

Chapter 8

Slurry Seals

From... Maintenance Technical
Advisory Guide (MTAG)

Managers' Overview

From... Maintenance Technical
Advisory Guide (MTAG)

Slurry Seals

- What are slurry seals?
- Why use slurry seals?
- Where to use slurry seals?
- When to use slurry seals?



What is Slurry Seal?

- A thin maintenance treatment
- A mixture of:
 - asphalt emulsion
 - graded aggregates
 - mineral filler
 - water
 - Additives



- When placed on the pavement surface the mixture breaks and cures creating a new wearing surface.

Why Use Slurry Seals?

- Cost Effective
- Benefits:
 - minimize oxidation/ageing
 - reduce water infiltration
 - provide skid resistance
 - improve aesthetics
 - correct raveling and weathering
- Average performance life: 3 to 5 years

Where to Use?

- Hot Mix Asphalt Pavements:
 - Roadways (All traffic levels)
 - Parking Lots
 - Taxiways and Runways
 - Bridges and Over-Crossings
- Geographic Regions/Climate Zones:
 - All throughout California



Cape Seal (Slurry over Chip Seal)

When to Use?

- To correct/improve:
 - raveling and weathering
 - loss of frictional properties
 - aesthetics
- To prevent/reduce:
 - ageing/oxidation of asphalt concrete
 - surface water infiltration
 - pavement degradation due to the elements



When NOT to Use?

- On pavements with structural defects:
 - Alligator Cracking
 - Rutting
 - Bumps and Depressions
 - Potholes
- Nighttime construction



Slurry Seal Vs. Microsurfacing

<i>Differences in:</i>	<i>MICROSURFACING</i>	<i>SLURRY SEAL</i>
Asphalt Emulsion	always polymer modified, quick set	could be polymer modified
Aggregate Quality/Gradation	stricter spec. for sand equivalent; use only Type II and Type III	Can use Type I, II or III
Additives/Break	chemical break largely independent of weather conditions	breaking and curing dependent on weather conditions

Slurry Seal Vs. Microsurfacing

<i>Differences in:</i>	<i>MICROSURFACING</i>	<i>SLURRY SEAL</i>
Mix Stiffness/ Equipment	stiffer mix, use augers in the spreader box and secondary strike-off	softer mix, use drag box
Applications	same as slurry seal + rut filling, night work, correction of minor surface profile irregularities	correct raveling, seal oxidized pavements, restore skid resistance

Module 8-1

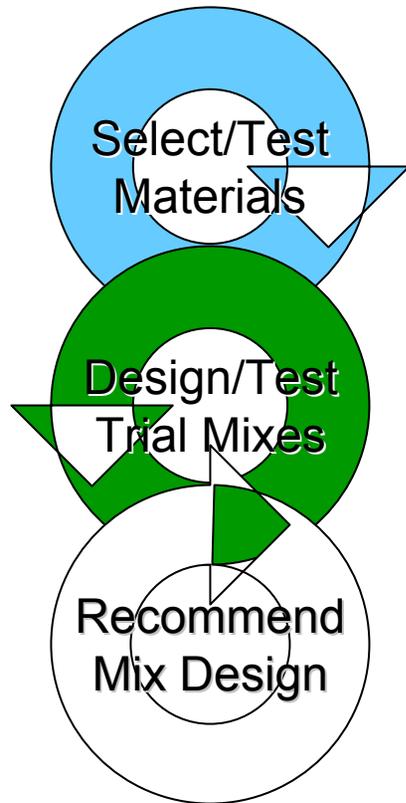
Design, Materials & Specifications

From... Maintenance Technical
Advisory Guide (MTAG)

Slurry Seal Design

- Design Process
- Specification
- Materials
- Laboratory Tests

Mix Design Process



- **Pre-screen materials**
- **Check materials compatibility**
- **Try different mixing proportions**
- **Prepare mixes at a range of emulsion contents**
- **Check for cohesion build-up**
- **Check for abrasion resistance**
- **Check for sand adhesion**
- **Select optimum emulsion content**
- **Test proposed mix to meet specification requirements**

