Slurry/ Micro-Surface Mix Design Procedure

Prepared By
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APTech
Consolidated Engineering Laboratories
MACTEC

Northeast Pavement Preservation Partnership
Warwick, Rhode Island
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Caltrans Contract No. 65A0151
Pooled Fund Study Team

- DOT’s
  - Caltrans, Delaware, Georgia, Illinois, Kansas, Maine, Michigan, Minnesota, Missouri, New Hampshire, New York, North Dakota, Texas, Vermont

- FHWA
- ISSA
- Contractors
  - Fugro Consultants
  - MACTEC Engineering and Consulting
  - Consolidated Engineering Laboratories
  - Applied Pavement Technology
Project Objectives

Improve the performance of slurry surfacing systems through the development of:

- Rational mix design procedures
- Guidelines for proper use and application of these systems
- Improved specifications
Work Plan and Study Approach

- **Phase I**
  - Review literature
  - Survey industry and agencies
  - Develop detailed plans for Phases II and III

- **Phase II**
  - Develop and evaluate mix design procedures

- **Phase III**
  - Conduct field validation
  - Develop guidelines & specs
  - Develop training materials
Phase I – Literature Review

- Extent of use worldwide
- Mix design procedures and laboratory tests
  - ISSA, ASTM, TTI
- Performance of existing projects
  - 9 projects in U.S. and Canada
- Guidelines and specifications
  - ISSA, Caltrans, TTI, CSIR, Austroads
Phase I - Surveys

- Mix design method
- Extent of use
- Benefits
- Problems
- Life expectancy
- Tests that relate to performance
- Quality assurance testing
Phase I - Surveys

- Agencies – 21 respondents
- Industry – 21 respondents
- Advisory panel – 4 respondents
Findings

- All methods derived from ISSA Guidelines A105 and A143
- Extensive experience with product needed to ensure success of a project
- Concerns with the repeatability of the laboratory tests used in design
Findings (Cont’d)

- Documented slurry seal and microsurfacing performance data limited
- Failures generally a result of:
  - Poor project selection (need to educate agencies on the proper use of slurry and microsurfacing)
  - Contractor capabilities and experience
Phase I Deliverables

- Phase I Report
- Detailed Work Plan for Phase II
- Detailed Work Plan for Phase III

Phase I – Completed
Panel Meeting – Due February 2004
Phase II Activities

- Develop framework for rational mix design procedure
- Evaluate existing and proposed test methods
- Perform ruggedness testing of proposed test methods
- Finalize mix design and develop AASHTO style test protocols
- Make recommendations for “field test” for slurry and microsurfacing
Philosophy – Mix Properties

- Mixable – Components can be mixed, coated and applied through the machine

- Workable – Applied mixture sets and cures within a reasonable time to allow return of traffic without causing damage
Philosophy

- **Mixture performance**
  - Maintains acceptable friction resistance
  - Does not ravel, de-bond, bleed, exhibit moisture damage, or lose cohesiveness over the life of the treatment
Philosophy – Laboratory Tests

- Repeatable
- Relate to field performance
- Covers the range of temperature and humidity conditions that may occur in the field
- Easy to implement
- Reasonable cost
Should there be a distinction?

- **Performance** – Mix design method should simply show the benefit of one system over the other (e.g., rut filling capabilities, rapid vs. slow set)

- **Constructability** – Issues are the same

Team’s recommendation:

Slurry = Micro = Slurry Surfacing Systems (S3)
## Strawman Specification

<table>
<thead>
<tr>
<th>Set Time</th>
<th>Test or field Condition</th>
<th>Units</th>
<th>Traffic</th>
<th>Temperature</th>
<th>Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hi</td>
<td>Med</td>
<td>Low</td>
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<td>35 C</td>
<td>25 C</td>
<td>10 C</td>
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<td>Hi</td>
<td>Med</td>
<td>Low</td>
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<td></td>
<td></td>
<td></td>
<td>90%</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td>Rapid</td>
<td>PFS-1 (Mixing)</td>
<td>kg-cm</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Mixing Torque - maximum</td>
<td>sec.</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>Mixing time - minimum</td>
<td>sec.</td>
<td>120</td>
<td>120</td>
<td>120</td>
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<tr>
<td></td>
<td>Spread index - maximum @ 120 sec.</td>
<td>kg-cm</td>
<td>12</td>
<td>12</td>
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</tr>
<tr>
<td></td>
<td>Blot test - 30 sec.</td>
<td></td>
<td>clear water</td>
<td>clear water</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Coating</td>
<td></td>
<td>100%</td>
<td>100%</td>
<td>95%</td>
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<tr>
<td></td>
<td>PFS-2 (Wet Cohesion)</td>
<td>kg-cm</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>30 min. cohesion - minimum</td>
<td>kg-cm</td>
<td>12</td>
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<td>12</td>
</tr>
<tr>
<td></td>
<td>60 min. cohesion - minimum</td>
<td>kg-cm</td>
<td>20</td>
<td>20</td>
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</tr>
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<td>90 min. cohesion - minimum</td>
<td>kg-cm</td>
<td>25</td>
<td>25</td>
<td>25</td>
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<tr>
<td></td>
<td>12 hr. cohesion - minimum</td>
<td>kg-cm</td>
<td>28</td>
<td>28</td>
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<td></td>
<td>PFS-3 (Abrasion Loss)</td>
<td>g/m²</td>
<td>200</td>
<td>200</td>
<td>400</td>
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<tr>
<td></td>
<td>30 min. loss - maximum</td>
<td>g/m²</td>
<td>100</td>
<td>100</td>
<td>300</td>
</tr>
<tr>
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<td>1 hr. loss - maximum</td>
<td>g/m²</td>
<td>100</td>
<td>100</td>
<td>300</td>
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<tr>
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<td>3 hr. loss - maximum</td>
<td>g/m²</td>
<td>100</td>
<td>100</td>
<td>300</td>
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<tr>
<td>Slow</td>
<td>PFS-1 (Mixing)</td>
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### Summary of Proposed Major Changes

<table>
<thead>
<tr>
<th>CURRENT</th>
<th>PROPOSED</th>
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<tbody>
<tr>
<td><strong>ISSA TB 113 – Trial Mix Procedure for Slurry Seal Design</strong></td>
<td>Automated Mixing Test (AMT)</td>
</tr>
<tr>
<td><strong>ISSA TB 100 – Test Method for Wet Track Abrasion of Slurry Surfaces (WTAT)</strong></td>
<td>Cohesion-Abrasion Test (CAT)</td>
</tr>
<tr>
<td><strong>ISSA TB 139 – The Modified Cohesion Tester</strong></td>
<td>Automated Cohesion Test (ACT)</td>
</tr>
<tr>
<td><strong>Tests run at standard laboratory temperature and humidity conditions</strong></td>
<td>Tests run over a range of temperature and humidity conditions</td>
</tr>
</tbody>
</table>
Automated Mixing Test (AMT)
AMT Results

Graph showing:
- Torque (N-cm) on the y-axis
- Time (minutes) on the x-axis

Key points:
- Mixing Torque
- Spread Time
- Mixing Time
Cohesion-Abrasion Test (CAT)
CAT Evaluation

- 300 tests on 5 slurry surfacing systems at 3 temperatures and 2 humidity levels
  - With and without compaction
  - With and without conditioning (soaking + oven cure)

- Major findings
  - Compaction does not influence the results
  - Temperature, humidity and curing time affect abrasion resistance of non-soaked specimens and predictive models can be developed to estimate these effects
Automated Cohesion Tester (ACT)
The graph shows the comparison between manual and automated torque values. The equation of the line is given by:

\[ y = 0.5711x \]

with a coefficient of determination, \( R^2 = 0.7073 \).

The graph includes data points and lines representing automated, automated corrected, equality, and linear (automated) conditions.
Field Test for Micro/Slurry

Purpose

- Correlate with long term performance
- Evaluate uniformity and conformance with mix design
- Evaluate readiness for opening to traffic
Field Test for Micro/Slurry

- **Approach**
  - Literature review / select candidate test methods
  - Limited experimental study
  - Recommendations for future
Candidate Field Tests

- Field cohesion test (traffic time)
- Field abrasion test (performance)
- GeoGauge (traffic time)
- Infrared camera (traffic time, uniformity)
- In situ shear tester (performance)
Phase II Deliverables/Progress

- Recommended mix design / Strawman V.3 available
- Evaluation of promising test methods / AMT, CAT completed, ACT in progress
- Ruggedness testing / in progress
- New and revised test methods in AASHTO format / AMT, CAT completed, ACT in progress
- Recommended field tests for QA purposes / in progress
Phase III – Pilot Projects

- Identify test sections
  - Develop site selection guidelines
  - Develop test section layout
    - Control / preferred / new (S3)
- Develop construction guidelines
  - Pre-construction
  - Construction
  - Post-construction
Phase III – Training

- 1.5-Day training course
  - Reference manual
  - Visual aids
  - Instructors guide
  - Hands-on workshops:
    - Use of laboratory test equipment
    - Evaluate learning using game-style Q&A
Phase III – Training

- Pre-job training module
  - Pocket guide
  - “Tailgate” session
Phase III - Deliverables

- Training – 95% completed
- Guidelines – 90% completed
- Pilot projects / field validation – completion due by fall 2008
Thank You

For more info: