



Joint Inspector Training For...

MIX DESIGN AND MATERIAL TESTING

Slurry Seal and Micro Surfacing Systems

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Outline

- **Intro**
- **Design Considerations**
- **Materials**
- **Specifications of Materials
(Slurry vs. Micro)**
- **Mix Design (Slurry vs. Micro)**
- **How these relate to Section 37**

Introduction

- **Slurry and Micro Surfacing systems:**

- zero emissions
- thin pavement systems
- applied at ambient temperatures
- Without compaction
- Using advanced materials

- **It is not:**

- A fix for structural problems
- For placement in the rain or cold temperatures (<50F)
- For extremely deteriorated pavements
- Free

Design Considerations

- **Slurry and Micro Surfacing Systems are 5 component systems:**
 - Aggregate
 - Emulsified Asphalt
 - Water
 - Cement or other mineral fillers (optional)
 - Chemical Additives (as required)

Materials

- **Aggregate**

- There are three gradations of aggregate used for slurry and two for micro surfacing

- **Purpose**

- Structure
 - Wearing Surface



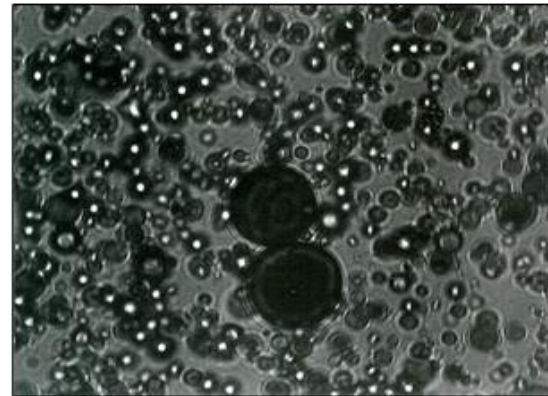
Materials

- **Asphalt Emulsion**

- Micro Surfacing and Slurry Seal use a polymer modified cationic quick set asphalt emulsion

- **Purpose**

- Binder
 - Water proofing
 - Color



Materials

- **Water**

- **Purpose**

- Mixing
 - Lubrication
 - Handling

- ***hydraulic power, or water power is power that is derived from the force or energy of moving water, which may be harnessed for useful purposes.(wikipedia)***



Materials

- **Mineral Filler**

- **Purpose**

- Mix Consistency
 - Strength
 - Durability
 - Curing



Materials

- **Chemical Additive**
 - **Purpose**
 - Control Break, Set & Cure Process
 - Adhesion (can have anti-strip properties)



Slurry Seal vs. Micro Surfacing

Difference In:	Slurry	Micro
Asphalt Emulsion	Polymer optional Slow set, quick set Anionic, cationic	Always polymer modified Always cationic quick set
Additives/ Break	More dependent on weather	Chemical break
Mix Stiffness/ Equipment	More workable mix Drag box	Stiffer mix Double auger box Secondary strike-off
Aggregate	Type I, II, III	Type II and III only Higher S.E. (cleaner) More durable
Application	Fill voids, seal ageing pavement, durable wearing course	Same plus+ high traffic, rut filling, night work, correct minor profile irregularities

Slurry Seal vs. Micro Surfacing



Slurry Seal vs. Micro Surfacing



Materials Testing

- **What do the tests mean?**
- **Who should be testing?**
- **Which tests matter?**
- **How to sample**

Asphalt Emulsion

PMCQS and MSE

Test	Specification	Measure
TEST ON EMULSION		
Viscosity	15-90 SFs	Handling Flow
Sieve	0.3% maximum	Stability Handling
Stability (1 day)	1 % maximum	Stability
Storage Stability (5 day)	5% maximum	Shelf life
TESTS ON RESIDUE		
Residue	62% minimum	Asphalt content + other
Penetration	40 -90 dmm	Hardness
Softening Point	135 degF minimum	Presence of polymer

