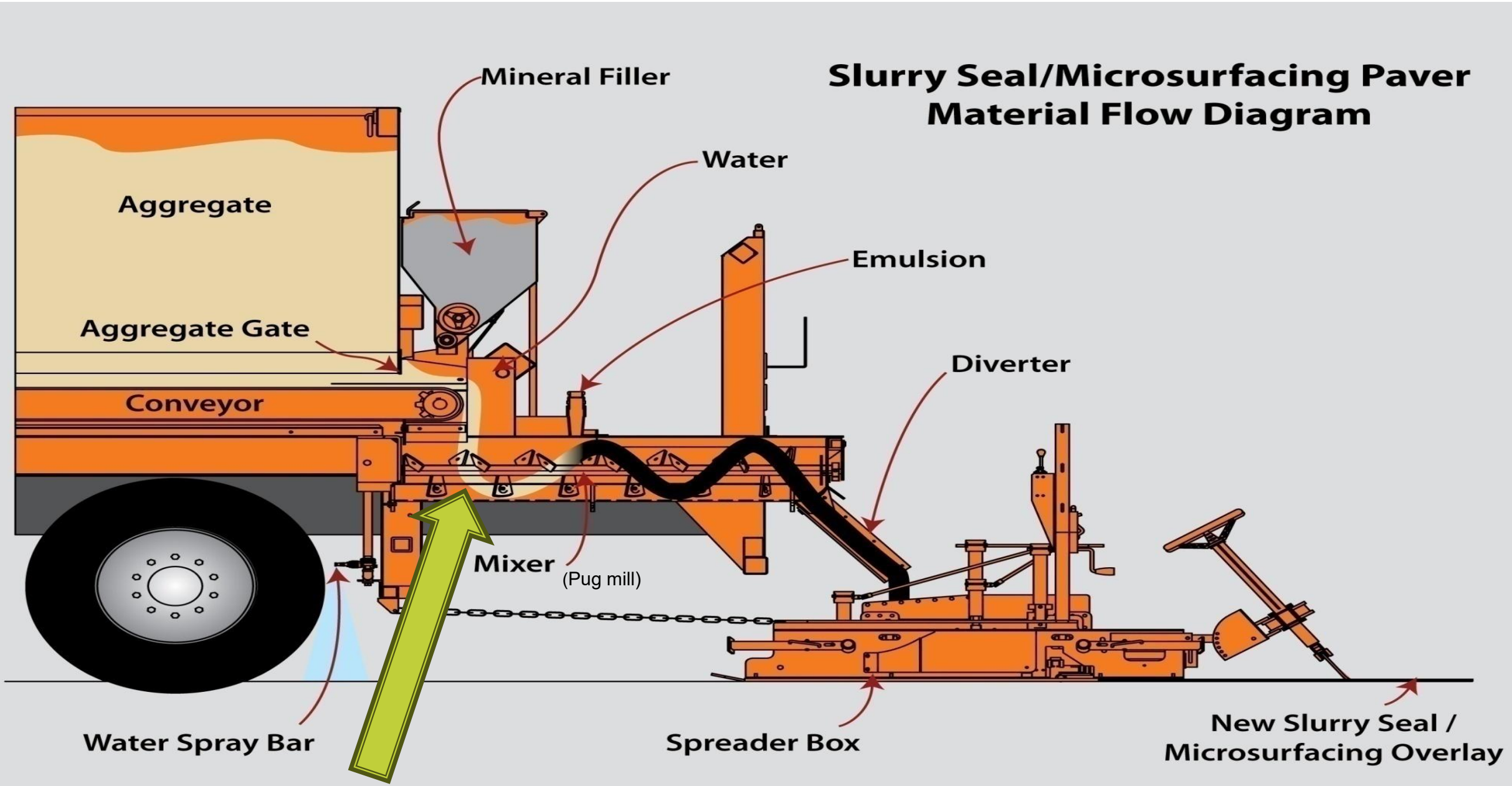
Microsurfacing materials may be used to fill ruts, utility cuts, depressions in the existing surface, and minor surface blemishes. Ruts less than 0.5 inches in depth shall be filled with a leveling course pulled full width with the spreader box. Ruts equal to or *greater than 0.5 inches* in depth shall be filled independently with a rut-filling box. Ruts *greater than 1.5 inches* in depth may require multiple applications with the rut-filling box to restore the cross-section. The rut-filling box shall be either 5 foot or 6 foot in width. All rut-filling material shall be allowed to cure under traffic for at least 24 hours before any additional material is placed.


Rut Fill Spreader Box

Equipment Inspection Items

- Cleanliness
  - Mixer cleaned nightly
  - Spreader Box cleaned at every stop (micro) and nightly.
- Aggregate Spillage
  - Under Feed Belt
  - Under Mixer
  - Front Hopper Rubber
- Liquid Leakage
  - Hydraulic Oil or Fuel
  - Emulsion

Application Equipment



Equipment Inspection Items

- Spreader Box
  - Clean
  - Augers within ½ inch of roadway or as low as possible.
  - Augers not foaming or splashing mix
  - Front Rubber in Place
  - Side Rubbers in Place and tight.
  - Side Runners are level and not rocking.
  - Box Urethane is Tight with No Wrinkles

Materials

Materials

Laboratory designed mixture of asphalt emulsion, aggregate, mineral filler, water and other additives accurately proportioned, mixed…

MIX DESIGN

MIX DESIGN

403.02 Materials. All materials shall comply with the requirements of Division 800, Materials, except as noted herein. Special reference is made to the following:

(a) Aggregate.

1. Coarse aggregates for micro surfacing seal coat shall be crushed aggregate meeting the requirements of Section 801. The kind of aggregate materials used shall be at the Contractor's option within the following limits.
2. The use of carbonate stone such as limestone, dolomite, or aggregate tending to polish under traffic shall be restricted as follows, based on the average daily traffic (ADT) count in both directions:

- 500 vehicles per day or less – No restrictions apply.
- 501 to 5,000 vehicles per day – Carbonate stone shall be limited to a maximum of 30% of the blended gradation.
- Over 5,000 vehicles per day – Carbonate stone shall not be used in any application. Aggregates shall be limited to siliceous aggregates such as granite, quartzite, blast furnace slag or lightweight aggregates (expanded clays or shales produced by the Rotary Kiln Method). Crushed gravel shall have a bulk specific gravity greater than 2.550 (AASHTO T 85). The aggregate shall meet the appropriate requirements of Sections 801 and 802, and the following: Test Property Test Method Sand Equivalent on material passing No. 4 Sieve Specification AASHTO T 176 LA Abrasion AASHTO T 96 65 Min Sodium Sulfate Soundness AASHTO T 104 36% Max 10% Max

MIX DESIGN

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(a) Aggregate.

3. Aggregates shipped to the project shall be uniform and *shall not require blending or pre-mixing* at the storage area before use and shall meet the appropriate gradation as shown in Table No. 1 in Article 403.03. All aggregates shall be thoroughly screened directly into the support vehicles prior to the application of any mixture to eliminate the potential of oversized and deleterious materials.

AGGREGATE

Type I (1/8”)

Type II (1/4”)

Type III (3/8”)

MIX DESIGN

403.02 Materials. All materials shall comply with the requirements of Division 800, Materials, except as noted herein. Special reference is made to the following:

(b) Mineral Filler.

The **mineral filler may be any recognized brand of non-air entrained Portland cement or hydrated lime** that is free of lumps, or any other mineral additive approved by the Engineer. It shall be accepted upon visual inspection. The *amount of mineral filler needed shall be determined by the laboratory mix design* and shall be considered as part of the material gradation requirement. The *mineral filler shall not exceed 3% of the weight of the aggregate and shall have a mixture control tolerance of ±0.25%.*

Cement

- Cement promotes a thicker/creamier mix and keeps the water from separating in the spreader box.
- Cement also starts the breaking process of Micro surfacing by causing a PH shift that makes the aggregate more attractive to the emulsion.
- The contractor may adjust his cement percentage (within the JMF) throughout the day. This changes can increase or decrease the break time.

MIX DESIGN

403.02 Materials. All materials shall comply with the requirements of Division 800, Materials, except as noted herein. Special reference is made to the following:

(c) Asphalt Emulsion.

The emulsified asphalt shall be either a cationic type CQS-1hp meeting the requirements of Section 804 or a cationic type CQS-1h meeting the requirements of Section 804. The CSS-1h shall also be polymer modified containing a minimum of 3.0% polymer by volume. The polymer shall conform to the requirements given in Section 811.

Emulsion

- Temperature
  - Micro surfacing works best when the temperature of the emulsion is between 80 and 110 F.
    - Emulsion under 75 F may separate or shear. It may separate during storage.
    - Emulsion over 125 F will probably cause the system to break quickly and be "out of control".
- Separation
  - Small amounts of separated latex are ok but watch for large strings in the tanker.
  - Also watch for large strings of separated latex in the spreader box. In this case, contractor should shut down and ship the load back.

