



Providing solutions to highway building materials problems

FIRST YEAR WORK PLANS

June 18 - December 25, 2007

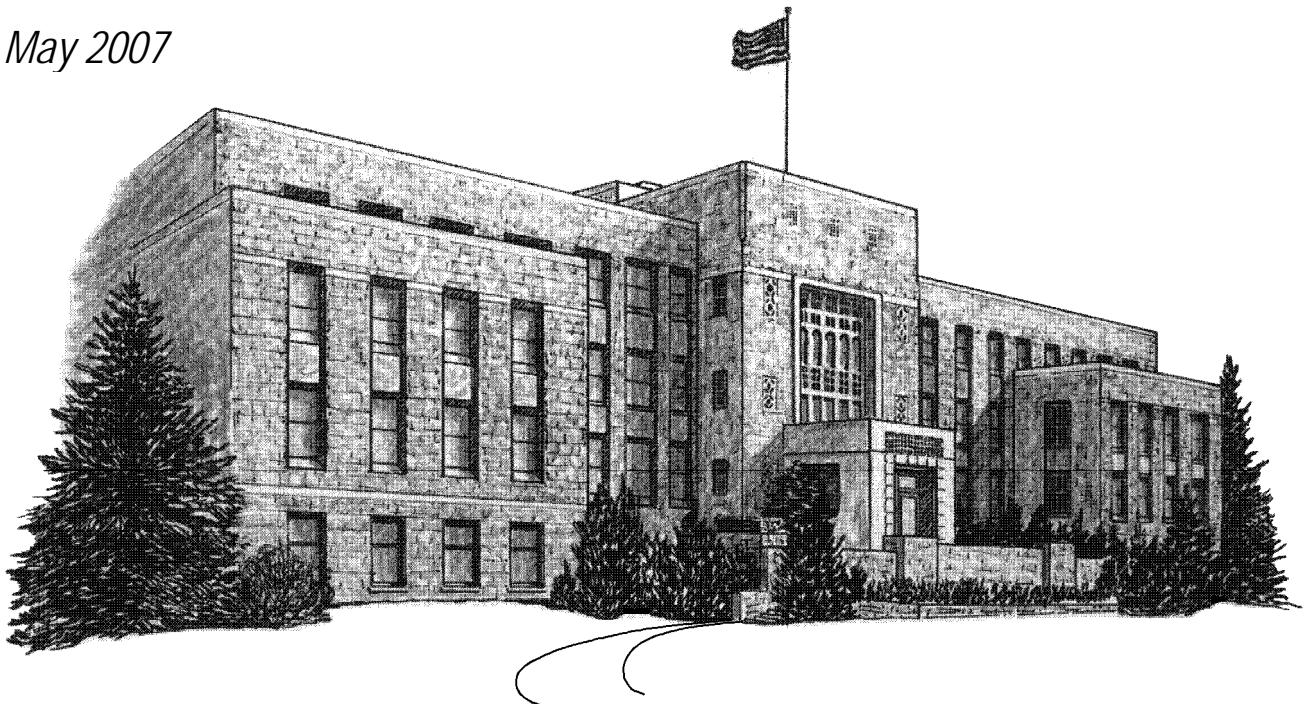
ASPHALT RESEARCH CONSORTIUM

PROGRAM AREA:

VALIDATION

*Prepared for
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**RESEARCH PLAN FOR YEAR 1 OF FEDERAL HIGHWAY
ADMINISTRATION CONTRACT DTFH61-07-H-00009
“ASPHALT RESEARCH CONSORTIUM”**

FOREWORD

This document is the proposed Research Plan for Year 1 of 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 Year 1 research plans are grouped into seven areas, Moisture Damage, Fatigue, Engineered Paving Materials, Vehicle-Pavement Interaction, Validation, Technology Development, and Technology Transfer. The format of the presentation of the work plans varies somewhat because of the different interactions of the work elements. The Moisture Damage and Fatigue areas contain work elements that are interrelated and thus will work together to advance the knowledge of mechanisms and models in these areas. In addition, there are some work elements that compliment one another by investigating a common principle using different methods. For example, in the Moisture Damage area, the principle of measuring surface energy of asphalts and aggregates is being pursued using the “macro” (or bulk) approach using the Wilhelmy plate and Universal Sorption Device for asphalts and aggregates, respectively. The surface energy of asphalts and aggregates is also being pursued using Atomic Force Microscopy at the nano scale. Using the two different methods provides a check on one another so that the true significance and importance of surface energy can be evaluated and related to performance properties. There are also examples of Modeling activities that compliment each other in a similar fashion. The Consortium members firmly believe that this approach make the research more robust.

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

Finally, the areas of Technology Development and Technology Transfer are the areas where the research deliverables will get transmitted to the user community. The Technology Development area will 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 will also transfer Consortium research findings to the asphalt community using the Consortium website, presentations, publications, and workshops.

The Asphalt Research Consortium members strongly believe that the proposed 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.

TABLE OF CONTENTS

PROGRAM AREA: VALIDATION.....	111
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PROGRAM AREA: VALIDATION

TITLE: FIELD VALIDATION

BACKGROUND

The concept of Validation may encompass several different areas. In the process of taking a fundamental scientific or engineering principle from theory to general use, there are many steps involved. Initially, the experimental process has to be developed and refined such that the experimental method can distinguish between different materials and provide useful information. As the method progresses toward development, the sample set to which the method is exposed generally expands to a much more diverse set. This expansion of the tested sample set is a form of validation. In this project, the application of a test method or procedure to a larger, more diverse sample set is considered to be development, rather than validation, although either label may be appropriate to describe this type of research activity.

Another type of Validation is the use of larger scale test facilities that incorporate a variety of materials in an accelerated loading environment. The accelerated loading is often accomplished using a large-scale load frame such as the ALF (Accelerated Load Facility) at the FHWA Turner-Fairbank Highway Research Center. Accelerated loading at larger scale facilities may also be accomplished by using full or partial scale load vehicles such as the third-scale model mobile loading simulator at Texas Transportation Institute. Some of the advantages of using larger scale accelerated facilities are that the testing is more representative of actual pavement loading compared with laboratory loading devices. The pavement materials used in larger scale loading facilities are generally produced with standard construction equipment using standard construction techniques, and the test sections may be highly instrumented in order to acquire the necessary data. As might be expected though, temperature control during testing is less precise than a laboratory setting, but the data are valuable because they are closer to real-life pavement conditions and are used to evaluate pavement performance. These sites provide a source of original materials collected at the time of construction from which physical property data and any other acquired data can be compared and used for performance prediction, a source of pavement core samples that can be tested as the pavement ages in service (although usually a short time period), a comparative assessment of the performance of different materials under accelerated loading that can be correlated with predicted performance, and sites where instrumentation devices, both new and existing, can be used to acquire pavement performance information. The Asphalt Research Consortium research team intends to use any available materials and data from larger-scale accelerated-loading test facilities in several work elements and also investigate the possibility of constructing new validation sites at accelerated loading facilities such as the Pecos (Texas) test site a collaboration between Texas Transportation Institute and industry.

Validation can also be accomplished using full-scale validation sections constructed in coordination with State Departments of Transportation (DOT's) where specification-grade materials from different sources are compared. Five of these types of sites were constructed to

date as part of the recently completed FHWA-sponsored project “Fundamental Properties of Asphalts and Modified-Asphalts II” by Western Research Institute. These sites provide exposure of the pavement to actual traffic loading and environmental conditions while being monitored annually using standard-format LTPP monitoring procedures. These sites have available a source of original materials collected at the time of construction from which physical property data can be compared and used for performance prediction, pavement core samples that can be tested as the pavement ages in service, a comparative assessment of the actual field performance of different materials that can be correlated with predicted performance, and sites where instrumentation devices, both new and existing, can be used to acquire pavement performance information. The Asphalt Research Consortium research team intends to use the existing WRI validation sites and also construct new sites in coordination with State DOT’s to validate the research findings from this project.

Two additional areas of Validation are the continual assessment of the current SuperPave[®] specifications (M320, M323, and MP8) for appropriate updates/improvements, and the implementation of the Mechanistic-Empirical Pavement Design Guide (MEPDG). The advent of the multitude of “SHRP Plus” specifications in many states that are used to measure properties that State DOT’s believe are important is the impetus that is behind the need to continually assess the current specification tests. As new methods of testing are developed by the Consortium and others to measure binder and mixture properties, the need exists to implement the best methods in a timely manner. The Consortium intends to work closely with FHWA, AASHTO, and others to keep the SuperPave[®] PG grading system up to date with the best methods. The Consortium also intends to use State DOT sites where they have implemented the Mechanistic-Empirical Pavement Design Guide (MEPDG) to validate the asphalt materials models.

