# PROGRESS REPORT
# Slurry/Micro-Surface Mix Design Procedure
# April 2007 – September 2007

**To:** T. Joe Holland, CALTRANS
**Contract No.:** CALTRANS 65A0151
**Contractor:** Fugro Consultants, Inc.
**Contract Period:** June 30, 2003 – October 31, 2008
**Prepared By:** Jim Moulthrop, Principal Investigator
**Date Prepared:** October 12, 2007

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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, and figures (example in left margin).

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## 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.

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## 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 third quarter of 2006. 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:

| | | |
|---|---|---|
| Mix: | M5 | A3+E3 |
| Aggregate: | A3 | Marble Falls |
| Binder: | E3 | Ergon |

Testing continued during the last reporting period. 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<br>LA Abrasion<br>Sulfate Soundness<br>Sand Equivalent<br>Durability Index<br>Micro-Deval | All Completed | All Completed | All Completed |

**Table 2. Emulsion/Asphalt Residue Tests**

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

**Table 3. ISSA Mix Tests**

| Test | M1 | M2 | M3 | M4 | M5 |
|---|---|---|---|---|---|
| Mixing Test (TB113)<br>Wet Track Abrasion Test (WTAT TB100)<br>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) | 100% (60 of 60) | 100% (60 of 60) | 100% (60 of 60) | 100% (60 of 60) | 100% (60 of 60) |
| Automated Cohesion Test (ACT) | 0% (0 of 60) | 0% (0 of 60) | 0% (0 of 60) | 0% (0 of 60) | 0% (0 of 60) |
| 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 shown in Table 4, the CAT testing is now complete. A total of 300 tests were performed using the CAT device over a range of conditions:

- Temperature: 15°C, 25°C, 35°C
- Humidity: 50% and 90%
- Conditioning:
  - 30, 60, 180 min.
  - oven dry, 1 hour soak

  - o oven dry, 6 days soak
- Compaction:
  - o compacted
  - o not compacted

An analysis of the data was carried out and the following preliminary observations were made:

1. Compaction does not seem to have an effect on the abrasion resistance of slurry surfacing systems

2. Temperature, Humidity and Curing Time are affecting the abrasion resistance of non-soaked specimens according to the following trends:
   a. Abrasion loss is higher at lower temperatures
   b. Abrasion loss increases with humidity
   c. Abrasion loss decreases with curing time

3. For the oven dried specimens, the abrasion loss for 1-hour soaked specimens was consistently higher than the abrasion loss for the 6-day soaked specimens which is in contradiction with conventional trends specific to the Wet Track Abrasion Test

To further investigate the effect of compaction on the measured abrasion loss (Observation 1), a plot of compacted versus not compacted test results was developed and is presented in Figure 1:

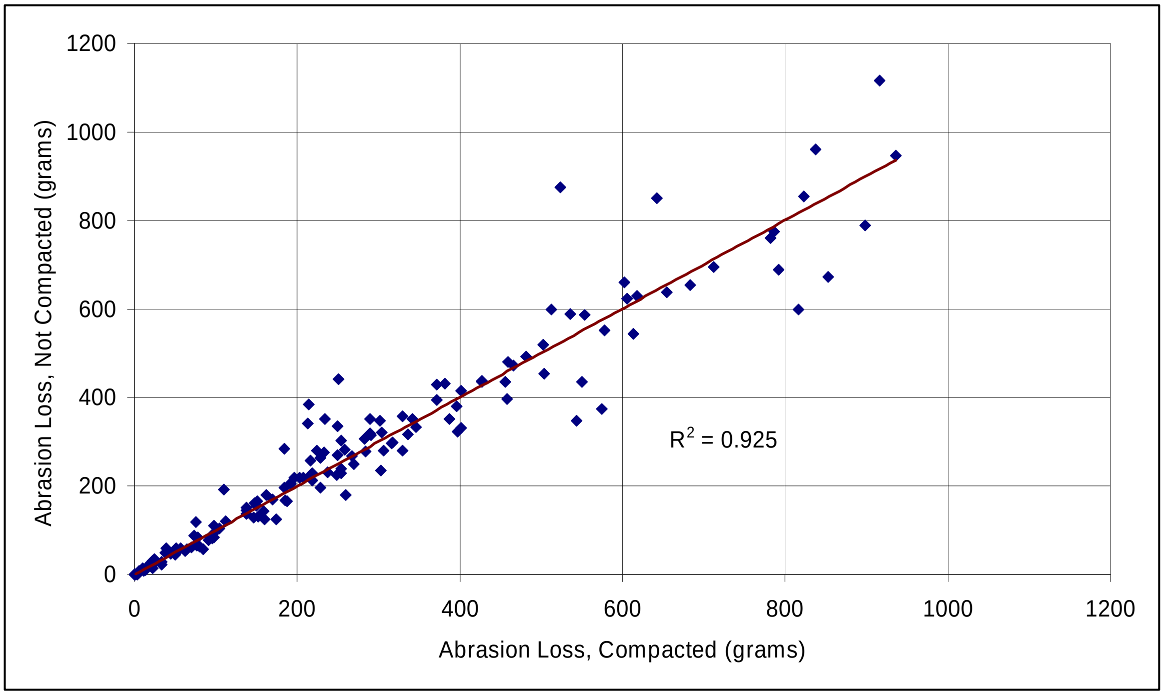


**Figure 1 CAT Test Results, Compacted Vs. Not Compacted Specimens**

As illustrated in Figure 1, the very good correlation between "Compacted" and "Not Compacted" specimens allows us to conclude that compaction does not have an effect on the measured abrasion loss.

To further investigate the effects of temperature, humidity and curing time on the measured abrasion loss (Observation 2), for specimens that were not oven-dried, a simple regression model was developed:

$$Abrasion\_Loss = Intercept + kT \cdot Temperature + kH \cdot Humidity + kC \cdot Cure\_Time$$

Where *kT*, *kH* and *kC* are fitting parameters

Using a regression analysis, fitting parameters were found for each of the five mixes tested. The $R^2$ values obtained ranged from: 0.29 (i.e. poor goodness of fit) to 0.85 (i.e. good fit). The analysis shows that more accurate models could be developed using a more complex model formulation. Work is under way to evaluate and enhance these predictive models.

The third observation was that the abrasion loss from 1-hour soaked specimens was consistently higher than the loss from 6-day soaked specimens. Indeed, in 29 out of 30 cases, the abrasion loss was higher for the 1-hour soaked specimens. And the difference in 15 out of 30 cases was more than 100 grams – which is significant. This contradicts conventional wisdom according to which 6-day soak will induce more damage than 1-hour soak and the corresponding loss will be higher. This "irrational" trend is being investigated by the team.

The Automated Cohesion Test device is now operational. 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. The device was then sent to MACTEC's laboratory in Phoenix, Arizona, to complete the testing matrix.

Limited comparison testing with both the automated and the conventional cohesion testers was carried out by Temple Systems and MACTEC. The results are presented in Figures 2, 3 and 4.