MIX DESIGN

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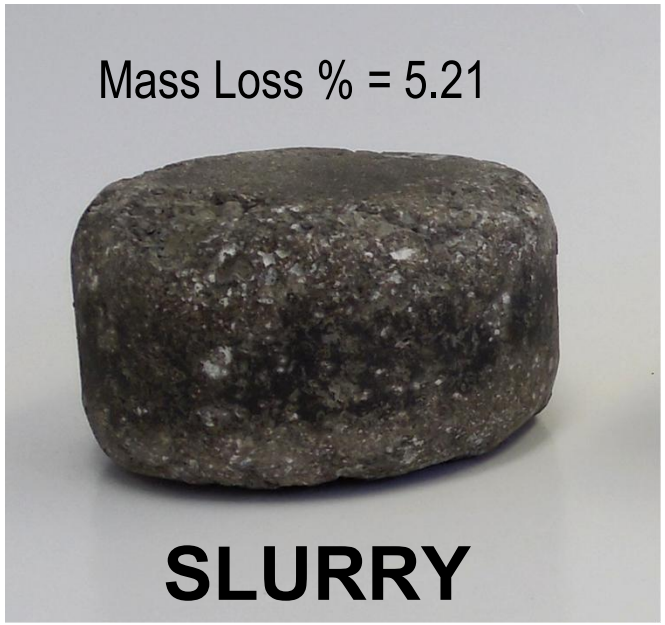
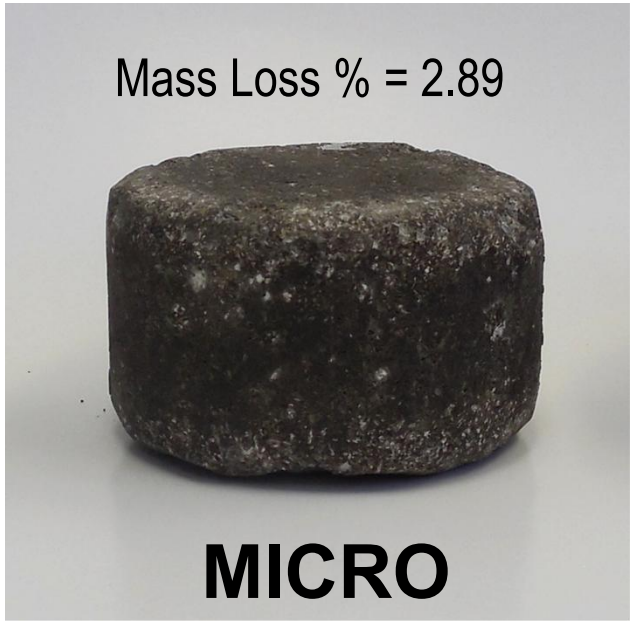
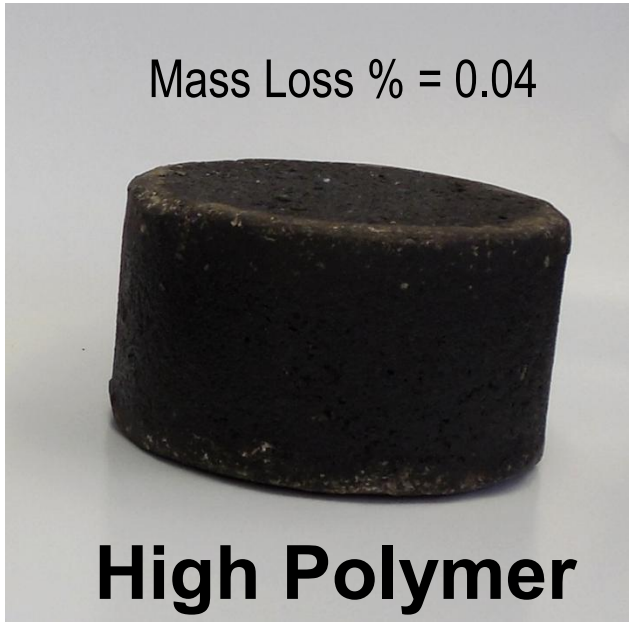
(c) Asphalt Emulsion.

The emulsified asphalt shall be either a cationic type CQS-1hp meeting the requirements of Section 804 or a cationic type CQS-1h meeting the requirements of Section 804. The CSS-1h shall also be **polymer modified containing a minimum of 3.0% polymer** by volume. The polymer shall conform to the requirements given in Section 811.

Polymer Effects







Sharp turns, especially by heavy vehicles, are damaging micro surfacing for some time after application, particularly in hot weather.

How can I reduce the chances of this happening?

Sharp turns, especially by heavy vehicles, are damaging micro surfacing for some time after application, particularly in hot weather.

How can I reduce the chances of this happening?

How can I reduce the chances of this happening?

- Heavy duty micro
- High Polymer Micro (CSS-1EP)
- Double the polymer (6% vs. 3%)
- Aids in prevention of power steering burns and snowplow damage

When should I use high polymer micro???

- High Volume roads
- Roads with lots of turning movements where the surface is vulnerable early in the curing period.
- Intersections
- To Reduce raveling
- To Address rutting
- Enhances durability
- Restore friction
- Extends service life 7-9 years (1-2 years more than conventional micro)

MIX DESIGN

403.02 Materials. All materials shall comply with the requirements of Division 800, Materials, except as noted herein. Special reference is made to the following:

(d) Water.

The water for the Micro-Surfacing mixture shall be potable and free from any contaminants detrimental to the mixture.

(e) Other Additives.

The emulsion manufacturer shall provide other additives as required to control the set time of the mixture in the field.

MIX DESIGN

403.03 Composition of Mixture.

(a) Constituents

The Micro-Surfacing material shall be a uniform mixture of aggregate, polymer modified emulsified asphalt, mineral filler, water and other additives as required to control set time in the field. The Engineer will require immediate adjustments or replacement of any constituent as needed to produce an acceptable mixture. The constituents shall be proportioned to produce a uniform mixture meeting the requirements of **Table No. 1.**

MIX DESIGN

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TABLE NO. 1	MICRO-SURFACING DESIGN LIMITS		
	GRADATION REQUIREMENTS		
Mixture Control Tolerances	Sieve Size	Percent Passing	
		Type II	Type III
± 0 %	3/8 inch	100	100
± 5 %	No. 4	90 - 100	70 - 90
± 5 %	No. 8	65 - 90	45 - 70
± 5 %	No. 16	45 - 70	28 - 50
± 5 %	No. 30	30 - 50	19 - 34
± 5 %	No. 50	18 - 30	12 - 25
± 3 %	No. 100	10 - 21	7 - 18
± 2 %	No. 200	5 - 15	5 - 15
	DESIGN REQUIREMENTS		
± 0.75 %	Range for Residual Asphalt	6.0 - 10.0	5.0 - 9.0
		Specification	Test Method
	Mixing Time Test, secs @ 77° F (25° C),	120 minimum	ISSA TB 102
	Mix Time @ 50 and 100° F (10° C and 37.7° C)	(informational)	ISSA TB 102
	Set Time Tests: 30 minutes	12 kg-cm minimum	ISSA TB 139
	Early Rolling Traffic Time: 60 minutes,	20 kg-cm minimum	ISSA TB 139
	Wet Stripping Test, % coating	90% minimum	ISSA TB 114
	Wet Track Abrasion Test, loss in g/ft2 (g/m2)	75 (800) max 6 days 50 (538) max. 1 hour	ISSA TB 100
	Measurement of Excess Asphalt	Max. 50 grams/ft2 (540 grams/m2) Sand Adhesion, 1,000 Cycles @ 125lbs. (57 kgs)	ISSA TB 109

Note 1: Percent residual asphalt based on weight of dry aggregate.
Note 2: Type II for spread rates of 10 - 20* pounds per square yard based on dry aggregate weight.
Note 3: Type III for spread rates of 15 - 30* pounds per square yard based on dry aggregate weight.
Note 4: If more than 30 pounds per square yard of mixture is required, additional lifts shall be applied.
Note 5: The gradation and percent residual asphalt as shown on the Micro-Surfacing design or as established by the Engineer shall be maintained with the listed Mixture Control Tolerances. The Micro-surfacing type and target spread rate will be as shown in the plans and shall be controlled to within plus or minus 2 pounds per square yard except in no case shall a spread rate be less than the minimum be allowed. Scratch courses and rut filling applications are exempt from these specifications as rates will vary based upon the depth of the ruts and shall be spread as separate lifts.

