PROGRESS REPORT
Slurry/Micro-Surface Mix Design Procedure
January 2006 – September 2006

To: **T. Joe Holland, CALTRANS**
Contract No.: **CALTRANS 65A0151**
Contractor: **Fugro Consultants LP**
Contract Period: **June 30, 2003 – Nov. 30, 2007**
Prepared By: **Jim Moulthrop, Principal Investigator**
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PROJECT OVERVIEW

The overall goal of this research is to improve the performance of slurry seal and micro-surfacing systems through the development of a rational mix design procedure, guidelines, and specifications.

Phase I of the project has two major components: 1) the first consists of a literature review and a survey of industry/agencies using slurry and micro-surfacing systems, 2) the second deals with the development of a detailed work plan for Phases II and III.

In Phase II, the project team will evaluate existing and potential new test methods, evaluate successful constructability indicators, conduct ruggedness tests on recommended equipment and procedures, and prepare a report that summarizes all the activities undertaken under the task.

In Phase III, the project team will develop guidelines and specifications, a training program, and provide expertise and oversight in the construction of pilot projects intended to validate the recommended design procedures and guidelines. All activities of the study will be documented in a Final Report.

NOTE: New information for the current month is notated by double-lines to the left of text, tables, or figures.

PHASE I—LITERATURE SEARCH AND WORK PLAN DEVELOPMENT

Task 1 Literature Review and Industry Survey—Completed

The literature review process is complete with all sources of information on the design and use of micro-surfacing and slurry seals reviewed and summarized in Chapter 2 of the Phase I Report. The three survey questionnaires were included in the August 2003 monthly report and the results were summarized in the Phase I Report.

Task 2 Work Plans for Phases II and III—Completed

The Phase II Work Plan was included in Chapter 3 of the Phase I Report. The Phase III Work Plan was included in Chapter 4 of the Phase I Report.

All activities of Phase I are complete. The results are included in the Phase I Interim Report that was submitted to CALTRANS in March 2004.

PHASE II—MIX DESIGN PROCEDURE DEVELOPMENT

Tasks 3 & 4—Evaluation of Potential Test Methods & Successful Constructability Indicators

Progress on Tasks 3 and 4 has been summarized in the August 2005 progress report as well as presented at the September 15, 2005 videoconference. Draft test protocols for the Automated Mixing Test (AMT) and the Cohesion Abrasion Test (CAT) tests were included in Appendices A and B of the September 2005 report.

Two aggregates and two asphalt emulsions were used initially in the study. Four slurry systems (mixes) were created using all possible combination of aggregate and emulsion:

Aggregates:

- A1 Table Mountain (ISSA Type III)
- A2 Lopke Gravel Products (ISSA Type III)

Emulsions:

- E1 Koch Ralumac
- E2 Polymer Modified LMCQS-1h, VSS Emultech

Mixes:

- M1 A1+E1
- M2 A1+E2
- M3 A2+E1
- M4 A2+E2

A third aggregate and emulsion were acquired during the last reporting period. The aggregate is a sandstone from Delta Materials in Marble Falls, TX, and the emulsion is from Ergon Asphalt and Emulsions, Inc., from their Waco, TX, plant. The aggregate and emulsion were used to design the “unknown” mix, denoted M5:

- M5 A3+E3
- A3 Marble Falls
- E3 Ergon

Testing continued during the last five months, however at a much slower pace than initially estimated. The following tables illustrate the proposed test factorial and the progress made up to date:

Table 1. Aggregate Tests

Test	Table Mountain	Lopke Gravel	Marble Falls
Sieve Analysis LA Abrasion Sulfate Soundness Sand Equivalent Durability Index Micro-Deval	All Completed	All Completed	All Completed

Table 2. Emulsion Tests

Test	Koch Ralumac	Polymer Modified LMCQS-1h, VSS Emultech	Ergon
Residue Recovery Penetration Ring and Ball Softening Point Dynamic Shear Rheometer	All Completed	All Completed	All Completed

Table 3. ISSA Mix Tests

Test	M1	M2	M3	M4	M5
Mixing Test (TB113) Wet Track Abrasion Test (WTAT TB100) Wet Stripping Test (TB114)	All Completed	All Completed	All Completed	All Completed	All Completed

Table 4. New/Modified Mix Tests, Percent Completed

Test	M1	M2	M3	M4	M5
Automated Mixing Test (AMT)	100% (6 of 6)	100% (6 of 6)	100% (6 of 6)	100% (6 of 6)	100% (6 of 6)
Cohesion Abrasion Tests (CAT)	17% (10 of 60)	28% (17 of 60)	20% (12 of 60)	27% (16 of 60)	15% (9 of 60)
Automated Cohesion Test (ACT)	0% (0 of 24)	0% (0 of 24)	0% (0 of 24)	0% (0 of 24)	0% (0 of 24)
Asphalt Pavement Analyzer (APA)	0% (0 of 24)	0% (0 of 24)	0% (0 of 24)	0% (0 of 24)	0% (0 of 24)

As illustrated in Table 4, a significant amount of testing remains to be done. The CAT tests are under way and should be completed in the following 4-5 weeks.