Specification

- Caltrans
 - 2006 Standard Specifications, Section 37-2 Slurry Seal
 - http://www.dot.ca.gov/hq/esc/oe/specs_html/2006_specs.html
- International Slurry Surfacing Association (ISSA):
 - A105 (2005) Recommended Performance Guidelines for Emulsified Asphalt Slurry Seal
 - <http://www.slurry.org/downloads/A105.pdf>
- ASTM:
 - ASTM D 3910-98(2004) Standard Practices for Design, Testing, and Construction of Slurry Seal
 - <http://www.astm.org>

Materials

- Asphalt Emulsion
- Aggregate
- Mineral Filler
- Water
- Additives

Asphalt Emulsion

- Type/Grade
 - Anionic/Quick Set (QS-1h)
 - Cationic/Quick Set (CQS-1h)
- Specification
 - CALTRANS 2006 Standard Specifications Section 94
- Notes
 - Could be polymer-modified, CALTRANS standard specification for PMCQS not available at this time

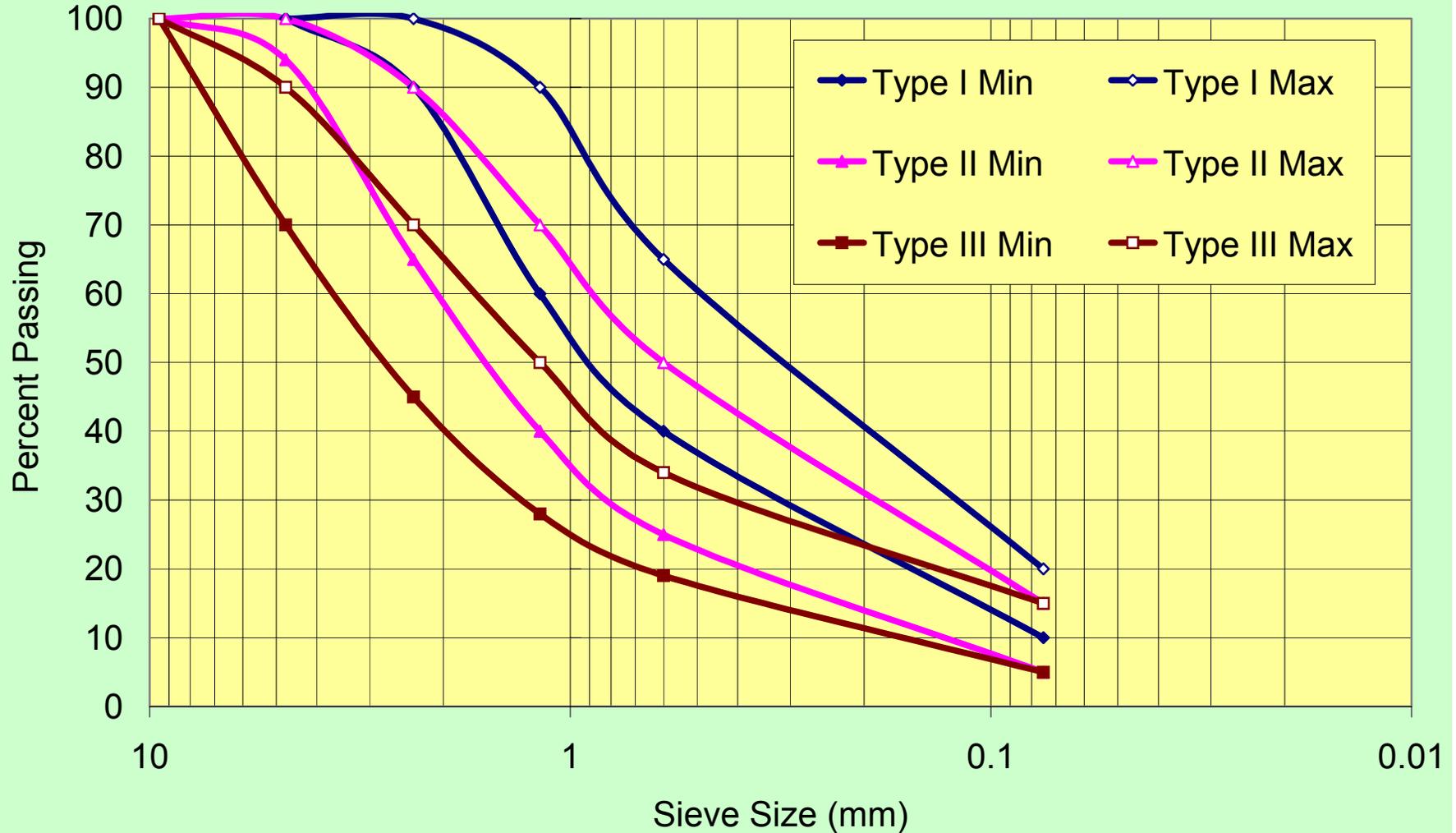
Asphalt Emulsion - Tests

Tests on Emulsion	Typical Specification (CQS1h)	Method
Viscosity, SSF @ 50°C, sec	15 – 90	AASHTO T 59
Sieve Test, %	< 0.30	AASHTO T 59
Settlement, 5 days, %	< 5	ASTM D 244
Storage Stability, 1 day, %	< 1	AASHTO T 59
Residue by Distillation, %	> 57	California Test 331
Particle Charge	Positive	
Tests on Residue from Distillation Test	Typical Specification	Method
