FHWA Asphalt Mixture and Construction Expert Task Group
July 24-25, 2007
Denver, CO

The meeting of the FHWA Asphalt Mixture and Construction Expert Task Group (ETG) was held on July 24 and 25, 2007 in Denver, Colorado. Chairman Frank Fee of Citgo Asphalt Refining Company, Co-chairman Ramon Bonaquist of Advanced Asphalt Technologies, and Secretary John Bukowski of the Federal Highway Administration (FHWA) conducted the meeting. Allen Cooley and Jimmy Brumfield of Burns Cooley Dennis, Inc. were present to assist with meeting logistics.

The following members of the FHWA Asphalt Mixture and Construction ETG were in attendance:

Frank Fee, Citgo Asphalt Refining Company (Chairman)
Ray Bonaquist, Advanced Asphalt Technologies (Co-chairman)
John Bukowski, FHWA (Secretary)
James A. Musselman, Florida Department of Transportation (DOT)
Kevin D. Hall, University of Arkansas
Y. Richard Kim, North Carolina State University
John Haddock, Purdue University
Eyad Masad, Texas A&M University
Judie Ryan, Wisconsin DOT
Julie E. Kliewer, Arizona DOT
Cynthia LaFleur, Callanan Industries
Gerry Huber, Heritage Research Group
Ervin L. Dukatz, Jr., Mathy Construction Company
Todd A. Lynn, SEM Materials
Charles R. Marek, Vulcan Materials Company
F. M. Rick Harvey, Wyoming DOT
Randy West, National Center for Asphalt Technology

The following "friends" of the FHWA Asphalt Mixture and Construction ETG were in attendance:

Imad Al-Qadi, UIUC
Howard Anderson, UDOT
Gaylon Baumgardner, Paragon
Amit Bhasin, Texas A & M University
Ken Brown, Troxler Laboratories
John Casola, Malvern Instruments
Francois Chaignon, Colas, Inc.
Matthew Corrigan, FHWA
John D'Angelo, FHWA
Dale Decker, Dale S. Decker, LLC
Raj Dongré, DSLI
Denis Donnelly, CAPA
Jon Epps, Granite Construction
Mike Farrar, WRI
Andrew Hanz, UW-Madison
Mike Harnsberger, WRI
Andy Horton, Heritage Research Group
Johnny Lam, CDOT
Bob Kluttz, Kraton Polymers
M. Emin Kutay, FHWA
Laurand Lewandowski, PRI Asphalt Tech.
Mihai Marasteanu, University of Minnesota
Eyad Masad, Texas A & M University
Richard May, SemMaterials

Andy Mergenmeier, FHWA
Karissa Mooney, Citgo Asphalt
Steve Mueller, FHWA
Katherine Petros, FHWA
Simon Prout, Malvern Instruments
Joe Procton, Pretech
Roger Pyle, Pine Instruments
Ali Regimand, Instrotec, Inc.
Gerald Reinke, Mathy Construction
Ray Robertson, WRI
Pedro Romero, Univ. of Utah
Delmar Salomon, Pvmt. Preservation Sys.
Tom Scarpas, TuDelft
Jim Scherocman, Consulting Engineer
Kevin Van Frank, Utah DOT
Eric Weaver, FHWA
Haifang Wen, Univ. of Wisconsin
Jack Youtcheff, FHWA

OBJECTIVE

The primary objective of the FHWA Asphalt Mixture and Construction ETG is to provide a forum for the discussion of ongoing asphalt mixture technology and to provide technical input for current and future research development and technology implementation related to asphalt mixtures and construction.

DAY 1 (1:00 PM, July 24, 2007)

Welcome and Introductions - Frank Fee (Citgo Asphalt)

Chairman Fee called the meeting to order at 1:00 PM, welcomed the group, and called for self-introductions of all attendees to be made.

(1) - Review of Action Items from the last meeting – Frank Fee (Citgo)

Copies of the agenda **(Attachment 1)** were distributed to those in attendance. Fee reviewed the following action items from the last meeting and gave an update on the progress achieved since the last ETG meeting in February 8-9, 2007:

1. ***Action Item:*** Bukowski send to ETG members and guests for review of proposed changes to TP62 and background and request members send comments to Masad and copy Fee/Bukowski. ***Progress:*** Discussing at this meeting.

2. ***Action Item:*** Bukowski send to ETG members and guests for review of proposed standards for SPT, specimen preparation and master curve calculation and request members send comments to Bonaquist and copy Fee/Bukowski. ***Progress:*** Completed.

3. ***Action Item:*** Kevin Hall complete development of Guidance document for SGCs history/background operation and internal angle measurement supporting documents. Submit to ETG's members and TRB subcommittee AFK50 for potential publication as a TRB Circular. ***Progress:*** To be presented at this meeting.

4. ***Action Item:*** Dukatz will upon completion of work (two months) forward to ETG members' copy of ASTM study procedures and results of SGC P&B statement for internal angle measurement. ***Progress:*** Dukatz to present at this meeting.

5. ***Action Item:*** Bukowski forward to SOM (Harvey) recommendation of ETG to modify T312 (Hall attached changes) and adjust TP58 for a single precision statement. ***Progress:*** Completed, Harvey to give update at this meeting.

6. ***Action Item:*** Ray Bonaquist will forward to the members of the Mix ETG 9-33 Evaluation Task Group a mix evaluation procedure and spreadsheet and the Task Group chair (Musselman) will provide comments to Fee NLT March 30, 2007. ***Progress:*** Completed.

7. ***Action Item:*** Any ETG member with input on materials presented on the 9-33 project, should provide comments to Fee/Bukowski for inclusion in the meeting minutes. ***Progress:*** Completed.

