



Providing solutions to highway building materials problems

QUARTERLY TECHNICAL PROGRESS REPORT

April 1 – June 30, 2007

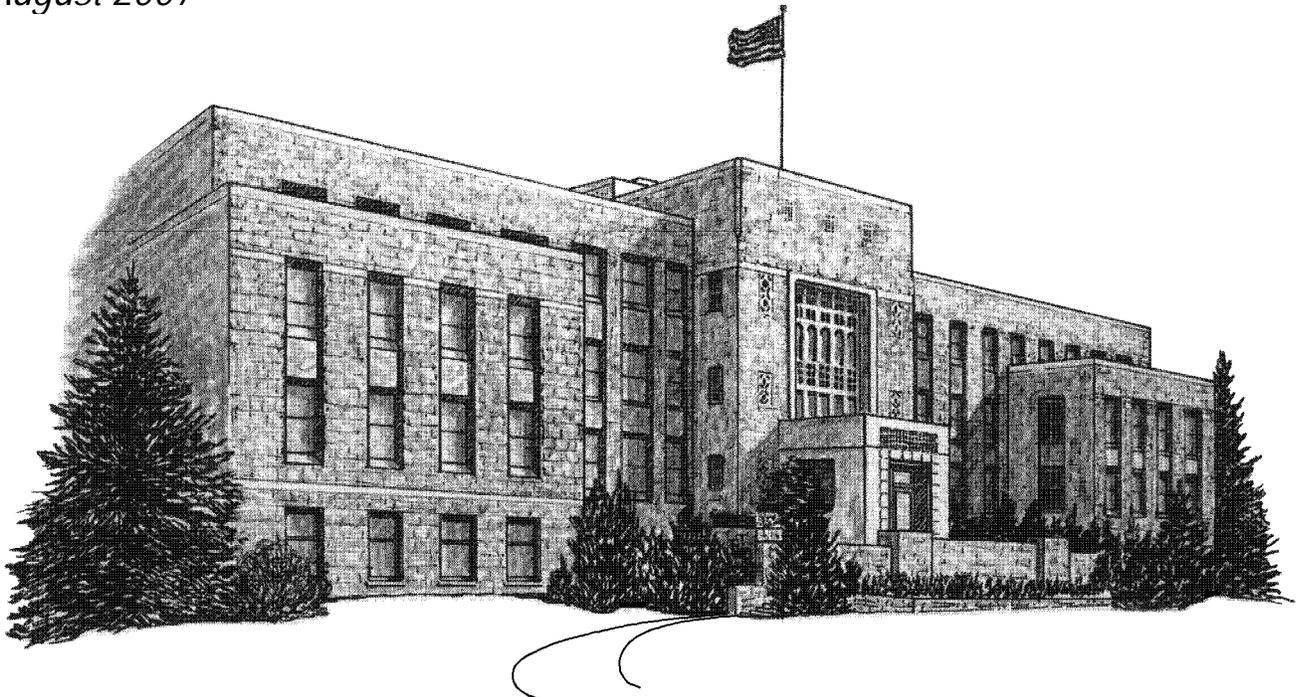
ASPHALT RESEARCH CONSORTIUM

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FOREWORD

This document is the Quarterly Report for the period of April 1 to June 30, 2007 for the Federal Highway Administration (FHWA) Contract DTFH61-07-H-00009, the Asphalt Research Consortium. The Consortium is coordinated by Western Research Institute with partners Texas A&M University, the University of Wisconsin-Madison, the University of Nevada Reno, and Advanced Asphalt Technologies.

The Quarterly Report is grouped into seven areas, Moisture Damage, Fatigue, Engineered Paving Materials, Vehicle-Pavement Interaction, Validation, Technology Development, and Technology Transfer. The format of the report is based upon the Research Work Plan and is grouped by Work Element and Subtask. The Moisture Damage and Fatigue areas report on Work Elements and Subtasks that are interrelated and thus work together to advance the knowledge of mechanisms and models in these areas.

The research areas of Engineered Paving Materials, Vehicle-Pavement Interaction, and Validation generally report work elements that are more “stand-alone” in nature but this doesn’t mean that these work elements operate independently because in most cases, at least two Consortium partners are teaming to conduct the work. These work elements also provide useful information to the other research activities in the Consortium.

Finally, the areas of Technology Development and Technology Transfer report where the research deliverables have been transmitted to the user community. The Technology Development area reports the progress to take promising research developments and refine them into useful tools for engineers and technologists involved in the design, construction, and maintenance of flexible pavement systems. The Technology Transfer area reports on the transfer of Consortium research findings to the asphalt community using the Consortium website, presentations, publications, and workshops.

SUPPORT OF FHWA AND DOT STRATEGIC GOALS

The Asphalt Research Consortium research is responsive to the needs of asphalt engineers and technologists, state DOT’s, and supports the FHWA Strategic Goals and the Asphalt Pavement Road Map. More specifically, the research reported here supports the Strategic Goals of safety, mobility, and environmental stewardship. By addressing the causes of pavement failure and thus determining methods to improve asphalt pavement durability and longevity, this research will provide the motoring public with increased safety and mobility. The research directed at improved use of recycled asphalt pavement (RAP), warm mix asphalt, and cold mix asphalt supports the Strategic Goal of environmental stewardship.

GENERAL CONSORTIUM ACTIVITIES

PROGRESS THIS QUARTER

In general, all Consortium members participated in the following activities:

Meetings to interact with stakeholders, etc.

