# Slurry/Microsurface - Mix Design Procedure

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# Outline

- Introduction
- Project objective and review
- Preliminary results
- Phase II activities
- Mix Design characteristics
- Automated tests
- Proposed mix design
- Strawman specification
- What's next

# Introduction

- Slurry seals and Microsurfacing wide-use as preservation treatments
- Extend pavement’s life
- Becoming more and more popular as agencies incorporate them into pavement preservation strategies
- Currently, designing and testing slurry seals and micro-surfacing is more of an art than science

# Project Objective

- **To update current design method and testing practices**
  - Current ISSA and ASTM methods originated before polymer modified emulsion were used in slurry seals
  - Tests and design methods are empirical
  - Limited relation to performance in the field

- **FHWA Pooled Fund Study conducted by Fugro with 14 participating states:**

  California, Delaware, Georgia, Illinois, Kansas, Maine, Michigan, Minnesota, Missouri, New Hampshire, New York, North Dakota, Texas, and Vermont.

# Project Review

- **PHASE 1**
  - Review Literature
  - Survey industry
  - Develop plans for Phases 2 and 3

# Project Review

- **PHASE 2**
  - Evaluate current mix design procedures
  - Consider potential tests and methods
  - Develop new rational mix design procedure
  - Ruggedness testing
  - Summary report, findings, and recommendations

# Project Review

- **PHASE 3**

  Development of guidelines

  Specifications

  Training

  Field trials (validation)

# Preliminary Results

After reviewing current recommended laboratory test methods and design practices it was found that:

1. **Poor repeatability**
2. **Limited relation to field performance**
3. **Important factors (temperature, humidity) are not considered**

# Phase II Activities

A single mix design procedure will be developed for both, slurry seals and microsurfacing systems. Proposed specification:

**<u>S3</u>**

**"Slurry Surfacing Systems"**

# DESIRABLE FEATURES

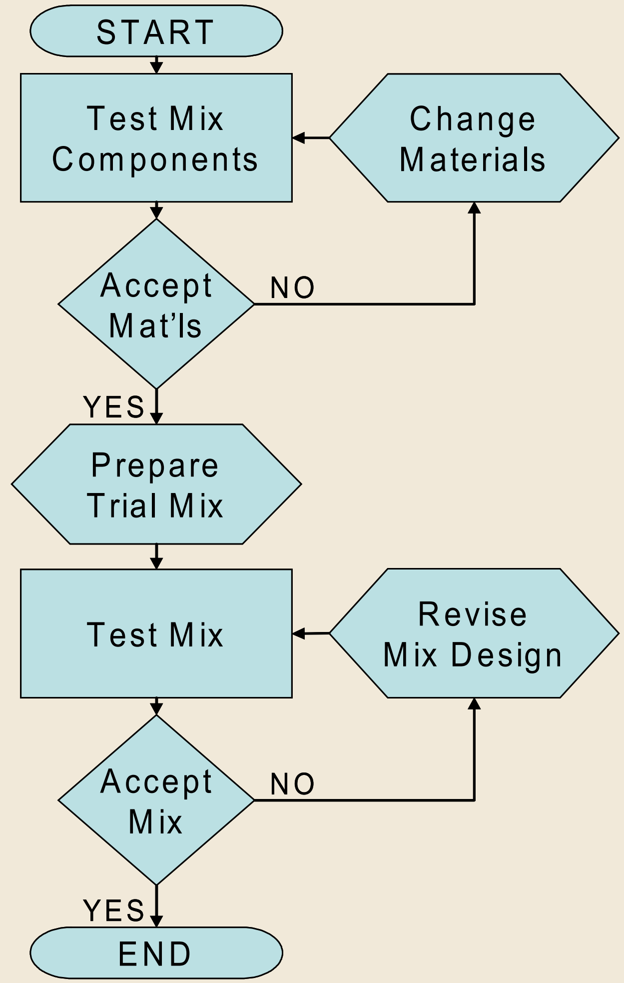
- Repeatable
- Relate to field performance
- Representative of field conditions (temperature, humidity)
- Mixable
- Workable

# DESIRABLE FEATURES

- **Performance**
- **Ease of use**
- **Cost**
- **Ease of implementation**

# Rational Mix Design Process

- Test for material properties
- Test for mixing, spreading, and setting properties
- Long-term performance tests




Schematic of typical mix design process

# Experimental Mix Matrix

- A1: George Reed, Inc. Table Mountain, Sonora, CA (ISSA Type III)
- A2: Lopke Gravel Prod. Lounsberry Pit, Nichols, NY (ISSA Type III)
- A3: Delta Materials, Marble Falls, TX
- E1: SEM Materials (Koch), Tulsa, OK, Ralumac
- E2: VSS Emultech, Polymer Modified LMCQS-1h, Sacramento, CA
- E3: Ergon Asphalt & Materials, Waco, TX

| System | Aggregate + Emulsion Combination |
|---|---|
| M1 | A1+E1 |
| M2 | A1+E2 |
| M3 | A2+E1 |
| M4 | A2+E2 |
| M5 | A3+E3 |

## New Mix Design: Test for material properties

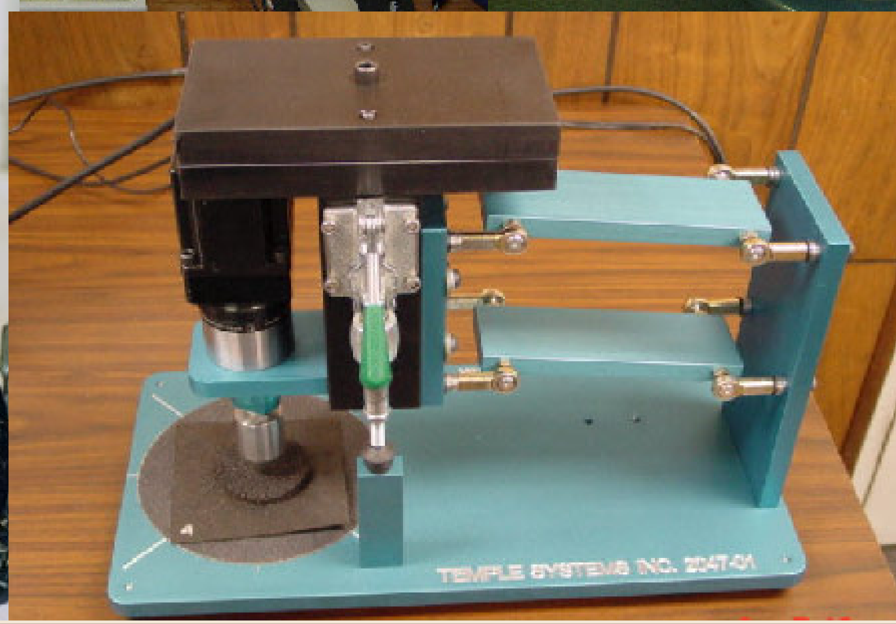
Current specifications for material testing were adopted with minor modifications to acceptance treshholds. Additional tests for some of the components of the mix were also incorporated (e.g. Methylene blue test for aggregates).

**System components:**

- **Aggregate**
- **Mineral filler**
- **Emulsified asphalt**
- **Control additives**
- **Water**

# Automated Tests

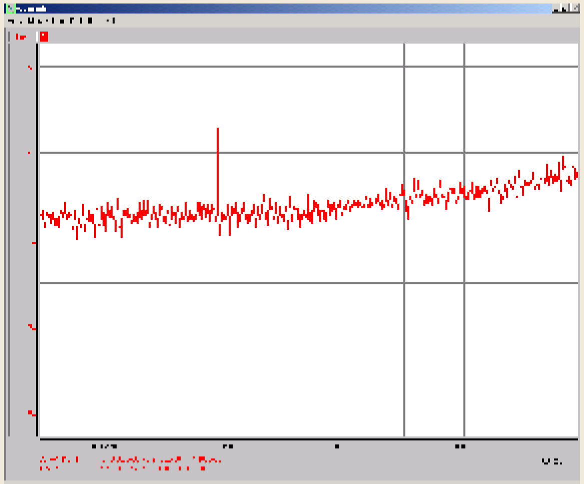




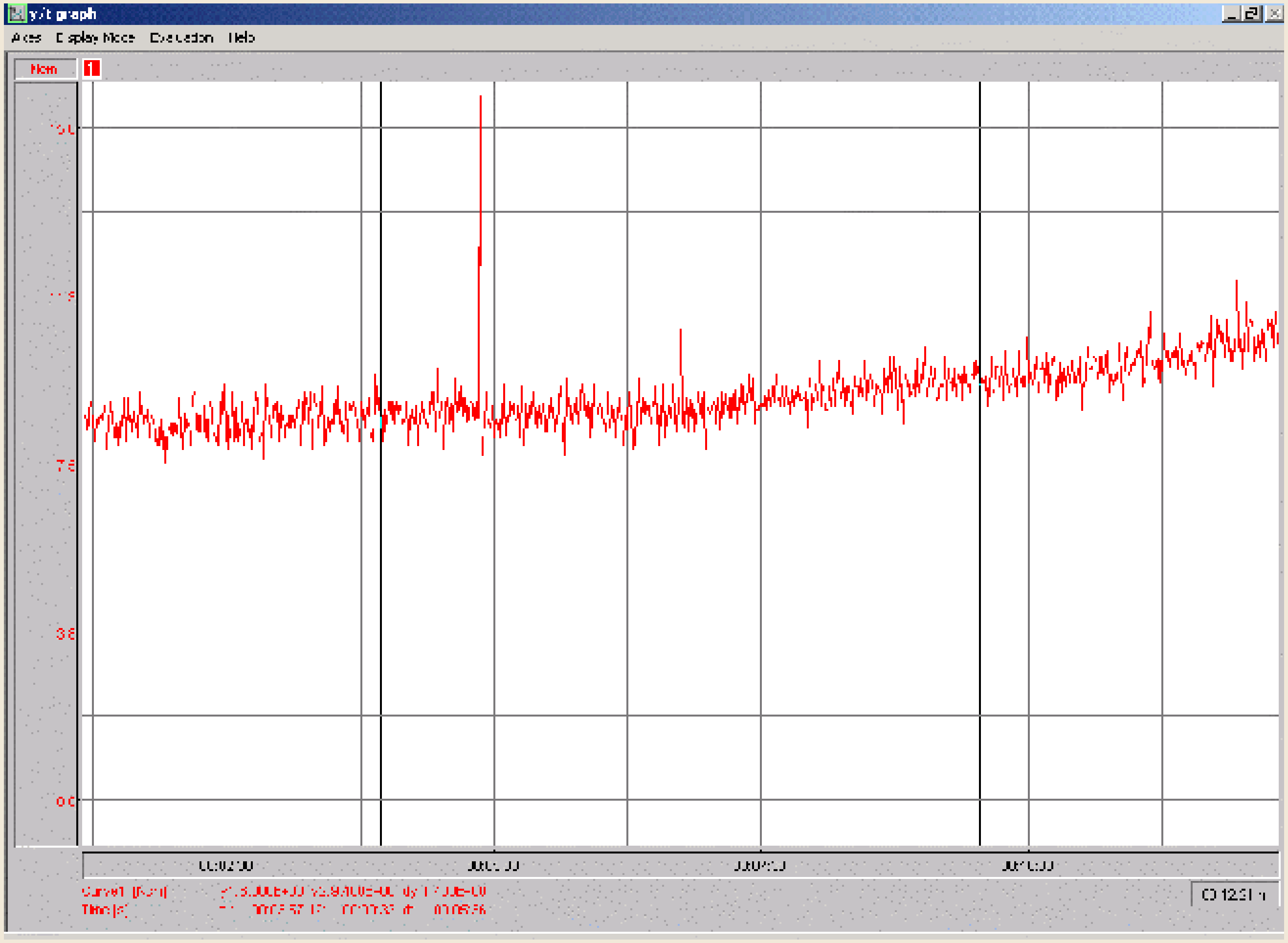

# New Mix Design: Test for mixing, spreading, and setting

Current test for slurry seals and microsurfacing are operator dependent. To overcome this deficiency, automated tests were developed.

- **Automated Mixing Test (AMT):**determines mixability and workability. Records change in viscosity (torque) with time.

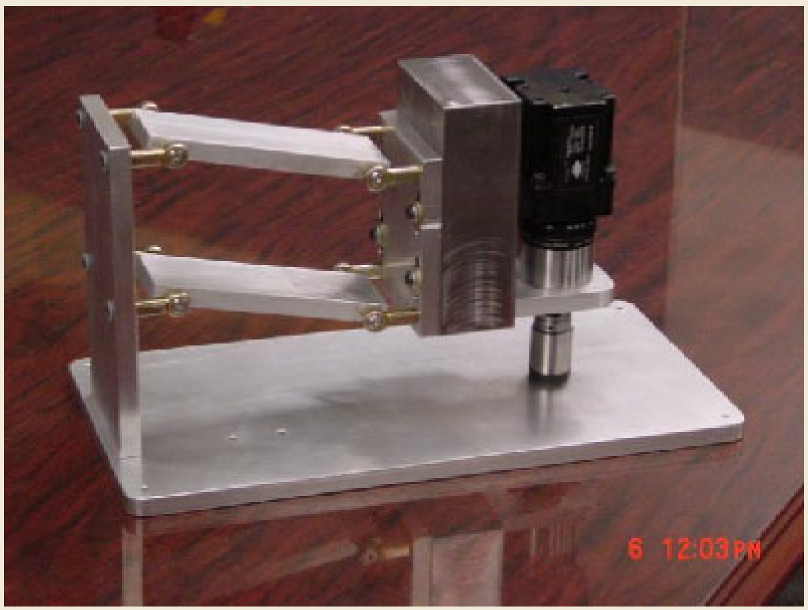


# AMT Trace for Mix M2 (Moderate Viscosity System)

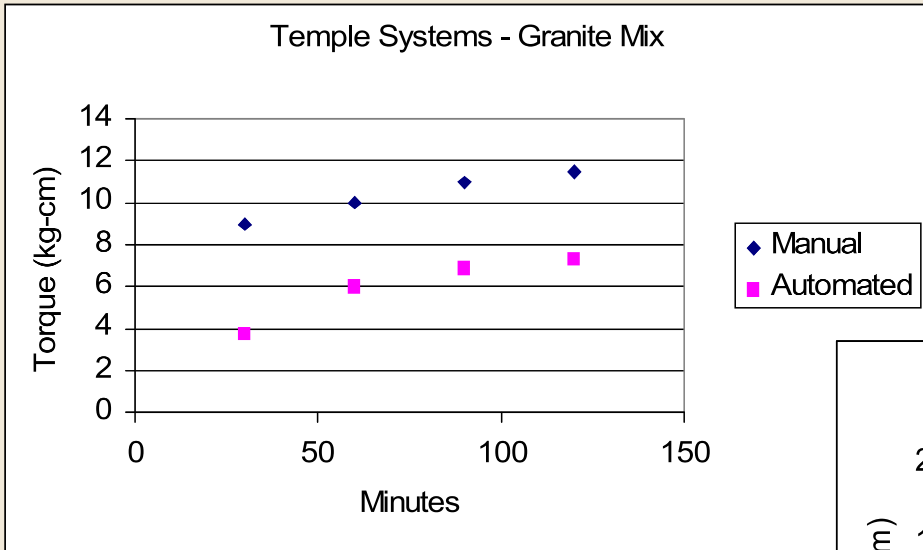


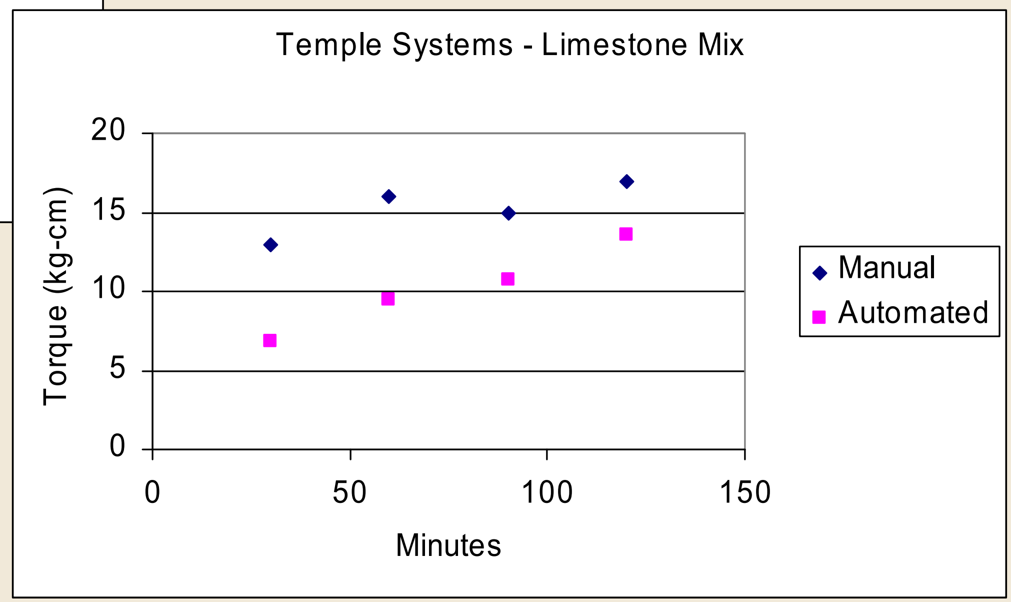
# New Mix Design: Test for mixing, spreading, and setting

- **Automated Cohesion Test (ACT):**determines time to allow traffic. Applies torque after one hour cure to measure resistance to shear force.




# Example ACT testing results



## New Mix Design: Test for mixing, spreading, and setting

- **Cohesion Abrasion Test (CAT):** modified Wet Track Abrasion Test (WTAT). Incorporates wheels instead of abrasion head to measure abrasion loss and short-term stone retention.

# Long term performance tests

**Main properties of interest:**

**- Abrasion Resistance (raveling)**

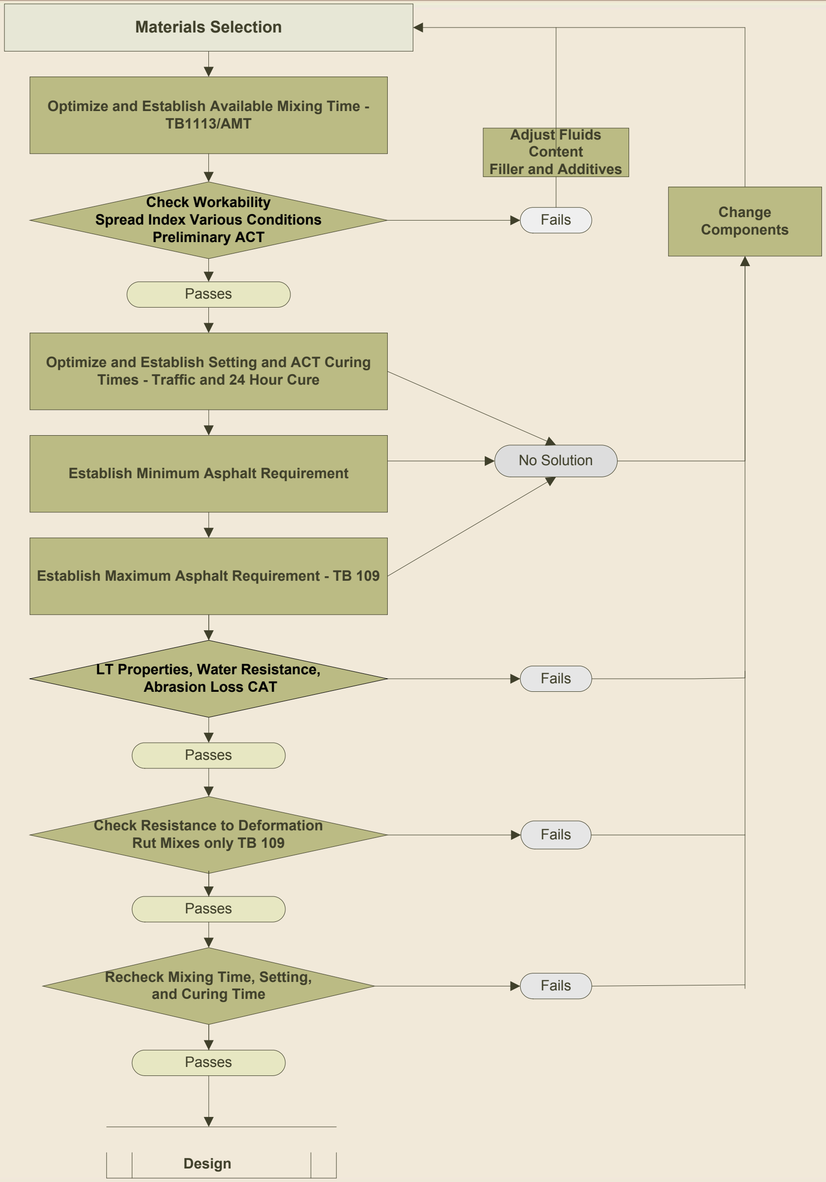
**- Water resistance (stripping)**

**- Deformation resistance (rutting)**

S3 specifications proposed the **CAT** to quantify abrasion and water resistance, and the current **ISSA TB 109 (Loaded Wheel Test)** for deformation resistance.

# Proposed Mix Design Flowchart

1. Materials selection
2. Create mix matrix and determine mix constructability
3. Determine short-term constructability properties
4. Determine optimum binder content
5. Evaluate cohesion properties at various curing conditions
6. Evaluate long-term properties of mixture



# 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 |
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| | *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 |

# Asphalt Emulsion Requirements

| PROPERTY | Test Method | Minimum | Maximum |
|---|---|---|---|
| Viscosity, Saybolt Furol @ 77° F, Seconds | AASHTO T 59 | 20 | 100 |
| Storage Stability test, one day, % | AASHTO T 59 | - | 1 |
| Particle Charge test | AASHTO T 59 | Positive | |
| Sieve Test, % | AASHTO T 59 | - | 0.1 |
| **Tests on Distillation** | | | |
| Oil distillate, by volume or emulsion, % residue | AASHTO T 59 | 60 | - |
| **Tests on Residue** | | | |
| Penetration, 77° F, 100g, 5 sec | AASHTO T 49 | 55 | 90 |
| Ductility, 77° F 5 cm/min, cm | AASHTO T 51 | 70 | - |
| Solubility in trichlorethylene, % | AASHTO T 44 | 97.5 | |
| Softening Point, minimum | AASHTO T 53 | 135 ° F | |

# Aggregate Quality Requirements

| Test | Test Method | Requirement |
|---|---|---|
| Sand Equivalent, min | AASHTO T 176 | 65 |
| Los Angeles Abrasion, loss at 500 rev., max* | AASHTO T 96 | 35 |
| Percentage of Crushed Particles, minimum | AASHTO T | 100 |
| Magnesium sulfate soundness, max. loss, %, 4 cycles | AASHTO T 104 | 20 |
| Micro-Duval, loss, %** | AASHTO | Report |

# Aggreagate Gradations

| Grade | US Sieve Size | | Passing by Weight, % | Job Mix Formula Tolerance Limits, %+ - |
|---|---|---|---|---|
| **A** | ? | 9.5 mm | 100 | 5 |
| | #4 | 4.75 mm | 70-90 | 5 |
| | #8 | 2.36 mm | 45-70 | 5 |
| | #16 | 1.16 mm | 28-50 | 5 |
| | #30 | 600µm | 19-34 | 3 |
| | #50 | 330 µm | 12-25 | 3 |
| | #200 | 75 µm | 5-15 | 2 |
| **B** | ? | 9.5 mm | 100 | 5 |
| | #4 | 4.75 mm | 94-100 | 5 |
| | #8 | 2.36 mm | 65-90 | 5 |
| | #16 | 1.18 mm | 40-70 | 5 |
| | #30 | 600 µm | 25-50 | 3 |
| | #50 | 330 µm | 18-30 | 3 |
| | #200 | 75 µ | 5-15 | 2 |
| **C** | ? | 9.5 mm | 100 | |
| | #4 | 4.75 mm | 100 | 5 |
| | #8 | 2.36 mm | 90-100 | 5 |
| | #16 | 1.16 mm | 65-90 | 5 |
| | #30 | 600µm | 40-65 | 5 |
| | #50 | 330 µm | 25-42 | 4 |
| | #200 | 75 µm | 10-20 | 2 |

# Where Are We?

Really Good Question!

# Work Plan and Study Approach

- Phase III Activities

# Phase III – Training

- Training – Complete 1.5-day Training Course materials and Pre-Job Module

- Instructor's Guide
  - Basic Information
    - General introduction
    - Set-up and wrap-up procedures
    - Annotated outline by session

# Pre-Job Training Module

- "Tailgate" presentation
  - Targeted at agency and contractor personnel on the job
  - Share "must know" information
  - Pocket-size guide book for field use

# Work Plan- Phase III

- Construct Pilot Projects
  – Identify Test Sections
    - Site Selection guidelines
    - Test Section Layout
  – Construction Guidelines
    - Pre-construction
    - Construction
    - Post-Construction

# Work Plan- Phase III

- **Identify Test Sections**

| Traffic | Surface Type | Climatic Region | | | |
|---|---|---|---|---|---|
| | | Wet-Freeze | Wet-No Freeze | Dry-Freeze | Dry-No Freeze |
| High | HMAC | *(1,2) | *(1,2) | *(1,2) | *(1,2) |
| | PCC | | | | |
| Moderate | HMAC | *(1,2) | *(1,2) | *(1,2) | *(1,2) |
| | PCC | | | | |

# Work Plan- Phase III

- Construction Guidelines
  - Insure proper placement
  - Observe and evaluate constructability
  - Coordinated effort between
    - Agency
    - Research Team
    - Contractor
    - Material Supplier
  - Use Guidelines developed in study
  - Document activities

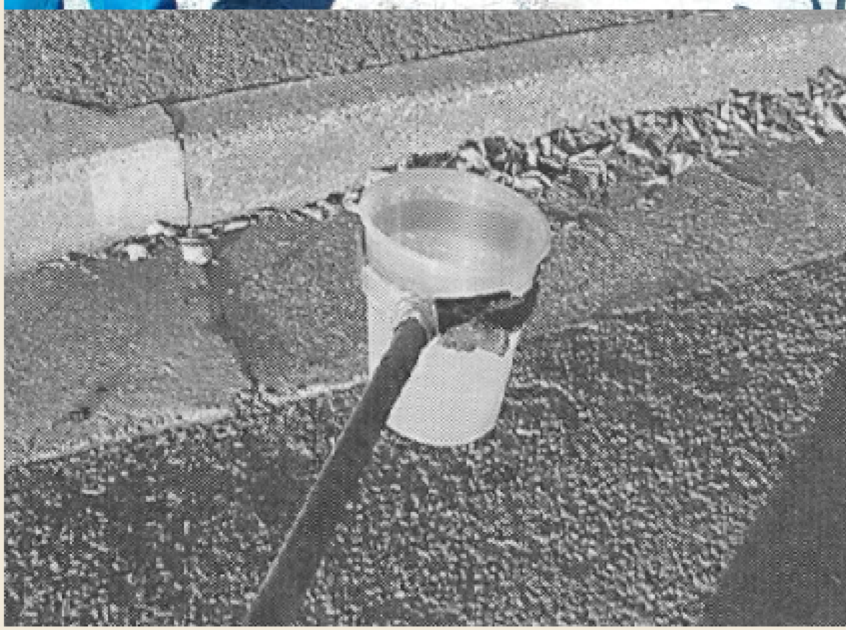
# Acceptance of Mixture

- Need for field control test
- Need for sampling and testing of completed mixture
- Automated sampling device from equipment manufactures?

# GeoGauge

- Non-destructive, quick measurements of stiffness
- Can be used to measure the rate of cure in cement-treated base materials
- Produced by Humboldt

# Sampling



# Q and A

Questions?

Thanks!