8. ***Action Item:*** Specific Gravity Task Group (West Chair) asked to provide a report of activities of the subgroups and provide for the minutes. Additionally prepare an outline of impact of combining various methods and changes and statements of needed research. ***Progress:*** Completed, West to present at this meeting.

9. ***Action Item:*** Recommend to SOM change to T166 to reduce the absorption level from 2% to 1%, allow use of TP69 (Corelok); wording and background to be supplied by West prior to forwarding to SOM. Additionally, verify changes to T269. ***Progress:*** Completed

10. ***Action Item:*** ETG will review 9-9(1) final report and discuss potential action for next meeting. ***Progress:*** Still opened for discussion.

11. ***Action Item:*** ETG will review the research problem statement "Improving Shear Resistance Modeling of Fine Aggregate Used in HMA" involving the CAR for comment at next meeting. ***Progress:*** Completed.

12. ***Action Item:*** At last meeting Cindy LaFleur was asked to look at how the ETG could include construction in future meetings. LaFleur presentation will be added to the agenda for tomorrow morning.

(2) Subcommittee on Materials Updates/Comments – Rick Harvey (Wyoming DOT) **(Attachment 2)**

Rick Harvey provided an update on activities of the AASHTO Subcommittee on Materials (SOM) related to the Asphalt Mixture and Construction ETG. The annual SOM meeting is to be held August 12-17, 2007 in Loon Mountain, New Hampshire. Harvey first provided an update on two upcoming NCHRP projects: NCHRP 9-46, Mix Design and Evaluation Procedure for High Reclaimed Asphalt Pavement Content in Hot Mix Asphalt, and NCHRP 4-35, Enhanced Test Method for Specific Gravity and Absorption of Coarse and Fine Aggregates. In 2007, revisions were published for AASHTO standards T320 (Superpave Shear Tester), T321 (Beam Fatigue), and T322 (Indirect Tensile Test). Harvey provided an update on AASHTO T62, Determining Dynamic Modulus of Hot mix Asphalt Concrete Mixtures. Recommendations from

the ETG in 2005 were balloted and put into the AASHTO Standards in 2005; however, some discussion is still needed as to whether changes to the current T62 are needed or to move onto new standards. AASHTO PP35, Evaluation of Superpave Gyratory Compactors, will no longer be published. AASHTO PP47, Evaluation of Different Superpave Gyratory Compactors Used in the Design and Field Management, has also been dropped and replaced with a white paper prepared by Kevin Hall. A new standard, AASHTO TP71, Evaluation of Superpave Gyratory Compactor Internal Angle of Gyration Using Simulated Loading, has been approved and published. A Technical Section ballot is ongoing concerning whether internal angles using simulated loading will be the lone method of measuring the angle of gradation. Harvey will provide comments on the balloting to the ETG. Harvey reported on discussions for the current fine aggregate angularity test. The Technical Section is considering the new strike-off procedure documented in the revised ASTM procedure.

(3) NCHRP Update and Discussion – John Bukowski (FHWA) **(Attachment 3)**.

In the absence of Ed Harrigan, John Bukowski gave a presentation on recently completed NCHRP projects as well as the status of ongoing NCHRP projects pertinent to this ETG.

(4) Mix Durability Task Force Report – M. Emin Kutay (FHWA) **(Attachment 4)**

Emin Kutay provided an update on research being conducted at the Turner-Fairbank Highway Research Center on HMA Durability. The title of the study is ”Effect of Aggregate Packing on HMA Performance.” This research is being conducted under the guidance of the ETG’s Durability Task Force and is designed to evaluate the packing/compaction/blending of coarse aggregate. The coarse aggregate fraction was selected because this fraction is especially important for coarse-graded and SMA mixes and numerous literature exists for modeling compaction. Characterization of the aggregates included both two-dimensional and three-dimensional testing. Using the results from the characterizations, parameters such as sphericity, angularity, etc can be calculated. These parameters, along with aggregate gradations, were used to conduct micromechanical similations of laboratory compaction of HMA. Initially, random aggregate were allowed to randomly free-fall into a compaction mold. Then the compaction simulation was conducted using the Lattice Boltzman Method. Kutay indicated that this type of information, if validated, could be utilized to: evaluate the number of contact points for different aggregate characteristics/gradations; investigate the locking point concept; effect of the number of aggregate contact points or HMA performance; or, conduct mix designs considering contact points and packing. The next steps in the research include development of two- and three-dimensional aggregate image databases, develop loose mix pouring and compaction models (Lattice Boltzman, dissapative particle dynamics), laboratory validation, and virtual compaction specimens. At the conclusion of the presentation, there was discussion on the ability to validate the results. Also, it was strongly suggested that the research focus on field compaction initially and then bring to laboratory compaction.

(5) NCHRP 9-33 Evaluation Task Group Report Update – Ray Bonaquist (AAT) **(Attachment 5)**

Ray Bonaquist provided an update on the NCHRP 9-33 Evaluation Task Group. Bonaquist presented a flow diagram that describes the current form of the mix design method. The first step in the mix design process is materials selection. Materials requiring selection include asphalt binder, aggregates and recycled asphalt pavements. The next step is to conduct a volumetric design. The designed mix is then subjected to performance testing. Moisture susceptibility testing is conducted in accordance with AASHTO T283 while rutting resistance is evaluated using either the Flow Number or NCHRP 9-19 E* Methods. Finally, properties of the mixture are either estimated or determined for input into the mechanistic-empirical pavement design guide. The goal is to strengthen the relationship between mix design and pavement design. Bonaquist also stated that a beta version of an Excel workbook to be used with the mix design has been provided for review to the NCHRP panel and ETG members.