Penetration, 25°C	40 – 90	AASHTO T 49
Ductility, 25°C, mm	> 400	AASHTO T 51
Solubility in trichloroethylene, %	> 97	AASHTO T 44

Aggregate - Gradations

Sieve	Type I	Type II	Type III
3/8 in (9.5mm)	-	100	100
No. 4 (4.75 mm)	100	94-100	70-90
No. 8 (2.36 mm)	90-100	65-90	45-70
No. 16 (1.18 mm)	60-90	40-70	28-50
No. 30 (600-μm)	40-65	25-50	19-34
No. 200 (75-μm)	10-20	5-15	5-15

Slurry Surfacing Systems Aggregate Gradations



Aggregate - Quality

Test	Type I	Type II	Type III	Test Method
Sand Equivalent (min)	45	55	60	CT 217
Durability Index (min)	55	55	55	CT 229

- Other aspects of interest:
 - Geology
 - Shape
 - Texture
 - Age and Reactivity
 - Cleanliness

Mineral Filler

- Portland cement, hydrated lime, limestone dust, fly ash or other approved filler meeting the requirements of ASTM D242
- Considered part of the dry aggregate
- Mixing aid, improves cohesion, absorbs water from the emulsion causing it to break faster after placement

Water

- Water should be of such quality that the asphalt will not separate from the emulsion before the slurry seal is placed

Additives

- Emulsifier solutions, aluminum sulfate, aluminum chloride, borax
- Generally act as retardants, useful when temperatures rise during the day

