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Implementation of the Asphalt Mixture Performance Tester for Superpave Validation

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BACKGROUND INFORMATION

The majority of state highway agencies have implemented the Superpave volumetric mix design process created during the Strategic Highway Research Program (SHRP) as part of their system for designing Hot Mix Asphalt (HMA) mixtures. However, at the conclusion of SHRP no test was available that provides information on the probable performance of asphalt mixtures designed using Superpave volumetric mix design. State highway agencies, as well as industry, have expressed the need for simple load tests to use during the mix design process and in field quality control to evaluate permanent deformation and fatigue cracking of Superpave-designed HMA.

The Federal Highway Administration (FHWA) and the National Cooperative Highway Research Program (NCHRP) sponsor research to develop and validate advanced materials characterization models and related laboratory testing procedures for HMA. NCHRP Project 9-19 *Superpave Support and Performance Models Management* included the development of simple performance tests for permanent deformation and fatigue cracking to be incorporated in the volumetric mixture design process. The following three tests were recommended to evaluate permanent deformation of asphalt mixtures: dynamic modulus (E^*) using the triaxial dynamic modulus test, flow time (F_t) using the triaxial static creep test, and flow number (F_n) using the triaxial repeated load test. The dynamic modulus at intermediate temperatures is recommended for fatigue cracking and a separate test, the indirect tensile creep test, is recommended for low-temperature cracking.

As part of NCHRP Project 9-29 *Simple Performance Tester for Superpave Mix Design*, a Simple Performance Tester (SPT) designed to conduct all three tests recommended by NCHRP 9-19 was procured and evaluated for use in Superpave mix design and in HMA materials characterization for structural design. NCHRP 9-29 concluded that the Simple Performance Tester (SPT) is a reasonably priced, user-friendly device for testing stiffness and permanent deformation properties of asphalt concrete, however it should be noted that the capabilities of the SPT are limited compared to the specifications of NCHRP 9-19 and standards have been revised accordingly. The performance of the SPT protocol, which includes dynamic modulus, flow number and flow time, has been evaluated in laboratory studies using Long Term Pavement Performance (LTPP) program data and in field tests using accelerated pavement testing facilities. Data from all three simple performance tests have been shown to correlate well with observed rutting in field pavements (NCHRP 9-29). The next step is to get the SPT in the hands of highway agencies, train technicians to properly use the device, and evaluate the device's ability to assess performance of asphalt mixes designed using the Superpave volumetric mix design method.

<ins>Supporting Documents</ins>

NCHRP Report 465 *Simple Performance Test for Superpave Mix Design*

NCHRP Report 567 *Simple Performance Tests: Summary of Recommended Test Methods and*

Database

NCHRP Report 513 *Simple Performance Tester for Superpave Mix Design: First-Article Development and Evaluation*

NCHRP Report 530 *Evaluation of Indirect Tensile Test (IDT) Procedures for Low-Temperature Performance of Hot Mix Asphalt*

AASHTO TP62 *Standard Method of Test for Determining Dynamic Modulus of Hot-Mix Asphalt Concrete Mixtures*

OBJECTIVES

This pooled fund study is open to any highway agency interested in using simple performance tests to aid in material characterization for design and analysis of flexible pavements.

The objectives of this pooled fund study are to:

(i) nationally procure the SPT for highway agencies interested in obtaining and using the SPT to characterize asphalt mixtures designed using Superpave technology;

(ii) provide support in training technicians to use the SPT to perform the proposed standard practices for measuring dynamic modulus, flow number and flow time of asphalt mixtures compacted using the Superpave Gyratory Compactor (SGC); and

(iii) evaluate the nation-wide implementation and use of the SPT for assessing performance of asphalt mixtures over a wide range of climatic conditions, materials, and structures.

SCOPE OF WORK

A Technical Advisory Committee (TAC) will be established to provide oversight and guidance for the project. Each project partner may appoint a representative to serve on the TAC. In addition, technical experts in SPT development, equipment, and Superpave technology implementation will be invited to serve on the TAC. Throughout the project the TAC will oversee the implementation of the SPT and review project progress reports, annual and final reports. This will be accomplished via electronic and telephone-based communication as much as possible; however periodic meetings are required.