The research team attended the following meetings;

1. Asphalt Research Consortium meeting in Reno, NV on April 24, 2007
2. Asphalt Research Consortium “Kickoff” meeting with Co-AOTR’s Jack Youtcheff and Eric Weaver to discuss format and content of Detailed Work Plan preparation and delivery in Reno, NV on April 25 & 26, 2007. At the kick off meeting in April, the work plan was divided into seven focus or concept areas: (1) Fatigue, (2) Moisture Damage, (3) Engineered Paving Materials, (4) Vehicle-Pavement Interaction, (5) Validation, (6) Technology Development, and (7) Technology Transfer. These focus areas were then divided into work elements that were refined and identified in detail in the work plan development and in the plan.

Preparation of Detailed Workplans

The tasks completed included the following:

1. Developed detailed responses to questions received from FHWA contracting office and WRI in order to complete sub-recipient awards.
2. Prepared detailed work plans with emphasis on year 1 and brief outline for remaining years, submitted to FHWA May 25th. The ARC submitted a work plan that emphasized the first year effort, which will be completed by December 22, 2007. However, the detailed first year plan was submitted as part of an overall framework that describes the vision for each work element over the five year duration of this work. The ARC felt that this type of an integrated plan would be necessary in order for the FHWA reviewers and the ETG reviewers to properly evaluate the work elements planned for year one. The approach to the development of the work plan and the work elements are described in the “Forward” to the “First Year Work Plans, June 18 – December 25, 2007”, page i.

WORK PLANNED FOR NEXT QUARTER

1. All Consortium members attended the Fundamental Properties and Advanced Models, Mixture and Construction, and Binder ETG meetings in Denver, CO during July 23 – 27, 2007. The Consortium members participated in presentations and discussions of consortium related issues.
2. Approval of the Detailed First Year Work Plans was obtained on July 12, 2007, which is after the period of this report; therefore, only minor work was completed on the First Year Work Plan.

PROGRAM AREA: MOISTURE DAMAGE

CATEGORY M1: ADHESION

Work Element M1a: Affinity of Asphalt to Aggregate

Subtask M1a-1: Select Representative Asphalt Binders and Mastics, and Aggregate Materials (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

The Asphalt Research Consortium (ARC) members and FHWA Co-AOTR's will identify knowledgeable people from the asphalt and aggregate materials community that will be solicited for input for the materials to be used in the ARC research. Criteria will also be established for selection of materials. A selection committee consisting of one member from each Consortium organization, the FHWA Co-AOTR's and approximately six other members will then select the materials for the bulk of the ARC research. It is anticipated that as the research progresses, additional materials will be added to the Materials Library.

Subtask M1a-2: Use the Modified DSR Tests to Evaluate Various Moisture Testing Conditions Including Control of Rate and Temperature and to Measure Affinity of Asphalts to Aggregates and also Cohesion of Binders (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

Begin DSR testing of asphalt/aggregate combinations.

Subtask M1a-3: Evaluate the Moisture Damage of Asphalt Mixtures with Selected Material Combinations by the TSR Test or an Alternative Test System

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask M1a-4: Correlate Moisture Damage as Measured by the Modified DSR Test with the Mixture Test Results - Analyze Results on Each Combination and Material

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask M1a-5: Propose a Novel Testing Protocol

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work Element M1b: Work of Adhesion Based on Surface Energy

Subtask M1b-1: Surface Free Energy and Micro-Calorimeter Based Measurements for Work of Adhesion (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

The planned activity for the next quarter is to conduct preliminary measurements of the enthalpy of adhesion between asphalt binders and aggregates using the micro calorimeter. These measurements will be made at room temperature by using the asphalt binder in the form of a solution. Different solvents will be evaluated in this preliminary study. Generic aggregate types and asphalt binders will be used to develop the test method.

Subtask M1b-2: Work of Adhesion at Nano-Scale using AFM

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask M1b-3: Identify Mechanisms of Competition Between Water and Organic Molecules for Aggregate Surface (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

The planned activity for the next quarter is to develop a synthesis of mechanisms of interaction between organic functional groups and mineral surfaces. In addition this synthesis will also identify: i) minerals that can be used to represent aggregate surfaces, ii) model organic compounds that can be used to represent the most common functional groups in asphalt binders, and iii) a list of candidate test methods that can be used to investigate the interfacial interactions.

Work Element 1c: Quantifying Moisture Damage Using DMA

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

CATEGORY M2: COHESION

Work Element M2a: Work of Cohesion Based on Surface Energy

Subtask M2a-1: Methods to Determine Surface Free Energy of Saturated Asphalt Binders (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work is planned for the next quarter. Activity related to this subtask is anticipated to start in the last quarter of this year.

Subtask M2a-2: Work of Cohesion Measured at Nano-Scale using AFM

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work Element M2b: Impact of Moisture Diffusion in Asphalt Mixtures

Subtask M2b-1: Measurements of Diffusion in Asphalt Mixtures (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

The planned activity for the next quarter is to start the development of a methodology to measure diffusion of water through binder / mastic films. Two different techniques will be critically reviewed as candidates to obtain diffusivity constants. The first technique will be based on gravimetric measurements of water diffusion through binder / mastic test specimen. The second technique will be based on FTIR measurements of water diffusion through binder / mastic films.