Asphalt Emulsion Section 37

Polymer Modified Asphaltic Emulsion

Quality characteristic	Test method	Minimum sampling and testing frequency	Sampling Location
Tests on emulsion:			
Saybolt Furol Viscosity @ 25 °C (Saybolt Furol seconds)	AASHTO T 59	1 per truck tank minimum 1 per r day	Distributor truck
Sieve test (%)	AASHTO T 59		
Storage stability after 1 day (%)	AASHTO T 59		
Residue by evaporation (min, %)	California Test 331		
Particle charge	AASHTO T 59		
Tests on residue by evaporation:			
Penetration at 25 °C	AASHTO T 49	1 per truck tank minimum 1 per day	Distributor truck
Ductility at 25 °C (min, mm)	AASHTO T 51		
Torsional recovery (min, %) Or Polymer content based on residual asphalt (min %)	California Test 332 California Test 401		

Asphalt Emulsion Section 37

Micro-Surfacing Emulsion

Quality characteristic	Test method	Minimum sampling and testing frequency	Sampling location
Test on emulsion			
Saybolt Furol Viscosity, at 25°C (Saybolt Furol Seconds)	AASHTO T59	1 per truck tank minimum 1 per day	Distributor truck
Storage stability test, 1 day (max, %) ^a			
Sieve test (max, %)			
Residue by evaporation (min, %)	California Test 331	1 per truck tank minimum 1 per day	Distributor truck
Tests on residue from evaporation test:			
Penetration at 25 °C	AASHTO T 49	1 per truck tank minimum 1 per day	Distributo truck
Softening point (min, °C)	AASHTO T 53		

Asphalt Emulsion Section 37

Polymer Modified Asphaltic Emulsion Requirements

Quality characteristic	Test method	Requirement
Tests on emulsion:		
Saybolt Furol Viscosity @ 25 °C (Saybolt Furol seconds)	AASHTO T 59	15–90
Sieve test (%)	AASHTO T 59	0–0.3
Storage stability after 1 day (%)	AASHTO T 59	0–1
Residue by evaporation (min, %)	California Test 331	60
Particle charge	AASHTO T 59	Positive
Tests on residue by evaporation:		
Penetration at 25 °C	AASHTO T 49	40–90
Ductility at 25 °C (min, mm)	AASHTO T 51	400
Torsional recovery (min, %)	California Test 332	18
Or Polymer content based on residual asphalt (min %)	California Test 401	2.5

Asphalt Emulsion Section 37

Micro-surfacing Emulsion Requirements

Quality characteristic	Test method	Requirement
Tests on emulsion:		
Saybolt Furol Viscosity @ 25 °C (Saybolt Furol seconds)	AASHTO T 59	15–90
Sieve test (%)	AASHTO T 59	0.30
Storage stability after 1 day (%)	AASHTO T 59	0–1
Settlement after 5 days (max, %) ^a	ASTM D244	5
Residue by evaporation (min, %)	California Test 331	62
Tests on residue by evaporation:		
Penetration at 25 °C	AASHTO T 49	40–90
Softening point (min, °C)	AASHTO T 53	57

^aWaived if used within 48 hours of shipment.

Micro-surfacing Emulsion Acceptance Criteria

Quality characteristic	Test method	Requirement
Tests on emulsion:		
Saybolt Furol Viscosity at 25 °C (Saybolt Furol seconds)	AASHTO T 59	15–90
Sieve test (%)	AASHTO T 59	0.30
Storage stability after 1 day (%)	AASHTO T 59	0–1
Settlement after 5 days (max, %) ^a	ASTM D244	5
Residue by evaporation (min, %)	California Test 331	62
Tests on residue by evaporation:		
Penetration at 25 °C	AASHTO T 49	40–90
Softening point (min, °C)	AASHTO T 53	57

^aWaived if used within 48 hours of shipment.

