August 10, 2001

Mr. John C. Horsley
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Mr. Vincent F. Schimmoller
Deputy Executive Director
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Dear Mr. Horsley and Mr. Schimmoller:

This is the sixth letter report of the Transportation Research Board's Superpave Committee. The Superpave® system of asphalt paving materials selection and mixture design was initially an outcome of the Strategic Highway Research Program (SHRP). The American Association of State Highway and Transportation Officials and the Federal Highway Administration are engaged in a joint effort to further develop and deploy the Superpave system among transportation agencies. Throughout its existence, the SHRP was guided by a tripartite arrangement among the FHWA, AASHTO, and the National Research Council (NRC). By mutual agreement of the three parties, the NRC, through its TRB Superpave Committee, will continue to provide advice and assistance on the conduct of the Superpave deployment and development program.

The sixth meeting of our committee was held on May 14 and 15, 2001. The focus of this meeting was review of the current status of the overall Superpave deployment program, including progress toward completing the long-range plan for deployment. The committee also discussed potential research problem statements that may be recommended for the National Cooperative Highway Research Program (NCHRP) and Federal Highway Administration FY 2003 programs. The committee also continued discussion on several items reported in my letter of November 27, 2000. These discussions and related committee recommendations are summarized below. I have enclosed a committee roster (Appendix 1) that indicates those members in attendance at this meeting. The recommendations included in this letter report were developed in closed sessions held on May 14 and 15th.

The meeting was the first for five new committee members. These new members are:

- Dr. David A. Anderson, Professor, Pennsylvania State University
- Mr. Jed S. Billings, President, FNF Construction, Inc., Tempe, AZ
- Dr. John E. Haddock, Asst. Professor, Purdue University

Mr. Dean C. Weitzel, Chief Materials Engineer, Nevada Dept. of Transportation
Mr. J.T. Yarnell, Chief Engineer, Missouri Dept. of Transportation.

REVIEW OF CURRENT STATUS

In reviewing the current status of the program, the committee heard reports on program activities from FHWA and NCHRP staff, the Mixture and Aggregates Expert Task Group (ETG), and the Asphalt Binder ETG. The committee also heard reports from AASHTO staff regarding adoption of Superpave-related standards by the AASHTO Highway Subcommittee on Materials. In general, the Committee is very pleased with progress on all projects. Both NCHRP- and FHWA-administered projects are showing rapid progress, and the goals that we set in our long-range plan seem increasingly within reach. Significant progress has been shown in the following key areas:

- accommodation of recycled asphalt pavement in the Superpave system
- resolution of the "Restricted Zone" aggregate gradation requirements
- improved specifications and test protocols for modified asphalts
- improved test methods for fine aggregate angularity
- development work on the "simple" performance tester
- integration with the FHWA Integrated Climatic Model.

Increasingly the Superpave system has been adopted into the general engineering practices for hot-mix asphalt design and construction. In consequence, the deployment of the system has also progressed. As was reported in our meeting, a survey of state departments of transportation conducted by the New York State DOT and the FHWA indicated that, in 2000, over 50% of all state asphalt paving projects used Superpave mix designs. Continued research will resolve outstanding design and specification issues and further extend the deployment of the Superpave system.

SUPERPAVE PROJECTS PROPOSED FOR FISCAL YEAR 2002

NCHRP staff reported that, pending approval by the AASHTO Board of Directors, eight of the nine research problem statements recommended in our last letter report have been accepted into the NCHRP annual work program for fiscal year 2002.

Resolution of outstanding concerns about the consensus aggregate standards is crucial to the continued deployment of Superpave. We were particularly pleased to note, therefore, that the research problem statement "Improved Test Methods for the Determination of Critical Shape Factors for HMA Aggregates" has been included in NCHRP Project 4-30, <u>Improved Testing Methods for Determination of Critical Shape/Texture Factors for Aggregates</u>. We were also pleased to see that NCHRP will pursue additional research on moisture susceptibility of asphalt-aggregate mixtures and a synthesis of research on the effects of aggregate properties on Superpave-designed asphalt mixes. Last year, our Expert Task Group on mixtures and aggregates expended considerable energy on identifying unresolved aggregate issues that might inhibit continued deployment of Superpave. This proposed research should address major issues identified by the ETG.