Subtask M2b-2: Kinetics of Debonding at the Binder-Aggregate Interface

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work Element M2c: Measuring Thin Film Cohesion and Adhesion Using the PATTI Test and the DSR

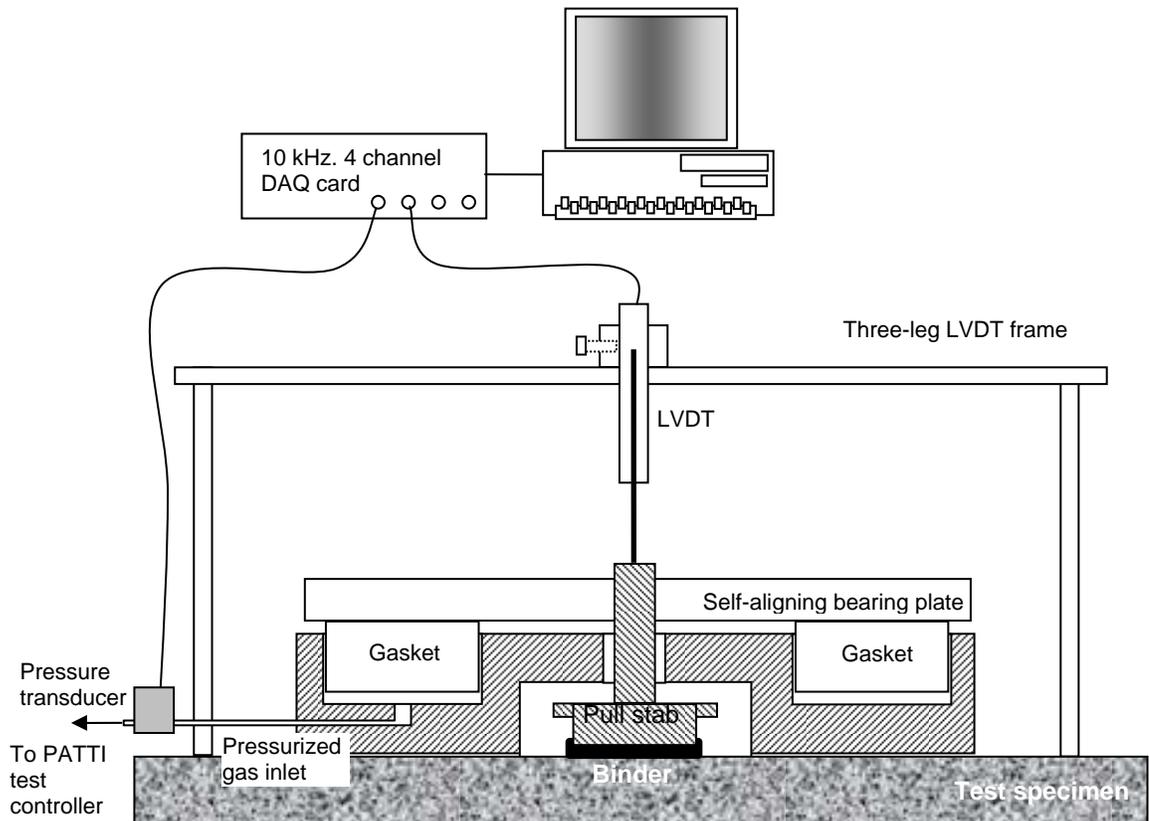
Subtask M2c-1: Evaluate Load and Deflection Measurements using the Modified PATTI Test (Year 1 start)

Progress This Quarter

A proposed modification to the PATTI test (shown below) was presented and preliminary data acquisition and sensor tests were performed with a 200 kS/s data acquisition card, 150 psi load cell, and 5-mm miniature LVDT tests. The modification will be complemented with a system for temperature control of binder and aggregate and a mechanism to monitor/control the geometry and thickness of the binder.

Modified pneumatic piston setup – Conceptual design

This proposed modification will add loading-displacement history to the binder pullout test.



Work Planned Next Quarter

Complete subtask M2c-1 (testing and design of PATTI test modification) and begin testing for subtask M2c-2.

Subtask M2c-2: Evaluate Effectiveness of the Modified PATTI Test for Detecting Modification Effects (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

Begin testing using modified PATTI apparatus.

Subtask M2c-3: Validation of the Modified PATTI Test using Results from DSR Testing

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask M2c-4: Testing of Mastics Using Modified PATTI and DSR Tests

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask M2c-5: Commercialization and Practicality Evaluation of the Modified PATTI Test

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask M2c-6: Analysis and Recommendations for the Modified PATTI Test

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

CATEGORY M3: AGGREGATE SURFACE

Work Element M3a: Aggregate Surface Characterization (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

A list of aggregate surface properties, such as mineral composition and specific surface area and corresponding test methods by which to measure these properties will be compiled. Measurement of selected properties will commence immediately upon the receipt of representative samples of aggregates selected for this project.

CATEGORY M4: MODELING

Work Element M4a: Micromechanics Model

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work Element M4b: Analytical Fatigue Model for Mixture Design

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work Element M4c: Unified Continuum Model

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

CATEGORY M5: MOISTURE DAMAGE PREDICTION SYSTEM

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

PROGRAM AREA: FATIGUE

CATEGORY F1: MATERIAL AND MIXTURE PROPERTIES

Work Element F1a: Cohesive and Adhesive Properties

Subtask F1a-1: Critical Review of Measurement and Application of Cohesive and Adhesive Bond Strengths (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

A critical review of the literature will be conducted to identify experimental and analytical methods to determine the work of cohesion and adhesion using mechanical tests, including approaches based on contact mechanics. Preliminary transverse tensile tests on thin asphalt films will be conducted in order to i) develop a test protocols, and ii) select appropriate analytical models to analyze results from these tests.