It is anticipated that the implementation process will encompass the following tasks:

1. Conduct a workshop with the TAC to:
   (i) review findings and protocols developed in NCHRP 9-29;
   (ii) conduct a meeting with manufacturers of the SPT to discuss requirements and cost estimates;
   (iii) develop a “request for proposals” document which specifies requirements for the SPT, related equipment and services;
   (iv) prepare objectives and draft work plan(s) for task studies (Tasks 3 & 6);
   (v) prepare an outline of necessary topics to include in the national training course.

   The workshop may require multiple days or multiple, separate meetings may be required.
2. Solicit proposals from manufacturers of the SPT that meet all necessary requirements specified in Task 1(iii). At a minimum the manufacturers will provide the SPT and all necessary equipment and software, calibrate the device, provide technical support and

service, and initially train highway agency technicians on using the SPT and provided software. Based on the proposals received, FHWA will procure a limited number of SPTs from multiple manufacturers. The SPTs will be delivered to laboratories chosen by the TAC to verify that they are compliant (i.e. properly calibrated, operate according to manufacturer instructions, etc.).

3. Conduct precision and bias experiments for developing dynamic modulus curves for HMA concrete using the SPT system. During Phase V of NCHRP 9-29, ruggedness and equipment effect experiments were conducted on SPTs. The future Phase VI of NCHRP 9-29 involves conducting an interlaboratory study for the SPT. This task will be a cooperative effort between selected participating agencies and the research team conducting Phase VI of NCHRP 9-29.
   3.1. The TAC and members of NCHRP 9-29 panel will hold a meeting to draft work plans to conduct an interlaboratory study. If possible, at least six laboratories will be chosen to participate in a round robin study to determine precisions and bias statements for dynamic modulus, flow number and flow time tests. A detailed laboratory schedule of experiments and materials will be prepared;
   3.2. Participating agencies may be required to provide materials such as binder, coarse and fine aggregate, and mixture design information such as gradation and other information to be selected. Prepare specimens and conduct experiments for dynamic modulus, flow number and flow time test methods on Superpave designed and gyratory compacted specimens. FHWA will issue task order contracts to conduct the task studies;
   3.3. Collect data and perform statistical analyses according to ASTM E 691 *Standard Method of Test for Conducting an Interlaboratory Study to Determine the Precision of a Test Method* and ASTM C 670 *Standard Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials*;
   3.4. Prepare final task report that summarizes findings, provides precision and bias statements, and recommends any necessary changes in the SPT protocol.
4. Procure and implement the SPT for participating agencies.
   4.1. A SPT will be delivered to, installed, and calibrated at each participating agency by one of the selected vendors;
   4.2. The vendor will provide instruction in setting up and operating the SPT including the use of software;
   4.3. Practical issues associated with implementation of the SPT and proposed standard practices will be solicited from participating organizations. This information will be summarized in the final study report and made available to other highway agencies.
5. Develop a training course to provide highway agency personnel a better understanding of the proposed standards, procedures, and requirements associated with the SPT.
   5.1. A workshop will be held between the TAC and representatives from the Transportation Curriculum Coordination Council (TCCC), a partnership between FHWA, state DOTs, and highway industry, to provide an outline of the necessary curriculum for the training course. At a minimum, the course curriculum will include information on SPT calibration and tuning (load cell, signal quality, process control, etc.), specimen preparation, determination of air void content, storage of specimens, test result data quality, as well as procedures for generating information on performance of HMA mixtures. The best manner(s) for offering training, which may include web- and video-based training tools, will be determined.

5.2. Proposals will be solicited by interested organizations and a contractor chosen by FHWA and the TAC to develop and administer the course.
5.3. The TAC will evaluate all training materials and provide guidance and oversight to the contractor throughout course development.