MIX DESIGN

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	Classification Compatibility	11 pt. minimum	ISSA TB 144

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MIX DESIGN

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MIX DESIGN

Note 5: The gradation and percent residual asphalt as shown on the Micro-Surfacing design or as established by the Engineer shall be maintained with the listed Mixture Control Tolerances. ***The Micro- surfacing type and target spread rate will be as shown in the plans and shall be controlled to within plus or minus 2 pounds per square yard except in no case shall a spread rate be less than the minimum be allowed.*** Scratch courses and rut filling applications are exempt from these specifications as rates will vary based upon the depth of the ruts and shall be spread as separate lifts.

Aggregate

- Gradation
  - Small deviations in the middle of the sieves (#16,#30,#50) are not a major issue.
  - Watch for the #8 and #4 going coarse. This may cause raveling and or a noisy ride.
  - The #200 is very important. The amount passing the #200 must stay within the JMF.
    - Not enough passing the Lbs.200 can cause the system to flush. Too much can cause the system to be too fast.
- Cleanliness
  - Watch that the loader operator stays out of the bottom of the pile, especially at the end of the job.
  - Low Sand Equivalent and High Methylene Blue Results can cause the mix to break too quickly.
    - Dirt or Base Rock can be a killer.

STOCKPILES

Good Stockpile Maintenance is Necessary

Calibration

Calibration

What is calibration?

- **Calibration is the process of measuring by weight the:**
  - Aggregate
  - Emulsion
  - Mineral Filler

  Then correlating the weight to revolutions of the aggregate conveyor recorded by a counter. The goal is to obtain a weight per count.

Why do we calibrate?

- Calibration sets the paver, so the ratios of material stay match the mix design
- Calibration will ensure quality control of the Micro surfacing system for the contractor and buying agency
- Calibration serves as a basis for recording the amount of materials used.

When Do We Calibrate?

- Slurry/Micro Pavers must be calibrated to make sure the mix matches the Mix Design.
- Must be calibrated using the aggregate and emulsion type to be used on the project.
- Must be re-calibrated if:
  - Material Change
  - Pump Repair or Change
  - Replacement of Conveyor Skirt Rubbers.
- Emulsion should be calibrated every job* or at least once per month.

Converting Mix Design to Paver Mix

Aggregate

+

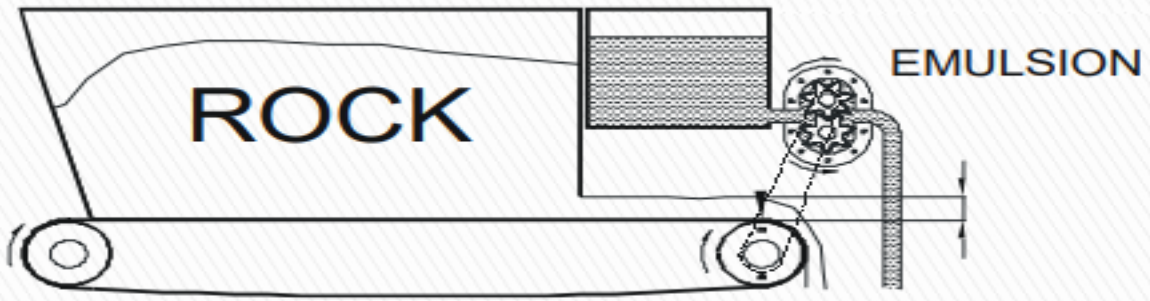
% Emulsion

+

% Water

+

% Additives

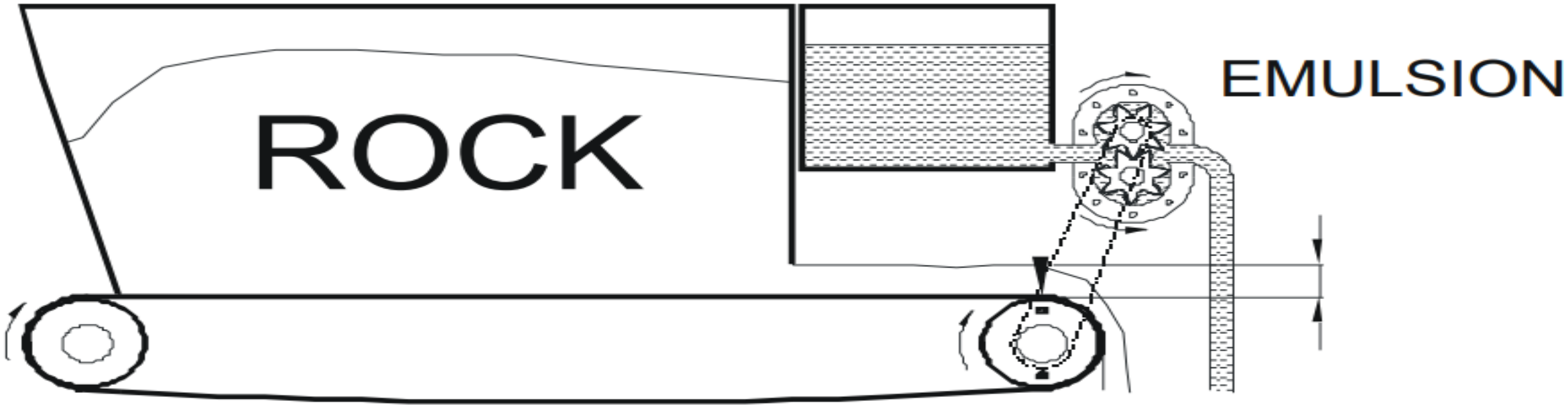


Batch Mix Design VS. Continuous Flow Mixing

Paver Calibration

- Calibration converts Volumetric Batch Mix Design into a Continuous Feed Process.
- Aggregate and Emulsion are mechanically or electronically connected to maintain Mix Design Ratios.
- In most pavers the emulsion rate is fixed and the aggregate is adjustable by raising or lowering a rock gate.

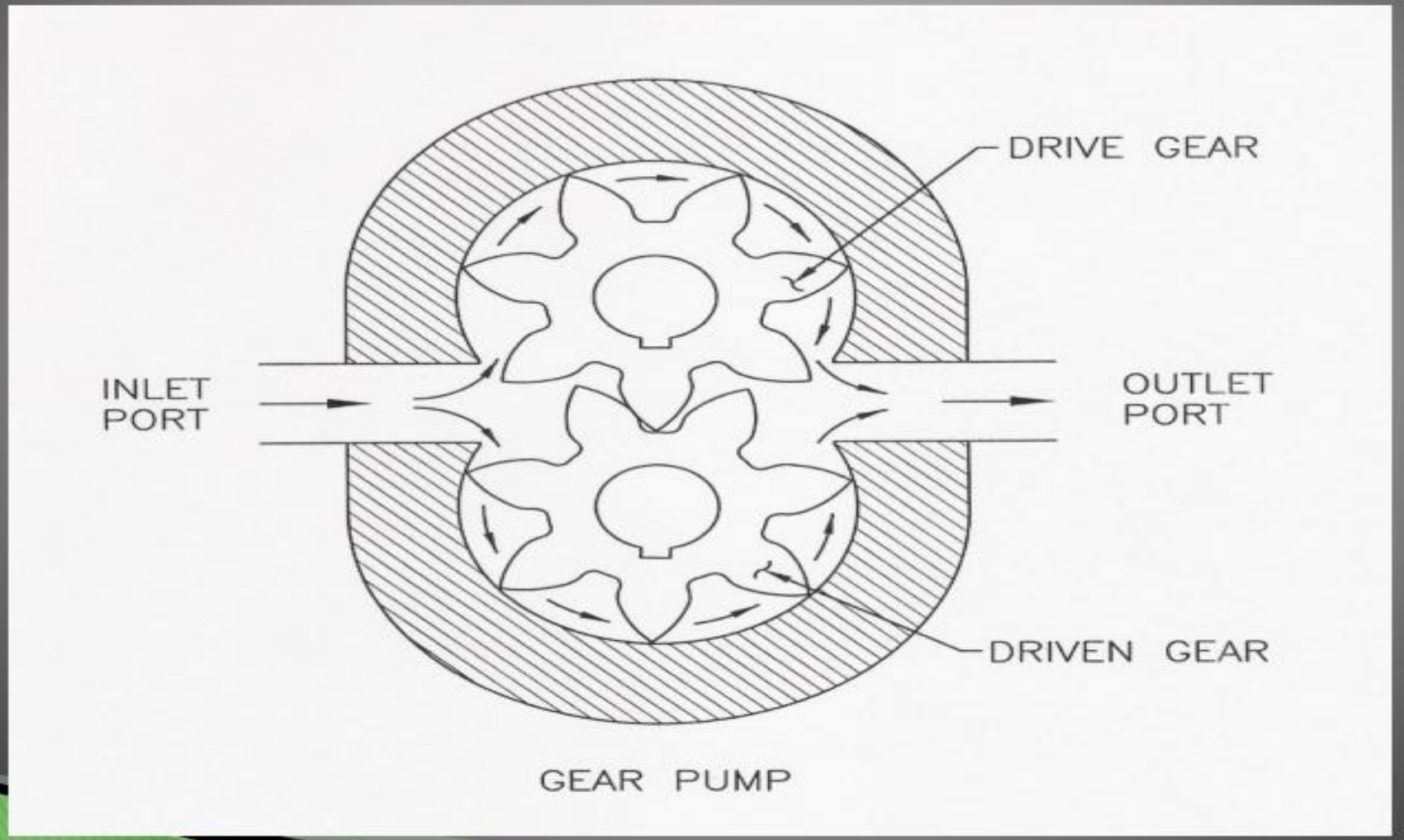
Aggregate Conveyor



The aggregate is delivered by a conveyor, delivering a consistent amount of aggregate (at a given gate setting) from the hopper into the pugmill.