Subtask F1a-2: Develop Experiment Design (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask F1a-3: Thermodynamic Work of Cohesion and Adhesion (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask F1a-4: Mechanical Work of Adhesion and Cohesion

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask F1a-5: Evaluate Acid-Base Scale for Surface Energy Calculations

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work Element F1b: Viscoelastic Properties (Year 1 start)

Subtask F1b-1: Separation of Nonlinear Viscoelastic Deformation from Fracture Energy under Cyclic Loading

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

In the next quarter we will develop and formalize a model that can be used to represent the linear and nonlinear viscoelastic properties of asphalt mixtures (including mastics and fine aggregate matrix). This model will build upon Schapery's approach to characterize non-linear viscoelastic response using static creep data. The proposed analytical model will be capable of representing non-linear response of the asphalt material within each cycle of a high stress or strain amplitude cyclic load test. An experiment design to validate the efficacy of this model will also be developed.

Subtask F1b-2: Separation of Nonlinear Viscoelastic Deformation from Fracture Energy under Repeated and Monotonic Loading

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

Same as F1b-1.

Work Element F1c: Aging

Subtask F1c-1: Critical Review of Binder Oxidative Aging and Its Impact on Mixtures (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

A critical review will be conducted to achieve the objectives outlined in the work plan.

Subtask F1c-2: Develop Experimental Design (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

Experimental design may commence if time permits.

Subtask F1c-3: Develop a Transport Model of Binder Oxidation in Pavements (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask F1c-4: The Effects of Binder Aging on Mixture Viscoelastic, Fracture, and Permanent Deformation Properties

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask F1c-5: Polymer Modified Asphalt Materials

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work Element F1d: Healing

Subtask F1d-1: Critically Review Previous Work on Healing under FHWA Contracts DTFH61-C-92-00170 and DTFH61-C-99-00022 (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

A critical review will be conducted to identify: i) mechanisms of healing, ii) test methods that can be used as a direct measure of healing in asphalt binders as well as material properties related to healing.

The healing work element has always been a key work element as the historical work between WRI and Texas A&M has focused on proving the importance of healing, proving that healing does indeed occur and can be quantified in the lab as well as in the field, and defining the mechanism(s) responsible for healing. The WRI – TAMU work has been referenced in a number of recent key publications on fatigue and the endurance limit. Key publications include the work of Sam Carpenter of the University of Illinois on the endurance limit and the work of Rey Roque at the University of Florida on the fatigue process. A CHRP Project 9-44 Endurance Limit Workshop will be held at the NAS Keck Center in August, 2007. TAMU researchers will focus on how the ARC work will help identify the impact of the healing process on the endurance limit and how the ARC work can assist the NCHRP 9-44 effort. TAMU researchers will also focus on the efficacy of the convolution mechanism of healing, where healing was defined by TAMU researchers to be a convolution of the processes of wetting of micro and nano cracks followed by the diffusion and randomization of asphalt structures at these interfaces.

Subtask F1d-2: Select Materials with Targeted Properties (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask F1d-3: Develop Experiment Design (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask F1d-4: Investigate Test Methods to Determine Material Properties Relevant to Asphalt Binder Healing

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask F1d-5: Testing of Materials

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask F1d-6: Evaluate Relationship Between Healing and Endurance Limit of Asphalt Binders (Year 1 start)

Progress This Quarter

Literature review on the relation of asphalt healing and fatigue life has begun, with a focus on the viscoelastic continuum damage (VECD) approach in use by the Texas Transportation Institute along with their fellow researchers Dr. Y. Richard Kim and Dr. Jo Sias Daniel, among others. A fundamental approach is being developed in order to gain a better core understanding than what has developed in previous binder fatigue studies. This approach will begin with three types of tests to be performed on the binders in the Dynamic Shear Rheometer (DSR): standard cyclic loading fatigue testing, frequency sweep testing, and a constant shear rate monotonic test.

The standard cyclic loading fatigue and frequency sweep tests have been run previously for many other studies on binders, but using the DSR to conduct monotonic shear testing is a method new to the researchers at UW-Madison. During this quarter, a test protocol was developed and is producing good results. The procedure uses existing features of a standard DSR along with the 25-mm plate commonly used in SuperPave binder testing. The test can be thought of as analogous to the Direct Tension Test, only run in shear mode at intermediate temperatures.

Work Planned Next Quarter

Work for the coming quarter will be to begin collecting data so that the analysis method can be refined. Using the VECD approach involves complex computations, so research team will take great care in obtaining a full understanding of the fundamental material behavior models at use. This will involve further literature review, as well as coordination with other ARC members regarding the methodologies used for analysis.

Subtask F1d-7: Coordinate with Atomic Force Microscopic (AFM) Analysis.

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask F1d-8: Coordinate Form of Healing Parameter with Micromechanics and Continuum Damage Models.

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask F1d-9: Design Experiment on Selected Binders with Synchrotron

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

CATEGORY F2: TEST METHOD DEVELOPMENT

Work Element F2a: Binder Tests and Effect of Composition

Subtask F2a-1: Analyze Existing Fatigue Data on Polymer Modified Asphalts (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

Begin analysis of existing data.

Subtask F2a-2: Select Virgin Binders and Modifiers and Prepare Modified Binder (Year 1 start)

Progress This Quarter

Materials have been collected. We have acquired base binders from three different common sources for Wisconsin. We have also collected modifier samples (SBS, Elvaloy®, Entira Bond™, and several grades of PPA). We have also started blending different concentrations of the polymer modifiers with the base binders, and blending of the base binders with PPA. Preliminary testing is being conducted on these modified binders and on the base binders, for the purpose of obtaining a “base line” for future testing of effects of modification.