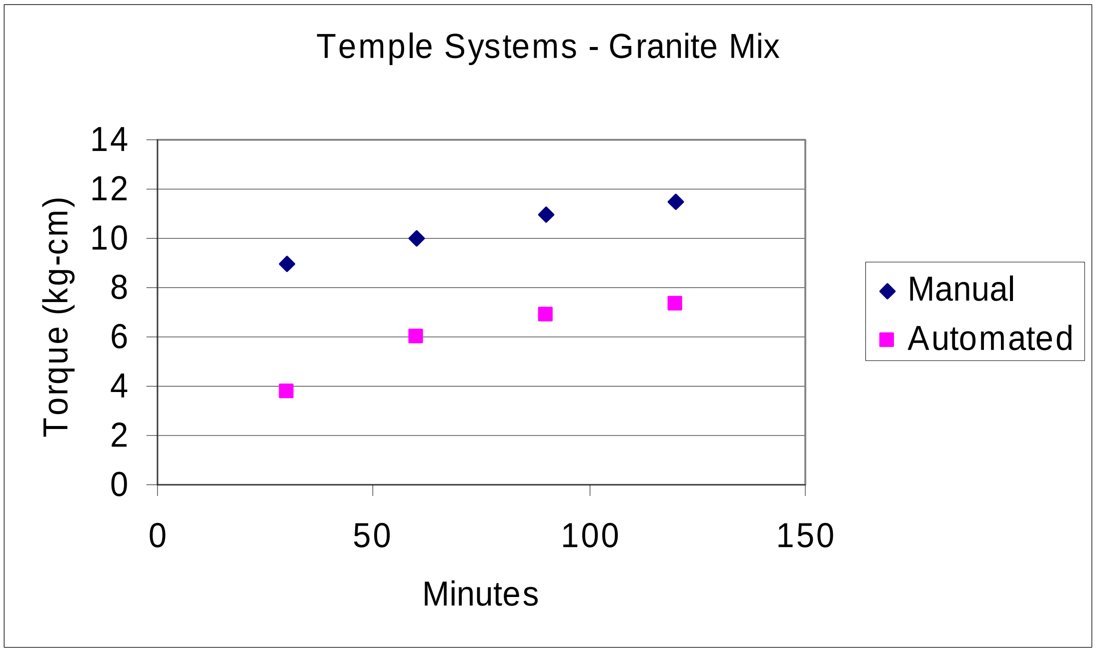


**Figure 2 Cohesion Testing Results from Temple Systems – Granite Mix**

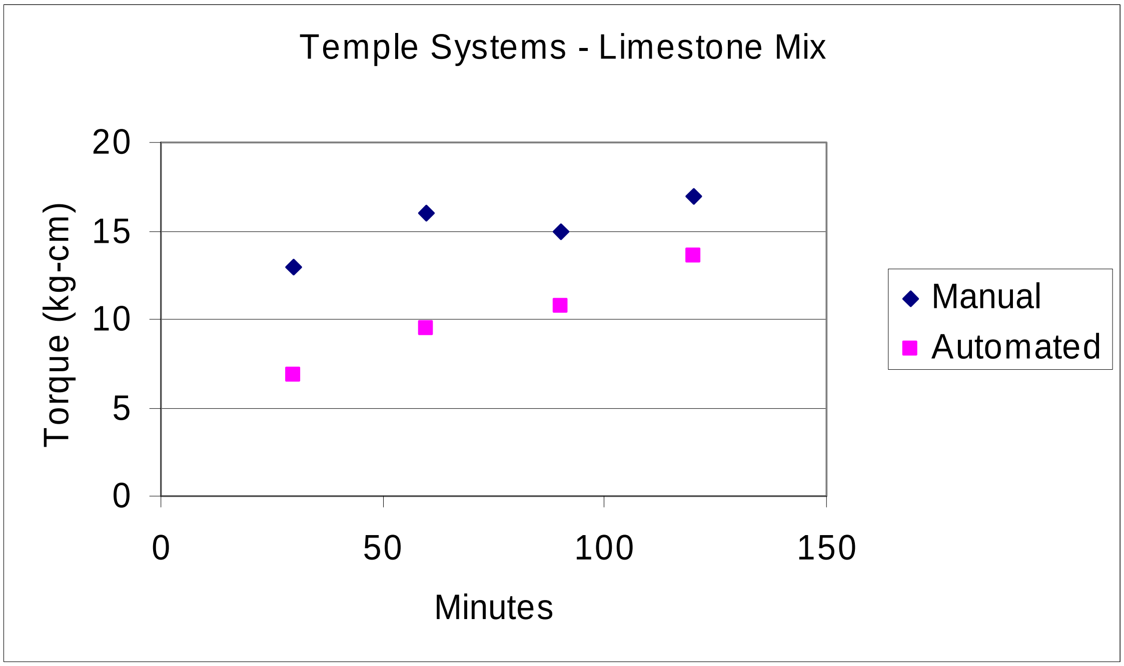


**Figure 3 Cohesion Testing Results from Temple Systems – Limestone Mix**

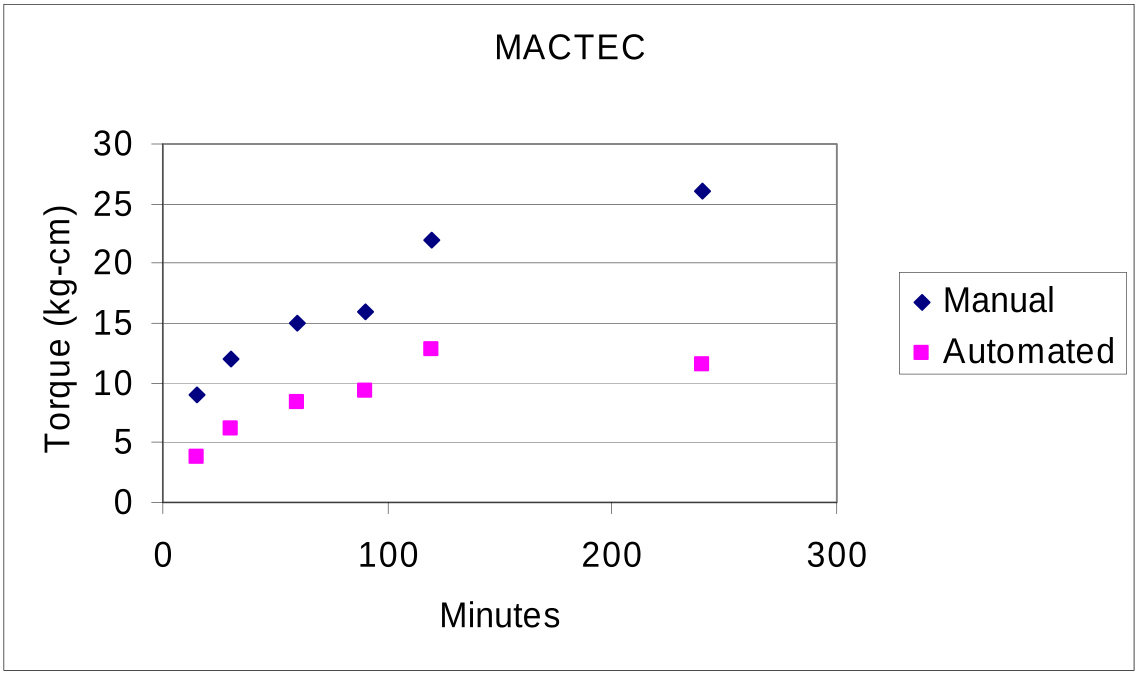


**Figure 4 Testing Results from MACTEC**

As illustrated in Figures 2, 3 and 4, the ACT results are consistently lower than the conventional (manual) wet cohesion results. The possibility of correcting the ACT results by a correction factor or model was then investigated. This was done by pooling the data from Temple Systems and MACTEC into a single data set and plotting "automated" versus "manual" results, as illustrated in Figure 5.