At the conclusion of the presentation, ETG members were encouraged to test the beta version. It was suggested that existing mix designs be put into the Excel workbook to test for reasonableness. It was also noted that the design gyration levels (Ndes) currently contained within the mix design system are those that were recommended for different Ndes values when polymer modified binders are utilized in the HMA. Based upon the discussion, the ETG strongly believes that a single list of Ndes values should be utilized. There were also questions about whether the Witzcak or High model was being used to estimate dynamic modulus values. Bonaquist stated that both models are available within the Excel workbook. Frank Fee commented that the Excel workbook could also be an effective tool for training technicians.

(6) NCHRP 9-33 Trial Mix Results – Gerry Huber (Heritage Research Group) **(Attachments 6 & 7)**

Following the update on NCHRP 9-33 by Ray Bonaquist, Gerry Huber provided some discussion on incorporating gradation evaluation into mix design. Huber illustrated an example trial mix design using six aggregate stockpiles. After developing a base design, Huber increased the percent coarse aggregate blend from 62 percent to 72 percent by altering the proportions of different aggregate stockpiles. The 9-33 spreadsheet was then used to predict the volumetric properties of the new blends. Huber showed that the 9-33 spreadsheet inaccurately predicted VMA in most instances. Huber hypothesized that the reason for the inaccuracies were because the packing characteristics changed for each blend. Things that influence packing include: type and amount of compaction (usually constant), gradation, aggregate shape, aggregate texture and aggregate strength. Huber then discussed the ability of the Bailey Method to take these properties into account and provide a better estimation of the resulting volumetric properties. Huber finished by providing the following suggestions: 1) add discussion about the five properties that affect packing; 2) add discussion about the four gradation principles that affect packing (from Bailey Method); and 3) remove split between coarse and fine aggregates from mix design procedure. At the conclusion of the presentation, Erv Dukatz echoed the concerns expressed by Huber based upon some mix designs he had evaluated.

(7) Effects of Design Compaction on Mix Properties - Gerry Huber (Heritage Research Group) **(Attachment 8)**

A discussion on the recently recommended Ndes table resulting from the NCHRP9-9 (1) was next. The recommended Ndes table had two columns for Ndes values; one for unmodified asphalt binders and one for modified binders (listed as PG76-22). It was stated that the NCHRP 9-33 panel has voted against this dual column Ndesign table and now guidance from the ETG was needed on the appropriate Ndes levels. Gerry Huber then provided a presentation on the effect of design compaction effort on mix properties. Huber indicated that the concept of using ultimate density to select appropriate Ndes levels is not correct. Because of the influence of Ndes on volumetric, aggregate and mix properties, there is, in effect, a range of Ndes values that are reasonable. At the conclusion, the ETG members maintained that only one Ndes column, that related to unmodified binders be utilized.

(8) Specific Gravity Task Force Report – Randy West (NCAT) **(Attachment 9)**

Randy West provided an update on the Specific Gravity Task Group. The Specific Gravity Task Group was asked to review available research pertaining to methods of specific gravity measurements, present advantages and disadvantages of each method, compare results from different methods, and recommend changes, use the alternate methods, and/or future research technologies. Four areas were to be evaluated: bulk specific gravity of coarse aggregates, bulk specific gravity of fine aggregates, maximum specific gravity of mixtures, and bulk specific gravity for compacted mixtures.

For the bulk specific gravity of coarse aggregates, the Task Group did not recommend any changes; however, they did recommend future research aimed at reducing test time. The Task Group stated that further research is needed to improve the reproducibility and accuracy of determining the bulk specific gravity of fine aggregates. Current standards have poor reproducibility due to the subjective method of determining the saturated surface dry condition. For some fine aggregate materials, the accuracy of the current standards is also in question. The Task Group did indicate that some alternate/new methods of determining the saturated-surface dry condition of fine aggregates appear promising; however, further research is needed.

With respect to the maximum specific gravity, the current test, AASHTO T209, was deemed satisfactory for mixes with low absorption aggregates. The supplemental method within AASHTO T209 for mixes with absorptive aggregates (Dry-Back) has poor precision. Therefore, the Task Group recommended future research to improve the reproducibility of maximum specific gravity measurements for mixes with absorptive aggregates. The research should also be aimed at reducing the time to complete the test for such aggregates.

Two primary recommendations were made for determining the bulk specific gravity of compacted HMA specimens in accordance with AASHTO T166. First, the Task Group recommended replacing the reference within AASHTO T166 to the paraffin method (AASHTO T275) for high absorption values and replacing it with the vacuum sealing method (ASTM D6752). The second recommendation stated that the saturated-surface dry method (AASHTO T166) should be limited to specimens having a water absorption of 1.0 percent or less. Current requirements are 2 percent or less.

At the conclusion of the presentation, West discussed some implementation impacts that would result from implementing these recommendations. He began by stating that specification limits for volumetric properties should be based on well documented precision information for specific gravity measurements. If the recommendations for the bulk specific gravity of compacted HMA specimens are implemented, then VMA requirements for coarse-graded mixes during mix design should be increased by 0.5 percent and minimum in-place density requirements should be reduced by 1.0 percent for coarse graded mixes and 1.7 percent for SMA mixes or compactive efforts will have to be increased. Following the implementation impacts, there was discussion about the recommendation on lowering the in-place density requirements. It was stated that maintaining the same density specification, but following the recommendations would improve density, which would be a desirable outcome. Another stated that it may lead to more fine aggregates being placed in HMA. This appears to be the current trend around the US.

Frank Fee indicated that these recommendations have now been made to the ETG and that the ETG members need to provide feedback. The final product will be a report along with commentary to the recommendations.