Work Planned Next Quarter

Based on the results of subtask F2a-1, a complimentary work plan will be developed. Modified binders will be prepared using two different “base” virgin binders and four modifiers (SBS rubber, Elvaloy®, Sasobit® wax, and a polyphosphoric acid modifier). In order to better

examine the influence of the butadiene moiety along with the variation in ratio between the lengths of the butadiene and styrene blocks, more than one type of SBS will be tested. Every “base” binder will be modified using each of the chemical additives selected. The sample size produced will be determined taking into consideration the amount needed for the testing procedures for the materials.

Subtask F2a-3: Subject Samples of Virgin and Modified Binder to Several Laboratory Aging Procedures

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

Samples from both the modified and unmodified types of binders will be subjected to lab aging techniques. This is done to enable the study of aging as a determining factor in the fatigue life of binders. Modified and unmodified binder samples will undergo RTFO and one or more PAV treatments.

Subtask F2a-4: Collect Fatigue Test Data for All Samples

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

This subtask will concentrate on testing the previously prepared samples according to the work plan.

Subtask F2a-5: Analyze Data and Propose Mechanisms by which Aging and Modification Influence Fatigue of Binders

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work Element F2b: Mastic Testing Protocol

Subtask F2b-1: Develop Specimen Preparation Procedures (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

In earlier research conducted at Texas A&M University, several different approaches to design and fabricate test specimen for use with the dynamic mechanical analyzer (DMA) were evaluated. This information will be used in the next quarter to finalize a specimen preparation procedure. The specimen preparation procedure will include a method to design the fine aggregate matrix, prepare SGC compacted specimen, and extract test specimens.

The importance of the DMA test as a screening tool that can be used with confidence to assess properties of the fine aggregate matrix and the mastic on the fracture and healing processes was emphasized several times at the NCHRP 9-44 workshop on the endurance limit. TAMU researchers will focus on fast track development of this methodology.

Subtask F2b-2: Document Test and Analysis Procedures in AASHTO Format

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work Element F2c: Mixture Testing Protocol

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work Element F2d: Tomography and Microstructural Characterization

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work Element F2e: Verification of the Relationship between DSR Binder Fatigue Tests and Mixture Fatigue Performance

Subtask F2e-1: Evaluate Binder Fatigue Correlation to Mixture Fatigue Data (Year 1 start)

Progress This Quarter

The research team studied the relationship between the fatigue of binder and mixtures, using the data collected for the Pacific Coast Conference on Asphalt Specification (PCCAS). It was found that the type of strain-control method by the Dynamic Shear Rheometer (DSR) greatly affects the test results. A paper regarding the evaluation of strain-controlled testing in the DSR has been accepted for publication by the Italian Society for Transportation Infrastructure for their 2007 meeting. The paper draws from data collected earlier this year from binder fatigue testing in the DSR, as well as mixture fatigue data collected from a previous study for the PCCAS. Both studies shared the same binders, so fatigue data was compared between the mixture and binder testing with varying results. Depending on the type of strain-control method used by the DSR controller software, fatigue life could vary significantly. One method in particular involved periods of discontinuous oscillation, i.e. rest periods, and showed high correlation to mixture fatigue life. Further testing still needs to be performed to verify the correlation.

In addition, the research team at UW-Madison studied the characterization of binder fatigue used at the FHWA Accelerated Loading Facility (ALF). Strain-controlled binder fatigue testing in the DSR was compared to results from an ALF test using the same binders. Ranking of the fatigue performance of the materials from both experiments was compared and shown to be similar. The results from using the stress sweep as a surrogate fatigue test in the DSR also showed similar rankings to the ALF test, validating the possibility for its use as a quick and accurate predictor of fatigue performance. A paper discussing these results will be submitted to TRB for publication.

Work Planned Next Quarter

Work for the coming quarter is to involve further binder fatigue testing of the materials used for the PCCAS study. This will provide a more complete picture of the relation with the results from the mixture fatigue experiment.

Subtask F2e-2: Selection of Testing Protocols

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask F2e-3: Binder and Mixture Fatigue Testing

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

Continue binder fatigue testing of the PCCAS materials.

Subtask F2e-4: Verification of Surrogate Fatigue Test

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask F2e-5: Interpretation and Modeling of Data

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask F2e-6: Recommendations for Use in Unified Fatigue Damage Model

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

CATEGORY F3: MODELING

Work Element F3a: Asphalt Microstructural Model

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work Element F3b: Micromechanics Model

Subtask F3b-1: Model Development

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

The state of the art of the micromechanics models to characterize mixture performance will be reviewed. This review effort will identify: i) alternative strategies for micromechanical modeling in addition to the cohesive zone model (CZM) and discrete element model (DEM), ii) scope for improvement in the CZM and DEM and material properties that can further enhance these models, and iii) strategy for development of these models and integration of material properties within these models for the remainder of this project.

Subtask F3b-2: Account for Material Microstructure and Fundamental Material Properties

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work Element F3c: Development of Unified Continuum Model

Subtask F3c-1: Analytical Fatigue Model for Mixture Design

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

Existing analytical fatigue models, such as the crack growth index, will be reviewed. Any shortcomings of the existing model will be identified and a strategy to resolve these will be recommended. This activity will be closely related to the development of a model to determine non linear viscoelastic properties in sub task F1b.