Emulsion Pump

Gear Pump (Positive Displacement)

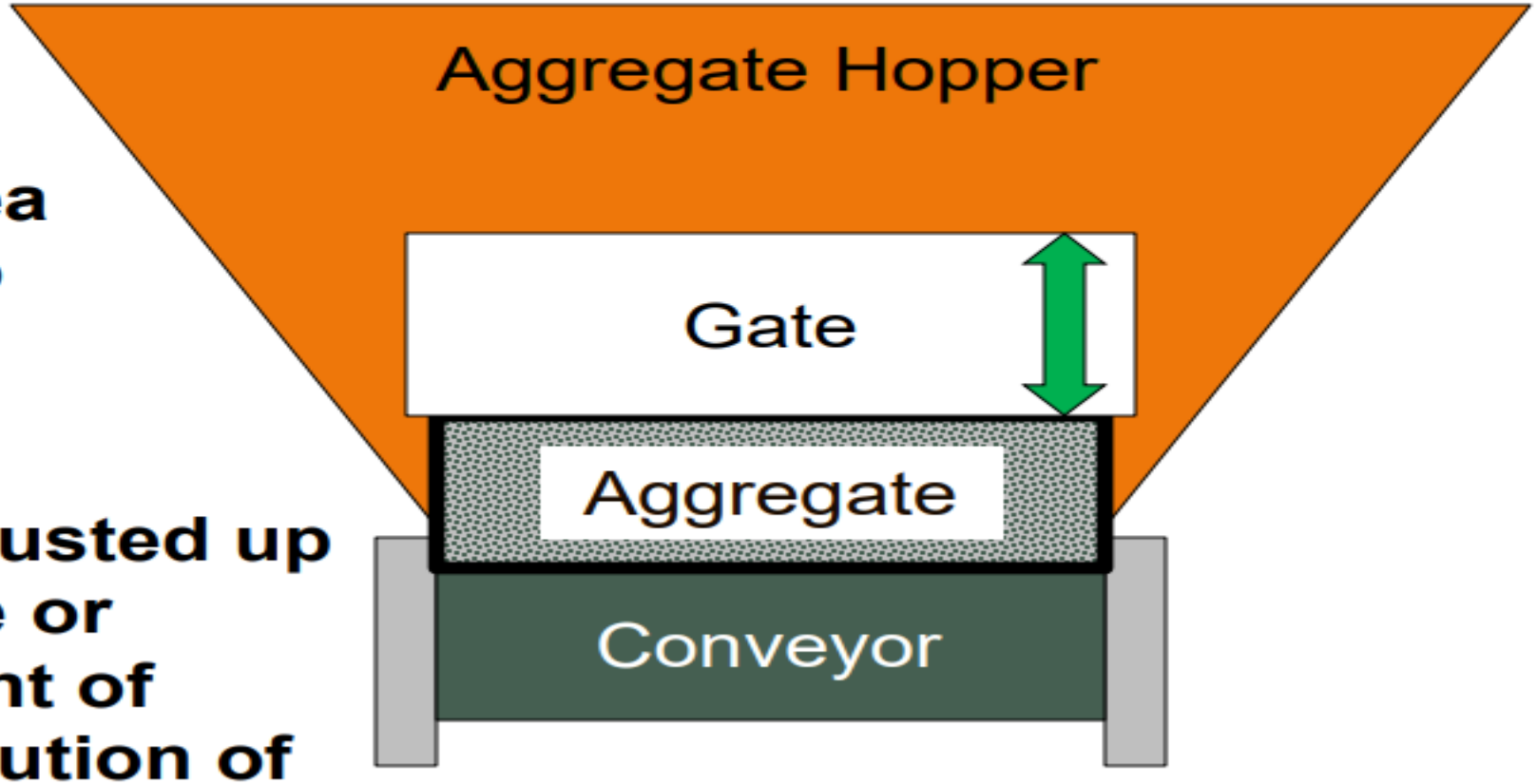


Aggregate Gate

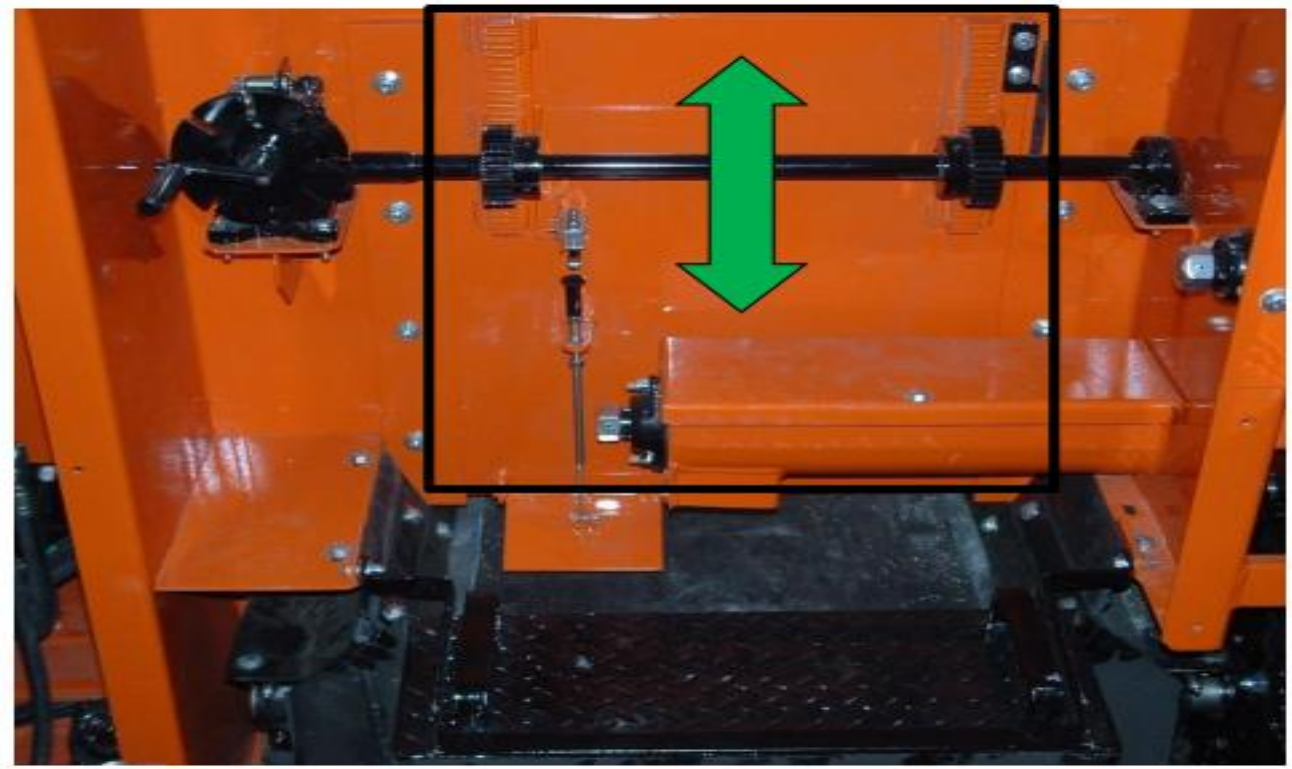
The outlet of the aggregate hopper provides a fixed area for the aggregate to flow through

The gate can be adjusted up or down to increase or decrease the amount of aggregate per revolution of the conveyor pulley

End View of Paver



Gate setting of the hopper is varied to achieve different emulsion/aggregate ratios.