Asphalt Emulsion Section 37

- Submit 2 x 1qt plastic container, insulated 15 days prior
- Include CoC and test results per spec
- Acceptance testing based on Department sampling and testing per QC specified
- QC frequency sample 1 per truck tank minimum 1 per day (delivery truck)
- QC testing due within 3 days



Asphalt Emulsion Sampling

(in the field)

- Sample half way through load
- Sample cock on Delivery Truck Run 1-3 gallons out before sampling
- Store in cool, shady place
- AASHTO T40, ASTM D140



Asphalt Emulsion Sampling

(in the field)

- **Clean, wide-mouth jars**
 - not metal
 - retain, duplicate samples
- **Test for sieve**
 - window screen



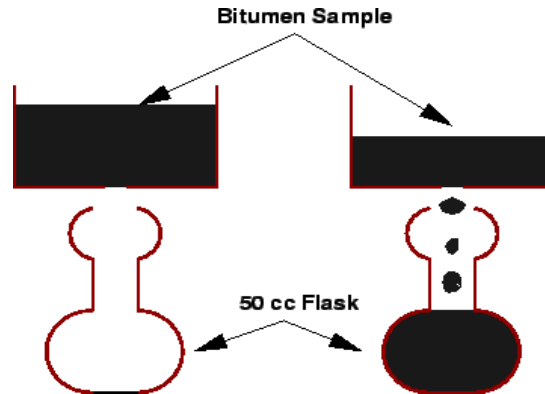
Asphalt Emulsion Sampling

Third Party Testing

- **Test Within 3 days**
- **Maintain Sample before shipping**
 - Keep out of sun
 - Don't leave in the back of a truck
- **Label properly (on jar, not lid)**
 - Date
 - Sample location
 - Product name
 - Job name
- **Use a qualified tester**
 - experienced in emulsion testing

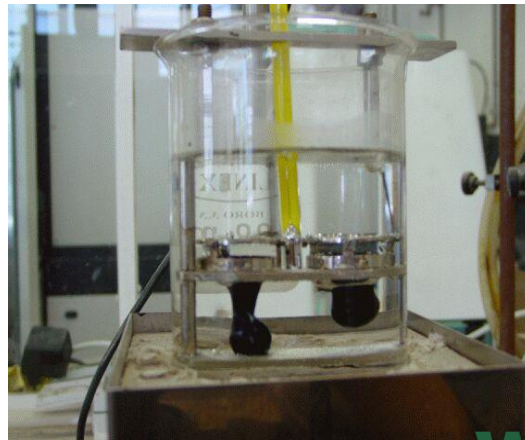
Asphalt Emulsion Testing

Tests on Emulsion



Asphalt Emulsion Testing

Tests on Residue



Aggregate

TEST	SPECIFICATION		MEASURES
	slurry	micro	
Sand Equivalent	45 (55) minimum	65 minimum	Clay content Dust/ Clay like content
Durability Index	55 minimum	55 minimum	Resistance to abrade to clay like particles
Abrasion (LA Rattler)	35% maximum	30% maximum	Resistance to traffic
Crushed Particles	100%	100%	Angularity for interlocking
Moisture Content	Within 0.5% per day	Within 0.5% per day	Pile consistency
Gradation	Type I Type II Type III	Type II Type III	I- Fill surface voids Moderate distress Protection from elements II- Fill surface voids, seal Moderate distress Durable wearing course III- Max skid resistance Improved drainage High traffic Ret. III

Aggregate Section 37

Aggregate Quality Control

Quality characteristic	Test method	Minimum sampling and testing frequency	Location of sampling
Los Angeles Rattler Loss, %, max Loss at 500 revolutions	California Test 211	1st day of production	See California Test 125
Percent of crushed particles	AASHTO T 335	1st day of production	See California Test 125
Sand equivalent, min	California Test 217	1 per working stockpile per day	See California Test 125
Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus	ASTM D 7428	1 per working stockpile per day	See California Test 125
Gradation, percentage passing	California Test 202	1 per working stockpile per day	See California Test 125
Moisture Content, from field stockpile	AASHTO T 255 ^a	1 per working stockpile per day	See California Test 125

^aTest aggregate moisture at field stockpile every 2 hours if you are unable to maintain the moisture content to within a maximum daily variation of \pm 0.5 percent.