Subtask F3c-2: Unified Continuum Model

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask F3c-3: Multi-Scale Modeling

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work Element F3d: Calibration and Validation

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

PROGRAM AREA: ENGINEERED MATERIALS

CATEGORY E1: MODELING

Work element E1a: Analytical and Micro-mechanics Models for Mechanical Behavior of Mixtures (Year 1 start)

Subtask E1a-1: Analytical Micro-mechanical Models of Binder Properties

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask E1a-2: Analytical Micro-mechanical Models of Modified Mastic Systems

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask E1a-3: Analytical Models of Mechanical Properties of Asphalt Mixtures (Year 2 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask E1a-4: Analytical Model of Asphalt Mixture Response and Damage (Year 3 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work element E1b: Binder Damage Resistance Characterization (DRC)

Subtask E1b-1: Rutting of Asphalt Binders

Progress This Quarter

1. Literature Review

Literature related to the rutting of asphalt binders was reviewed. The recent advances made by the UW team shed some light on the future direction of the study of binder rutting, based on the results from the Airfield Asphalt Pavement Technology Program (Project 04-02) and the Wisconsin Highway Research Program (Project 0092-03-13). The stress levels and loading time selected for multiple stress creep and recovery (MSCR) tests on asphalt binder are found to have significant effects on the characterization of rutting performance of binders and mixtures. The team will be coordinating closely with FHWA Research Team in this area. To develop meaningful test protocol and specifications for the rutting performance of binder, it was proposed to use the materials that had field performance, such as FHWA ALF and LTPP binders and/or mixtures. The University of Wisconsin at Madison is developing a detailed experimental plan for testing and validation.

2. Modeling of Rutting Behavior

The data collected by the research team from previous studies are being analyzed to model the rutting behavior. A detailed review of the literature related to the stress sensitivity of creep behavior of visco-elastic materials resulted in identifying a few mechanistic models available are being reviewed. Preliminary investigation of the applicability and effectiveness of these models were conducted.

Work Planned Next Quarter

Continue to develop a mechanistic model for the stress sensitivity of creep behavior of modified binders. Start testing to fit the models selected and define protocol.

Subtask E1b-2: Feasibility of Determining Rheological and Fracture Properties of Thin Films of Asphalt Binders and Mastics using Nano-indentation (Year 2 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work element E1c: Warm and Cold Mixes

Subtask E1c-1: Warm Mixtures

Progress This Quarter

The following activities have been accomplished this quarter:

1. Establishment of temperature controlled mixing stations to combine warm mix additives and asphalt binders. The temperature control has a tolerance of +/- 1C.
2. Development of a frequency sweep test procedure in the DSR from 40C to 76C to evaluate the change in stiffness of the binder due to the addition of warm mix additives. All tests were conducted using a PG 64-22 binder.
3. Investigation of the change in viscosity due to the addition of both mineral based and wax based additives as measured by the Brookfield Rotational Viscometer.
4. Investigation of the physical hardening effects at low temperatures on asphalt binder due to Sasobit.
5. Preparation of trial blends for 12.5mm and 19.5mm aggregate blends from a WI aggregate source to investigate the effects of NMAS on mixture workability.

Work Planned Next Quarter

The following activities are planned for next quarter:

1. Develop a detailed year two work plan for submittal to FHWA and review by ETG. The workplan will involve a literature review to address ETG comments received in July.
2. Detailed analysis and interpretation of test results in quarter 1 to evaluate the effectiveness of the approach in quantifying the effects of warm mix additives on binder stiffness and viscosity.
3. Selection of materials including asphalt binder sources and grades, aggregates, and warm mix additives to conduct testing.

Subtask E1c-2: Development and Evaluation of a Volumetric Mix Design Process for Cold Mix Asphalt

Progress This Quarter

The following activities have been accomplished this quarter:

1. Collection of literature from worldwide sources regarding current cold mix practices, with a specific focus on developments in Europe.
2. Visit to South Africa by H Bahia to study emulsions and the application of surface seals and cold mix technologies. Work has been conducted with Dr. Kim Jenkins of Stellenbosch University and consultants specialized in production of emulsions and design of seals.

3. Conceptual development of a white paper to propose specification of emulsified asphalts based on the current PG Grading specification.
4. Received and reviewed comments through ETG review of work plans.
5. Discussed cold mixes with a representative from COLAS and made preliminary plans to attend an AEMA informational workshop on emulsified asphalts to build knowledge base.

Work Planned Next Quarter

The following activities are planned for next quarter:

1. Development of a detailed year 2 work plan for review by FHWA and the ETGs. The work plan will address year one ETG comments.
2. Selection of materials including asphalt binder sources and grades, aggregates, and emulsions to begin testing.
3. Evaluation and refinement of proposed emulsified asphalt PG specification.
4. Upon approval of year 2 work plan begin binder testing.

CATEGORY E2: DESIGN GUIDANCE

Work element E2a: Comparison of Modification Techniques (Later start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work element E2b: Design System for HMA Containing a High Percentage of RAP Material (Year 1 Start)

Subtask E2b-1: Develop a System to Evaluate the Properties of RAP Materials

Progress This Quarter

Attended the RAP ETG meeting to establish cooperation. Contacted NCHRP (Ed Harrigan) to establish cooperation.

Work Planned Next Quarter

Conduct an organizational meeting with all participants on August 31, 2007 to develop the detailed experimental program.

Subtask E2b-2: Compatibility of RAP and Virgin Binders

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask E2b-3: Develop a Mix Design Procedure

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask E2b-4: Impact of RAP Materials on Performance of Mixtures

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask E2b-5: Field Trials

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work element E2c: Critically Designed HMA Mixtures (Year 1 start)

Subtask E2c-1: Identify the Critical Conditions

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

Conduct an organizational meeting on August 17, 2007 to develop the detailed experimental program.

