Chapter 9
Microsurfacing

From... Maintenance Technical Advisory Guide (MTAG)
Managers Overview

*From*… Maintenance Technical Advisory Guide (MTAG)
Microsurfacing

- What is microsurfacing?
- Why use microsurfacing?
- Where to use microsurfacing?
- When to use microsurfacing?
What is Microsurfacing?

- A thin maintenance treatment
- A mixture of:
  - polymer modified emulsion
  - graded aggregates
  - mineral filler
  - water
  - Additives
- Instead of breaking and curing via evaporation, like slurry, a chemical reaction causes the material to set-up.

Chapter 9 – Microsurfacing
## Microsurfacing Vs. Slurry Seal

<table>
<thead>
<tr>
<th>Differences in:</th>
<th>MICROSURFACING</th>
<th>SLURRY SEAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Emulsion</td>
<td>always polymer modified, quick set</td>
<td>could be polymer modified</td>
</tr>
<tr>
<td>Aggregate Quality/Gradation</td>
<td>Stricter spec. for sand equivalent; use only Type II and Type III</td>
<td>Can use Type I, II or III</td>
</tr>
<tr>
<td>Additives/Break</td>
<td>chemical break largely independent of weather conditions</td>
<td>breaking and curing dependent on weather conditions</td>
</tr>
</tbody>
</table>
# Microsurfacing Vs. Slurry Seal

<table>
<thead>
<tr>
<th>Differences in:</th>
<th>Microsurfacing</th>
<th>Slurry Seal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mix Stiffness/Equipment</td>
<td>Stiffer mix, use augers in the spreader box and secondary strike-off</td>
<td>Softer mix, use drag box</td>
</tr>
<tr>
<td>Applications</td>
<td>Same as slurry seal + rut filling, night work, correction of minor surface profile irregularities</td>
<td>Correct raveling, seal oxidized pavements, restore skid resistance</td>
</tr>
</tbody>
</table>
Why Use Microsurfacing?

- Cost Effective
- Benefits:
  - minimize oxidation/ageing, reduce water infiltration, correct raveling and weathering
  - provide skid resistance
  - improve aesthetics
  - correct rutting and minor surface profile irregularities
- Average performance life: 5 to 7 years
Caltrans District 11 -

Type III Micro Surfacing Project,
Contract No. 11-276004, 11-SD-76-30.2/52.9
Intermountain Slurry Seal
Where to Use?

- Hot Mix Asphalt Pavements:
  - Roadways (All traffic levels)
  - Taxiways and Runways
  - Bridges and Over-Crossings

- Geographic Regions/Climate Zones:
  - All throughout California
When to Use?

- To correct/improve:
  - raveling and weathering
  - loss of frictional properties
  - aesthetics
  - rutting and surface profile irregularities

- 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
  - On-going Rutting
  - Bumps and Depressions
  - Potholes

Chapter 9 – Microsurfacing
Module 9-1

Design, Materials & Specifications

From… Maintenance Technical Advisory Guide (MTAG)
Microsurfacing 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**
    - Not available for download

- **International Slurry Surfacing Association (ISSA)**:
  - A143 (2005) Recommended Performance Guidelines for Micro-Surfacing

- **ASTM**:
    - [http://www.astm.org](http://www.astm.org)

Chapter 9 – Microsurfacing
Materials

- Asphalt Emulsion with Polymer Modification
- Aggregate
- Mineral Filler
- Water
- Additives
Asphalt Emulsion

- **Type/Grade**
  - Polymer Modified Anionic/Quick Set (PMQS-1h)
  - Polymer Modified Cationic/Quick Set (PMCQS-1h)

- **Specification**
  - CALTRANS proposed “Microsurfacing Emulsion” (MSE)

- **Notes**
  - Always polymer-modified. If Latex is used, the emulsion may be called latex-modified (LM)