HYPOTHESES

The Consortium working hypotheses for Validation are:

- Field validation sites built on public highways in cooperation with state DOT’s that have a stored supply of original materials, documented location, and monitored performance are useful and necessary for validation of methods, models, and theories developed in research programs intended to improve asphalt pavement performance.
- Field validation using accelerated loading facilities to compare performance of compositionally different materials are also useful for validation of methods, models, and theories developed in research programs intended to improve asphalt pavement performance and offer the advantage of acquiring performance data in a shorter period of time.

OBJECTIVES

- Construct comparative pavement validation sites on public highways in cooperation with State DOT’s or at accelerated loading facilities using compositionally different asphalts

and perhaps different additives such as RAP, polyphosphoric acid, lime, or liquid anti-strip.

- Collect and store sufficient material from the construction of comparative pavement sites in order to support the research activities of the Consortium and other researchers as approved by the Consortium Program Manager and the AOTR.
- Monitor the comparative validation sites annually, or more often if necessary, to document pavement performance.
- Assist State DOT's with the implementation of the MEPDG. Validation through MEPDG Sites and Revisions of the MEPDG Asphalt Materials Models
- Continually assess the SuperPave[®] PG specifications for improvements derived from Consortium or other research.

EXPERIMENTAL DESIGN

Category V1: Field Validation

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

The FHWA and FHWA Western Federal Lands is planning to construct two warm-mix asphalt sections and a hot-mix asphalt control section in a project on the road just inside the east gate of Yellowstone National Park in August 2007. It is planned for Consortium personnel to collect samples of the paving materials at the time of construction for use in the Engineered Paving Materials area and possibly other areas of research. The FHWA was not planning on annual monitoring of the sections; therefore, it is planned for the Consortium to establish two 500-foot performance monitoring sections within each different material that will be monitored using LTPP established procedures on an annual basis.

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

Western Research Institute has constructed five comparative pavement validation sites in five states where different asphalt sources (different crude sources or different blends) are compared. The five sites were built in cooperation with state DOT's under a previous contract with FHWA entitled "Fundamental Properties of Asphalts and Modified Asphalts II". The sites are located in climate areas that can be labeled cold-dry, hot-dry, and cold-wet. These sites provide a source of original materials that were collected during construction, documented performance that is recorded on an annual basis, and serve as a mechanism to validate methods, models, and procedures that are developed as part of the Consortium research.

Construction of additional sites is desirable to have a more robust variation in environmental exposure, materials, and loading. It will be most advantageous to have the new validation sites constructed as early as possible to maximize service and monitoring during the period of this contract. This effort involves planning and coordination efforts with State DOT's and

contractors. Substantially different asphalt sources also need to be identified at each new site to provide the most variability. The focus will be on projects where the different asphalt sources can be used throughout the full-depth of the asphalt pavement construction, especially on the surface. However, other types of construction, such as “mill and fill” can be acceptable provided the different asphalt sources are used on the surface. Each asphalt source will have two 500-foot performance monitoring sections that will be monitored throughout the pavement life. The 500-foot sections will be permanently marked and identified so future monitoring can provide meaningful data and samples. Sampling of all materials including: aggregate, asphalt, loose mix, and as-constructed cores will provide materials from which data can be obtained that can be used to predict pavement performance. The objective is the placement of field validation sites that are constructed using consistent engineering practices. Ideally, each site will contain four pavement sections that are constructed using asphalt binders obtained from different sources. The performance of the sites will be documented over many years of service and core samples will be obtained to evaluate the chemical, rheological, and mechanical properties as a function of service. The sites will also provide core samples that represent the changes the pavement undergoes during actual service with traffic loading and environmental exposure.

Category V2: Accelerated Pavement Testing

Work element V2a: Scale Model Load Simulation on small test track (Later start)

The Third-Scale Model Mobile Loading Simulator (MMLS3) has been successfully used by the TTI and NCSU research team to evaluate the fatigue and rutting performance of asphalt pavements under moving loads. The accurate control of temperature and loading provided by the MMLS3 and an instrumented pavement slab provides an excellent framework from which pavement response and performance models can be validated. In a recently completed research project funded by the NCDOT, the NCSU research team has demonstrated that the pavement performance under MMLS3 loading can be predicted using a set of mechanistic material and pavement models within a reasonable accuracy. In this research, the micromechanics model and the VEPCD-FEP++ model will be validated using the MMLS3. Both fatigue cracking and rutting performance will be evaluated.

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

The Pecos Research & Testing Center (RTC) is a collaboration between Texas A&M / Texas Transportation Institute and industry. The consortium will investigate the possibility of constructing comparative pavement validation sections at the Pecos RTC. The Pecos RTC is suitable for applied research testing under controlled conditions. The 5,800-acre facility has nine distinct test tracks and a full range of support facilities.

Category V3: R&D Validation

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

For the past several years the spread of the PG Plus specifications has resulted in a concern about the future of the PG system. In the Consortium research, there will be several new procedures that will be developed to measure rutting of binders, fatigue of binders, cohesion, adhesion, and other possible tests. This work element will review and evaluate concepts and test methods resulting from Consortium and other efforts and evaluate their potential for future revisions of the performance graded binder specifications (AASHTO M320), the Superpave mixture specifications (AASHTO M 323), and the SMA mixture specification (AASHTO MP8).

This work element will focus on recommendations and building consensus for a sequence of gradual changes to improve the PG system and minimize if not eliminate the empirical tests that are being used today. This work element will include visits to various state highway agencies, coordination with FHWA, the Asphalt Institute, NAPA, and other stakeholders. This work item will also include close monitoring of the development of specifications in Europe and leveraging the evaluation and reviews done by the technical teams of the European Specification Harmonization project.

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

Background

The mechanistic-empirical pavement design guide (MEPDG) has been recently developed to conduct structural designs for flexible and rigid pavements. The MEPDG uses a mechanistic approach that is empirically calibrated using field performance data to establish the required structural section for a given set of loading, materials, and environmental conditions.

The structural design for flexible pavements conducted through the MEPDG is based on the long term performance of such pavements in rutting, fatigue, and thermal cracking. The constructed pavement is supposed to perform according to the design criteria established during the structural design process.

Several state highway agencies are currently in the process of implementing the MEPDG. These implementation efforts necessitate the design of flexible pavements using the guide and monitoring their long term performance to calibrate the mechanistic models based on the localized conditions. The MEPDG-designed and monitored flexible pavements represent an excellent opportunity for the Consortium to cooperate with the state agencies at two distinct levels: validation of the Consortium's research activities and updating of the fundamental models used by the MEPDG based on the Consortium's research activities. When coordination is done at the design stage the validation of current models, and the revisions for these models that could come out of the consortium research, would be more effective.

In addition to the new sites, the LTPP program has a large number of sites that could be used for early verification of the technologies that are in advanced stages of development by the Consortium research members or by other researchers for improvement of specifications and design guidelines. For example the binder tests that are being proposed for modified binders, the methods for measuring adhesion and cohesion, the binder fatigue tests, and others. These technologies are either already ready for validation or are very close to being ready. Using selected sites from the LTPP program for which excellent performance or premature failures have been observed could expedite the process of technology development and provide means for deriving specification limits or guidelines. The LTPP data base can serve as basis for early validation because sections included in the data base have had several years of traffic and aging.

Hypothesis

The performance of the MEPDG designed flexible pavements coupled with the data generated by the Consortium research activities can be effectively used to validate the research findings of the Consortium and to update the models used in the MEPDG. In addition, some of the existing LTPP sections can be used for early validation of the recently developed tests and properties.

Objectives

The objectives of this task are to cooperate with state highway agencies to design and construct flexible pavements using the AASHTO MEPDG. Also, to cooperate with the LTPP program to make use of selected performance and materials of selected sections. The constructed sections and the LTPP selected sections will be used to validate the findings of the research activities of the Consortium and to evaluate the models used in the MEPDG for possible revisions. The recommended revisions, if needed, will be based on new testing procedures proposed by the Consortium research.

Experimental Design

In order to achieve the objectives of this research effort, the following subtasks will be completed.

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

This task will solicit state highway agencies that are willing to cooperate on designing and constructing flexible pavement sections using the AASHTO MEPDG. The solicited agencies will cover the various regions of the U.S.

This task will cooperate with the selected state agencies to design and build MEPDG sections. UNR will assist the agencies with the design of the sections using the MEPDG and will conduct the necessary testing for strength properties, fatigue, rutting, and thermal cracking. The agencies will construct the sections as designed. It is anticipated that a total of 25 sections will be constructed throughout the duration of the research. The sources and properties of the materials will be incorporated into the Materials Database.

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

This task will sample materials during the construction of the sections and will conduct additional testing on the field mixtures that will be used to validate the models generated from the consortium research activities. This task will be conducted by researchers from UNR, AAT, and UWM. Each member will conduct the necessary tests to validate their research efforts. The long-term performance data of the sections will be collected in cooperation with the owner agencies and used to validate the models/tests that will be developed throughout the research. For the LTPP sections, the samples stored in the materials' library will be used.