DAY 2 - Wednesday, July 25, 2007

(9) Defining the Construction Focus – Cindy LaFleur (Callanan Industries) **(Attachment 10)**

Next, a discussion was provided for defining the focus of the construction issues for the ETG. The presentation was give by Cindy LaFleur. A "poll group" was developed for determining the focus with the following problem statement; "With all the technology we are developing and exploring, we still are unable to 'reliably' construct and compact a pavement." Three issues were highlighted for field construction: Compaction/Workability, Longitudinal Joint Construction, and Segregation. Two items listed under the category Compaction/Workability was the locking point concept and working with the Durability Task Group to evaluate the roles of aggregate and binder on workability. Other issues that were of interest included ride quality, pavement friction, cold weather paving and reflective cracking.

For Construction/Plant Production, three issues were identified. First is to better mesh mix design and production. The second issue was to evaluate methods to minimize process variation. Finally, the third issues related to Construction/Plant Production, was developing methods to minimize sampling and testing variability.

The final category discussed by LaFluer was "Shared Issues Plant and Field." Two items were identified for this category: increasing the number of qualified personnel and validation of statistical control and acceptance procedures.

Work to be conducted by the Poll/Task Group will include partnering with NAPA and NCAT to develop a strategy to assess the state of practice for compaction/workability, longitudinal joints and segregation. The Poll/Task Group will report back to the ETG at the next meeting. The Group will also participate and assist with other efforts ongoing through the ETG. Finally, the Poll/Task Group will work through the secondary items of concern to address at the ETG level.

At the end of the presentation, it was stated that many of the items presented should be developed into problem statements for TRB. Comments by ETG members should be provided to Cindy LaFleur. Finally, it was stated that from some state DOT's perspective, the construction topics are of higher priority than many of the material/design items being discussed by the ETG. An additional comment however was made that the material/design and construction issues are inter-related and questioned whether it would be advisable to treat them separately.

(10) ASTM SGC Precision & Bias Study – Erv Dukatz (Mathy Construction) **(Attachment 11)**

Erv Dukatz presented the results of an interlaboratory study for ASTM D7115, Standard Test Method for Measurement of Superpave Gyratory Compactor (SGC) Internal Angle of Gyration Using Simulated Loading. The study included a total of twelve different internal angle devices, 31 gyratory compactors and 58 molds. Each gyratory-mold combination was considered a sample. Three replicates for each sample were tested. The internal angle measurement was considered the response. Dukatz presented a number of plots and tables that presented different methods to check the data. Based upon the results of the analyses, Dukatz presentation recommended the following precision statements: "The single operator standard deviation to be 0.00811 degrees. Therefore, the repeatability of two properly conducted measurements by the same operator would not be expected to differ by more than 0.0229 degrees (d2s limit)." "The multi-laboratory standard deviation to be 0.0215 degrees. Therefore, the reproducibility of two properly conducted measurements by two different laboratories would not be expected to differ by more than 0.0609 degrees (d2s limit)."

Dukatz recommended that the precision statement within AASHTO PP48, Standard Practice for Evaluation of the Superpave Gyratory Compactor Internal Angle of Gyration, be revised based upon the results of this interlaboratory study. He also qualified that this interlaboratory study did not address the effect of internal angle on bulk specific gravity. Finally, Dukatz stated that an updated ruggedness study on the Superpave gyratory compaction method was needed. These issues were also discussed in the next presentation by Kevin Hall.

(11) SGC Guidance Document (Internal Angle) - Final Comments – Kevin Hall (University of Arkansas) **(Attachment 12)**

Kevin Hall provided an update on the guidance document being developed for internal angle measurements for Superpave gyratory compactors. He presented a draft table of content for a proposed TRB E-Circular document. Topics included within the draft table of contents included: 1) Sources of variability in Determining the Bulk Specific of HMA; 2) determinations of SGC Bias; 3) Rationale for Using the Dynamic Internal Angle (DIA) for Calibrating the SGC: 4) Measurement of Dynamic Internal Angle; 5) SGC Frame Stiffness Concepts; 6) Temperature Issues; 7) Comparison of Internal Angle Measurement Systems; and 8) Summary and Recommendations.

The presentation generated a significant discussion. One question that was raised was "Should the references to the original Dynamic Angle Validation kit be removed?" The ETG members maintained that references to the original DAV should be contained within the guidance

document. Additionally, references to external angle measurement should also remain in the guidance document because some agencies may not adopt the current recommended internal angle measurements.

Erv Dukatz stated that some supplementary analyses of the ASTM inter-laboratory study looked at the effect of measuring "hot" internal angles. The majority of the SGCs were agency owned and calibrated to an agency-acceptable angle either internally or externally. When evaluating "hot", the trend was that all of the SGCs drifted toward an angle of 1.16.

The E-Circular guidance document is solely intended as a commentary, not a specification. Therefore, it is basically a history lesson. It was stated that the internal angle is not the end all for variability. Kevin Hall asked if there were comments on the proposed section on sources of variability. It was stated that a method for evaluating SGC bias was needed. Rick Harvey emphasized the importance of recommending a method for evaluating bias. AASHTO TP35, Standard Practice for Evaluation of Superpave Gyratory Compactors will no longer be printed. Therefore, the proposed E-Circular may be the only guidance for evaluating SGC bias.

The final discussion was on the comparison of internal angle measurement systems. Should the guidance document include precision statements separated by internal angle device and SGC model? This question was raised because precision statements within the guidance document could be different than those published in AASHTO or ASTM. Frank Fee stated that the E-Circular could present some precision statements as historical with recent research presenting new precision statements. Following this statement there was a call for evaluating the tolerance on internal angle or conducting a new ruggedness study. Frank Fee stated that a draft problem statement should be developed and provided to the ETG. The ETG agreed that a ruggedness study was needed and ways to perform this work would be investigated.