Mixing Properties



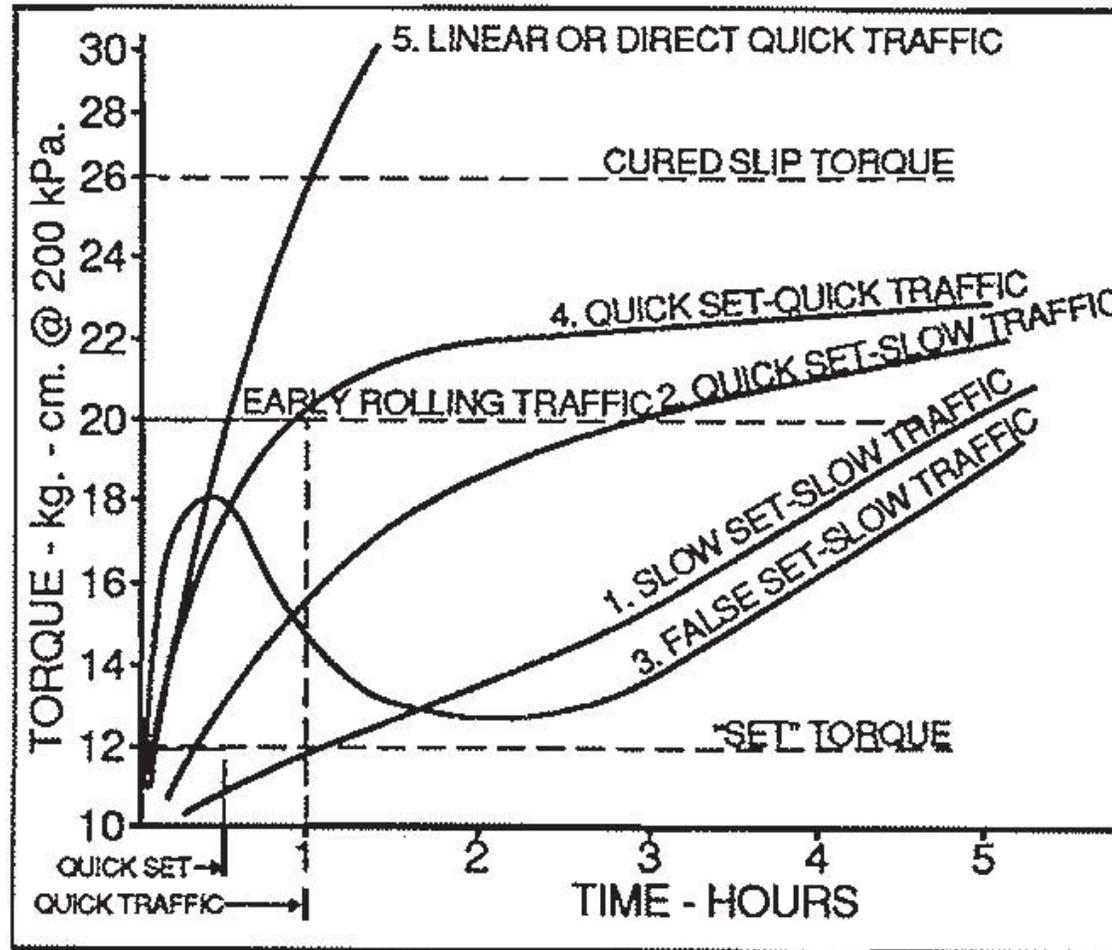
- ISSA TB 102 (Mixing Test)
 - Determine approximate proportions of component materials by trying different “recipes”
 - The amount of time the slurry can be mixed and retain its homogenous consistency is recorded (mixing time)
 - Foaming and coating are visually assessed
 - The test can be performed at expected field humidity and temperature conditions
 - Select the proportions that results in mixing times over 180 seconds and good coating over the range of humidity and temperature condition expected at placement

Cohesion Build-Up

- ISSA TB 139 (Modified Cohesion Test)
- Fabricate 3 test specimens:
 1. At selected emulsion content
 2. -2% emulsion content
 3. +2% emulsion content
- Determine the build-up of cohesion with time
- Differentiate between “Quick Set” and “Slow Set”; “Quick Traffic” and “Slow Traffic” mixes