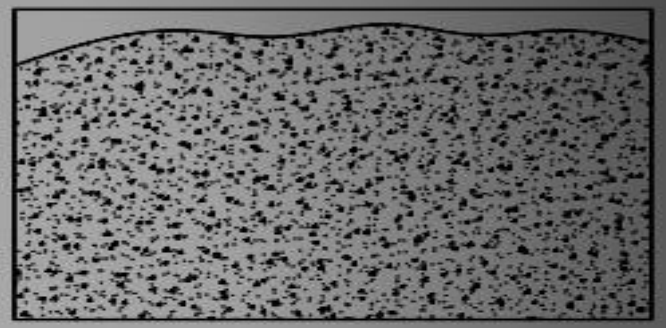


Lower gate to increase emulsion %
Raise gate to decrease emulsion %

If we mixed in a batch:

10%

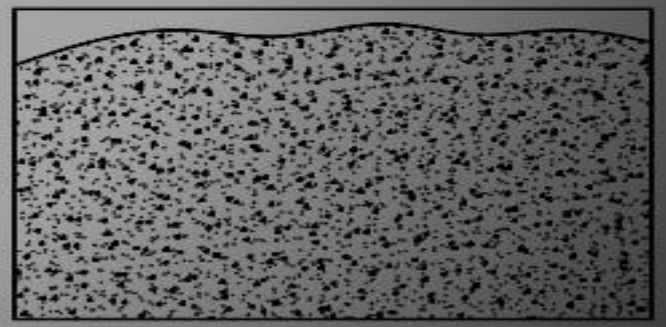
Emulsion – 10 lbs



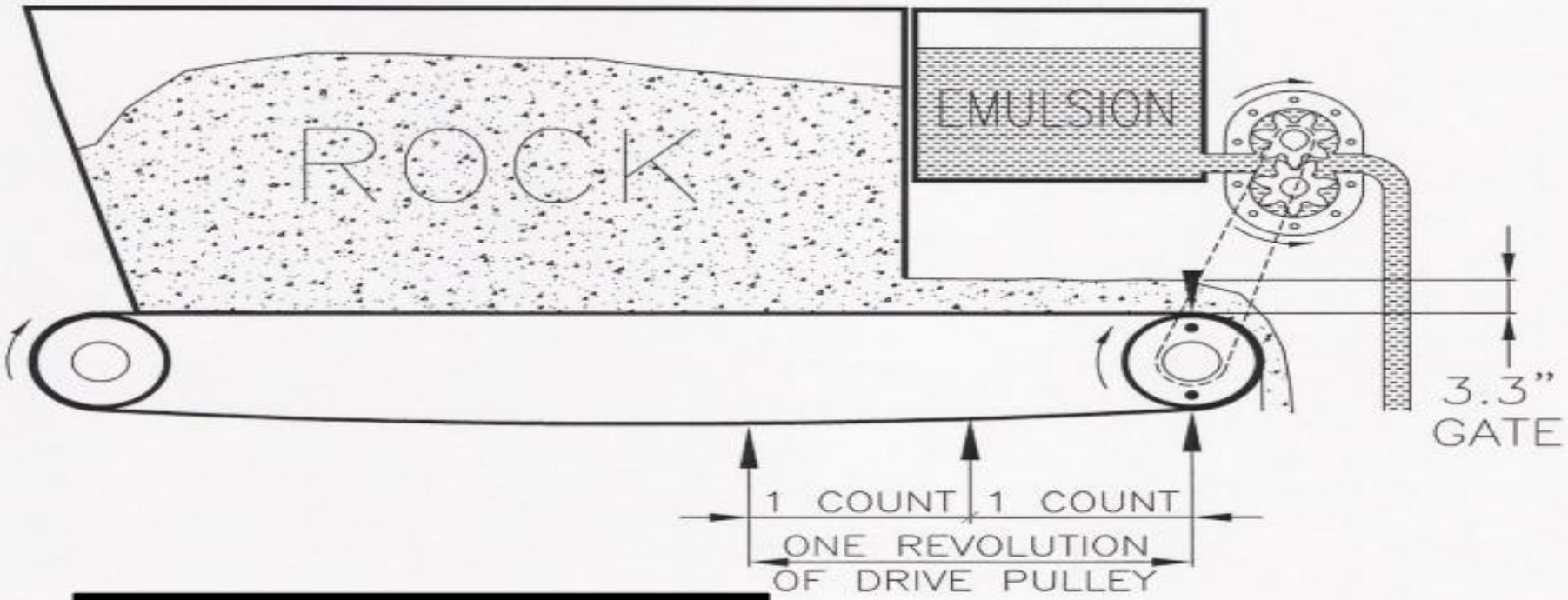
Rock – 100 lbs

12%

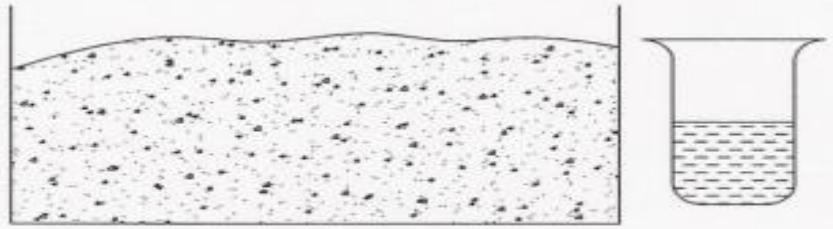
Emulsion – 12 lbs



Rock – 100 lbs



$$\frac{\text{10 lbs emulsion}}{\text{83.3 lbs rock}} = 12\%$$



ROCK
83.3 LBS

EMULSION
10 LBS

Using the Calibration to Double Check Quantities

- It is easy to double check the contractor's application rate and/or emulsion percentage using the calibration data.
- First – Request the following information from the contractor:
  - Emulsion Weight per Aggregate Conveyor Count
    - Assume 4.8 Lbs./Count
  - Aggregate Dry Weight per Aggregate Conveyor Count
    - Assume 38.4 Lbs./Count

Using the Calibration to Double Check Quantities

- Next – Measure a known lane length and width.
  - Assume 1000 ft. by 12 ft = 1,333 S.Y.
- Request a count at the beginning point.
  - Assume 356
- Request a count at the ending point
  - Assume 1120
  - 1120 – 356 = 764 Counts

Using the Calibration to Double Check Quantities

- Calculate Aggregate Application Rate
  - 764 counts X 38.4 Lbs./Count = 29,337.60 Lbs.
  - 29,337.60 Lbs. / 1,333 S.Y. = 22.01 Lbs. / S.Y.
- Calculate Emulsion Percentage
  - 764 X 4.8 Lbs./Count = 3,667.20 Lbs. Emulsion
  - 3,667.20 / 29,337.60 = 0.125 or 12.5%
- Calculate Mix Application Rate*
  - 3,667.20 + 29,337.60 = 36,672 / 1,333 = 27.5 Lbs. / SY

Calibration

(f) Equipment Calibration

- Each mixing unit shall be calibrated in the presence of the engineer prior to the start of the project. Any component replacement affecting material proportioning requires that the machine be recalibrated.
- *No machine will be allowed to work on the project until the calibration has been completed and/or accepted.*
- Additional calibrations may be required during production as directed by the Engineer.
- Calibrations shall be performed in accordance with ALDOT procedure 454, “Calibration of Microsurfacing Equipment”.
- The Contractor shall provide a copy of the of the calibration worksheets to the Engineer.

Calibration

(f) Equipment Calibration

- Calibrations shall be performed in accordance with ALDOT procedure 454, “Calibration of Microsurfacing Equipment”.

ALDOT-454-(2015)

Procedure for Calibrating Microsurfacing Equipment

1.1. This procedure provides a method for calibrating microsurfacing equipment to verify individual component material output. These calibrations of the individual machines are necessary because of the continuous feed nature of the mixing machines.

1.2. This procedure also helps to ensure that should the size of the project be large enough for the Contractor to justify the use of multiple mixing machines, all of the mixing machines will place the materials at the specified rate and in accordance with the approved job mix formula.

2. Referenced Documents

2.1. ALDOT SPECIFICATIONS

- Section 401 Bituminous Surface Treatments

2.2. BMT FORMS

- BMT 213 Microsurfacing Calibration Worksheet

2.4. ISSA A-143

2.5. NCHRP Synthesis 411- Microsurfacing

2.6 AASHTO T 255 Total Evaporable Moisture Content of Aggregate by Drying

3. General Requirements

3.1. This section provides general calibration requirements for microsurfacing equipment used for quality control for acceptance testing on Department paving projects where microsurfacing paving specifications are applicable.

3.2. An ALDOT Engineer must be present during the calibration procedure.

3.3. Obtain the job mix design from the contractor.

3.4. Review the job mix formula to ensure the emulsion and aggregates are from approved ALDOT sources.

3.5. The asphalt emulsion pump, the aggregate gates, and the dry additive/mineral filler gates all shall be calibrated prior to the beginning of production.

3.6. The calibration process shall accomplish the following tasks:

- Set the machine(s) to verify component material output

Calibration

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Calibration

3.2. An ALDOT Engineer must be present during the calibration procedure.

Calibration

- Establish the consistency of the feeds of the equipment if more than one mixing machine is used on a project.