(12) TP 62 Issues Task Force – Amit Bhasin (Texas A & M University) **(Attachment 13)**

Amit Bhasin provided an update on the TP62 Issues Task Force. AASHTO TP62 has been developed and reviewed to be a stand alone document. There are two other additional proposed standards to support TP62: sample preparation procedure and master curve development procedure. AASHTO TP62 was developed for conducting dynamic modulus testing using a universal testing machine (UTM). Potential users for the standard are materials design laboratories where the simple performance tester (SPT) equipment is not available and a UTM is available, engineers who desire inputs for the MEPDG and researchers. A separate standard is being developed during NCHRP 9-29 that will apply to the specific SPT equipment. When using the AASHTO TP62 method, the user will be able to obtain dynamic modulus test results at temperatures and frequencies defined by the user. It is anticipated that the stand alone standard for sample preparation can be used whether AASHTO T62 or the SPT are utilized for testing. The other stand alone standard being developed, master curve methods, will have two methods. Method A will specify how to develop master curves for testing conducted in accordance with AASHTO T62 and Method B will be appropriate for testing conducted with a SPT. The primary difference between the two methods is that Method A will allow utilization of a large spectrum of temperatures and frequencies.

Gerry Reinke asked if the sample preparation method would allow for the testing of 6 in. diameter, uncored samples. Ray Bonaquist stated that the current standard was for testing of 4 in. diameter, cored samples. Ray Bonaquist and Gerry Huber collectively reported on work from NCHRP 9-19. Within this study, various sample geometries along with sawed and unsawed were investigated. This research did indicate that similar magnitudes of E* could be obtained with different sample diameters; however, if the length-to-diameter ratio was less than 1.5, the variability in modulus values increased. The purpose of coring the middle 4 in. from the samples is to minimize the density gradient in the samples.

A question was asked about how the standard should go forward. Since AASHTO T62 and the two stand along standards are needed. The sample preparation standard is currently ready to be forwarded. Advanced Asphalt Technologies has submitted a standard for measuring E* using the SPT along with sample preparation and master curve development for NCHRP 9-29. The only issue not addressed is Method A of the stand alone standard on developing master curves. Comments are expected from the NCHRP 9-29 panel. Because of the current review being conducted by the NCHRP 9-29 panel, it was recommended for the ETG to wait until the reviews are complete. It was requested for Ray Bonaquist to provide an update on the standard from the NCHRP 9-29 project.

Rick Harvey asked if a pooled fund purchase was planned for the SPT. John D'Angelo indicated that there would be a pooled fund purchase and that a ruggedness study would be performed. A training school would be developed on how to run the tests and analyze the data. Rick Harvey then indicated that there is some urgency to get the standards adopted.

Richard Kim stated that he would like to see an action item on how to deal with Method A of the standard for developing master curves. Frank Fee also indicated that this should be expedited.

(13) Predicted vs. SPT Measured E* Values – Raj Dongré (DSLI) (**Attachment 14)**

Raj Dongre presented work he has done to compare predicted E* values versus SPT measure values at 10°F and 130°F. Version 1.00 of the MEPDG requires E* input values at five temperatures for Level 1 analyses: Dongre highlighted that an error message comes up if the lowest test temperature is not between 10 and 20°F E* measurements for typical laboratories. Secondly, obtaining 10°F data can be time consuming and the results can be more variable. At higher temperatures, variability can be a concern, especially when softer grades of asphalt binder are involved.

Dongre suggested that the solution to the problem was first suggested by Bonaquist et al in 2005. Within this process, E* measurements are only needed at three or four temperatures, and the modulus is predicted at 10°F and 130°F. Additionally, only four frequencies are needed, instead of the six recommended in the MEPDG. Dongre showed a series of master curves to illustrate the concept. The concept basically states that the maximum modulus can be estimated using the Hirsch Model and a limiting binder shear modulus of 1GPa. By limiting the modulus values, the shape of the sinusoidal can be defined. Bonaquist et al found generally good agreement with this approach.

Dongre then presented some data from the AFL sections and a VTRC mix using the approach. For the most part, there was generally good agreement between the predicted and measured E* values. Dongre then took the predicted and measured E* data from VTRC and conducted a Level 1 analysis to evaluate rutting and fatigue. Results from this comparison resulted in good agreement in performance measures when using the measured and predicted E* values.

Dongre stated that the master curves from three temperatures may be used to predict E* data at the extreme temperatures. The effect of the error in predicting performance was small. Finally, there is a need for the MEPDG to provide an automated prediction process based on fewer temperatures.

Following the presentation, there was discussion on the proposed concept. Several members indicated that the concept had potential validity with the current performance prediction models because of the relative insensitivity of E*; however, there was concern about future models that may be incorporated into the MEPDG. Richard Kim indicated that NCSU had some difficulty in extrapolating based upon limited temperature data. Ray Bonaquist then stated that the procedure cited by Dongre was a direct request by the NCHRP 9-29 project panel. He indicated that the extrapolation is only for the tails of the function. By fixing the high temperature to a maximum E* value and measuring the intermediate temperature E*, the master curve is set because the sinusoidal function is symmetrical. The question was then raised on whether the concept should be continued to be evaluated. Frank Fee indicated that more work should be conducted and reported back to the ETG.

(14) Low Temperature Cracking in Asphalt Pavements – Mihai Marasteanu, University of Minnesota **(Attachment 15)**

Mihai Marasteanu provided an update on National Pooled Fund Study 776, Investigation of Low Temperature Cracking in Asphalt Pavements. This Pooled Fund includes four universities and the testing of both binders and mixtures. Two types of mixtures are being included; laboratory prepared mixes and field cores. For the lab mixes, the experimental matrix includes ten different asphalt binders, two aggregate types, two film thicknesses (asphalt binder content) and two air void levels. For the field mixes, thirteen sites were selected: seven from MnRoad, two from Wisconsin, three from Illinois and one from North Dakota.

