Slurry / Micro-Surface Mix Design Procedure

Prepared By

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Northeast Pavement Preservation Partnership

Warwick, Rhode Island
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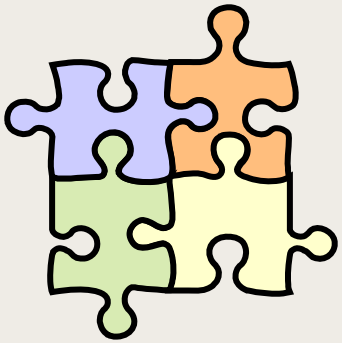
Pooled Fund Study Team

- 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

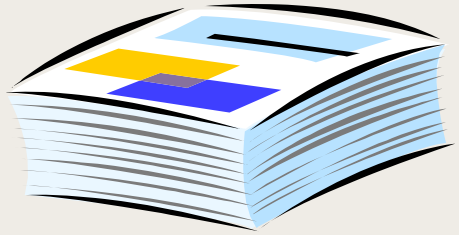
- Extent of use worldwide
- Mix design procedures and laboratory tests
  - ISSA, ASTM, TTI
- Performance of existing projects
  - 9 projects in U.S. and Canada
- Guidelines and specifications
  - ISSA, Caltrans, TTI, CSIR, Austroads

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

Slurry Vs. Micro | *S3*

- **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

Set Time	Test or field Condition	Units	Traffic Hi	Traffic Med	Traffic Low	Temperature Hi 35 C	Temperature Med 25 C	Temperature Low 10 C	Humidity Hi 90%	Humidity Normal 50%
Rapid	***PFS-1 (Mixing)***									
	Mixing Torque - maximum	*kg-cm*	9	9	9	9	9	9	9	9
	Mixing time - minimum	*sec.*	120	120	120	120	120	120	120	120
	Spread index - maximum @ 120 sec.	*kg-cm*	12	12	12	12	12	12	12	12
	Blot test - 30 sec.	-	clear water	clear water	N/A	clear water	clear water	clear water	clear water	clear water
	Coating	-	100%	100%	95%	95%	95%	100%	100%	95%
	PFS-2 (Wet Cohesion)									
	30 min. cohesion - minimum	*kg-cm*	12	12	12	12	12	12	12	12
	60 min. cohesion - minimum	*kg-cm*	23	20	20	20	20	20	20	20
	90 min. cohesion - minimum	*kg-cm*	25	25	25	25	25	25	25	25
	12 hr. cohesion - minimum	*kg-cm*	28	28	28	28	28	28	28	28
	PFS-3 (Abrasion Loss)									
	30 min. loss - maximum	g/m^2	200	200	400	300	300	300	300	300
	1hr. loss - maximum	g/m^2	100	100	300	100	200	100	100	200
	3 hr. loss - maximum	g/m^2	100	100	200	100	100	100	100	100
Slow	***PFS-1 (Mixing)***									
	Mixing Torque - maximum	*kg-cm*	9	9	9	9	9	9	9	9
	Mixing time - minimum	*sec.*	120	120	120	120	120	120	120	120
	Spread index - maximum @ 120 sec.	*kg-cm*	12	12	12	12	12	12	12	12
	Blot test - 30 sec.	-	clear water	clear water	N/A	clear water	clear water	clear water	clear water	clear water
	Coating	-	100%	100%	95%	95%	95%	100%	100%	95%
	PFS-2 (Wet Cohesion)									
	30 min. cohesion - minimum	*kg-cm*	12	12	12	12	12	12	12	12
	60 min. cohesion - minimum	*kg-cm*	23	20	20	20	20	20	20	20
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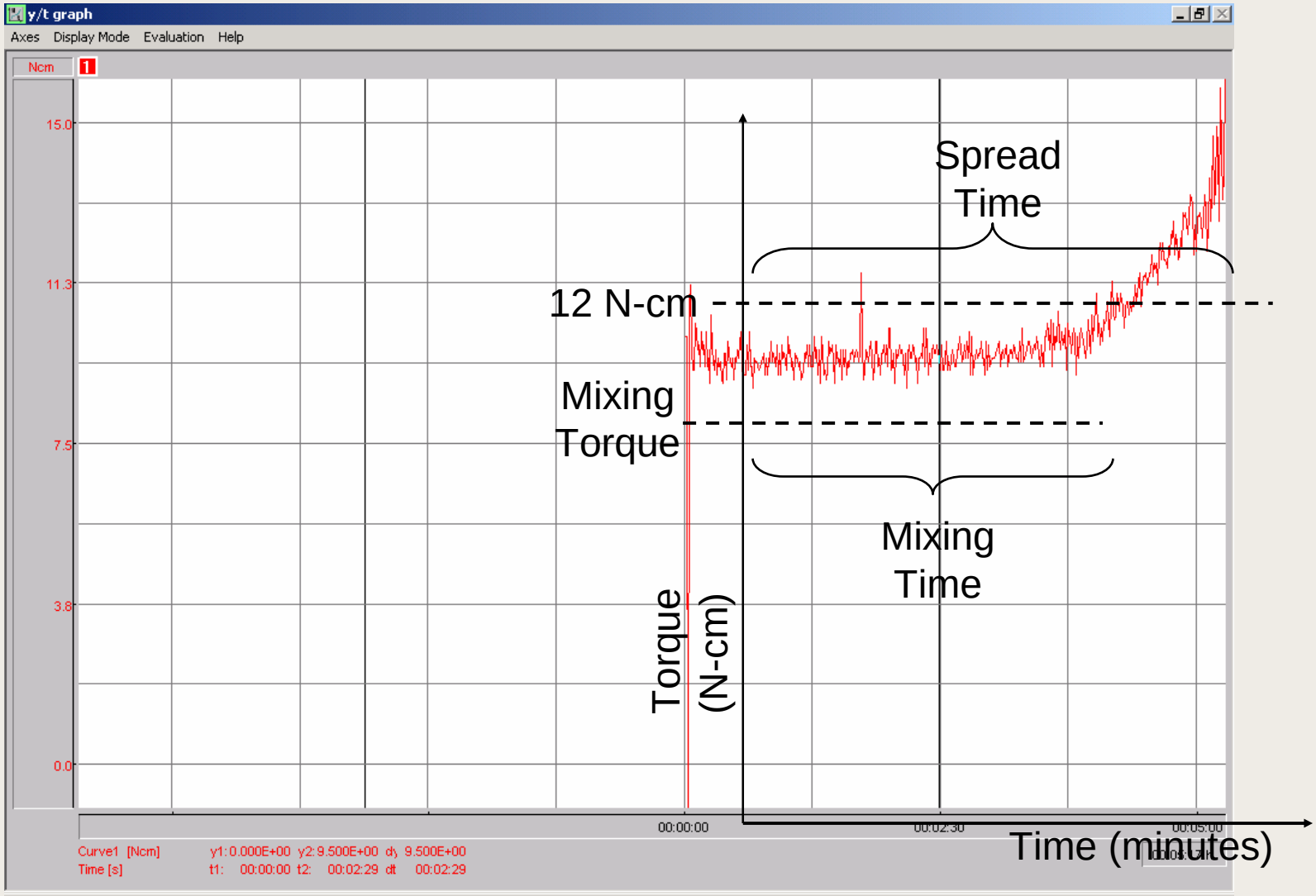
	3 hr. loss - maximum	g/m^2	100	100	200	100	100	100	100	100

Summary of Proposed Major Changes

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

Automated Mixing Test (AMT)

AMT Results


y/t graph
Axes Display Mode Evaluation Help
Ncm
15.0
11.3
7.5
3.8
0.0
00:00:00
00:02:30
00:05:00
Curve1 [Ncm] y1: 0.000E+00 y2: 9.500E+00 dy 9.500E+00
Time [s] t1: 00:00:00 t2: 00:02:29 dt 00:02:29
Spread Time
12 N-cm
Mixing Torque
Mixing Time
Torque (N-cm)
Time (minutes)

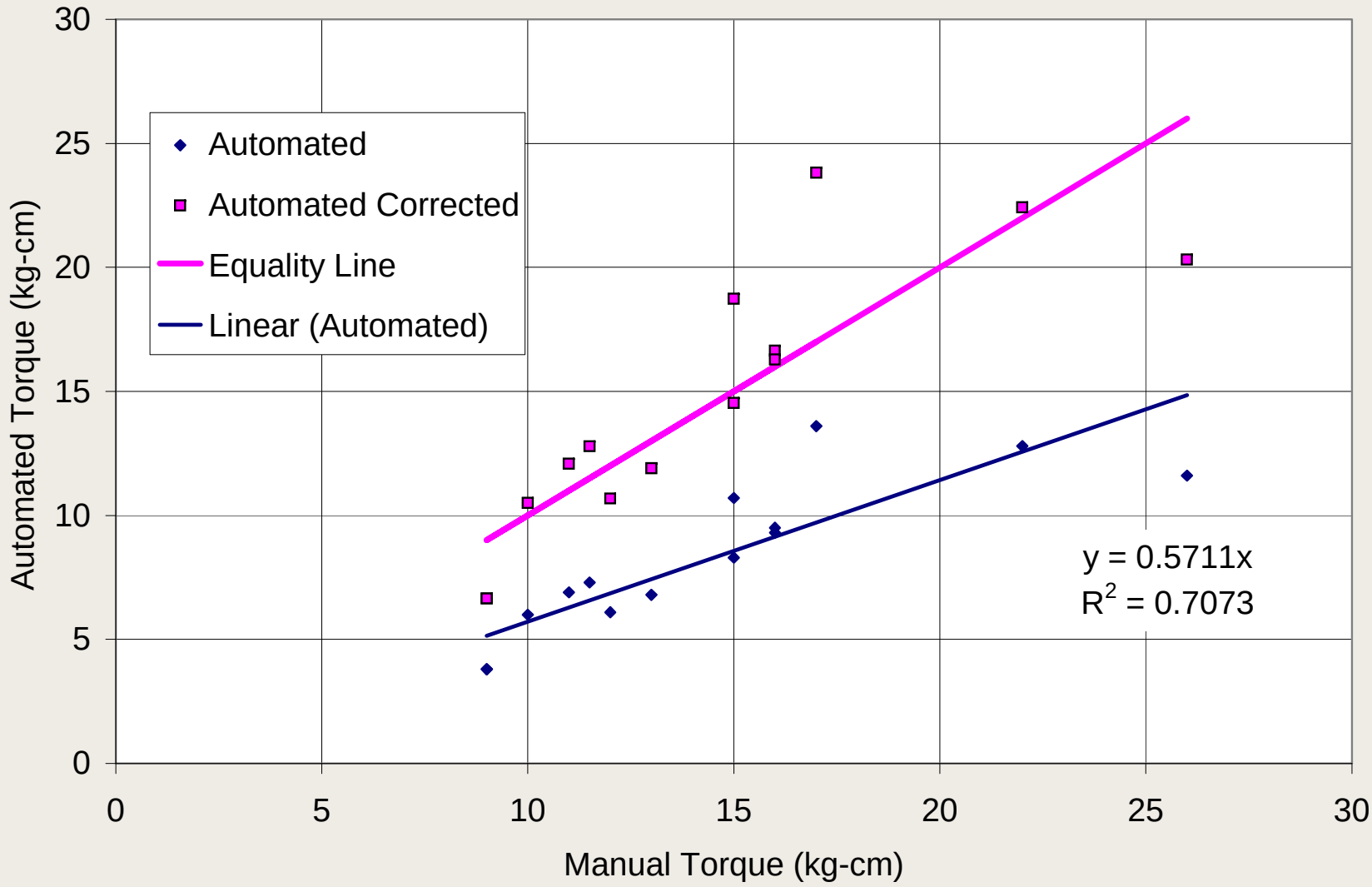
Cohesion-Abrasion Test (CAT)

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)

ACT Comparison with Modified Cohesion Tester



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:**

  www.dot.ca.gov/newtech/maintenance/slurry_micro-surface/slurry_micro-surface.htm

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