Aggregate Section 37

Quality Control Test Reporting Requirements

Quality characteristic	Maximum reporting time allowance
Los Angeles Rattler Loss, %, max	2 business days
Percent of crushed particles	2 business days
Durability, min	2 business days
Gradation, percentage passing	48 hours
Sand equivalent, min	48 hours
Moisture content, %	48 hours

Aggregate Section 37

Slurry Seal

Aggregate Gradation Acceptance Criteria

Quality characteristic	Test method	Requirements		
Gradation, (% passing by weight) Sieve Size	California Test 202	Type I	Type II	Type III
3/8"		--	100	100
No. 4		100	94–100	70–90
No. 8		90–100	65–90	45–70
No. 16		60–90	40–70	28–50
No. 30		40–65	25–50	19–34
No. 200		10–20	5–15	5–15

Aggregate Acceptance Criteria

Quality characteristic	Test method	Requirement
Los Angeles Rattler Loss, %, max Loss at 500 revolutions	California Test 211 ^a	35
Percent of crushed particles	California Test 205	95
Durability, min	California Test 229	55
Sand equivalent, min	California Test 217	45
Type I		55
Type II		60
Type III		

^aCalifornia Test 211 must be performed on the source aggregate before crushing.

Aggregate Section 37

Slurry Seal

Aggregate Requirements

Quality characteristic	Test method	Requirement
Los Angeles Rattler Loss, %, max Loss at 500 revolutions	California Test 211 ^a	35
Percent of crushed particles	California Test 205	95
Durability, min	California Test 229	55
Sand equivalent, min Type I Type II Type III	California Test 217	45 55 60

^aCalifornia Test 211 must be performed on the source aggregate before crushing. The aggregate supplier must certify that the crushed aggregate being used on the project is manufactured from the source aggregate meeting the LA rattler requirements.

Aggregate Section 37

Micro Surfacing

Aggregate Acceptance Criteria

Quality characteristic	Test method	Requirement
Los Angeles Rattler Loss, %, max Loss at 500 revolutions	California Test 211 ^a	35
Percent of crushed particles	California Test 205	95
Durability, min	California Test 229	65
Sand equivalent, min Type II Type III	California Test 217	65 65

^aCalifornia Test 211 must be performed on the aggregate before crushing. The aggregate supplier must certify that the crushed aggregate being used on the project is manufactured from the source aggregate meeting the LA rattler requirements.

Aggregate Section 37

Micro Surfacing

Aggregate Requirements

Quality characteristic	Test method	Requirement
Los Angeles Rattler Loss, %, max Loss at 500 revolutions	California Test 211 ^a	35
Percent of crushed particles	California Test 205	95
Durability, min	California Test 229	65
Sand equivalent, min Type II Type III	California Test 217	65 65

^aCalifornia Test 211 must be performed on the source aggregate before crushing. The aggregate supplier must certify that the crushed aggregate being used on the project is manufactured from the source aggregate meeting the LA rattler requirements.

Aggregate Section 37

- Submit 50 lb bag 15 days prior
- Submit aggregate test results with aggregate
- Dept Acceptance
 - LA Rat, % Crushed, Durabilty, SE