- Establish a standard for the data output from the calibrated machine(s).

4. Emulsion Calibration Procedure

4.1. The Contractor will use Subarticle 401.03(a) to ensure that the asphalt emulsion pump is working correctly and ensure the feed rates are as set by the job mix formula.

4.2. The emulsion pumps shall be calibrated as follows::

4.2.1. Empty machine of all aggregates.

4.2.2. Fill the machine with emulsion and determine the gross weight using a calibrated set of truck scales.

4.2.3. Weigh aggregate on certified scales prior to adding to the machine, record weight.

4.2.4. Hook pump outlet to a second container with a volumetric capacity of approximately 600 to 700 gallons, to contain the amount of emulsion pumped during calibration process.

4.2.5. Pump from the emulsion truck into the second container for a minimum of 12,000 counts of emulsion (yields approximately 50 gallons of emulsion) on the aggregate counter.

4.2.6. Determine weight of emulsion that has been pumped from the machine.

4.2.7. Perform the pumping process a minimum of three (3) times to ensure accurate results.

4.2.8. For each trial pumping process, divide the pounds of emulsion by the count of the aggregate counter to determine the rock count.

4.2.9. For each trial pumping process, divide the pounds of emulsion by the count of the emulsion counter to determine the emulsion count.

Example:

Starting Weight **(a)**	**a** = 0.00
Ending Weight Emulsion **(b)**	**b** = 406.00
Pounds of emulsion **(b-a) = c**	**c** = 406.00
Counts of emulsion counter **(d)**	**d** = 12015.00
Counts of Rock counter **(e)**	**e** = 2540.00
1) Pounds of emulsion per aggregate count **(c/e) = f^1**	**f^1** = 0.1598
2) Pounds of emulsion per emulsion count **(c/d) = g^1**	**g^1** = 0.0338

4.2.10. The emulsion pump shall deliver emulsion to the pug mill with a volumetric consistency that is within 2% of the mathematical average of three (3) runs of at least 12,000 counts (approximately 50 gallons) of emulsion.

Calibration

4.2.11 The Contractor shall use BMT 213 worksheet titled "Emulsion Calibration Worksheet" for calculating the results of the emulsion pump calibration.

4.2.12 The Contractor will ensure that the Engineer receives a copy of the completed calibration forms for the project files.

5. Dry Additive/Mineral Filler Calibration

5.1.1 Empty machine of all aggregates.

5.1.2 Use a small pan or other applicable container suitable for catching the amount of dry additive/mineral filler that will fall from the feeder during calibration process.

5.1.3 Weigh the empty container and record the weight prior to performing the calibration process.

5.1.4 Using the "fines counter" to count the turns of the head pulley or the fines feeding auger, run out a minimum of 10 counts of material into the container.

5.1.5 Reweigh the container containing the filler and subtract the empty weight of the container. The weight of material divided by the number of counts from 5.1.4 above gives the weight per turn of the pulley/auger.

5.1.6 Perform the process a minimum of three (3) times per gate setting at three different gate settings to develop an average for the material at various gate settings to help ensure accurate results.

5.1.7 Calculate the desired setting to meet the job mix formula requirements.

5.1.8 The Contractor shall use BMT 213 titled 'Cement Calibration Worksheet" for calculating the results of the average pounds per count of cement calibration.

5.1.9 The Contractor will ensure that the Engineer receives a copy of the calibration worksheets for the project files.

6 Aggregate Gate Calibration

6.1 Aggregate Moisture

6.1.1 Test the aggregate for moisture following AASHTO T 255.

6.1.2 Calculate the moisture factor. The moisture factor is the percent (in decimal format) of the moisture in the aggregate + 1.00.

Example:
A moisture is calculated to be 5%, therefore the moisture factor is:
0.05 + 1.00 = 1.05 moisture factor.

6.2 Calibrate Gate Settings

6.2.1 Select three (3) gate openings

6.2.2 Aggregate larger than the #4 sieve shall be screened out at the plant and remaining aggregate shall be weighed prior to placing aggregate into the transport vehicle.

6.2.3 Using the following table, perform calibration by running material, at least two (2) times per gate setting, recording the net weight conveyed and the number of counts of the rock belt for the three test samples.

Calibration

Table 1	
3" gate	Minimum of 700 counts
4" gate	Minimum of 500 counts
5" gate	Minimum of 300 counts

6.2.4 The placement machine shall deliver such volumetric consistency that the deviation for any aggregate delivery rate check-run shall be within 2% the mathematical average of three (3) runs.

6.2.5 Determine the average dry weight per count using BMT 213 worksheet titled "Aggregate Calibration Worksheet" to determine the dry aggregate pounds per count. If the results do not yield a straight line, the tests shall be rerun.

Example:

1. Aggregate weight divided by no. of counts equals pounds per counts (3" gate)
   Pounds of aggregate = 580.00 (A)
   Number of counts = 704 (B)
   Pounds per counts = (C)

   A ÷ B = C
   580.00 ÷ 704 = 0.8239 lbs. per count

2. Dry Aggregate Weight per Count = Average aggregate weight per count divided by moisture factor.
   Average weight per count determined to be 0.8239 pound (D)
   Moisture factor determined to be 1.0371 (E)
   Dry Aggregate Weight per count (F)

   D ÷ E = F
   0.8239 ÷ 1.0371 = 0.7944 lbs. per count

6.3 Calibrate machine at job mix formula.

6.3.1. Set the gate to the settings required by the job mix formula.

6.3.2 Run sufficient material past the gate to establish the flow and fill the gate.

6.3.3 Reset the aggregate counter to zero.

6.3.4 Run material out of the machine and stop the belt as the counter changes to a new count to avoid partial counts.

6.3.5 Remove any excess material from the belt that may have passed the gate but not fallen into the pug mill.

6.3.6 The net weight of the run divided by the count of aggregate counter provides the pounds of aggregate per revolution of the head pulley.

7 Reporting

7.1 Report test results on BMT 213 Summary Worksheet.

7.2 All documentation shall be sent to the Project Engineer.

Surface Preparation

Construction Requirements

403.05 Construction.

(a) Weather Limitations.

The Micro-Surfacing mixture shall be spread only when the *ambient temperature for the 48 hours prior to placement is at least 50 F.*

The *current pavement surface and ambient temperature is at least 50 F and rising.*

The weather is *not foggy or rainy and there is no forecast of temperatures below 32 F within 48 hours* from the time of placement.

The Micro-Surfacing mixture shall be spread at the discretion of the Engineer if the *relative humidity exceeds 80 percent or the weather is overcast*.

Construction Requirements

403.05 Construction.
(b) Surface Preparation.

The area to be surfaced shall be ***thoroughly cleaned*** of vegetation, loose aggregate, and soil.

All cracks shall be cleaned to the satisfaction of the Engineer prior to overlay.

Traffic markings and stripe shall be removed flush with the pavement surface.

Whenever conditions are such as to require pre wetting the surface, the water shall be sprayed ahead of and outside of the spreader box at a rate sufficient to dampen the surface without any free flowing water ahead of the spreader box.

Surface Preparation

Surface Preparation

- Cleaning
  - Slurry Surfacing will not stick to ANY loose rock, mix, dust, vegetation.
  - Vacuum, Sweep, Wash as necessary.
- Crack Sealing
  - Sealant should be kept flush with minimal over banding. Thick over bands will get caught by the box runners.
  - It is best to seal at least 30 days prior to surfacing.
- Patching
  - Make sure patches are kept at or below the road surface. Remember – Micro surfacing does a great job of filling low areas. Bumps will be Bumps.
  - Cold Mix patches should "cure" at least 30 days prior to Micro surfacing.

Construction Requirements

403.05 Construction.

(c) Application.

The *paving mixture shall be spread on the prepared surface in such a way as to leave a uniform finished surface*.

Care shall be taken when filling ruts to restore the designed profile of the pavement cross section. *Excess crowning or overfilling of the rut area will not be permitted*.

The Contractor shall use squeegees and lutes to spread the mixture in areas inaccessible to the spreader box and areas requiring hand spreading.

A sufficient amount of material shall be carried at all times in all parts of the spreader box to ensure complete coverage.
No lumping, balling or unmixed aggregate shall be permitted. No segregation of the emulsion and aggregate fines from the coarse aggregate will be permitted.
If the coarse aggregate settles to the bottom of the mix, the mix will be removed from the pavement. The paving mixture shall have proper consistency so that excessive splattering and excessive free water is avoided.
The paving mixture shall be applied based on dry aggregate weight as specified on the plans.
Adjustments to the additive will be permitted if necessary to provide a slower setting time when hand spreading is needed.
If hand spreading is necessary, the mixture shall be poured in a small windrow along one edge of the surface to be covered and then spread uniformly by a hand squeegee or lute.
A smooth, neat seam shall be provided where two passes meet.
Excess material shall immediately be removed from ends of each run.