Subtask E2c-2: Conduct Mixture Evaluations

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask E2c-3: Develop a Simple Test

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask E2c-4: Develop a Standard Test Procedure

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask E2c-5: Evaluate the Impact of Mix Characteristics

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work element E2d: Thermal Cracking Resistant Mixes for Intermountain States (Year 1 start)

Subtask E2d-1: Identify Field Sections

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

Conduct an organizational meeting on September 6, 2007 to develop the detailed experimental program.

Subtask E2d-2: Identify the Causes of the Thermal Cracking

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

Same as E2d-1.

Subtask E2d-3: Identify an Evaluation and Testing System

Progress This Quarter

The functionality and repeatability of data collection on the TGD (glass transition determination) instrument were investigated. Three mix types were tested, in duplicate samples, in order to check for repeatability and reliability of test results. Also two different binders were tested. The binder testing was done on both previously vacuumed and non-vacuumed samples. Readings were both automated and manual. Also measurements were taken for both PAV and RTFO samples. Based on results, it was found that the instrument to be in good working condition and the repeatability of data to be adequate. The Tg measuring instrument has great potential and, if

operated properly, can yield excellent results. However there are some improvements that could be incorporated in the instrument setup:

- Lengthening the connecting hose between the LN2 tank and the environmental chamber, so that the probability of nitrogen in liquid form entering the chamber is lessened. This will make for a better temperature control of the chamber.
- Replacement of the present heater (which is a liquid heater) with a heater similar to a space heater (the same setup used in the TA DSR environmental chamber). This will speed up the heat transfer and reduce lag due to thermal inertia.
- Building a solid sturdy (less moving parts) frame for the LVDTs. This should improve the accuracy for mix measurements and greatly reduce operator error.
- Determining the optimum heating/cooling rate so it allows enough time for thermal equilibration, especially on the mix testing where the inside of the sample has a hard time “keeping up” with the chamber temperature.
- Mount the glass tubes for the binder test setup in a permanent wall fixture. This should improve the ease of testing and operator safety.

Work Planned Next Quarter

Same as E2d-1.

Subtask E2d-4: Modeling and Validation of the Developed System

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

Same as E2d-1.

Subtask E2d-5: Develop a Standard

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

Same as E2d-1.

Work element E2e: Design Guidance for Fatigue and Rut Resistance Mixtures (Year 1 Start)

Subtask E2e-1: Identify Model Improvements

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask E2e-3. Perform Engineering and Statistical Analysis to Refine Models

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask E2e-4. Validate Refined Models

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned

Subtask E2e-5. Prepare Design Guidance

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

PROGRAM AREA: VEHICLE-PAVEMENT INTERACTION

CATEGORY VP1: WORKSHOP

Work element VP1a: Workshop on Super-Single Tires

Progress This Quarter

Identified the workshop participants in coordination with FHWA. Sent invitations to the Workshop participants and received 100% acceptance.

Work Planned Next Quarter

Continue planning for the Workshop to be held on October 25-26, 2007

CATEGORY VP2: DESIGN GUIDANCE

Work element VP2a: Mixture Design to Enhance Safety and Reduce Noise of HMA

Subtask VP2a-1: Evaluate Common Physical and Mechanical Properties of Asphalt Mixtures with Enhanced Frictional Skid Characteristics

Progress This Quarter

Work focused on performing literature review (collecting bibliography and identifying possible partners and resources).

Work Planned Next Quarter

Complete literature review as part of subtasks VP2a-1 and VP2a-2.

Subtask VP2a-2: Evaluate Pavement Macro and Micro-textures and Their Relation to Tire and Pavement Noise-generation Mechanisms

Progress This Quarter

Same as VP2a-1.

Work Planned Next Quarter

Same as VP2a-1.

Subtask VP2a-3: Develop a Laboratory Testing Protocol for the Rapid Evaluation of the Macro and Micro Texture of Pavements

Progress This Quarter

Same as VP2a-1.

Work Planned Next Quarter

Same as VP2a-1.

Subtask VP2a-4: Run Parametric Studies on Tire-pavement Noise and Skid Response

Progress This Quarter

Same as VP2a-1.

Work Planned Next Quarter

Same as VP2a-1.

Subtask VP2a-5: Establish Collaboration with Established National Laboratories Specialized in Transportation Noise Measurements. Gather Expertise on Measurements and Analysis

Progress This Quarter

Same as VP2a-1.

Work Planned Next Quarter

Same as VP2a-1.

Subtask VP2a-6: Model and Correlate Acoustic Response of Tested Tire-pavement Systems

Progress This Quarter

Same as VP2a-1.

Work Planned Next Quarter

Same as VP2a-1.

Subtask VP2a-7: Proposed Optimal Guideline for Design to Include Noise Reduction, Durability, Safety and Costs

Progress This Quarter

Same as VP2a-1.

Work Planned Next Quarter

Same as VP2a-1.

CATEGORY VP3: MODELING

Work element VP3a: Pavement Response Model to Dynamic Loads (Later start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

PROGRAM AREA: VALIDATION

CATEGORY V1: FIELD VALIDATION

Work element V1a: Use and Monitoring of Warm Mix Asphalt Sections (Year 1 start)

Progress This Quarter

Planning activities continued to sample materials and establish performance monitoring sections for the Sasobit and Aspha-Min warm mix asphalt sections and the control HMA section being placed at the East Entrance to Yellowstone National Park. This project is being constructed by FHWA Western Federal Lands.