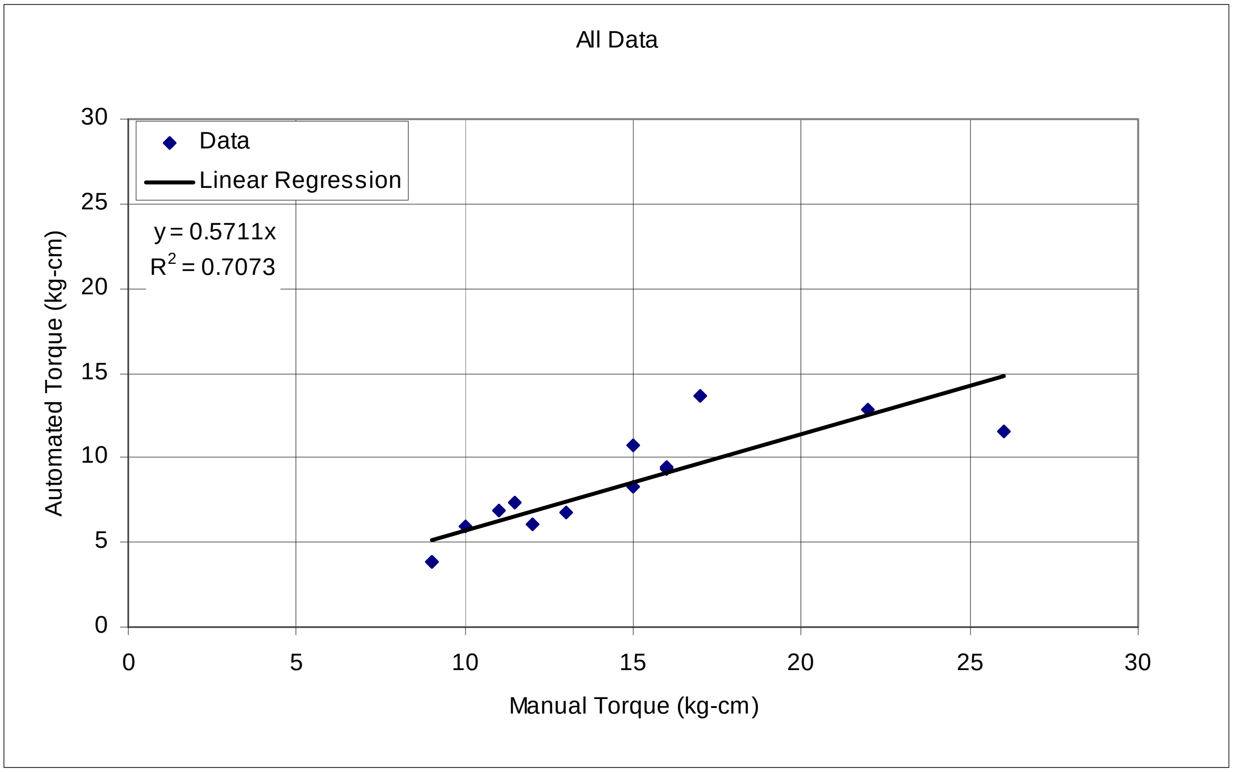


**Figure 5 Correlation of Test Results from ACT (Automated Torque) and the Conventional Wet Cohesion Tester (Manual Torque)**

As illustrated in Figure 5, there is a good correlation between the two tests ($R^2$ = 0.7). A correction factor of 1.75 (=1/0.5711) can be used to bring the Automated values within the range of values obtained from the conventional wet cohesion test. A plot of corrected values versus the conventional ones is shown in Figure 6.