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Surface Texture

- Factors that influence final surface texture are:
  - Existing pavement surface texture
  - Mix consistency (accurate calibration)
  - Adherence to JMF
  - Type of screed rubber used
  - Spreader box maintenance
  - Use of drags or secondary strike off
  - Application rate
  - Speed of application machine (too fast may cause wash boarding)
  - Opening to traffic too early
  - Rolling (if required)

Surface Texture Uniformity

- Slurry systems have an aggressive surface texture and when applied properly can maintain a high friction surface for the duration of their useful life.

Surface Texture

Unacceptable

Acceptable

Construction Requirements

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Address rutting

Rut Fill Highway 82 in Alabama

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REPROFILING RUTTED WHEELPATHS WITH MICRO-SURFACING

For each inch of applied micro-surface mix
add 1/8" to 1/4" crown to each rutfill
to compensate for return traffic compaction.

Original Pavement Cross Section

Ruts in Wheelpaths

RUTS 1/2" & OVER MUST USE THE RUT BOX

Rutting

- True Rutting of a Micro surfacing is Rare.
  - Was Slurry Seal used to fill ruts instead of Micro-surfacing.
  - Was the Micro surfacing level at completion?
    - Should the road have been leveled?
    - Did the contractor put the rut into the mat?
  - Is the underlying surface continuing to rut?
  - Did the Micro surfacing not meet the JMF?
  - Did the Aggregate and Emulsion Match the Mix Design.

Construction Requirements

403.05 Construction.
(d) Joints

Longitudinal joints and transverse joints shall have no more than *¼ inch vertical space over the joint when measured with a 10 ft. straightedge placed perpendicular to the joint*.

A maximum of 3 inches shall be allowed for overlap of the longitudinal lane line joints.

The *edge lines shall be repaired if the edges vary more than 3 inches from a 100 foot straight line or from a 100 foot arc on a curved section*.

Longitudinal Joints

Longitudinal Joints

- Should be straight on tangent lines
- Uniformly follow the traffic lane
- Should be constructed as an overlap or butt joint
- If the overlap method is used it should be kept to a minimum (3" maximum)
- Should be smooth and neat in appearance
- Excessive buildup or uncovered areas should not be permitted

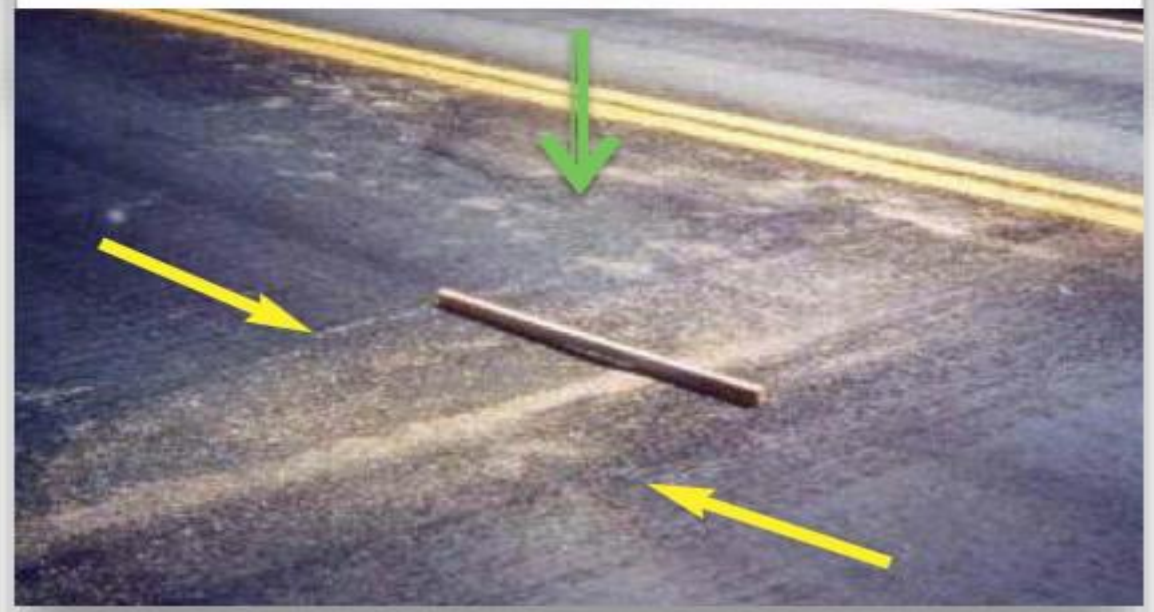
Acceptable Joints

Unacceptable Joints

Unacceptable Joints

Transverse Joints

- Should be smooth and neat in appearance
- Hand work should be kept to a minimum
- Excessive buildup or uncovered areas should not be permitted
- Should be constructed as a butt joint
- Use of roofing felt may assist contractor in construction of acceptable transverse joints



Edge Lines

- Should be parallel to curb or centerline.
  - May require a paint or stringline.
- Edge line should be even and match existing edge.
- Should have consistent color and texture

Edge Lines

Unacceptable	Acceptable

Construction Requirements

403.05 Construction.
(e) Traffic Control.

Traffic shall not be allowed on the Micro-Surfacing mixture until it has cured sufficiently to prevent pick up and/or marring of the surface. *Curing of the Micro-Surfacing with the ability to carry rolling traffic shall be within 60 minutes of placement.*

The Contractor shall maintain traffic control as necessary to prevent damage to the mixture. Any such damage done by traffic to the mixture shall be repaired by the Contractor at no additional cost to the Department.

Application of the surfacing mixture shall be suspended early enough each day to permit traffic to safety travel over the completed work before sunset.

Work required or materials used in controlling of traffic will not be paid for directly but shall be considered subsidiary obligations of the item of Micro- Surfacing seal coat.

When will the mixture break, set, and support traffic?

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- **Breaking and setting characteristics**–The mixture should cure within a reasonably defined period to allow return to traffic without raveling, displacement, or flushing.
- **Break**–The time when the slurry system transitions from a workable fluid state to an unworkable solid state. After the break, the mixture can no longer be mixed or finished.
- **Set**–the time after placement when the emulsified asphalt has coalesced to the point that no free emulsified asphalt is available for dilution or washing away by water and an absorptive paper towel would not be stained when depressed lightly into the surface of the mix
- **Traffic readiness**–the time when the cohesive strength (the bonds between asphalt coated aggregate particles) of the mixture has developed sufficiently to support slow-moving, straight-rolling traffic without damage to the system

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The Shoe Test

The Shoe Test

- The shear strength and bond can be checked subjectively by placing your full weight flatly on the sole of your shoe on the placed treatment. If the sole can be placed on the new treatment for two seconds without picking up aggregate, then the pavement can be opened to rolling traffic without significant negative effects.
- If you can place your weight on the heel of one shoe on the placed treatment and twist the heel (about 180°) with only minor surface marks and without the large aggregate being displaced, the mixture can probably be opened to turning traffic without significant damage. However, sharp turns, especially by heavy vehicles, can damage micro surfacing for some time after application, particularly in hot weather.

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Construction Requirements

403.05 Construction.
(f) Quality Control

The Contractor shall produce a mixture in compliance with the mix design, mixture control tolerances and spread rate placement tolerances. The Contractor shall maintain all quality control documentation.

Quality control documentation shall be made available to the Engineer upon request or at the completion of work.

1. Asphalt Cement The Contractor shall calculate the % asphalt content of the mixture from the equipment computer display readings, a minimum of 3 times a day.

2. Application Rate The Contractor shall calculate the yield of the course being placed from the equipment computer display readings, a minimum of 3 times a day.

3. Daily Report The daily report shall include aggregate used in tons, asphalt emulsion used in tons, mineral filler used in tons, water used in mixture in gallons, and additive used in mixture in gallons.

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Construction Requirements

403.05 Construction.
(g) Test Strip

Prior to production application, the *Contractor shall place a 1,000 foot test* section to verify the mix design and the ability to carry rolling traffic within 60 minutes.

If rolling traffic cannot be carried within 60 minutes, the emulsion or mixture must be adjusted and another test strip shall be required.

The *test section shall be placed at the same time as the paving is to take place, night or day, and under the same ambient conditions.*

Construction Requirements

403.06 Method of Measurement.

The quantity of Micro-Surfacing mixture, of the type specified, used and accepted will be measured in tons.

A means, suitable to the Engineer, for confirmation of the weights of the materials shall be furnished by the Contractor. The weight of the dry aggregate, asphalt emulsion, and the cement used in the mixture shall be calculated and included in the total weight measured for payment.

Additional materials such as mineral fillers, water, and chemical additives shall be included in the contract price for micro-surfacing seal coat and will not be measured separately for payment.