SUPERPAVE SOFTWARE

Dr. Anthony Kane, AASHTO's Director of Engineering and Technical Services, briefed the committee on the current status of the AASHTO Superpave software. This software package, introduced in January 2000, was the culmination of a decade of development under the sponsorship of AASHTO, FHWA and the NRC. The intended purpose of the software was to ease the deployment of the Superpave system by providing a largely automated design computation system. The software would also ensure that the underlying principles of the Superpave system are being applied uniformly by all system users.

Unfortunately, Dr. Kane reported that license sales for the software have been very disappointing and AASHTO has decided to suspend licensing, technical support, and product maintenance as of June 30, 2001. Dr. Kane reported that AASHTO had already sustained losses of $211,000 in software development and support. The decision to suspend sales and support was taken to stem further losses. While the committee found this news disappointing, the need to limit further financial loss is obvious and no objection was raised.

I have appointed an ad hoc task group of committee members to work with staff to consider several issues related to further development or disposition of the software. These include:

- current usage and current problems
- merits of release to the public domain
- potential unintended consequences of public release
- relationship to anticipated, emerging software products from other asphalt research projects.

The committee has also asked TRB staff to establish if there are any intellectual property rights held by individuals or organizations that might inhibit future disposition of the software. We have also asked staff to determine if public distribution might adversely affect protection of the registered Superpave trademark currently held by the National Academy of Sciences. The committee will take up discussion of the future of the software at our next meeting.

CALIBRATION AND COMPARISON OF GYRATORY COMPACTORS

The widespread availability and use of Superpave gyratory compaction devices is a mark of the success of Superpave deployment. Increasingly these devices are being used for quality control and quality assurance purposes in asphalt pavement construction. Occasionally a dispute arises between an agency and a construction contractor as to whose device is "right" if the bulk specific gravity of specimens prepared with different devices varies unacceptably. Often the difference is attributed to mechanical problems with one of the devices or to incorrect calibration of the internal angle of gyration. At the request of FHWA, we have investigated this issue with the aid of our Expert Task Group on Mixtures and Aggregates.

We find that currently there is no standard calibration procedure that permits unequivocal comparison of devices in such circumstances. If devices of different manufacturers are involved, the issue is more complex as each manufacturer uses unique calibration procedures. We also note that differences may arise due to procedural errors unrelated to the mechanical condition or calibration of the gyratory compaction devices. Parties to such disputes should ensure that all possible procedural errors have been eliminated before focusing on device calibration or condition as the root cause of specimen variation. Toward this end, we have reviewed a draft "Standard Practice for the Evaluation of Different Superpave Gyratory Compactors Used in the Design and Field Management of Superpave Mixtures" proposed by the ETG. We forward this draft standard practice (enclosed as Appendix 2) to you with our recommendation that it be considered by the AASHTO Highway Subcommittee on Materials.

Eliminating procedural errors associated with preparation of Superpave Gyratory Compactor specimens will reduce the potential for disputes among agencies and construction contractors. It does not, however, resolve the essential problem. Inevitably disputes will arise that are traceable to mechanical differences in compaction devices. FHWA has been researching a technology to directly compare the internal angle of gyration of different devices. This Angle Validation Kit (AVK), as this technology is known, shows promise to solve the problem. While the AVK is not yet ready for general use, the committee encourages the FHWA to continue the research.

In closing, I can report that the committee is generally pleased with recent progress in the deployment of the Superpave system. Every innovative engineering technology, no matter how valuable, must be accommodated within a greater pre-existing engineering system. Superpave is no exception. Recent research sponsored by AASHTO through the NCHRP and by the FHWA has resolved many of the problems inhibiting the accommodation of Superpave within the standard engineering practices of hot-mix asphalt pavement construction. Recently initiated projects and those approved for the fiscal year 2002 program of the NCHRP will carry the process forward. We believe that the goal of complete fusion of Superpave with standard engineering practice is in sight. We do not want to underestimate the difficulties that may be encountered in the final fusion process; but, through the mutual efforts of AASHTO, FHWA and TRB, most of the needed research findings will soon be in place.