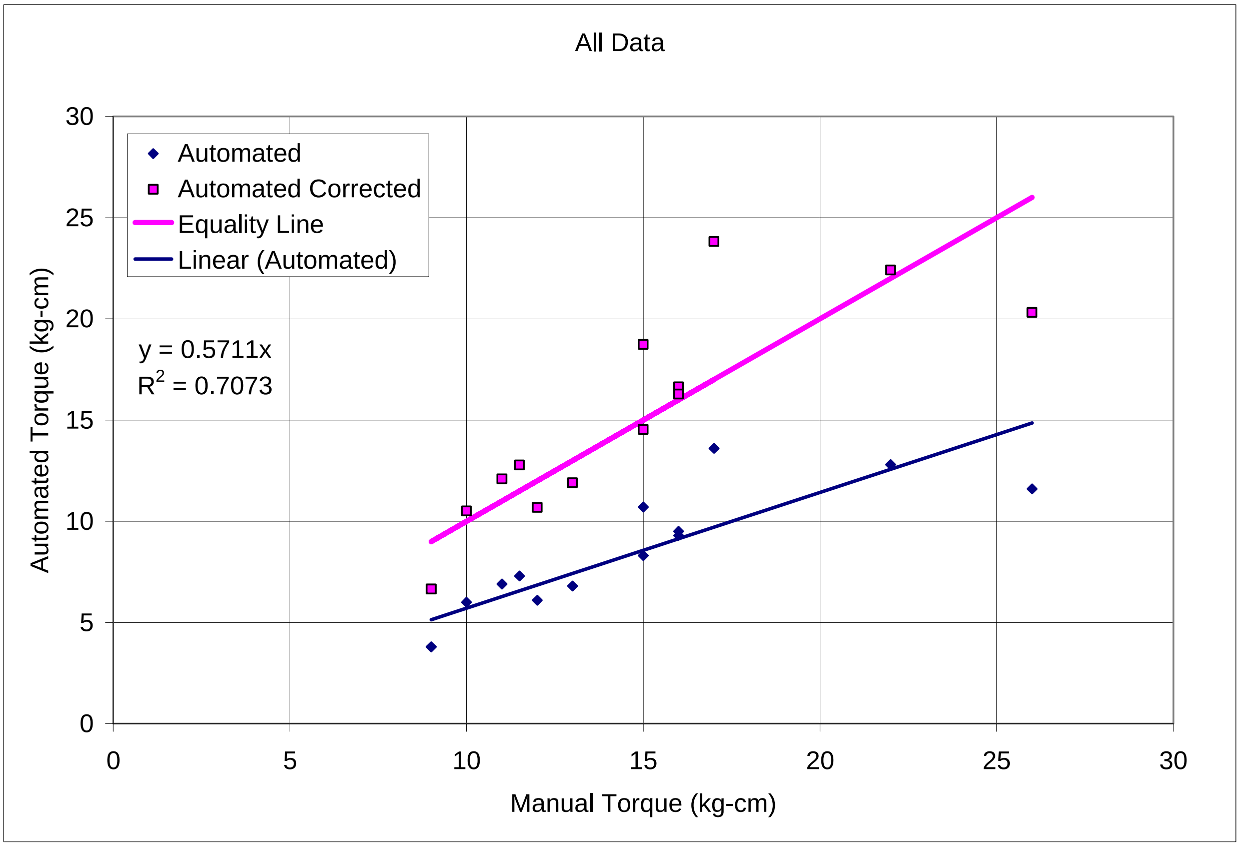


**Figure 6 Correction of Test Results from ACT.**

As illustrated in Figure 6, the 1.75 correction factor can be used to bring the ACT results within the range of values normally measured with the conventional wet cohesion test. As more comparison data will become available, the value of the correction factor may be changed or a more complex correction may be applied to the raw ACT results.

Another experiment run at the MACTEC laboratory in Phoenix consisted of calibration tests with the two devices on 220 grit sand paper. A number of 10 measurements were taken with each device. The average and standard deviation of the test results are given in Table 5.

**Table 5. Results of Calibration Tests on 220 Grit Sand Paper**

| ***Statistic*** | ***Conventional Wet Cohesion Torque (kg-cm)*** | ***Automated Cohesion Torque (kg-cm)*** |
|---|---|---|
| Average | 19.90 | 11.22 |
| Standard Deviation | 0.99 | 1.14 |

Note that the ratio of the two averages (i.e. 19.9/11.22) equals 1.77, which is very close to the correction factor of 1.75 obtained from the tests on slurry systems. Therefore, the experiment on sand paper confirms the value of the correction factor. For purposes of this project, the 1.75 factor will be used to adjust the values obtained with the ACT device.

Evaluation testing with the ACT device is planned to be carried out during the month of October. A total of 300 tests will be performed at the MACTEC laboratory in Phoenix.

## 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 were given in the July-September 2006 progress report. Tables 6-9 summarize progress made to date on the ruggedness testing; an "X" next to the test number indicates that the test was completed.

**Table 6. 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 7. 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 8. Cohesion-Abrasion Test (CAT) – Short Term (Cured, 1-Hour Soak)**

| Parameter | Units | Values | | Test No. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | High (H) | Low (L) | 1X | 2X | 3X | 4X | 5X | 6X | 7X | 8X |
| 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 9. 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 |

Ruggedness testing is performed concurrently with the evaluation testing of Tasks 3 and 4. Although the proposed ruggedness testing for CAT was completed for mix M4, the team is considering the possibility of performing a similar test factorial on mix M1 or M5.

### Task 6—Phase II Report

Work on the Phase II Report began in May 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.

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## 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.

The team is working on 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 April 2007. Also, Draft PowerPoint Presentation Modules are available 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 State agencies expressed an interest in participating in this task:

- KS
- TX
- MN
- MI
- CA

**Task 10—Final Report**

No Activity

## NEXT REPORTING PERIOD'S WORK PLAN

The activities planned for next month are listed below.

- Coordinate with CALTRANS personnel on an as-needed basis.
- Begin ACT evaluation testing.
- Continue with the ruggedness testing plan.

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## PROBLEMS / RECOMMENDED SOLUTIONS

All problems with the acquisition of the test equipment have been overcome. The Automated Cohesion Testing should start mid October 2007. Significant delays in testing have occurred and are discussed in the report. Overall, project activities have been delayed by at least six months.

The team met with representatives of the industry and state agencies in Sacramento on August 14-15, 2007. Progress and plans for the completion of the project tasks were presented. Minutes from the meeting are included in Attachment A.