Deductions in measurement will be made for all material wasted or lost or applied beyond the limits of the work.

Construction Requirements

403.07 Basis of Payment.

(a) Unit Price Coverage.

Compensation for the Micro-Surfacing material, measured as provided above, ***will be made on a tonnage basis and the contract unit price per ton*** shall be full compensation for construction of the Micro-Surfacing complete in place as shown on the plans or directed.

This price shall include all materials, procurement, handling, hauling, and processing and includes all equipment, tools, labor, and incidentals required to complete the work, with the *following exception*:

> Tonnage placed *in excess* of the amount shown on the plans or directed in writing, plus two pounds per square yard, will be paid for at eighty percent of the contract unit price bid.
>
> No payment will be made *for unacceptable material*; for material furnished or used in excess of the amount indicated or directed, except as provided above; for material used in replacing defective or condemned work; for material wasted in handling, hauling, or otherwise; or for maintaining the work.

Construction Requirements

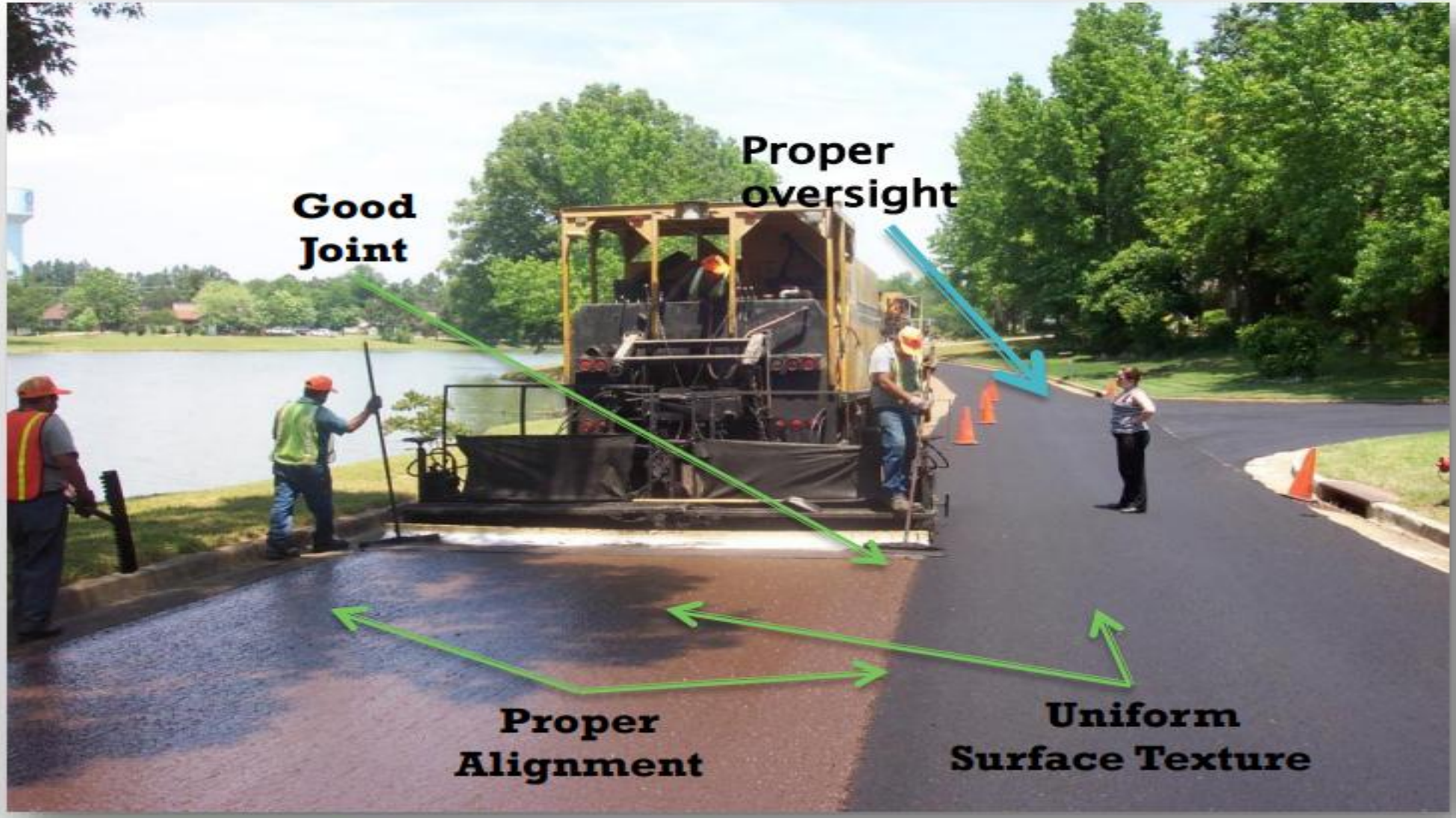
403.07 Basis of Payment.

(b) Payment will be made under Item No.:

403-B Micro-Surfacing Seal Coat, Type * - per ton * Specify Type “II” or “III”.

Paving Techniques

Performing A Great Job



Micro Best Practices

- Seal cracks > ¼”Micro Surfacing is not a crack relief layer. Adequate time should be left for the seal to cure, and excessive buildup should be kept to a minimum.
- Mix Design is important
- Check aggregate stockpile on job prior to project startup
- Calibrate continuous paver
- As with any treatment treat vegetation prior to paving
- Ruts >1/2” need a rut box (up to 1.5” in multiple lifts)
- Allow ruts 24 hours to cure under traffic before applying second course.

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Micro Best Practices (Cont'd)

- When paving: Mix getting out of the spreader box? Can the contractor perform handwork? (60"-120")
- Sand in turnout areas.
- Base failures, major pavement damage, curb and gutter problems and utility issues should be addressed.
- The pavement should be free of loose aggregate and soil, vegetation and oil spots before paving begins.
- Pavement markings should be removed, particularly thermoplastic marking in excess of 4". Conventional paint with reflective glass beads embedded does not require removal unless there is significant buildup from multiple applications.
- Utilities should be protected by covering them with roofing felt or plastic sheeting.

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Problem Solving

Possible Quality Issues

- Flushing / Slick Surface
  - Excess asphalt binder that creates a shiny tacky surface.
- Surface Loss – Debonding
  - Due to traffic wear, debonding or delamination.
- Raveling
  - Loose Aggregate
- Rutting
  - ¼" Rutting

Bleeding

- Bleeding can be caused by:
  - Excess asphalt in mix
    - Check Calibration against Mix Design
    - Paver Issue
  - Lack of fines in mix
    - If aggregate is too clean their may not be enough surface area for the amount of emulsion in the mix.
  - Application rate too high for gradation
    - Aggregate can settle to bottom leaving asphalt and fines on the surface
  - Incorrect emulsion supplied to project
    - Lack of Polymer Modification

Surface Loss

- Debonding or Delamination is usually caused by:
  - Poor Surface Preparation
  - Contamination from Paving Process
  - Mixture that is Breaking and Curing too Quickly
  - Debonding or Deterioration of Original Surface

Raveling

- A slight amount of raveling is normal within the first day or two.
  - You should NOT hear loose rock when driving over the surface.
  - The shoulders should not be black
- A Level Up or Scratch Course will be ravel more than a Surface Course.
- Raveling is more common in cooler temperatures.

Causes of Raveling

- The aggregate lacks sufficient embedment in the matrix caused from insufficient asphalt quantity to hold the larger aggregate;
- Poor quality aggregates may debond from the matrix;
- The application rate was too thin to hold larger aggregates;
- The matrix has a lack of fines to fill voids between larger aggregates;
- Cooler temperatures may result in slowing of the cure necessary for traffic;
- Premature opening to traffic; and
- Slurry system was exposed to rain before final cure was achieved.

Patching

- Traffic Marks or poor workmanship should be patched by placing a full width pass of slurry over the area.
- Patches should:
  - Match the existing texture
  - Edges should be square and parallel to edge of road.
  - Cover the entire lane.

Micro surfacing should not be used to:

- Fill potholes
- Improve the structural integrity of the existing pavement
- Improve traffic capacity

Figure 1 shows PCI values from 0–100 and their corresponding pavement condition rating.

Figure 1: StreetSaver Pavement Condition Index Classifications [22]

Damage from Early Traffic:

The Old Question "What Went Wrong?"

The Old Question "What Went Wrong?"

Let's Ask What Went Right!

Let's Ask What Went Right!

Let's Ask What Went Right!

Quality Is The Goal

5 Keys To Reach That Goal

- Equipment
- Materials and Calibration
- Surface Preparation
- Paving Techniques
- Problem Solving

THE END

LET THE GOOD TIMES ROLL


STOP

ALDOT

Alabama Department of Transportation

It's Quitting Time

THE END!!

Questions!