Cohesion Build-Up



Abrasion Loss

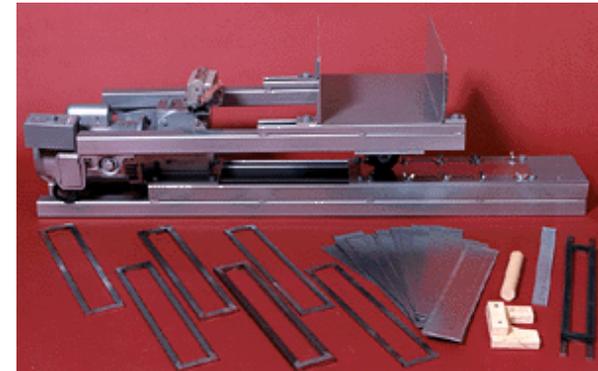
- ISSA TB 100 (Wet Track Abrasion Test)
- Fabricate 3 test specimens:
 1. At selected emulsion content
 2. -2% emulsion content
 3. +2% emulsion content
- Cure specimens for 16 hrs, than soak for 1 hr
- Determine abrasion loss under water
- Plot abrasion loss versus emulsion content



Sand Adhesion

- Fabricate 3 test specimens:

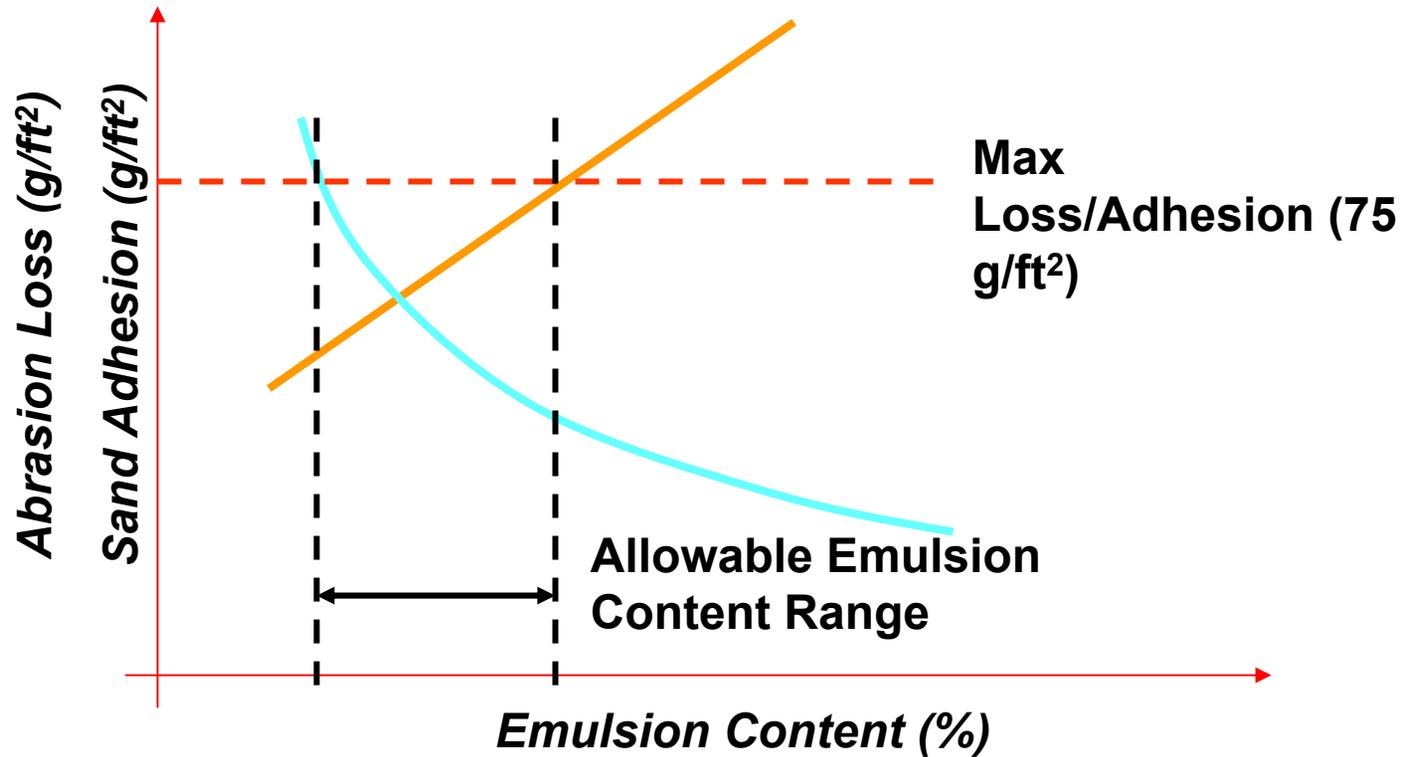
1. At selected emulsion content
2. -2% emulsion content
3. +2% emulsion content