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## FINANCIAL STATUS

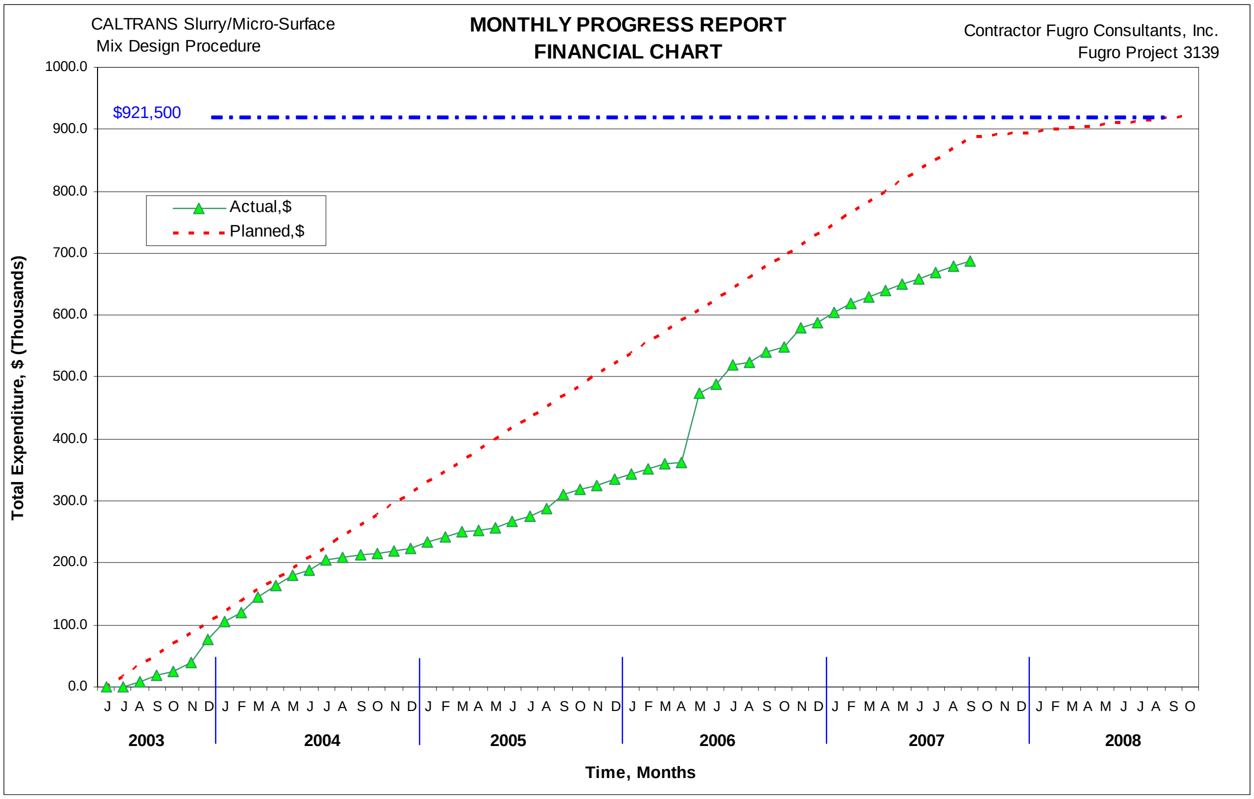
The Financial Summary Table shows the estimated expenses incurred during the reporting period and to the present from the inception of the contract. Testing has been removed as a separate Cost Element item because it is a subcontractor task activity.

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

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

**Financial Summary Table – Estimated Expenses for Last Period**

| Cost Element | Report Period Expenditures, $ | Cumulative Costs, $ |
|---|---|---|
| Direct Labor | 7,000 | 75,594 |
| Overhead | 10,640 | 114,903 |
| Consultants/Subcontractors | | |
| MACTEC | 14,251 | 92,246 |
| APTech | 11,023 | 163,279 |
| CEL | 7,496 | 164,036 |
| Temple Systems Lab | 0 | 20,000 |
| Travel | 4,119 | 19,285 |
| Communication | 0 | 1,026 |
| Materials/Supplies/Shipping | 0 | 3,329 |
| Fee | 2,177 | 21,415 |
| Phase II Retention | (7,778) | 58,407 |
| Total | 57,568 | 687,935 |



# ATTACHMENT A

## POOLED FUND STUDY
## SLURRY AND MICROSURFACING MIX DESIGN PROCEDURE
## PROJECT UPDATE MEETING NOTES
## SACRAMENTO, CA
## AUGUST 14-15, 2007

**Note: Action Items are Bolded**

Day 1, 1-5:30 pm

- Introductions ........................................................................................ Holland/Moulthrop
  - Attendees:
    - Jim Moulthrop - Fugro
    - Tim Martin - Fugro
    - Corey Zollinger - Fugro
    - Steve Seeds - APTech
    - Dragos Andrei - Mactec
    - Haiping Zhou - Mactec
    - Carol Goldman - CEL
    - Joe Holland - CALTRANS
    - Mark Ishee – Ergon Asphalt and Emulsions, Inc.
    - Mike Hemsley - Paragon Labs
    - Steve Gates – Antelope Industries
    - Rick Madison – Mead Westvaco
    - Tom Wood – Minnesota DOT
    - Arlis Kadrmas – SEM Materials
- Scope and Objective of the project ................................................................ Moulthrop
  - At April/May 2007 meeting at Translab, Joe Holland suggested a meeting to get Industry people together to discuss “Proof of Concept”
  - Purpose of meeting to get Industry feedback, comments, etc.
  - Current Status Project is in Phase II
  - Fall 2007 – Plan to use New Mix Design concurrent with ISSA design and new tools/tests on field project in California
  - Summer 2008 – Other States (New York, Minnesota, Dakotas) desire to perform field studies.
- Phase I report ........................................................................................ Moulthrop
  - Phase I report completed March 2004
  - Included literature review, survey results of AASHTO, Industry, and Advisory panel, and work plans for Phases II & III
  - Conclusions: Current design methods are “guidelines,” and concerns exist regarding laboratory test repeatability.
  - **Visit pooled fund website for project reports http:/www.dot.ca.gov/research/maintenance/slurry_micro-surface/slurry_micro-surface.htm**
  - Current status is 1 year behind, 1 year no – cost time extension granted by CALTRANS, and budget adjusted.
- Phase II activities
  - Materials acquisition activities ................................................................ Goldman
  - Testing completed at CEL ..................................................................... Goldman