Aggregate Sampling

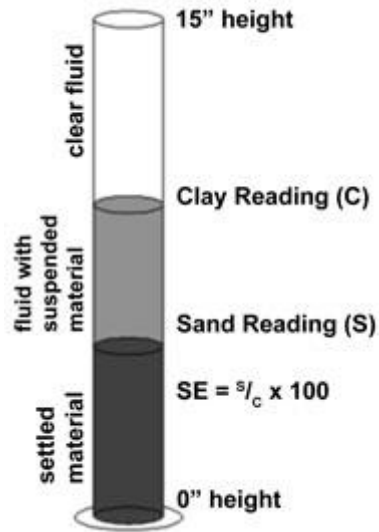
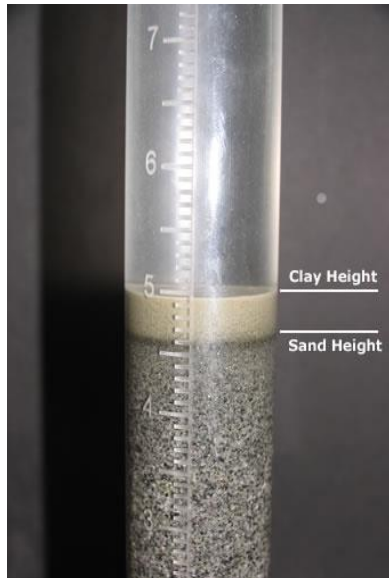
(in the field)

- Sample in multiple locations in the pile
- Dig deep into the pile, avoid segregated material
- Seal up sample to maintain moisture content
- Sample new deliveries
- Sample when issues arise in the field
- AASHTO T2, ASTM D75



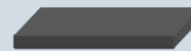
Aggregate Testing

Sand Equivalence

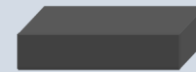


Gradation

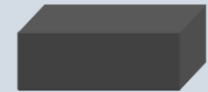
TYPES OF SLURRY SEAL



Type 1:
#200 x 1/8"
(3.175mm)



Type 2:
#200 x 1/4"
(6.35mm)



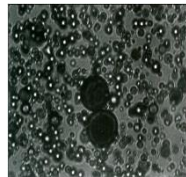
Type 3:
#200 x 3/8"
(9.525mm)



Mix Design

Mix-Design Steps

- **Selection and testing of component materials**
- **Mixture testing**
- **Long-term performance related testing**

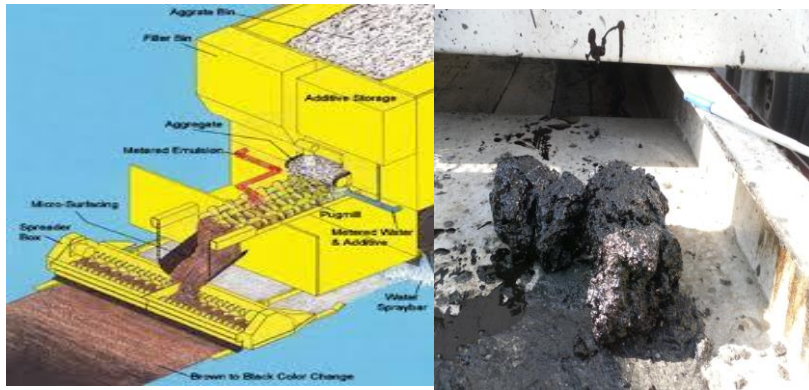


Mix Design

TEST	SPECIFICATION		MEASURES
	slurry	micro	
Mix Time	180 sec +	120 sec +	Compatibility Proportions Visual inspection
Cohesion	30 min, 12kg-cm 60 min, 20 kg-cm	30 min, 12kg-cm 60 min, 20 kg-cm	Traffic time Cohesion build-up Dislodged stones
Consistency	2.0 – 3.0 cm		Fluid content for workable mix
Wet Stripping	90% minimum	90% minimum	Adhesion of asphalt to stone

Mix Design

Mix Time



Cohesion Testing



Consistency



Wet Stripping



Mix Design

TEST	SPECIFICATION		MEASURES
	slurry	micro	
Wet Track Abrasion Loss	1 hr, 75 g/ft ²	1 hr, 50 g/ft ² 6 day, 75 g/ft ²	Raveling Wearing Qualities
Lateral Displacement- Loaded Wheel Test	N/A	5% maximum	Rutting Deformation Upper Binder Limit
Excess Asphalt- Loaded Wheel Test	50 g/ft ²	50 g/ft ²	Bleeding Heavy Traffic Ability
Classification compatibility (SB&R)	N/A	11 points min, (AAA,BAA)	Abrasion Adhesion Integrity