Sincerely,

Joseph A. Mickes, Chairman
TRB Superpave Committee

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Appendix 2

Standard Practice for
The Evaluation of Different Superpave Gyratory Compactors (SGC's) Used in the Design and the Field Management of Superpave Mixtures

AASHTO Designation: TP XX-01[1,2] **(DRAFT – May 15, 2001)**

[1] Proposed by the TRB Mixture/Aggregate ETG in April of 2001.

[2] Recommended by the TRB Superpave Committee, May 15th, 2001

Appendix 2

Standard Practice for
The Evaluation of Different Superpave Gyratory Compactors (SGC's)
Used in the Design and the Field Management of Superpave Mixtures
AASHTO Designation: TP XX-01[3,4] **(DRAFT – May 15th, 2001)**

1. Scope

1.1 This method covers the procedure for evaluation of different SGCs used in the design and the field management of Superpave mixtures. SGCs shall satisfy AASHTO PP35 and shall be operated according to AASHTO TP4. Evaluation of SGCs should include the SGC used for mix design evaluated with the SGC used for production quality control (QC) and the SGC used for production quality acceptance (QA). The evaluation will assist in the identification of within procedure differences that may impact the field management of asphalt mixes.

1.2 *This practice may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.*

2 Referenced Documents

2.1 AASHTO Standards (Note: Update to reflect current AASHTO designations)

MP1	Specification for Performance-Graded Asphalt Binder
MP2	Specification for Superpave Volumetric Mix Design
TP4	Method for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the SHRP Gyratory Compactor
PP28	Practice for Designing SUPERPAVE™ of Hot Mix Asphalt (HMA)
T166	Bulk Specific Gravity of Compacted Bituminous Mixtures (Method A)
T209	Maximum Specific Gravity of Bituminous Paving Mixtures
PP35	Practice for Evaluation of Superpave Gyratory Compactors (SGCs)

3. Summary of Method

3.1 This method is intended to provide a uniform process to assist in the identification of within procedure differences that may impact the field management of asphalt mixes.

3.1.1 If differences are attributed to mechanical differences in SGCs, a supplemental offset procedure is provided.

3.2 The design, QC, and/or QA SGCs shall be evaluated. All SGCs shall satisfy AASHTO PP35 and shall be operated according to AASHTO TP4.

3.3 Laboratory prepared or production mix shall be utilized in the evaluation.

3.4 Documentation of within procedure differences and assessment of compacted specimens shall be utilized in the evaluation.

3.5 The evaluation shall be conducted in two phases. The initial evaluation shall use multiple operators and existing within procedure handling practices. The second phase, if required, shall utilize a single operator and consistent, within procedure handling practices. One laboratory shall be used in the determination of the compacted bulk specific gravities of the gyratory specimens.

4. Significance of Use

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[3] Proposed by the TRB Mixture/Aggregate ETG in April of 2001.

[4] Recommended by the TRB Superpave Committee, May 15th, 2001

4.1 SGCs fabricated according to AASHTO TP4 and satisfying AASHTO PP35 create cylindrical specimens from loose, hot mix asphalt (HMA) through a gyratory (kneading) effort. AASHTO PP35 ensures that different manufacturer models of SGCs are statistically comparable based upon a single laboratory, single operator evaluation. However, within procedure differences may impact the comparability of SGCs. In addition, variability within the manufacturing process may result in mechanical differences in SGC performance.

5. Responsibilities Specific to the Standard

The laboratories used in the evaluation are identified in the following sections.

5.1 Mix Design Laboratory - Based upon the contract document, the Superpave mix design can be conducted by the specifying agency, contractor, or private consultant.

5.2 Field Quality Control Laboratory - QC testing is performed by the contractor to ensure the quality of the production process. QC results are not used in the acceptance of production mixes.

5.3 Field Quality Acceptance Laboratory - QA testing is required by the specifying agency for the acceptance of production mixes. Based upon the contract document, QA testing can be conducted by the specifying agency, contractor, or private consultant

5.4 Independent Quality Assurance Laboratory (IQAL) - Based upon the contract document, an IQAL may be employed to arbitrate differences in contractor and specifying agency results. Typically the IQAL is a private consultant or a different specifying agency laboratory.