- Mixing – (Automated Mix Test)
  - Draft test method handout passed out
  - Carol discussed the importance of mixer type with propeller and bowl characteristics
  - Torque is measured vs. mix time
  - Questions:
    - How would you measure the shear of the apparatus to insure the proper shear rate and how does it compare to the shear rate of the pug mill in the truck?
      - Shear rate 1 rev/sec on device and tried to match same as hand mix.
      - Nowhere near as fast as the pug mill.
    - What is batch size?
      - Batch size is 300 grams
    - Does propeller sit certain height from bowl bottom?
      - Approximately 1/8" from bottom.
    - Is there a target mix time?
      - Yes, done with hand mixer to establish proportion, and then placed in mixer. Adjusted mix components and measured mix time.
    - Could this replace TB106?
      - Yes, but have not thought about it.
    - Can you spot false set or loss of coalescence?
      - Yes
    - How do you account for initial hand mix time and reduce operator variability?
      - Set time limits such as less than 30 seconds, tried to adjust mixing components at different orders, but ended up with pockets of dry rock regardless.
    - Is it fair to say this equipment is not effective at going from non-homogeneous to homogeneous mix, but can maintain it?
      - Yes, and it can measure changes.
- CAT – (Cohesion Abrasion Test)
  - Draft test method handout passed out
  - Discussed test results on 5 mixtures using CAT
    - Question raised regarding 6-day soak having less abrasion loss than 1-hour soak. Does not meet expected results
    - Table Mountain Aggregate when doing abrasion test has many anomalies when running the soak times (Antelope comment).
    - Team needs to consider mix time and cure time and abrasion loss for certain mixes.
    - Changes in formulation with the curing times and humidity when addressing abrasion loss (comment from SEM Materials).

- Industry has always been submitting designs for the slowest cure times (Conservative approach) (SEM Materials).
- What is original reason for using the French foot?
  - Measures properties of mix of uncured system. Able to measure resistance to abrasion with cure time.
  - Able to use entire mix gradation
  - Glynn Holleran added by email - The hose abrasion is different from the wheels in that there is a large soft surface area in the sample surface. The hose seems more severe. The wheels are harder material and the movement is a bit more traffic like. If the hose is used on partly cured samples, the losses are very large and difficult to differentiate.
- Have we compared this with the traditional hose as compared to the wheels?
  - Are we sure this way we are comparing apples to apples with tires and this wheel.

♦ Cohesion testing ....................................... Huddleston (Not in attendance)
  - Used machine shop in Oakland to develop/adjust device with plenty of challenges at beginning
  - Mead Westvaco had and MACTEC has this device in their lab
  - Is it more consistent than human torque?
    - Yes, initial tests indicate so.
  - Jim – Goal for cost of all three equipment is $10K. Not sure of Temple's actual production cost, but specifications will be provided to all if he does not produce them.
  - Not able to accurately predict rutting is the current issue regarding industry (Ergon).

- Data Analysis ........................................................................................Andrei
  - ♦ Preliminary Mix Design Form...................................................... Goldman
    - Where is rutting, etc taken into account in the mix design?
      - Mark Ishee suggested the current mix design procedure does a poor job of this. Has not currently been addressed.
      - Current mix design procedure says you need to do LWT for a rut-resistant system. Therefore, it is no different from ISSA. We planned to look at the APA as an alternative to LWT, but have not so far.
  - ♦ ISSA vs. $S^3$ Design ..................................................................... Goldman
- Ruggedness Evaluation ..................................................................Andrei
  - ♦ Results on Cure Time limits should be edited to 5 minutes.
  - ♦ Ruggedness is the ASTM procedure to set limits in specification
  - ♦ Within lab repeatability is required to get ASTM procedure
  - ♦ **Complete cohesion testing on the 5 different samples (evaluation testing), ruggedness testing on 1 or 2 mixes, and prepare an AASHTO test method.**

- Will team do this with all type mixes, not just Type III? How does this change for the other mix types?
- AASHTO format for test methods.......................................................... Goldman
- Specification Development.....................................................Moulthrop/Holleran
    - Many things on the strawman spec have not been defined such as traffic levels, etc.
    - It is necessary to have a good discussion/debate as to what these values should be. This is meant to be a discussion starter.
    - Suggestion made that purpose should offer public agency the parameters and the contractor the recipe and effects of changes. Note team has taken a performance approach.
    - What about changing components of mix and how they affect performance?
    - Jim Moulthrop - **Send Industry ETG the specifications electronically for their edits/comments.**
    - **Complete Phase II and Finalize Report. Main industry concern is what will be the differences in the mix design methods, if any?**