Chapter 9 – Microsurfacing
## Asphalt Emulsion - Tests

<table>
<thead>
<tr>
<th>Tests on Emulsion</th>
<th>Typical Specification</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, SSF @ 25°C, sec</td>
<td>15 – 90</td>
<td>AASHTO T 59</td>
</tr>
<tr>
<td>Settlement, 5 days, %</td>
<td>&lt; 5</td>
<td>ASTM D 244</td>
</tr>
<tr>
<td>Storage Stability, 1 day, %</td>
<td>&lt; 1</td>
<td>AASHTO T 59</td>
</tr>
<tr>
<td>Sieve Test, %</td>
<td>&lt; 0.30</td>
<td>AASHTO T 59</td>
</tr>
<tr>
<td>Residue by Evaporation, %</td>
<td>&gt; 62</td>
<td>California Test 331</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tests on Residue from Evaporation Test</th>
<th>Typical Specification</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration, 25°C</td>
<td>40 – 90</td>
<td>AASHTO T 49</td>
</tr>
<tr>
<td>Softening Point, °C</td>
<td>&gt; 57</td>
<td>AASHTO T 53</td>
</tr>
<tr>
<td>G* @ 20°C, 10 rad/ sec, MPa</td>
<td>Report Only</td>
<td>AASHTO TP 5</td>
</tr>
<tr>
<td>Phase Angle @ 50°C, 10 rad/ sec, PA(max) - PA base</td>
<td>Report Only</td>
<td>AASHTO TP 5</td>
</tr>
<tr>
<td>Stiffness @ -12°C, MPa M-Value</td>
<td>Report Only</td>
<td>AASHTO TP 1</td>
</tr>
<tr>
<td>Torsional Recovery, %</td>
<td>&gt; 18% (LMCQS-1h)</td>
<td>California Test 332</td>
</tr>
<tr>
<td>Polymer Content</td>
<td>&gt; 2.5% (LMCQS-1h)</td>
<td>California Test 401</td>
</tr>
</tbody>
</table>
### Aggregate - Gradations

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 in (9.5mm)</td>
<td></td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>100</td>
<td>94-100</td>
<td>70-90</td>
</tr>
<tr>
<td>No. 8 (2.36 mm)</td>
<td>90-95</td>
<td>65-90</td>
<td>45-70</td>
</tr>
<tr>
<td>No. 16 (1.18 mm)</td>
<td>50-90</td>
<td>40-70</td>
<td>28-50</td>
</tr>
<tr>
<td>No. 30 (600-µm)</td>
<td>40-65</td>
<td>25-50</td>
<td>19-34</td>
</tr>
<tr>
<td>No. 200 (75-µm)</td>
<td>10-20</td>
<td>5-15</td>
<td>5-15</td>
</tr>
</tbody>
</table>

*NOT USED FOR MICROFACING*

**Chapter 9 – Microsurfacing**
Chapter 9 – Microsurfacing
Aggregate - Quality

<table>
<thead>
<tr>
<th>Test</th>
<th>Criteria</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand Equivalent (min)</td>
<td>&gt; 65</td>
<td>CT 217</td>
</tr>
<tr>
<td>Durability Index (min)</td>
<td>&gt; 55</td>
<td>CT 229</td>
</tr>
<tr>
<td>Abrasion (LA Rattler, 500 rev.)</td>
<td>&lt; 35%</td>
<td>CT 211</td>
</tr>
<tr>
<td>Crushed Particles</td>
<td>100%</td>
<td>CT 205</td>
</tr>
</tbody>
</table>

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

Chapter 9 – Microsurfacing
Mineral Filler

- Any recognized brand of non-air entrained Portland cement or hydrated lime that is free from lumps
- 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 microsurfacing 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 result in mixing times over 120 seconds and good coating over the range of humidity and temperature condition expected at placement

Chapter 9 – Microsurfacing
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

Chapter 9 – Microsurfacing
Cohesion Build-Up

Chapter 9 – Microsurfacing
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

Chapter 9 – Microsurfacing
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

Chapter 9 – Microsurfacing
Emulsion Content Selection

Chapter 9 – Microsurfacing
# Proposed MSE Specification

## Requirements

<table>
<thead>
<tr>
<th>Property</th>
<th>Test</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet Cohesion</td>
<td>ISSA TB 139</td>
<td>12 kg-cm @ 30 min. 20 kg-cm @ 60 min.</td>
</tr>
<tr>
<td>Sand Adhesion</td>
<td>ISSA TB 109</td>
<td>&lt; 540 g/m²</td>
</tr>
<tr>
<td>Wet Stripping</td>
<td>ISSA TB 114</td>
<td>&gt; 90%</td>
</tr>
<tr>
<td>Wet Track Abrasion Loss, 6-day soak</td>
<td>ISSA TB 100</td>
<td>&lt; 810 g/m²</td>
</tr>
<tr>
<td>Displacement</td>
<td>ISSA TB 147A</td>
<td>&lt; 5% lateral</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td></td>
<td>&lt; 2.1 @ 1000 cycles of 57 kg</td>
</tr>
<tr>
<td>Classification Compatibility</td>
<td>ISSA TB 144</td>
<td>(AAA, BAA) 11 grade points</td>
</tr>
<tr>
<td>Mix Time @ 25°C</td>
<td>ISSA TB 113</td>
<td>&gt; 120 sec.</td>
</tr>
</tbody>
</table>