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

This subtask will be focused on screening the available sections for which noticeable good or poor performance have been recorded. Also, sections for which sufficient materials have been saved to allow binder and mixture testing. The sections will cover various climatic and traffic conditions and preferably include modified binder grades and variety of mixture types. The scope of the task cannot be estimated at this stage but an attempt will be made to have significant number of sections for each type of pavement failure and in particular rutting, fatigue, and moisture damage. A work plan will be developed based on the test methods and the models that need to be validated. The main focus will be on models or test methods that are intended for filling some gaps in the specifications or the MEPDG models. The screening activity, if not covered by the LTPP program will be conducted by individual consortium partners based on the specific tests or models that they intended to validate. UNR will focus on the low temperature thermal cracking and UW-M will focus on new binder rutting and fatigue testing. Every effort will be spent to coordinate the activities among consortium members and with LTPP. The binder rutting and fatigue validation will start in year 1.

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

This subtask will be focused on testing extracted binders using the DSR and BBR as required for the current PG grading system with the objective of integrating the new data in the LTPP database and thus enhance the information about the relationship between the PG grading and actual pavement performance. During the first year, the Consortium will work with the FHWA LTPP Team to identify the materials that will be tested and establish protocols for data transfer. Actual testing of materials will begin in Year 2 and continue through the middle of Year 4.

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

The first part of this task will review all past and current activities on the revisions and modifications of the materials models that are included in the MEPDG. Also, the proposed changes in binder specifications, the Superpave plus specifications, and mixture design practices will be reviewed and a report for defining the "gaps" will be issued. Based on these reviews, the researchers will identify any additional modifications or revisions that maybe needed.

For example, the equations used to determine the dynamic modulus (E^*) from the binder properties will be validated for polymer-modified binders. The perceived shape of the E^* Master Curve may vary significantly when it comes to polymer-modified mixtures. Using the testing data from Tasks 1, 2 and 3, the research team will evaluate the prediction equations and E^* Master curves and modify them to accommodate polymer-modified binders and mixtures. Another example is the evaluation of the Superpave-plus binder specifications and the need for the elastic recovery test or the MSCR test. Using the pavement performance data from the LTPP sites and the laboratory test results of mixtures for the new MEPDG sections, an assessment of the value of these tests and their relationship to performance could be determined.

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

This task will evaluate the effects of moisture and aging on materials properties used in the MEPDG and the LTPP sections. This will lead to recommendations for revisions of models if needed based on our fundamental research results. The revised models could include cohesion, adhesion, trends in aging with effect of mineral surface, etc....

Researchers from UNR, AAT, UWM, and WRI will examine the aging models currently used in the MEPDG and identify the need for any modifications.

The current MEPDG does not incorporate the impact of moisture damage on the properties of the HMA materials. Also it has a good aging model that is based on changes in viscosity and could be modified to include some more fundamental properties. Also, the existing binder and mixture specifications having aging models based on the RTFO, which is not useful for many modified asphalts. In this task, researchers from UNR, AAT, UWM, and WRI will assess the gaps in the models and specifications and the need to revisions for aging models and the need to incorporate the impact of moisture damage on the properties and behavior of HMA mixtures in models of the MEPDG and in materials specifications.

YEAR 1 PROJECT DIRECTION

The first year project direction is to begin work on Work elements V1a, V1b, V3a, and V3b.

SCHEDULE

Activity	Year 1	Year 2	Year 3	Year 4	Year 5
Work element V1a	X	X	X	X	X
Work element V1b	X	X	X	X	X
Work element V2a			X	X	
Work element V2b			X	X	
Work element V3a	X	X	X	X	X
Subtask V3b-1	X	X	X		
Subtask V3b-2		X	X	X	
Subtask V3b-3	X	X	X	X	X
Subtask V3b-4	X	X	X	X	
Subtask V3b-5		X	X	X	X
Subtask V3b-6			X	X	X

RELATIONSHIP TO FHWA FOCUS AREAS

The Validation work elements support the FHWA Focus Area of Optimizing Pavement Performance by providing a relationship between material property variation and pavement performance in order to validate laboratory tests, performance models, and methods.

BUDGET

The budget for all of the work elements in the Validation area is estimated to be \$5.08M over the five years of the project but is subject to the number of projects identified and completed.