- Phase III Activities
    - Field test sections.......................................................................... Martin
        - Recommendations
            - **Prepare for Phase III by contacting agencies**
            - **May consider talking with State Pavement Management Engineer because they have different test section requirements, such as mile long, start at mile point, etc. When this project is done, the state will want these to match their other test sections for future analysis.**
            - MNDOT collects the IRI for complete mile, Visual distress for 1st 500' per mile, rutting total mile
            - MNDOT suggests 1 control section, 1 ISSA design and 1 new design, no slurry surfacing with different polymers.
            - Challenge will be that every state will be different.
            - 1 year monitoring is not enough; long-term evaluation needs to be bought into by state.
            - Contractor can make adjustments on fly, transition sections do not need to be as long (less than 1000')
        - Quality Assurance Testing..............................................................Andrei
            - Field version of CAT – long-term performance of abrasion.
                - Steve Ishee - Does not take into account variability of application rate, cure time, etc
                - Strong resistance in industry to field wet tracks
                - How is it powered?
                - Remember original abrasion test developed for optimum asphalt content, does not identify if too much, only if not enough.
                - 3 hours too long for traffic control
            - MNDDOT – Discussed their use of Infrared camera to measure temperature. Before micro surface placement, temperature is

high, after placement the temperature goes down, as moisture leaves the temperature rises and curing is progressing.

- o **Phase III Final Report will include the results of field-testing and applicability for adoption.**
- o Training ......................................................................................................Seeds
  - ♦ 1.5 day training
  - ♦ Pre-Job Tailgate training
    - ▪ Need module in inspector training for those factors affecting performance during construction

Day 2, 8-Noon

- Review session with Industry ............................................................Holland/Moulthrop
  - o Discussion regarding keeping terminology difference between slurry and micro surfacing. This terminology is becoming blurred. May need two different specifications, instead of one, such 135°F softening point eliminates slurry. Also important to separate because of different "target purposes" of each, and not to confuse these.
- Maintain differentiation of Slurry and Micro (Function/Use, Design, Application)
  - ♦ If we don't want to define the difference, we need to focus on the application rates.
  - ♦ Sand Equivalencies of 45 seems to be adequate for Slurry (Not for Micro)
  - ♦ Setting times and performance of both are equivalent.
  - ♦ Straw Man Specification seems to exclude Slurry and leaves only Micro due to the softening (differentiation is can you place greater than 0.5", if so, then Micro)
  - ♦ Modification for deep rut applications may be appropriate.
  - ♦ **Strawman spec will be sent out electronically,** and 2 separate specs may be developed
  - o Discussion regarding rut resistance/max binder content
    - ♦ Discussed possibly using APA, however very expensive and difficult to find, so currently have not done much with this.
    - ♦ Should not be applied because of blurring Slurry and Micro
    - ♦ A simple core could identify if rutting in slurry, so no need for test spec.
    - ♦ Existing specifications needs to be included in ours, but verbiage should be tightened up pertaining to the binder content.
    - ♦ Likely to put in LWT
  - o Questions/Issues not resolved previously in meeting –
    - ♦ Distribute Training Material and give 20-minute presentation along with equipment demonstration at ISSA Workshop (
    - ♦ **Distribute training materials at 3.5-day ISSA workshop in Las Vegas, very good workshop, and low fees.**
      - ▪ Demo's, presentations – additional presentations will include chip seal and crack sealing. <$400/person
      - ▪ Potentially demonstrate new test equipment
    - ♦ Once package is developed, will share with workshop committee
    - ♦ Changing components of mix and how does it affect performance
      - ▪ When mixing components together, develop min/max mix time, parameters to describe whether or not it is a reasonable mix.
      - ▪ Should optimize mix design prior to being out in the field to insure the type of emulsion and aggregate are adequate.

        - Mark Ishee noted with the use of TB113 should provide the mix window time and this concern should be taken care of.
      - Curves for different mix design times should be developed or be able to be formulated.
      - Viscosity vs. time should be considered for consistent application. Too sharp a curve will create issues in consistency. (See TB113)
      - Agencies want to use Micro/Slurry, but are having issues with contractors changing the mix design (emulsion, water, cement) on the fly during laydown. Training should cover this aspect – what could affect performance while under construction. Additives should also be discussed (its benefits and importance should be presented).
      - How do the adjustments made in the field affect long term performance
      - How do the mix properties change depending on the environmental conditions and should the same mix be approved for the calendar year regardless of location and time
      - Binder Specification recommendations should be applied to Slurry design
    - Test section setup – Accommodate agency requirements
      - Documents put together and sent to agencies
        - Few responses
        - Will need to sit with each state to set up test sections, develop evaluation time period, etc
        - Need to send copy of test section documents to MNDOT
        - Share site requirements and test section layout to the participating DOTs so that they are aware of any requirements in the bid (materials, constructability).
    - Field abrasion test
      - What about the fact that agencies are not responsible for determining when road is open to traffic. Is it necessary to have field test to determine this unless contractor is required to run this test before opening traffic. Currently it is done by visual inspection and experience. However, the States have requested this tool. Initially the field abrasion test thought to be able to compare field mix to lab mix performance, not necessarily traffic opening.
      - Report should include the reason why the French chose the abrasion test and how did it determine future performance. Why was it better than the wet cohesion (wet track) test?
    - Field Sampling
      - When this should be done to get representative samples and be able to verify within specifications of mix design.
      - Field Sampling issue and Field Cohesiometer test not needed because a contractor could make adjustments in the field that would make results useless.
    - Performance of aggregates used in Slurry/Micro have not been considered in A105 / A143 for concerns with Table Mountain anomalies.
- Equipment demonstrations ........................................................................ Goldman