Chapter 9 – Microsurfacing
Final Notes

- Design is generally performed by outside laboratory, CALTRANS will only review and approve
- Designer needs to have extensive experience with microsurfacing
Module 9-2

Construction and Inspection

From… Maintenance Technical Advisory Guide (MTAG)
Microsurfacing 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
- Can be used for rut filling
- Cannot correct: cracking, base failures, any structural deficiencies
- When applied correctly, it may increase pavement life by 5 – 7 years

Chapter 9 – Microsurfacing
## Distress Conditions

### Pavement Distress

<table>
<thead>
<tr>
<th>Distress Type</th>
<th>Slurry*</th>
<th>Micro*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surface cracking</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early longitudinal</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Hairline</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Full depth cracking</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal or Transverse</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fatigue or Alligator</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Block</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Reflective</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Late longitudinal</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Slippage (tack failure)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Corrugation or Shoving (wash boarding)</strong></td>
<td>-</td>
<td>X</td>
</tr>
</tbody>
</table>

Chapter 9 – Microsurfacing
## Distress Conditions (cont.)

<table>
<thead>
<tr>
<th>Pavement Distress</th>
<th>Slurry*</th>
<th>Micro*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rutting</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sound base</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>Unsound base</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Raveling</strong></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Bleeding</strong></td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td><strong>Polishing (loss of skid resistance)</strong></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Patched pothole</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pavement patch only</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Base repaired patch</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Loss of profile (crown, edge, etc.)</strong></td>
<td>-</td>
<td>X</td>
</tr>
</tbody>
</table>

Chapter 9 – Microsurfacing
**Applications**

<table>
<thead>
<tr>
<th>Application</th>
<th>Aggregate Type II</th>
<th>Aggregate Type III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Void Filling</td>
<td>⋄</td>
<td></td>
</tr>
<tr>
<td>Wearing Course</td>
<td>⋄</td>
<td></td>
</tr>
<tr>
<td>AADT &lt; 100</td>
<td></td>
<td>⋄</td>
</tr>
<tr>
<td>Wearing Course</td>
<td>⋄</td>
<td>⋄</td>
</tr>
<tr>
<td>AADT &lt; 1,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wearing Course</td>
<td>⋄</td>
<td>⋄</td>
</tr>
<tr>
<td>AADT &lt; 20,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minor Shape Correction</td>
<td></td>
<td>⋄</td>
</tr>
<tr>
<td>0.4 – 0.8 inch (10 – 20 mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Application Rates in lbs of dry aggregate per square yard</td>
<td>10 - 15</td>
<td>20 - 25</td>
</tr>
</tbody>
</table>

Chapter 9 – Microsurfacing
Safety and Traffic Control

- Ensure that the microsurfacing has had adequate time to cure prior to reopening to traffic - very often drivers assume that the microsurfacing 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.

Chapter 9 – Microsurfacing
Equipment

- Requirements similar to those for slurry seal, 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

Chapter 9 – Microsurfacing
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. 
9. Spreader Box

Chapter 9 – Microsurfacing
Spreader Boxes for Microsurfacing

Variable width spreader box for shoulders and longitudinal joints

Microsurfacing spreader box with augers and secondary strike-off

Chapter 9 – Microsurfacing
Spreader Boxes for Microsurfacing (Cont’d)

- Steel strike-off used for scratch course when rut depth is less than 0.5 inch
- Rut box used when rut depth is higher than 0.5 inches
Rut Filling

Chapter 9 – Microsurfacing
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

Chapter 9 – Microsurfacing
Utility Inlets

BEFORE

AFTER

Chapter 9 – Microsurfacing
Application Conditions

- Temperature: 50°F (10°C) and rising
- May be applied 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.

Chapter 9 – Microsurfacing
Transverse Joints Examples

GOOD QUALITY

POOR QUALITY

Chapter 9 – Microsurfacing
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

Chapter 9 – Microsurfacing
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

Chapter 9 – Microsurfacing
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 microsurfacing 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 microsurfacing is that it can be opened to traffic when it has turned black.

Chapter 9 – Microsurfacing
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.

Chapter 9 – Microsurfacing
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 microsurfacing.

Chapter 9 – Microsurfacing
Troubleshooting

- See Tables in MTAG, Volume 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

Chapter 9 – Microsurfacing
Field Considerations

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

Chapter 9 – Microsurfacing
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

Chapter 9 – Microsurfacing
Thank You

Questions?

Chapter 9 – Microsurfacing