The Automated Cohesion Test device is now operational. The device should be available for testing by 1 October. The device is presented in Figure 1. The “first article” design has been developed by Temple Systems Lab of Dayton, OH. Testing on sandpaper has been completed to assure that the device will function properly. Work is underway to run the device on an OH microsurfacing mix and compare the results to current ISSA procedures. The device will then be sent to CEL to complete the testing matrix.

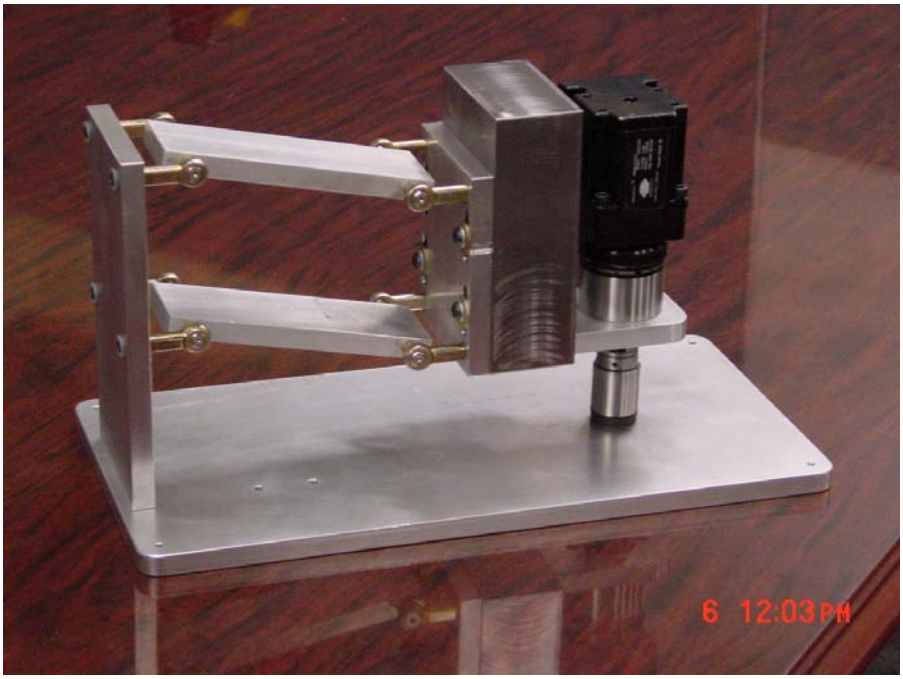


Figure 1. Automated Cohesion Test – under development

Overall, to complete all the remaining tests, the team estimates it will be accomplished by 30 November.

Some of the major issues causing the delay in testing are noted below:

- CEL did not have a temperature chamber to run tests at temperatures other than 25 C. Building the chamber and monitoring the ability of the chamber to maintain the desired temperature took several weeks but this issue is finally overcome.
- CEL has been very busy with other projects and short on personnel for this project and testing was carried out at a much slower pace than initially estimated
- Development of the automated cohesion tester was begun in Oakland, CA but was not successful. After evaluating other potential designers, the decision was made to contract with Temple Systems.
- A key member of the research team, Glynn Holleran, accepted a position with Fulton Hogan in New Zealand and this has created some difficulty in testing and evaluation

Draft Specification

A first draft of the specification has been developed in August 2005. Traffic, temperature, humidity and the desired set time dictate the threshold values to be met by a particular slurry system. The draft specification was provided in Appendix C of the September 2005 report.

Task 5—Ruggedness Tests of Recommended Equipment and Procedures

In comparison with the testing in Tasks 3 and 4, the tests of Task 5 will be performed at a single set of temperature, humidity, and cure time conditions. “Standard” conditions were chosen by the team (e.g., 50 percent humidity, 25°C temperature). Slight variations in these parameters

will be allowed to evaluate the ruggedness of the test procedures. The test factorials proposed for this part of the study are given in the following Tables. Note that the

Table 5. Automated Mixing Test (AMT)