5.5 The actual operator responsible for each laboratory shall be used in the initial phase of the evaluation.

6. Procedure: Phase I - Initial Evaluation

6.1 The specifying agency shall identify the laboratories to be included in the evaluation.

6.2 Prior to compaction of any specimens, each operator shall verify the SGC calibration according to AASHTO TP4.

6.3 Evaluation mix shall conform to one of the following sections.

6.3.1 <u>Laboratory Prepared Mix</u>: A mix similar to the anticipated production mix should be used. The mix should use the same asphalt binder anticipated for production. One laboratory shall prepare sufficient mix for four (4) SGC specimens per each evaluation SGC compacted to 115 mm in height and 150 mm in diameter.

6.3.1.1 The mixing temperature shall be according to AASHTO PP28.

6.3.1.2 The laboratory prepared mix shall be short-term aged according to AASHTO PP2. The alternative 2-hour procedure should be used if it was employed in the original mix design.

6.3.2 <u>Plant Produced Mix</u>: A mix similar to the anticipated production mix should be used. The mix should use the same asphalt binder anticipated for production. One sample shall be taken from a production haul vehicle, according to AASHTO 168, of sufficient size to fabricate four (4) SGC specimens per each evaluation SGC compacted to 115 mm in height and 150 mm in diameter.

6.3.2.1 The production mixing temperature shall be recorded and compared to the recommended mix temperature specified in AASHTO PP28.

6.3.2.2 No short-term aging is required of plant produced mix.

6.3.2.3 Logistics of the SGCs may result in the cooling of mix samples prior to compaction. The cooling and reheating of asphalt mixes can affect the measured volumetrics. Reheating of mix is not part of mix design, as specified in AASHTO PP28. The laboratory prepared or production mix shall be split and provided to each laboratory. Any differences in handling shall be recorded. If possible an observer, from either the specifying agency or contractor, should assist in recording any within procedure differences.

6.3.2.4 The mix shall be brought up to the required compaction temperature specified in AASHTO PP28. This can be performed in either the SGC mold or in a pan. The actual method employed by each laboratory and operator shall be recorded. In addition, the make and model of the oven used shall be recorded.

6.3.2.5 Four (4) SGC specimens shall be compacted in each SGC according to AASHTO TP4 to the design number of gyrations (N_{des}) anticipated for the production mix. Each individual operator shall perform the compaction and bulk specific gravity (G_{mb}) of the specimens.

7. Reporting

7.1 Phase 1: Initial Evaluation - The results of each laboratory shall be compiled as follows in Table 1.

7.2 The sample average ( ) and sample standard deviation (s) shall be calculated based on the four (4) compacted specimens' bulk specific gravity and SGC height data according to equations 7.3 and 7.4.

7.3 Sample average,

$$\overline{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

Where n is the number of specimens (4). Report the average to three (3) significant digits.

7.4 Sample standard deviation,

$$s = \left(\frac{\sum_{i=1}^{n} (\overline{x} - x_i)^2}{n-1} \right)^{0.5}$$

Report the standard deviation to four (4) significant digits.

7.5 The sample standard deviations for the various compaction levels for each laboratory should be within the typical values indicated in Table 2.

Table 2. Typical Standard Deviations for Bulk Specific Gravities of Specimens Compacted in the SGC.

SGC Compaction Level	Typical Standard Deviations
N_{ini}	0.008
N_{des}	0.006

Note 1: Values for tables 2 & 3 are based on four (4) specimens.
Note 2: Values are based upon an analysis of 20 production mixes from HMA plants located throughout the United States. Data was conducted as part of FHWA Demonstration Project No. 90, "Superpave Asphalt Mix Design & Field Management." Ninety-eight percent (98%) of the production data analyzed is within the above typical standard deviations, + 2s.

7.6 The absolute difference of the averages ( ) between of any two laboratories should be within the typical values indicated in Table 3.