A number of mixture tests were included in the research. All of the tests are being conducted at low temperatures. Mix tests included the indirect tensile test (creep and strength), Semi-Circular Bending, Disc-Shaped Compact Tension, Single-Edge Notched Beam, and Thermal Stress Restrained Specimen Test. Three different test temperatures were used during testing and were categorized as high, intermediate and low (again, all test temperature were considered low temperatures as -18°C was the “high” temperature for some mixes).

Marasteanu showed a series of plots depicting fracture energy results at the high, intermediate and low categories of test temperature. He indicated there was no trend in the data at the higher temperatures; however, at the lower temperatures, the granite mixes had more fracture energy.

This led to the observation that the asphalt binder is important, but a benefit can be realized from proper aggregate type selection. Similar results were seen with fracture toughness.

A series of comparisons were made to evaluate the significance of various factors. Results of comparisons showed a significant effect of aggregate type and air void content on fracture resistance (toughness and energy). However, the asphalt binder content only had a significant effect on fracture toughness.

Marasteanu then compared results of binder and mixture testing on the laboratory prepared mixes. Comparisons included bending beam rheometer (BBR) versus indirect tensile creep, BBR versus Semi-Circular Bending, direct tension testing (DTT) versus Disc-Shaped Compact tension, and DTT versus Semi-Circular bending. Correlation coefficients between the various laboratory parameters (binder and mix results) and field performance suggested that fracture energy and toughness best predicted performance. Therefore, he recommended that the selection of fracture resistant mixtures be based upon simple fracture tests. He further stated that there is a need to develop mixture selection criteria similar to the PG system for binders.

Following the presentation there was some discussion on the fracturing of aggregates during the laboratory testing. The question was asked whether aggregates are fractured due to thermal stresses in the field. There was agreement that fractured rocks in the field could be caused by a combination of stresses, traffic and construction effects.

(15) Determination of Phosphorous in Mixtures – Gerald Reinke (Mathy Construction) **(Attachment 16)**

Gerald Reinke provided an update on research being conducted by Mathy Technology and Engineering Services on a method to determine the amount of phosphorous in asphalt binders and in binders recovered from mixes. The purpose of the work was to develop a quick and accurate test method by which the percent phosphorous in asphalt could be determined. At the beginning of the research, several assumptions were made. First, virgin asphalt does not contain phosphorous. Second, the percent phosphorous can be converted back to polyphosphoric acid if the type of acid used is known. Finally, the deconvolution software is able to differentiate between sulfur and phosphorous peaks.

The instrument used during Reinke's study was an energy dispersive X-ray fluorescence (EDXRF) spectrometer. With this equipment, 27 standards were first evaluated. The standards included combinations of base asphalts, sulfur percentages and phosphorous percentages. The standards were utilized to evaluate the test method. The 27 standards were needed because the phosphorous peak is contained within the sulfur peak when evaluating the EDXRF results. After initial confirmation that the method and equipment were accurate, eight additional samples submitted by the Port Authority of New York and New Jersey were evaluated. The samples were tested blind and compared to the reported values. These results were also positive.

The second step in the research was development of procedures for extraction, recovery and determination of phosphorous in mixtures. For this part of the study, Reinke prepared a binder with a known amount of polyphosphoric acid. This binder was mixed with different aggregate

types to produce mixes. After conditioning samples overnight, the asphalt binder was extracted and recovered. The recovered binder was then tested to determine the percent phosphorous. The aggregates were also crushed to test for phosphorous. Initial tests were mixed, even when using different solvents. Reinke then tried a second extraction on the recovered aggregate.

Reinke summarized that the EDXRF is a suitable and accurate test method for determining the percent phosphorous found in PPA modified asphalt blends. Deconvolution of phosphorous and sulfur is possible at levels typically found in asphalt. Typical extraction solvents remove differing amount of phosphorous and different aggregates appear to hold only phosphorous at differing levels.

ASPHALT RESEARCH CONSORTIUM AND WRI FUNDAMENTAL PROPERTY CONTRACT UPDATES

(16) Year 1 Work Plan Overview – Fred Turner (WRI) **(Attachment 17)**

Fred Turner provided an Overview of the Year 1 plan for the WRI Fundamental Properties of Asphalt and Modified Asphalt III contract. Turner indicated that Work Plans have been submitted to the FHWA and ETGs for Task 2 and that comments have been received. For Task 3 of the contract, eight areas are proposed. Initially, white papers will be developed in the different areas. Proposals will then be developed for the selected white paper topics. ETG input will be solicited on detailed work plans for the selected proposals.

There are five focus areas from the Asphalt Roadmap that are being considered: Optimize Pavement Performance, Advanced Quality Systems, Pavement Surface Characteristics, Technical Capability Building and Environmental Stewardship. Of these focus areas, work is anticipated in all except pavement surface characteristics.

The contract structure includes four primary phases. The first phase is coordination. This includes maintaining contact with State of the Art and State of the Science in fundamental research related to asphalt; monitoring current ongoing fundamental research; and learning the needs of the technical community. The second phase is sustaining effort. Turner listed six areas included with this step; moisture damage, aging, nanotechnology, low temperature properties, modified asphalts and monitoring of existing validation sites. The third phase is the indefinite delivery, indefinite quantity task orders and the final phase is information deployment.

(17) Asphalt Research Consortium Overview - Mike Harnsberger (WRI) **(Attachment 18)**

Mike Harnsberger provided an overview and update on the Asphalt Research Consortium (ARC). The ARC is comprised of five team members: Western Research Institute, Texas A & M, University of Wisconsin-Madison, University of Nevada-Reno and Advanced Asphalt Technology. Proposals for the ARC were submitted in August of 2006 and work plans were approved in July of 2007. The total budget for the ARC effort is $26.25 million. Harnsberger identified a total of seven program areas including: moisture damage, fatigue damage, engineered materials, vehicle-pavement interaction, research and development validation,

technology development, and technology transfer. Subsequent speakers described the upcoming activities for some of the focus areas.

(18) Moisture Damage - Amit Bhasin (Texas A & M University) **(Attachment 18)**

Amit Bhasin presented the hypothesis, objectives, and deliverables for the moisture damage program area of the ARC. The hypothesis for this focus is that material and mixture properties can be used to model the moisture damage process. The moisture damage model developed will also be integrated with other distress models to predict pavement performance. Material properties to be considered include the aging of binders, pH of water and surface energy. Mixture properties include void structure, moisture content and filler type and content.

Bhasin listed five categories of work including adhesion, cohesion, aggregate, modeling, and prediction system. Various members of the ARC will work on each of the categories.

Following the presentation it was asked about the types of deliverables expected from this program area. Bhasin indicated that the research will decide what deliverables there will be. Some existing tests are available that could be deliverables. All products will come back to the ETG to help decide what is deliverable. Ray Robertson then stated that there are a number of methodologies that currently exist based on previous research that could be instant deliverables. The question was then asked if the model to predict moisture damage will be a stand alone system or will it be integrated into the NCHRP 9-33 mix design system or MEPDG. Bhasin stated that the work plans are written such that the model(s) will be stand alone systems.

(19) Fatigue - Eyad Masad (Texas A & M University) **(Attachment 18)**

Eyad Masad presented the hypothesis, objective and deliverables for the fatigue damage program area. The hypothesis of this program is that fatigue damage is a result of the growth of small cracks and voids to form larger cracks that result in damage. The objectives of the fatigue damage areas are to develop a fundamental understanding of the material properties and mechanics associated with fatigue, develop an implementable unified fatigue damage model, implement the unified fatigue damage model using micromechanical FE/DE methods and continuum damage models to assess fatigue behavior, and develop testing protocols for modified and unmodified binders, mastic, and mixture for the unified model.

Anticipated deliverables from this program area include: improved understanding of fatigue damage and healing mechanisms, micromechanic model to predict mix behavior in fatigue, unified fatigue damage model that can be implemented in structural design, structural model that incorporates the unified damage model; test protocols to determine properties required for the unified fatigue damage model, and component selection guidelines for perpetual pavements based on the unified approach.
Following the presentation, Frank Fee asked if the researchers envisioned a system of inputs that could be put into the model that could be married to the upcoming NCHRP 9-33 mix design system. In response to this question, Mike Harnsberger indicated “yes”. Every product resulting from the research may not be a final, implementable product, but will lead to an implementable product.

(20) Engineered Materials, Vehicle Pavement Interaction, Validation - Mike Harnsberger (WRI) **(Attachment 18)**

Mike Harnsberger discussed the engineered material program area. The hypothesis of this area include: materials that comprise the composite mixture have mechanical and geometric properties which may be combined, using micromechanics to obtain net properties; using additives and/or new production processes, modified binders and mixtures can be designed to tolerate extreme traffic and climatic conditions, superior performance of materials and mixtures incorporating high percentages of recycled asphalt mixtures, emulsions or warm mixture additive can be achieved by using fundamental engineering principles; and protocols for testing and modeling to provide guidance for selecting high performance materials with predictable performance. Objectives of the engineered materials area include: develop guidelines for producing and selecting engineered pavement materials focused on limiting risk of pavement failures; develop guidelines for high level use of recycled pavement mixtures, warm mixture and cold mixtures; and validate using laboratory damage resistance testing and full scale trails. Deliverables in engineered materials will be design models and guidelines for RAP mixes, warm mixes, thermal resistant mixes and stable mixes.

Harnsberger then discussed the area of vehicle-pavement interaction. The goal within this area is to develop simplified tools to compute dynamic tire-pavement interactions of special loading conditions and to use existing knowledge of marcotexture and microtexture to design mixtures to enhance safety. Anticipated deliverables include a near term computer model and database to estimate pavement responses to dynamic loads, a dynamic load model and database to serve as input for future integration with comprehensive pavement structural models and a method to estimate noise and friction properties of asphalt mixtures as part of the mix design process.

The final area of work discussed by Harnsberger was validation. The goal within this area is to evaluate selected existing specifications and validate research products developed by the ARC under realistic loading and environmental conditions encountered in the field. Deliverables anticipated in this work include construction and comparative evaluations of pavements, development of a materials library for material used at the projects, evaluation of the MEPDG and an improved Superpave performance grade specification.

At the conclusion of the presentation, Gerry Reinke asked how the researchers plan on doing the modeling of warm mix compared to other mix types. Harnsberger indicated the primary differences will be inclusion of modeling emissions and binder aging for warm mix asphalt. They will look at modeling to predict performance of these mixes. Frank Fee asked how the various deliverables will be validated, specifically, "… are these protocols to decide what can be used for validation…" Harnsberger stated that there currently are no protocols. It was then asked if the researchers were open to input from outside the ARC to which Harnsberger indicated yes.

(21) – Technology Development – Ray Bonaquist (AAT) **(Attachment 19)**

Ray Bonaquist discussed the technology development area of the ARC. The objective of this area is to begin the process of refining selected products from the ARC members' research into useful tools for engineers and technologists involved in design, construction and maintenance of flexible pavement systems. Three specific work elements were defined. The first element is early products. Within this element would be research that has already been completed. Bonaquist indicated that there are approximately ten such products. The other work elements are mid-term and long-term products. Mid-term products would be early ARC and Fundamental properties (WRI Contract) research.