Work Planned Next Quarter

Construction of the Yellowstone Park warm mix sections is scheduled to begin on August 20, 2007. All construction materials will be sampled and after construction is completed, two 500-foot performance monitoring sections will be established in each of the three different material sections.

Work element V1b: Construction and Monitoring of additional Comparative Pavement Validation sites (Year 1 start)

Progress This Quarter

Western Research Institute (WRI) was informed of a partnership that is being developed in Mississippi between the universities, Ergon Asphalt Products, and other industry participants to construct asphalt sections with different asphalt materials. This may be a possible location for new comparative pavement sections for validation activities.

WRI (and thus the Asphalt Research Consortium) is also involved in four sections being constructed at MnRoad that include polyphosphoric acid. The four sections are asphalt + PPA; asphalt + SBS+PPA; asphalt + SBS; and asphalt+Elvaloy+PPA. Planning activities continued to sample the construction materials during construction in late summer 2007.

Work Planned Next Quarter

Collect samples from all construction materials from the PPA sections from MnRoad. Continue contact with Ergon and Mississippi for possible construction of additional comparative pavement validation sites.

CATEGORY V2: ACCELERATED PAVEMENT TESTING

Work element V2a: Scale Model Load Simulation on Small Test Track (Later start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work element V2b: Construction of Validation Sections at the Pecos Research & Testing Center (Later start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

CATEGORY V3: R&D VALIDATION

Work element V3a: Continual Assessment of Specifications (Year 1 start)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work element V3b: Validation of the MEPDG Asphalt Materials Models Using New MEPDG Sites and Selected LTPP Sites.

Subtask V3b-1: Design and Build Sections (Start Year 1, Year 2, and Year 3)

Progress This Quarter

The AASHTO Lead States Group was contacted regarding the MEPDG to establish cooperation.

Work Planned Next Quarter

Continue contact with Lead States to design and build a MEPDG site.

Subtask V3b-2: Additional Testing (Start Year 2, Year 3, and Year 4)

Progress This Quarter

Same as V3b-1.

Work Planned Next Quarter

No work planned.

Subtask V3b-3: Select LTPP Sections (Start Year 1 thru Year 5)

Progress This Quarter

The team is currently working on the experimental design of using LTPP sites for the validation of some of the binder fatigue and rutting findings. In June during a visit to FHWA, H. Bahia discussed opportunity for collaborative work with FHWA staff. It was agreed to use ALF and LTPP field performance data to validate the results of subtasks. Work plan development is underway at the University of Wisconsin at Madison to use LTPP field performance to validate the development of findings for binder fatigue and rutting. The FHWA LTPP group will be contacted for materials procurement and data sharing. During the ETG meeting in Denver in late July, the team contacted the FHWA representative and discussed the details of this task.

Work Planned Next Quarter

Complete the detailed work plan to use the LTPP data and initiate the material and data procurement.

Subtask V3b-4: Testing of Extracted Binders from LTPP Sections (Start Year 1)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask V3b-5: Review and Revisions of Materials Models (Start Year 2, Year 3, Year 4, and Year 5)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask V3b-6: Evaluate the Impact of Moisture and Aging (Start Year 3, Year 4, and Year 5)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

PROGRAM AREA: TECHNOLOGY DEVELOPMENT

Work element TD1: Prioritize and Select Products for Early Development (Year 1)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

A Technology Development plan was presented at the Fundamental Properties and Advanced Models, Mixture and Construction, and Binder ETG meetings in Denver, CO during July 23 – 27, 2007. After the discussion during the Fundamental Properties and Advanced Models meeting, the original plan was modified to achieve agreement with all three ETG's on the process of review of potential early products. The modified plan will be conducted.

Work element TD2: Develop Early Products (Year 2)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

Same as TD-1.

Work element TD3: Identify Products for Mid-Term and Long-Term Development (Year 2, 3, and 4)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

Same as TD-1.

Work Element TD4: Develop Mid-Term and Long-Term Products (Years 3, 4, and 5)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

Same as TD-1.

PROGRAM AREA: TECHNOLOGY TRANSFER

CATEGORY TT1: OUTREACH AND DATABASES

Work element TT1a: Development and Maintenance of Consortium Website (Duration: Year 1 through Year 5)

Progress This Quarter

Developed the Consortium Website at: www.ARC.UNR.edu.

Work Planned Next Quarter

Continue updating and maintaining the Consortium website.

Work element TT1b: Communications (Duration: Year 1 through Year 5)

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

Start working on the first Newsletter of the Consortium.

Work element TT1c: Prepare Presentations and Publications

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

Presentations were made on the Asphalt Research Consortium work plans to the Fundamental Properties and Advanced Models, Mixture and Construction, and Binder ETG meetings in Denver, CO during July 23 – 27, 2007.

Work element TT1d: Development of Materials Database (Duration: Year 2 through Year 5)

Subtask TT1d-1: Identify the Overall Features of the Web Application

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask TT1d-2: Identify Materials Properties to Include in the Materials Database System

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask TT1d-3: Define the Structure of the Database

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask TT1d-4: Create the Database

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Work element TT1e: Development of Research Database (Duration: Year 2 through Year 5)

Subtask TT1e-1: Identify the Information to Include in the Research Database System

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask TT1e-2: Define the Structure of the Database

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.

Subtask TT1e-3: Create the Database

Progress This Quarter

No activity this quarter.

Work Planned Next Quarter

No work planned.