Table 3. Typical Absolute Difference of the Averages between Two Laboratories

SGC Compaction Level	Typical Absolute Differences
N_{ini}	0.022
N_{des}	0.015

Appendix 2

Table 1. SGC Evaluation Form

Laboratory						
Operator's Name						
SGC Make / Model	Make:		Model:		Meets PP35 Y(_) N(_)	
Oven Make / Model	Make:		Model:			
Mix Designation						
Mix Type (_) Lab or (_) Production						
Short-Term Aging	(_) 4-hours	(_) 2-hours	(_) None			
Mixing Temperature, °C	Specified (range):	Actual:				
Compaction Temp., °C	Specified:		Actual:			
Heating Method	(_) In Mold	(_) In Pan Comments:				
SGC Compaction	Bulk Specific Gravity					
	A	B	C	D	Ave. ( )	St.Dv. (s)
N_{ini} = ____ N_{des}= ____						
Recorded Observations:						

8. Procedure: Phase II - Single Operator Evaluation

8.1 If one or more of the SGCs evaluated is not providing results within the typical ranges as indicated in Tables 2 and 3, the second phase of the evaluation should be employed.

8.2 A meeting between the laboratory operators will be held to identify and discuss within procedure differences - see section 9 for discussion topics. The specifying agency should establish a uniform procedure to address the identified differences. This should be based on the consensus of the group.

8.3 Repeat section 6 with the following exceptions:

8.4 A single operator shall be used throughout the evaluation.

8.5 The laboratory prepared mix or production mix shall be mixed or sampled, split, and allowed to cool to ambient temperature for a minimum of 12 hours. The split samples shall be uniformly handled and reheated to the specified compaction temperature.

8.6 Table 1 shall be used to summarize the evaluation data.

8.7 A statistical evaluation shall be conducted using the typical values provided in Tables 2 and 3.

8.8 If one or more of the SGCs evaluated still does not provide results within the typical ranges, the single operator should verify the calibration of the SGCs or contact manufacturer for service.

9. Discussion Topics

9.1 Within procedure differences that may impact the field management of asphalt mixes. The following provides topics for discussion in identifying potential differences. This is by no means a complete list.

9.1.1 SGC Calibration - Most versions of the SGC manufactured today allow the use of both 100 mm and 150 mm molds. During the calibration process it is not always apparent which setting is in use. Verify each compactor is set to 150 mm per AASHTO TP4. A setting of 100 mm will result in a lower then specified consolidation pressure, which will in turn result in lower densities.

9.1.2 Sample Segregation - If a compactor is not providing results within the typical standard deviations, a comparison of each specimen's gradation should be performed. Extraction of the aggregate can be accomplished through either solvent or ignition method. If segregation has occurred, a review of splitting techniques should occur. In addition, the technician may be employing a 4-inch funnel, typically used for Marshall and Hveem, to charge the molds. This can also cause within specimen segregation.

9.1.3 Method of Heating - The method of heating specimens may affect the densities. Heating in the pan may age the mix more than heating in the mold. This can result in lower densities. Also, the method of transfer from the pan to the mold may result in cooling of the mix, which in turn can result in lower densities.

9.1.4 Use of One Mold - The use of one mold may affect the compaction effort. If the mold is not reheated between specimens, the mold may cool which can result in lower densities.

9.1.5 Rodding of the Sample - Operators familiar with Marshall may rod the specimen prior to compaction. This is not part of AASHTO TP 4, and should not be performed.

9.1.6 Forced-Draft Oven - The oven set temperature should not be significantly above the compaction temperature. Over heated molds and mix may result in excessive aging of the mix. Which may result in lower densities. Also, the level of forced-draft-ness may be discussed.

9.1.7 Reheating - Logistics may require some of the compacted specimens to be reheated. Reheated may result in higher absorption of the asphalt binder. The lower effective asphalt content can result in lower densities.

9.1.8 Different Mix - The evaluators may wish to include a different mix in the evaluation, ex. a coarse versus a fine mix.

9.2 SGC Calibration - Since the SGC is a relatively new piece of equipment, there may be unforeseen issues with calibration. If after the second phase of evaluation a given SGC is still not comparing to the other unit, the manufacturer should be consulted to verify the calibration.