- ISSA TB 109 (Loaded Wheel Test)

- Measure increase in weight of the specimen due to sand adhesion
- Plot sand adhesion versus emulsion content

Emulsion Content Selection



CALTRANS Specification Requirements

Property	Test	Requirement
Consistency	ISSA TB 106	< 1.2 in.
Wet Stripping	ISSA TB 114	Pass
Compatibility	ISSA TB 115	Pass
Cohesion, 1 hr.	ISSA TB 139	> 200 kg-mm
Wet Track Abrasion Loss	ISSA TB 100	< 800 g/m ²

Final Notes

- Design is generally performed by outside laboratory, Caltrans will only review and accept
- Designer needs to have extensive experience with slurry systems

Module 8-2

Construction and Inspection

From... Maintenance Technical
Advisory Guide (MTAG)

Slurry Seal Construction

- Project Selection
- Applications
- Safety and Traffic Control
- Equipment
- Construction
- Quality Control
- Troubleshooting
- Field Considerations

Project Selection

- A pavement preservation treatment: protect the pavement before distresses appear
- Can correct: raveling, oxidized pavement, friction loss
- Cannot correct: rutting, cracking, base failures, any structural deficiencies
- When applied correctly, it may increase pavement life by 3 – 5 years

Distress Conditions

Pavement Distress	Slurry*	Micro*
Surface cracking		
Early longitudinal	X	X
Hairline	X	X
Full depth cracking		
Thermal or Transverse	-	-
Fatigue or Alligator	-	-
Block	-	-
Reflective	-	-
Late longitudinal	-	-
Slippage (tack failure)	-	-
Corrugation or Shoving (wash boarding)	-	X

Distress Conditions (cont.)

Pavement Distress	Slurry*	Micro*
Rutting		
Sound base	-	X
Unsound base	-	-
Raveling	X	X
Bleeding	-	X
Polishing (loss of skid resistance)	X	X
Patched pothole		
Pavement patch only	-	-
Base repaired patch	X	X
Loss of profile (crown, edge, etc.)	-	X

Applications

Application	Aggregate Type I	Aggregate Type II	Aggregate Type III
Void Filling	•	•	
Wearing Course AADT < 100	•	•	
Wearing Course AADT < 1,000		•	•
Wearing Course AADT < 20,000			•
Minor Shape Correction 0.4 – 0.8 inch (10 – 20 mm)			•
Application Rates in lbs of dry aggregate per square yard	8 - 12	10 - 15	20 - 25