Parameter	Units	Values		Test No.							
		High (H)	Low (L)	1	2	3	4	5	6	7	8
1. Filler	%	+0.5	-0.5	H	L	L	H	L	H	H	L
2. Additive	%	+0.1	-0.1	H	H	L	L	H	L	H	L
3. Water	%	+2	-2	H	H	H	L	L	H	L	L
4. Emulsion	%	+2	-2	L	H	H	H	L	L	H	L
5. Temperature	C	+2	-2	H	L	H	H	H	L	L	L
6. Humidity	%	+10	-10	L	H	L	H	H	H	L	L

Table 6. Automated Cohesion Test

Parameter	Units	Values		Test No.			
		High (H)	Low (L)	1	2	3	4
1. Cure Temp	C	+2	-2	L	L	H	H
2. Cure Time	min	+3	-3	L	H	L	H
3. Cure Humidity	%	+10	-10	H	L	L	H

Table 7. Cohesion-Abrasion Test (CAT) – Short Term (Cured, 1-Hour Soak)

Parameter	Units	Values		Test No.							
		High (H)	Low (L)	1	2	3	4	5	6	7	8
1. Cure Time	min	5	-5	H	L	L	H	L	H	H	L
2. Cure Temp.	C	2	-2	H	H	L	L	H	L	H	L
3. Humidity	%	10	-10	H	H	H	L	L	H	L	L
4. Test Time	s	5	-5	L	H	H	H	L	L	H	L
5. Test Temp.	C	5	-5	H	L	H	H	H	L	L	L
6. Test Duration	s	5	-5	L	H	L	H	H	H	L	L

Table 8. Cohesion-Abrasion Test (CAT) – Long Term (Cured, 6-Day Soak)

Parameter	Units	Values		Test No.			
		High (H)	Low (L)	1	2	3	4
1. Soak Time	min	15min	-15min	L	L	H	H
2. Test Duration	s	5	-5	L	H	L	H
3. Water Temp.	C	5	-5	H	L	L	H

At the last project team meeting in Oakland (August 28, 2006), it was planned to start the ruggedness testing in parallel with the evaluation testing of Tasks 3 and 4. It is estimated that the ruggedness testing will be completed by 31 December 2006.

Task 6—Phase II Report

Work on the Phase II Report started after the project team meeting in Oakland, May 18, 2006. A draft of the Chapter describing the philosophy and development of the new mix design is currently available. The Chapters describing the evaluation and ruggedness testing efforts will be finalized after completing all laboratory testing.

PHASE III— PILOT PROJECTS AND IMPLEMENTATION

Task 7—Development of Guidelines and Specifications

A list of references that contain guidelines and specifications has been drafted and is noted below:

- ISSA A105 Guidelines for Slurry—Available
- ISSA A143 Guidelines for Micro-Surfacing—Available
- TTI Report 1289-2F Use of Micro-Surfacing in Highway Pavements—Available.
- Report contains:
  - Methods and Materials Specifications
  - Quality Control and Assurance Tests (including field cohesion and vane shear tests)
  - Quality Control Guidelines (including materials acceptance tests and mixture design verification)
  - A Checklist
  - Usage Guidelines.
- ISSA Inspector's Manual—Available
- Caltrans Maintenance Technical Advisory Guide Final Draft—Available
- The ISSA Workshop Folder—Available

The guidelines and specifications will be a concise collection, presented in AASHTO format. This is one area of Phase III where the team can work at present. At the end of Phase II, the document will be appended with findings and recommendations relative to the new tests developed in Phase II.

Task 8—Workshop Training Program/Pre-Construction Module

The team agreed that work could commence in several chapters of the Reference Manual to be developed under this task. The Reference Manual will be a comprehensive, textbook-like document with background information, explanations, and pertinent information on the design and use of slurry systems. A first draft of the Reference Manual has been included in Appendix A of the August 2005 progress report.

Significant progress has been made this year in preparing the Draft Reference Manual as well as two of the PowerPoint modules associated with the training course. The team plans to have a completed Draft of the Reference Manual by the end of October 2006. Also, Draft PowerPoint Presentation Modules will be available by the end of November 2006 for all except one or two of the Reference Manual chapters.

Task 9—Pilot Projects/Procedure Validation

The team developed guidelines for selecting pilot projects to be used by State agencies. The proposed pilot project layout contains six different sections:

- A control section placed using the ISSA current procedure.
- A bare section (do nothing)
- Improved mix design (using the method developed in Phase II), Replicate 1
- Another contractor-based control (ISSA design).

- Another bare section.
- Improved mix design (using the method developed in Phase II), Replicate 2

The final version of the Guidance Document was included in Appendix A of the October 2004 and April 2005 progress reports. The document was forwarded to the participant State agencies and other agencies interested in participating in the pilot project study. An alternative layout was proposed in the September 2005 report, for pavements on which snow plows are used.