6. Conduct experiments to showcase the correlation between characterization of HMA materials using the SPT and criteria for permanent deformation and fatigue evaluation. There are criteria available to evaluate permanent deformation using dynamic modulus (NCHRP 9-29) and flow number (NCHRP 9-33) results. The following sub-tasks will be further defined in the work plan developed by the TAC;
   6.1. Obtain HMA mixtures with varied degrees of field performance from state DOTs in different regions of the country. Participating agencies may be required to provide materials such as binder, coarse and fine aggregate, and mixture design information such as gradation and other information to be selected;
   6.2. Plan and conduct experiments for performing dynamic modulus, flow number and flow time experiments on Superpave designed and gyratory compacted specimens. The results of the experiments will be used to enhance and validate criteria for mixture design. FHWA will issue task order contracts to conduct the task studies;
   6.3. Collect data and perform statistical analyses. The results from Task 6.2 may be compared with results from other established tests and field performance observations such as distress measurements, etc. Measured responses may be used to relate laboratory results from mixture design to structural design using measured responses as input into the Mechanistic-Empirical Pavement Design Guide (MEPDG);
   6.4. Prepare final task report that summarizes findings and any necessary improvements to criteria for mixture design.
7. Prepare final report which will summarize:
   - all progress, annual, and final task reports;
   - issues raised during the implementation phase (Task 4);
   - conclusions, recommendations for future research and implementation studies; and
   - will include the final test protocols and standards.

IMPLEMENTATION AND PAYOFF

Simple performance tests are a quick, economical, and effective method for assessing performance of HMA mixtures designed using the Superpave system. The test methods utilized by the SPT supplement existing test methods and performance prediction models and may replace existing, less accurate tests resulting in tremendous cost and time savings. Further, the SPT is applicable in a variety of climates and to different materials, thus alleviating the need for extensive calibration procedures. The responses measured by the SPT are used not only to evaluate resistance to permanent deformation during the design process, but will also play a key role in quality acceptance and control of HMA mixtures in the field. In addition, the dynamic modulus determined by the SPT is an input in the MEPDG (NCHRP Project 1-37A) for structural design of flexible pavements. Currently the MEPDG is being implemented across the nation and the acquisition of a device such as the SPT that can more easily provide dynamic modulus data will result in long-term cost savings.

As part of the long-term plan for implementing the Superpave mix design system, the SPT should be demonstrated on a national basis. A cooperative effort by highway agencies to implement the SPT will allow for communication and information dissemination among agencies and increased knowledge regarding the use of SPT for mixture design, performance assessment, and structural design. It is anticipated that buying equipment in bulk and a coordinated training workshop will result in cost savings to the individual highway agencies.

DELIVERABLES

- Development of precision and bias statements for AASHTO proposed standards;
- Implementation of the SPT and related equipment to participating agencies;
- Development and delivery of a training course for SPT; and
- Public dissemination of results through peer-reviewed publications, conference proceedings, and final report(s).

BUDGET AND PROJECT TIMELINE

Each state is asked to contribute a minimum of $105,000 which may be transferred over a three year period.

Cost estimate for SPT Transportation Pooled Fund Study

Number of states participating = *x*

Estimated costs	Dollars ($)/participant			Fixed cost ($)	
Task 1 - Technical Advisory Committee					
Meeting costs (6 meetings x $200)				$	1,200
Travel costs (6 meetings x $1500/person)	$	9,000	*x*		
Task 2 & 4 - SPT equipment and associated costs*	$	75,000	*x*		
Task 3 - Precision and bias study				$	100,000
Task 5 - Training course development and delivery**				$	385,000
Travel for study participants to course	$	3,000	*x*		
Task 6 - Permanent deformation/fatigue study				$	200,000
Task 7 - Preparation and distribution of deliverables				$	50,000
Other costs (fees, etc.)				$	10,000
TOTAL Fixed Cost				**$**	**746,200**
TOTAL Cost/Participant			**+**		**$87,000**
Assume 50 states participate			*x* =		50
TOTAL Project Cost				**$**	**5,096,200**

Estimated project duration: 36 months

Task	Description	2008				2009				2010			
		1	2	3	4	1	2	3	4	1	2	3	4
1	TAC Workshop	■											
2	Equipment selection	■	■										
3	Precision and bias study			■	■	■							
4	Equipment implementation				■	■	■	■					
5	National training course				■	■	■	■	■	■	■		
6	Permanent deformation study				■	■	■	■	■	■	■		
7	Final report preparation										■	■	■