Safety and Traffic Control

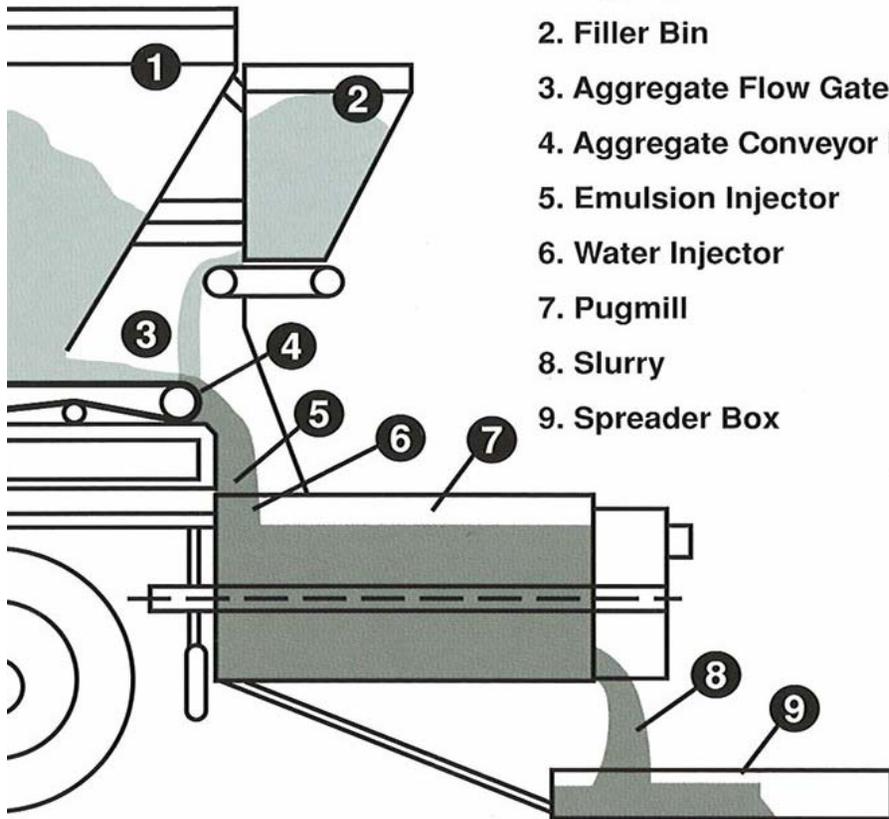
- Ensure that the slurry surfacing has had adequate time to cure prior to reopening to traffic - very often drivers assume that the slurry surfacing is drivable despite of the warning signs and cause damage to the fresh placed treatment
- Notify the residents and provide information on how to accommodate the construction activities
- Protect both employees and public
- Have signs/barricades in place before commencing work

Equipment



- Requirements covered in Caltrans Standard Specification Section 37
- Types:
 - Continuous, self propelled unit
 - Truck-mounted unit
- All equipment should be properly calibrated as per CT 109

Typical Setup



1. Aggregate Bin
2. Filler Bin
3. Aggregate Flow Gate
4. Aggregate Conveyor Belt
5. Emulsion Injector
6. Water Injector
7. Pugmill
8. Slurry
9. Spreader Box



Surface Preparation

- Restore pavement structural integrity and functional performance characteristics:
 - Patching
 - Crack sealing
- Clean pavement surface
 - Sweeping or High Power Pressure Washing
 - Remove rubber crack sealant and thermo-plastic markings
 - Cover utility inlets with heavy paper or roofing felt

Utility Inlets



BEFORE



AFTER

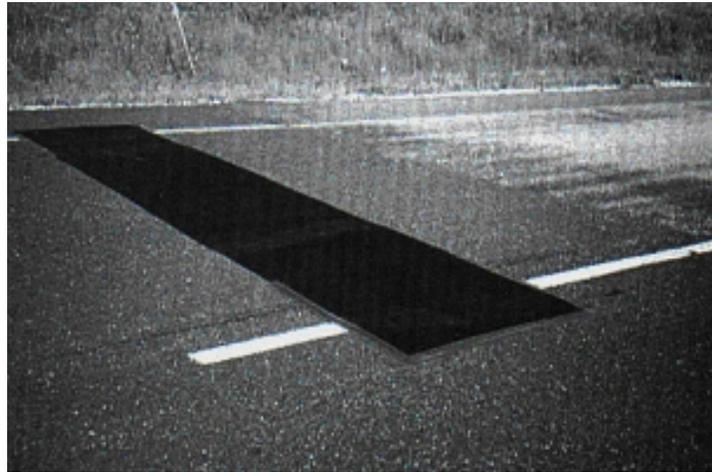


Application Conditions

- Humidity: 60% or less
- Temperature: 50°F (10°C) and rising
- Wind: slight breeze beneficial
- Sunlight: necessary, DO NOT apply at night
- DO NOT start work if:
 - Rain is imminent
 - Freezing anticipated within 24 hours