Mix Design

West Track Abrasion



Loaded Wheel Tester



Classification Compatibility (SB&R)



Mix Design Section 37

Slurry Seal Mix Design Requirements

Quality characteristic	Test method ^a	Requirement
Consistency (max, mm)	Technical Bulletin 106	30
Wet stripping	Technical Bulletin 114	Pass
Compatibility	Technical Bulletin 115	Pass ^b
Cohesion test ^c , within 1 hour (min, kg-mm)	Technical Bulletin 139	200
Wet track abrasion (max, g/m ²)	Technical Bulletin 100	810

^aTest methods are by the International Slurry Surfacing Association.

^bMixing test must pass at the maximum expected air temperature at the job site during placement.

Slurry seal type	Residue range
Type I	10-16
Type II	7.5-13.5
Type III	6.5-12.0

Slurry Seal Spread Rates

Slurry seal type	Application range (lb of dry aggregate/sq yd)
Type I	8–12
Type II	10–18
Type III	20–25

Mix Design Section 37

Micro-surfacing Mix Design Proportion Limits

Material	Proportion limits
Micro-surfacing emulsion asphalt residual content	5.5–10.5% of aggregates dry weight
Water and additives	As Required
Mineral filler	0–3% of aggregates dry weight

Micro-surfacing Mix Design Requirements

Quality characteristics	Test method ^a	Requirement
Wet cohesion @ 30 minute (set) (min, kg-cm) @ 60 minute (traffic) (min, kg-cm)	Technical Bulletin 139	12 20
Excess asphalt (max, g/m ²)	Technical Bulletin 109	540
Wet stripping (min, %)	Technical Bulletin 114	90
Wet track abrasion loss 6-day soak (max, g/m ²)	Technical Bulletin 100	810
Displacement Lateral (max, %) Specific gravity after 1000 cycles of 57 kg (max)	Technical Bulletin 147A	5 2.10
Classification compatibility (min, grade points)	Technical Bulletin 144	(AAA, BAA) 11
Mix time @ 25 °C (min)	Technical Bulletin 113	Controllable to 120 seconds

^aTest methods are by the International Slurry Surfacing Association.

Micro-surfacing type	Application range (lb of dry aggregate/sq yd)
Type II	10–20
Type III ^a	20–32
Type III ^b	30–32

^aOver asphalt concrete pavement

^bOver concrete pavement and concrete bridge decks

Mix Design Section 37

- Mix design submitted 10 days prior
- Signed by authorized lab
- Using materials that will be used on the job
- If materials change, new design required



What the design boils down to:

- **Compatibility and performance verification of material to be used on the project:**
 - Quality emulsified asphalt
 - Quality aggregate
 - Compatible chemistry and proper proportioning for handling, and curing



Summary Remarks

- **Slurry and Micro Surfacing systems are designed in the lab at 77F and normal lab humidity.**
- **Designs are an indication that the system can work.**
- **They are an indication that quality materials are available.**
- **The tests are an indication of mix performance on the road.**
- **Good contractors can make the system work and provide superior results.**
- **There is a large amount of generic, non-proprietary, information for these systems available from around the world.**

Slurry and Micro Mix Design

- **International Slurry Surfacing Association (ISSA)**
 - Over 60 contractor members worldwide
 - Over 150 members
 - www.slurry.org
- **Slurry Seal Guidelines**
 - A105 Recommended Performance Guidelines for Emulsified Asphalt Slurry Seal Surfaces, 2010.
- **Micro Surfacing Guidelines**
 - A143 Recommended Performance Guidelines for Polymer Modified Micro Surfacing, 2010.
- **ISSA Inspector's Manual for Slurry Systems**

Thank You

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