Road Map for Mitigating Moisture Sensitivity Concerns in Hot Mix Pavements

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MACTEC
Lab Testing for Moisture Sensitivity

Tensile
Compressive
Retained Stability
Hamburg & Tensile
None

Nationwide Problem
Misery loves company.
National Seminar - Feb 2003
La Jolla, CA
National Seminar - Goals

- Presentations & Group Discussions
  - Best Practices
  - Gaps & Barriers
  - Research Needs
- Products
  - Proceedings
  - Road Map
Organization & Participation

- The Usual Suspects
  - TRB, FHWA & DOT
  - Association
  - Industry
  - Consultants
  - Academia

125 attendees
Presentation Topics

- Fundamentals
- Test Methods
- Treatments
- Design & Production
- Construction
- Field Experiences
- Specs
- Implementation
Group Discussions

- Fundamentals
- Testing & Treatments
- Design & Specs
- Construction & Field Performance
Fundamentals

\[
\text{Si} \quad \text{OH} + \text{N} \quad \text{CH}_2\text{CH}_3 \quad \text{CH}_2\text{CH}_3 \\
\text{CH}_2\text{CH}_3 \\
\text{Si} \quad \text{O}^- + \text{H} \quad \text{N} \quad \text{CH}_2\text{CH}_3 \\
\text{CH}_2\text{CH}_3 \\
\text{H} \quad \text{(CH}_2\text{)}m \quad \text{OH} \\
\text{R} \quad \text{O} \quad \text{CO} \quad \text{A} \\
\text{H} \quad \text{N} \quad \text{CH}_2\text{CH}_3 \\
\text{CH}_2\text{CH}_3 \\
\text{Si} \quad \text{OH} + \text{N} \quad \text{CH}_2\text{CH}_3 \quad \text{CH}_2\text{CH}_3 \\
\text{CH}_2\text{CH}_3 \\
\text{Si} \quad \text{O}^- + \text{H} \quad \text{N} \quad \text{CH}_2\text{CH}_3 \\
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\text{R} \quad \text{O} \quad \text{CO} \quad \text{A} \\
\text{H} \quad \text{N} \quad \text{CH}_2\text{CH}_3 \\
\text{CH}_2\text{CH}_3 \\
\text{Si} \quad \text{OH} + \text{N} \quad \text{CH}_2\text{CH}_3 \quad \text{CH}_2\text{CH}_3 \\
\text{CH}_2\text{CH}_3 \\
\text{Si} \quad \text{O}^- + \text{H} \quad \text{N} \quad \text{CH}_2\text{CH}_3 \\
\text{CH}_2\text{CH}_3 \\
\text{H} \quad \text{(CH}_2\text{)}m \quad \text{OH} \\
\text{R} \quad \text{O} \quad \text{CO} \quad \text{A} \\
Factors to Consider

- Chemical
- Physical
- Mechanical
Mechanisms

- Spontaneous Emulsification
  - Clay, Dust, Filler, Salts in Asphalt

- Adhesive & Cohesive Failures
  - Water Absorption - Molecular Orientation at Interface
    - Aggregate Aging
    - Matrix Strength
Research Needed

- Adhesive Failure
  - Surface Energy Measurement
- Cohesive Failure
  - Bitumen or Mastic
  - Heithaus
  - Pull Off
- Water Absorption & Diffusion Test
- Aggregate
  - Screening Tests
Testing & Treatments
Current (Best?) Practices

- AASHTO T283-02
- Hamburg Wheel Tracking
- Loose Mix
  - Static Boiling
  - Rolling Bottle
  - Ultrasonic
Issues

- Compaction, Conditioning & Loading
- Sample Parameters - Air Void Content, Permeability, Saturation
- Calibration for Local Materials & Conditions
- Reproducibility & Repeatability
- Precision & Bias
Gaps

- Field Performance
  - Test Output
  - Definition of Moisture Damage
  - Data Collection
Research Needed - Testing

- Fundamental Property
- Long-Term Aging
- Rapid QC
- Completion of ECS research
- Dynamic Modulus - E (AASHTO 200?)
- Traffic Effect - Pore Pressures
- pH of Water
Treatments
Best Practices

- Mix Design w/ Additives
- Lime
  - Dry on Damp Aggregate
  - Method Spec
  - Acceptance - Production Data
- Liquid
  - Test Binder for Spec Compliance
Gaps

- Quantity of Additive
- Uniformity of Distribution
- Performance w/ Time
- Compatibility w/ Bitumen, Polymers
Research Needed - Treatments

- Uniformity of Additive Distribution
- Performance w/ Time
- Aggregate Stockpiling
- Lime in Bitumen
Design & Specs

- Design
  - Like Nike, Just Do it!

- Specs
  - Enforce ‘em!
Design & Specs

- **Structural Design**
  - Drainage - Surface & Subsurface
  - Don’t Overlay OGFC
- **Materials Selection & Proportioning**
  - Clean & Good Quality
- **Construction - Joint Density**
Construction
Best Practices

- Joint Training
- Production Balance & Control
- Materials Handling & Monitoring
  - Temp & Moisture
  - Optimum & Uniform
- Mat & Joint Density
Minimize/Eliminate Segregation
Joint Density

Notched Wedge
Gaps

- Personnel (Training & Turnover)
- Real-Time Process Control
- Accuracy of Density Measurements
- Pre-Construction Partnering
Research Needed

- Continuous Density/Stiffness Measurements
- Real-Time Automated Plant Control
- Automated Paver Control/Feedback
- Effect of Temp on Adhesion
- Incentive/Disincentive
Recurring Themes

- Long-Term & Widespread Problem
- Need Implementable Solutions
Recurring Themes

- Fundamentals
  - Chemical, Physical & Mechanical Properties of Components

- Testing
  - Standardize & Calibrate
  - Correlation w/ Field Performance
Recurring Themes

- Treatments
  - Compatibility
  - Long-Term Effectiveness

- Construction
  - Training ➔ Good Practices
  - Real-Time Process Control
  - Equipment Feedback
Recurring Themes

- Design
  - Implement What We Know!
- Specs
  - Consistently Enforce

DOCUMENTATION !!!
Best Practices

- Design - Subsurface & Surface Drainage
- Tests to Screen Aggregates
- Treat Mixes - Lime & Liquid Both Work
- Dry Lime on Damp Aggregate - Most Cost Effective
- Include Additive in Mix Design
- Conduct Mix Test - AASHTO T283 & Hamburg
- Verify Presence of Additive
- Adhere to Good Construction Practices
  - Materials Handling
  - Compaction - Mat & Joint Density
  - Training
  - Drainage
  - Acceptance Based on Mix Production
Gaps in Knowledge

- Standardized Test Procedures
- Refine Tests for Components and Mix
- Binder – Additive Compatibility
- Test to Evaluate Emulsibility of Binder
- Better Understanding of Failure Mechanisms
- Correlation of Lab Test(s) w/ Field Performance
- Documentation of Field Performance
- Correctly Identifying Moisture Damage
- Equipment Constraints on Production