Starts/Stops

- All starts, stops, and handwork on turnouts should be done on roofing felt to ensure sharp, uniform joints and edges



Longitudinal Joints

- May be overlapped or butt jointed
- Should be straight or curve with the traffic lane
- Overlaps should not be in the wheel paths and should not exceed 3 in (75 mm) in width
- Typically 3 passes required on a 2-lane roadway

Transverse Joints

- Transitions at these joints must be smooth to avoid creating a bump in the surface
- The joints must be butted to avoid these bumps and handwork should be kept to a minimum
- Do not over wet - this leads to poor texture and scarring at the joints.
- Start transverse joints on roofing felt to eliminate these problems

Transverse Joints Examples



GOOD QUALITY

POOR QUALITY



Edges and Shoulders

- The edge of the spreader box should be outside the line of the pavement
- Edge boxes should be used when shoulders are covered

Edges and Shoulders Examples



GOOD QUALITY

POOR QUALITY



Uneven Mix and Segregation

- Non-uniform mixes that appear to be setting very slowly
- Black and flush looking surface with poor texture
- “False Slurry” - where the emulsion breaks onto the fine material
- Causes: too much water or not enough cement
- Result: segregation and delamination



Smoothness

- Washboarding – mix too stiff or spreader box incorrectly set up
- Drag marks – dirty strike-off
- Original surface too rough



Premature Opening to Traffic

- The slurry seal must build sufficient cohesion to resist abrasion due to traffic. Otherwise, it will ravel off quickly, particularly in high stress areas
- Early stone shedding is normal, but should not exceed 3%
- General rule of thumb for a slurry seal is that it can be opened to traffic when it has turned black



Post-Construction Treatments

- Rolling with pneumatic rollers may be incorporated to limit the amount of stone loss
- Sweeping should be done just prior to opening to traffic and at periods determined by the level of stone loss to avoid windshield damage
- Sanding may be used to reduce the times that cross streets or intersections are closed

Post-Construction Conditions

- Heavy traffic coupled with heavy rain within hours of placement will most likely damage the slurry surfacing
- Freezing weather within 2 weeks of placement may cause the water in the system to freeze and damage the slurry surfacing

Troubleshooting

- See Tables in MTAG, Vol. I, 2nd Edition
- Problems addressed:
 - Brown Mix, Whitish Mix
 - Mix Won't Set
 - Poor Coating
 - Delayed Opening to Traffic
 - Mix Breaks in Spreader Box
 - Mix Ravels
 - Mix Flushes
 - Delamination
 - Segregation
 - Uneven surface, Washboarding
 - Poor joints

Field Considerations

- See Tables in MTAG, Volume I, 2nd Edition
- Project Responsibilities
 - Project Review
 - Document Review
 - Materials Checks
- Pre-Seal Inspection Responsibilities
 - Surface Preparation

Field Considerations (Cont'd)

- Equipment Inspection
 - Sweeping
 - Slurry Seal Unit (Truck Mounted or Continuous)
 - Rollers
 - Stockpile
- Site Considerations
 - Weather requirements
 - Traffic Control
- Application Considerations
 - Application Rates

Field Considerations (Cont'd)

- Project Inspection
 - Slurry Surfacing
 - Rolling
 - Truck Operation
 - Longitudinal Joints
 - Transverse Joints
 - Sweeping
 - Opening to Traffic
 - Clean Up

Thank You

Questions?