Bonaquist described a four step approach for technology development. For the first step, the ARC members would rate the various potential products and write executive summaries. The executive summaries would then be submitted for FHWA/ETG review. The ETGs would then rate each product leading to a prioritized list of products.

At the conclusion of the presentation, it was stated that the members should anticipate being contacted prior to the next ETG meeting. Contact will likely be email; however, in the future the product may require meetings. Ray Robertson stated that in the past the ETG as been a promotional group for new/improved technology. Members that volunteer for a particular product would hopefully champion the product. Kevin Hall stated that any test methods developed that yield a test result will need precision statements. Does the ARC plan to fund the ruggedness/interlaboratory studies? It was answered that the importance of the product will likely determine who funds the research required to develop the precision statements. Products of high urgency/importance may be conducted through the ARC. Other, less urgent/important, may be funded by others.

ISSUES/AREAS OF MUTUAL ACTION

(22) Binder ETG – John D'Angelo (FHWA)

John D'Angelo provided an update on the activities of the Binder ETG. He indicated that a significant amount of work has been conducted looking at polyphosphoric acid in binders. Warm mix asphalt is also being evaluated. Specifically, the warm mix additives and how they change the performance of the binders. D'Angelo also stated that the Binder ETG is working very hard to refine/improve the specifications for binders at high temperatures. He indicated that in a short period of time, the $G^*/\sin\delta$ will be deleted and replaced with a compliance value. The compliance value better describes the performance of modified binders.

(23) Models ETG – Katherine Petros (FHWA)

Katherine Petros provided an update on the Models ETG. She stated that the Models ETG has a keen interest in the ARC and WRI work to be conducted. This work may produce the next generation of the MEPDG. Petros indicated that the ETG is moving forward with the ARC models and need to mesh these models with mix design. One concern of the Models ETG is the next generation of performance models. There are a number of research projects underway to improve the current MEPDG models. A comment from the audience asked why the Models ETG would be considering the next generation of performance models when the MEPDG is not

even fully implemented yet. A task group of the Models ETG should be a focal point for improvements to the MEPDG. Rick Harvey stated that the Models ETG should make recommendations to AASHTO on improvements to the MEPDG. Ray Bonaquist stated that there should be a group of persons from the Models and Mix ETGs to help recommend improvements to the MEPDG, especially since there are some common memberships.

ACTION ITEMS AND NEXT MEETING PLANNING

(24) - Action Items and Next Meeting Planning - John Bukowski (FHWA)

Secretary Bukowski began the final session of the meeting going through a review of the new action items **(Attachment 20)**.

New Action Items:

A. Rick Harvey will send tech section comments on proposed T312 changes to Hall (copy to Fee & Bukowski) for response prior to August SOM meeting.

B. The Task Group will review the 9-33 spread sheet on mix design and Musselman (Group Leader) provide comments to Fee & Bukowski by 1 October.

C. ETG members are asked to provide Fee & Bukowski comments by 1 October on 9-9(1) for proposed gyratory levels.

D. All ETG members are asked to review and comment on Specific Gravity Report and provide input prior to next meeting to Fee & Bukowski. This goal is to provide potential test method/specification changes to AASHTO.

E. Hall will distribute the final SGC Guidance document for ETG review for eventual publication as a TRB Circular through subcommittee AFK50. This will provide the background information on the development of internal angle measurements.

F. Hall will describe a study to re-do the SGC study of effect of internal angle variability on resulting specimens G_{mb}, provide a copy to the ETG members and explore possibility of conducting work with ETG members.

G. Bonaquist will present to the ETG at the next meeting the results of the 9-29 panel review of the separate procedure for specimen preparation, the generation of master curve and the SPT procedure determination of dynamic modulus.

H. Bonaquist will work with the Task Group on TP62 (Masad chair) for recommendations for including Method A and Method B in the master curve procedure and present the results at the next meeting.

I. LeFleur will present at next meeting an overview of current in-place pavement density measurement practices and specifications.

J. ETG is asked to review/rate the Executive Summaries (to be released in October) for the potential products from past WRI/TTI efforts and return comments to Fee and Bukowski prior to the next meeting.

Chairman Fee pointed out that the next meeting would again be a combined meeting of all three groups and would probably be in the southeast during the last week of February 2008 (February 25-29, 2008).

(22) - List of Attachments

1. Fee – Mix and Construction ETG Agenda July 24-25, 2007

2. Harvey – AASHTO SOM Update

3. Bukowski – NCHRP Update

4. Kutay – HMA Durability Study: Effect of Aggregate Packing on HMA Performance

5. Bonaquist – NCHRP 9-33 Flow Chart

6. Huber – Incorporating Gradation Evaluation in Mix Design (Understanding How Aggregate Packing Effects VMA)

7. Huber - Packing of Aggregate and the Effect on Properties of Hot Mix Asphalt (WORD Document for Proposed Incorporation into Mix Design Manual)

8. Huber – Effects of Design Compaction on Mix Properties

9. West – Specific Gravity Task Group

10. LaFleur – Defining the Construction Focus

11. Dukatz – ASTM SGC Precision & Bias Study

12. Hall – SGC Guidance Document (Internal Angle)

13. Bhasin – Finalization of TP-62 Issues

14. Dongré – Predicted vs. Measured E* Values at 10°F & 130°F

15. Marasteanu – Low Temperature Cracking in Asphalt Pavements

16. Reinke – Determination of Phosphorous in Mixtures

17. Turner – Year 1 Work Plan Overview

18. Harnsberger/Bhasin/Masad – Asphalt Research Consortium (ARC) Research and Status Update

19. Bonaquist – Technology Development

20. Bukowski – Action Items