

**IMPLEMENTATION PLAN
FOR
USE OF SURFACE ENERGY MEASUREMENTS
TO
SELECT MATERIALS RESISTANT TO MOISTURE DAMAGE**

By

Eyad Masad
Associate Research Engineer
Texas Transportation Institute

Amit Bhasin
Associate Research Scientist
Texas Transportation Institute

Robert Lytton
Research Engineer
Texas Transportation Institute

Dallas Little
Senior Research Fellow
Texas Transportation Institute

Project Number 0-4524

Product: 0-4524-P3

February 2007
Published: June 2007

Texas Transportation Institute
The Texas A&M University System
College Station, Texas 77843-3135

1. Background

The main objective of the TxDOT 04524 study was to develop experimental methods to measure the adhesive and cohesive bonds in asphalt mixtures under dry and wet conditions as well as to develop protocols to quantify the resistance of asphalt mixtures and mastic to moisture damage. Results based on these protocols have shown very good correlation with asphalt mixture performance in terms of resistance to moisture damage. An implementation project is needed to provide training on the developed experimental and analysis methods. Also, the implementation project is needed to conduct more measurements of the surface energy of binders and aggregates and populate a database of these properties.

This document presents a plan to implement the use of the protocols developed in this project for selection of materials and mixtures that are more resistant to moisture damage. The implementation plan will be based on achieving the following broad objectives:

1. Development of a database of surface free energy components for various different types of aggregates and asphalt binders used in the state of Texas. This database can be used by TxDOT to select aggregate and binder combinations that exhibit optimum resistance to moisture damage.
2. Incorporate the surface energy measurements made during this project into the larger data base developed during the implementation.
3. Impart training to TxDOT personnel to facilitate the use of equipment and testing protocols in the routine characterization of materials.

A detailed description of the various components of the implementation plan is described in the following sections. Each component of the implementation plan can be treated as task for the implementation project.

2. Essential Components of Implementation Plan

2.1 Training for the use of test equipment

The implementation of protocols based on surface energy measurements requires the use of Wilhelmy plate device and the Universal Sorption Device (USD), to measure surface free energy components of the asphalt binder and the aggregate, respectively as well as the Dynamic Mechanical Analyzer (DMA) to determine the mechanical properties of the fine aggregate matrix. Therefore, an essential component of the implementation plan will be to develop a test procedure for the use DMA and surface energy equipment and impart first hand training to the TxDOT personnel that will primarily be involved with the use of this equipment.

As a part of the training program, a draft test procedure must be developed and sent to TxDOT two weeks prior to the training course to be distributed to those individuals who will participate in the training. The training must include the equipment operations, trouble shooting of equipment, use of developed analysis methods, and

interpretation of results. The training must focus on the use of the machine to run the test protocol as well as on the analysis methods and interpretation of the results. Appendix A presents the material for use in the training program for dynamic mechanical analysis and surface energy measurement.

2.2 Surface energy measurements

Another important component of the implementation plan is the development of database of surface energy values for different types of aggregates and asphalt binders used in the state of Texas. The database must include at least 50 binder samples and about 20 aggregate samples. The aggregates may be selected from the database of aggregate properties developed under project 5-1707-03. This is because mechanical properties of the aggregates selected from the aforementioned project are well documented. The aggregates must be selected in consultation with the PD and must represent the bulk of materials used in the state as well as a variety of different geological types based on TxDOT classification (limestone, sandstone, traprock, gravel, etc.). Similarly, the binders must be selected to represent common sources used in the state of Texas and must include base as well as modified asphalt binders.

2.3 Changes in surface energy of aggregates from the same source

The objective of measuring surface energy components of a wide variety of aggregates is to be able to use these values as a reference without extensive testing before each mixture design. However, in order to be able to do so it is important to ascertain the variability in the surface energy components of the aggregates from the same source but produced in different batches. In other words, one of the objectives of the implementation study must be to determine the variability in aggregate surface energy over time due to changes in the geological strata within a given source. Tests must be conducted on aggregate sources from which at least three samples are taken at different times. Typically, aggregates samples from the same source are obtained every six months as part of the TxDOT aggregate quality manual program.

2.4 Changes in surface energy of asphalt binders from the same supplier

The variability in surface energy components of the asphalt binder from the supplier but different batches is analogous to the assessment of variability in surface energy of aggregates from same source but different geological strata. This part of the implementation plan must focus on determining the variability in binder surface energy due to changes in the binder source and modification process. The binders must be selected in consultation with the PD in order to test those that have wide use in the state.

2.5 Updated database of aggregate and binder surface energies

This database will be valuable for the selection of aggregate and binder combinations with very good resistance to moisture damage. Also, it will be used later to verify the

analysis methods developed in this project (0-4524) through comparison between the predicted resistance to moisture damage and field performance. The database must be in Excel format and must be developed to be user-friendly and allow examining the results of multiple combinations of binders and aggregates.

2.6 Purchase equipment for CST and provide start up assistance

The most important part of the implementation plan will be to purchase equipment to measure surface energy on aggregates and asphalt binders for installation at CST Central laboratory and provide training and technical assistance on the operation of the equipment. If during the implementation program it is determined that an external agency can run the surface energy tests for TxDOT more effectively, then the equipment purchase will be canceled.

3. Anticipated achievements at the end of the implementation plan

It is expected that at the end of the implementation plan that successfully addresses the aforementioned components, the following will be available for TxDOT to continue the use of surface energy measurements to select materials and mixtures resistant to moisture damage:

- database of the surface energy of asphalt binders and aggregates in a user friendly Excel format,
- necessary equipment to carry out surface energy measurements at the CST laboratory, if deemed appropriate,
- initial and startup training to TxDOT personnel for the use of DMA and surface energy equipment.

Assistance of TxDOT may be required in the implementation plan during the selection of aggregates and asphalt binders.

APPENDIX A

MATERIAL FOR TRAINING
ON
DYNAMIC MECHANICAL ANALYSIS
AND
SURFACE ENERGY MEASUREMENT