The following agencies expressed an interest in participating in this task:

- KS
- TX
- MN
- MI
- CA

Task 10—Final Report

No Activity

NEXT MONTH'S WORK PLAN

The activities planned for next month are listed below.

- Coordinate with CALTRANS personnel on an as-needed basis.
- Continue with Phase II and Phase III activities.

PROBLEMS / RECOMMENDED SOLUTIONS

All problems with the acquisition of the test equipment have been overcome. The Automated Cohesion Test device should be operational by 1 October. Significant delays in testing have occurred and are discussed in the report. Overall, project activities have been delayed by at least six months.

FINANCIAL STATUS

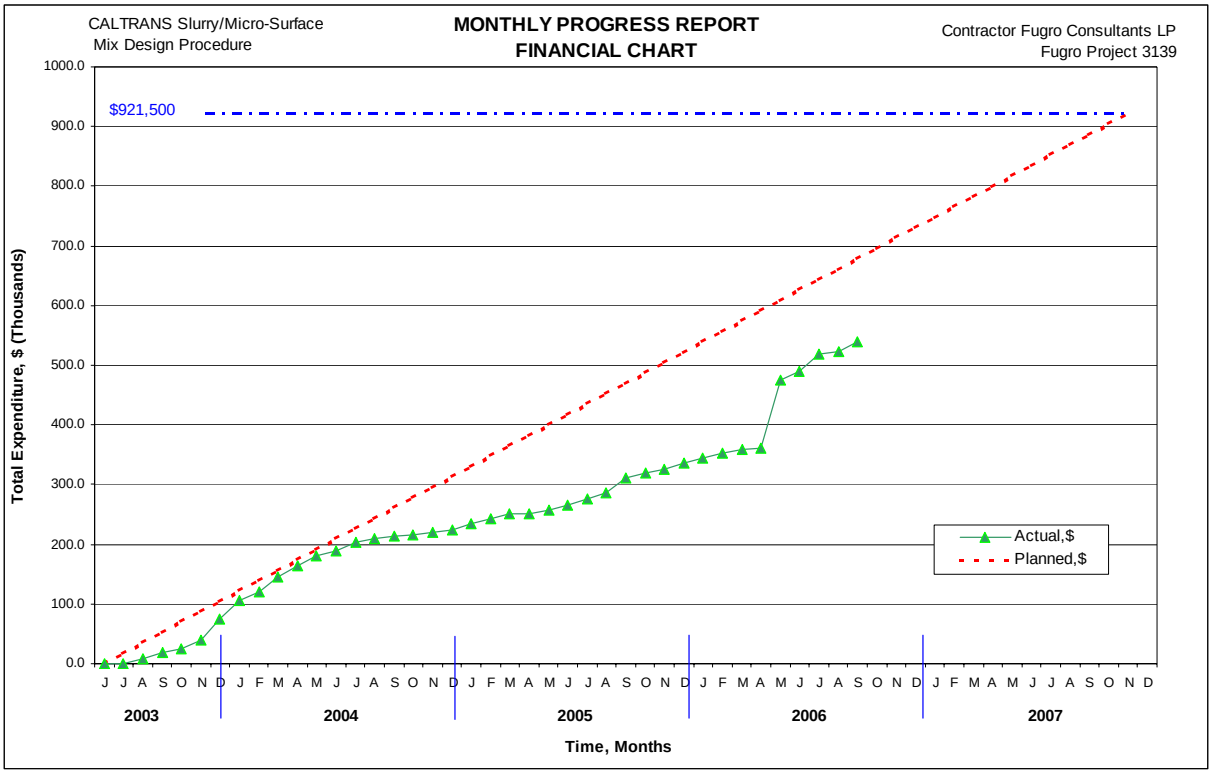
The Financial Summary Table shows the estimated expenses incurred during the reporting period and to the present from the inception of the contract. Testing has been removed as a separate Cost Element item because it is a subcontractor task activity.

The Financial Summary Chart illustrates total expenditures by month for the project.

cc: Jim Moulthrop, Dragos Andrei, Gary Hicks, Glynn Holleran, David Peshkin, Stephen Seeds, Carol Goldman, Charles Antle

Financial Summary Table – Estimated Expenses for Last Month

Cost Element	Report Period Expenditures, $	Cumulative Costs, $
Direct Labor	60	63,650
Overhead	91	96,747
Consultants/Subcontractors		
MACTEC	16,056	50,908
APTech	0	149,491
CEL	0	127,476
Temple Systems Lab	0	10,000
Travel	652	12,823
Communication	0	1,026
Materials/Supplies/Shipping	0	3,329
Fee	80	17,758
Phase II Retention	(1,694)	42,110
Total	15,245	545,169



Financial Summary Chart – Total Expenditures by Month