ANNUAL WORK PLAN SUMMARY

For Year 2 of Contract

DTFH61-07-D-00005

Fundamental Properties of Asphalts and Modified Asphalts, III

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MOISTURE DAMAGE MECHANISMS

Background

Moisture influences asphalt concrete behavior and failure in many ways, including

- **Displacement of binder from aggregate (stripping)**
- **Softening of binder (emulsification)**
- **Embrittlement (accelerated aging)**
- **Mechanical action (pumping, freeze-thaw)**
- **Microbial support**
- **?**

MOISTURE DAMAGE MECHANISMS

Background

Common treatments to mitigate moisture damage include

- **Sound construction practices**
- **Hydrated lime ($Ca[OH]_2$)**
- **Liquid anti-strips**
- **Polymer modification**
- **Sealers**

MOISTURE DAMAGE MECHANISMS

Problem Statement

- **Moisture damage is often detected after failure occurs**
  - **Prediction, monitoring, and forensic methodologies could enable preemptive actions**
- **The influence of moisture on oxidative aging is not well characterized**
- **The influence of oxidative aging on moisture damage is not well understood**

MOISTURE DAMAGE MECHANISMS

Approach

- **Examine organic and mineral particles that cause the turbidity observed during Hamburg testing for failure indicators. (continuing)**
- **Aging in the presence of water** (under Aging)
- **Magnetic resonance imaging of water in asphalt** (under Aging)

MOISTURE DAMAGE MECHANISMS

Approach

Characterize the inorganic and organic material generated during testing.

- **Inorganic material:** **Clays, fines, or other aggregate constituents that could be contributing to the moisture susceptibility of the mix.**
- **Organic material:** **What fraction of the asphalt does it represent and does it contain functional groups that have already been identified as problems (Organic acids, sulfur, etc?)**

Approach -- Procedures

Inorganic Material:

- **Isolate from water bath by filtration.**
- **Aggregate soundness testing (LA Abrasion or Micro-Deval)?**
- **Subject to Electron Probe Microanalysis, a qualitative fluorescence technique**
- **Subject to powder X-ray Diffraction: quantitative when coupled with EPMA**

Approach -- Procedures

Organic Material:

- Isolate from inorganic material, probably through extraction.
- FTIR analysis, functional group analysis if enough material is generated
- Relate to prior findings

Approach -- Procedures

Other Variables

- **Water-bath temperature**
- **Soak duration**

Approach -- Materials

Asphalts: *AAD-1, AAG-1, AAB-1*

- **Range of chemical composition and varying moisture susceptibility with aggregates below.**
  - ***AAD* has high acid and asphaltene contents,**
  - ***AAG* has low acid and asphaltene contents,**
  - ***AAB* has low acid, has a tendency to strip, and has similar asphaltene and wax contents to *AAD.***

Approach -- Materials

Aggregates: *RA, RD, RG*

- **Includes siliceous, calcareous, and intermediate aggregates.**
  - ***RA*** **is a known stripper with 73% SiO_2 concentration of primarily felsic minerals,**
  - ***RD*** **is a good performer with an intermediate concentration of SiO_2 and is comprised primarily of maffic minerals, and**
  - ***RG*** **is a calcareous sandstone known as a fair to poor performer that is comprised of a mix of maffic and felsic minerals.**

Expected Outcomes

- **Short term**
  - **Identification of failure products from Hamburg testing**
  - **Correlation of amounts and types of detectable products with failure progression**
- **Long term**
  - **Validate results with validation site cores**
  - **Develop protocol for monitoring pavements**

MOISTURE DAMAGE MECHANISMS

Accomplishments

- **Hamburg system was received, installed, and is being tested**
  - **Some auxiliary equipment has been added**
  - **Trial testing with excess cores is underway**