

## FHWA Asphalt Mixture and Construction Expert Task Group

### Mixture & Construction ETG Purpose

The primary objective of the FHWA Expert Task Group is to provide a forum for the discussion of ongoing asphalt mixture technology and to provide technical input related to asphalt mixtures design, production and construction.

A total of 64 individuals attended the meeting (19 members, 43 visitors, and 2 contract personnel). Attachment A is the meeting Agenda, Attachment B includes a listing of the ETG members, and Attachment C is a listing of the Mixture ETG working committee members. Members of the FHWA Asphalt Mixture and Construction ETG that were in attendance at the February 2010 meeting included:

Frank Fee, NuStar Asphalt (Chairman)  
Ray Bonaquist, Advanced Asphalt Technologies (Co-chairman)  
John Bukowski, FHWA (Secretary)  
Shane Buchanan, Vulcan Materials Co.  
Ervin L. Dukatz, Jr., Mathy Construction Company  
John Haddock, Purdue University  
Kevin D. Hall, University of Arkansas  
Adam Hand, Granite Construction  
F. M. Rick Harvey, Wyoming DOT/AASHTO SOM liaison  
Richard Kim, North Carolina State University  
Julie Kliewer, Arizona DOT  
Cindy LaFluer, Callanan Industries  
Todd Lynn, APAC/An Old Castle Co.  
Judie Ryan, Wisconsin DOT  
Kevin Van Frank, Utah DOT  
Mark Buncher (Liaison), Asphalt Institute  
Edward Harrigan (Liaison), NCHRP/TRB  
David Newcomb (Liaison), National Asphalt Pavement Association  
Randy West (Liaison), NCAT

Meeting Coordinator: Lori Dalton (SME, Inc.)

Meeting Notes: Harold L. Von Quintus, (ARA, Inc.)

“Friends” of the ETG that were in attendance included:

Chris Abadie, LTRC	Mihai Marasteanu, Univ. of Minnesota
Haleh Azari, AMRL	Dean Maurer, Practical Asph. Solutions
Hussain Bahia, University of Wisconsin at Madison	Richard May, Shell Solutions
Gaylon Baumgardner, Paragon Tech. Services	Rebecca McDaniels, NCSC-Purdue
Satish Belagutti, FHWA/ESC	Larry Michael, LLM Consulting
Alexander Brown, Asphalt Institute	Louay Mohammad, LSU/LTRC
Ken Brown, Troxler Labs	Ala Mohseni, Pave Systems
Audrey Copeland, FHWA	Chuck Paugh, ESC, Inc.
Matthew Corrigan, FHWA	Katherine Petros, FHWA

William Criqui, Road Science, LLC  
John D'Angelo, D'Angelo Consulting  
Raj Dongre, ESC, Inc.  
Lee Gallivan, FHWA  
Nelson Gibson, FHWA  
Beth Griffin, DuPont  
Ellie Hajj, University of Nevada at Reno  
Tom Harman, FHWA  
Mike Harnsberger, WRI  
Rick Holmgreen, Conoco Phillips  
Sang Soo Kim, Ohio University  
Dal Little, Kraton Polymers  
Bob Kluttz, Kraton Polymers

Roger Pyle, Pine Instruments  
Ali Regimanl, InstroTele, Inc.  
Gerald Reinke, Mathy Construction  
Geoff Rowe, ABATECH  
Shadi Saadeh, Calif. State Univ./LB  
Delmar Salomon, PPS, LLC  
Darin Teford, Nevada DOT  
Nam Tran, NCAT  
Shane Underwood, NCSU  
Eric Weaver, FHWA  
Jack Youtcheff, FHWA  
Waleed Zejada, ASU

### **DAY 1: Tuesday, February 23, 2010**

**1. Call to Order**—Chairman Frank Fee (NuStar) called the meeting to order at 1:00 PM.

**Welcome and Introduction** – Chairman Frank Fee (NuStar) welcomed the group to the meeting. Self introductions were made, and the attendance sign-in sheet was distributed. Fee requested that all presentations be given to Satish Belagutti prior to their presentation time. Belagutti noted that NCHRP is providing the attendees with a wireless internet connection for this meeting. Noted that the website will be monitored for questions during the presentations and discussion during the meeting.

**2. Review Agenda, Meeting Minutes, and Action Items**—John Bukowski (FHWA) Secretary John Bukowski noted that the agenda for this meeting and minutes from the September 2009 meeting had been distributed via e-mail prior to the meeting. Bukowski requested that any corrections to the minutes be provided to him during this meeting. Bukowski reported that all presentations will be posted on the web site.

Bukowski reviewed the meeting agenda (Attachment A) and action items from the September 2009 Mix and Construction ETG meeting. The first day topics on the agenda will address most of the action items from the previous meeting. Topics for the second day are items related to technology changes or issues. The following is a listing and status of the action items from the previous ETG meeting (Sept. 2009).

1. AASHTO Status Update: TP 79, Determining the Dynamic Modulus and Flow Number for HMA Using the AMPT. Ed Harrigan will be asked to provide the ETG with a copy of the AMPT equipment specification developed under NCHRP 9-29 and Ray Bonaquist will provide a write up on what is actually required for calibration.  
**UPDATE:** Harrigan provided a copy of the equipment specification. Ray Bonaquist will be making a presentation.

2. SGC Mold Wear Task Group members, Erv Dukatz, Kevin Hall, and Roger Pyle will prepare a brief summary explaining the methodology/rationale being proposed as an Annex to the standard. The Annex to T 312 and summary will be forwarded to Rick Harvey for consideration by the AASHTO Subcommittee on Materials.  
**UPDATE**: Action item is on the agenda. The rational and commentary have been forwarded to AASHTO. Erv Dukatz will be giving the status report on the procedure.
3. Ray Bonaquist with assistance of the AMPT Task Group (Von Quintus, Kim, Van Frank, Blakenship, Tran, Reinke, Huber, Copeland and Dongre) will develop a work plan on parameters needed to perform “flow number” testing and the gathering of output data. The work plan will be distributed to the ETG members and discussed at the next ETG.  
**UPDATE**: Action item is on the agenda. Ray Bonaquist will be making the presentation summarizing the status of this topic. Other members of the task group will then make brief presentations on various procedures for using flow number.
4. Richard Kim will prepare a written ruggedness plan for using the IDT to measure E\* and provide to the ETG for comment and provided a presentation to the ETG to explain the factors included in the experimental ruggedness plan.  
**UPDATE**: Action item is on the agenda. Richard Kim will be making the presentation summarizing the status of this topic.
5. Gyrotory Commentary Task Group (Fee, D’Angelo, Huber, West, Prowell, Hall, and Julie Kliewer) will develop a “stand-alone” summary/commentary document on approaches and impact for lowering N-design.  
**UPDATE**: Action item is on the agenda. John Bukowski will give the presentation summarizing information on this topic and its status. Specific guidance is needed on the commentary for adjusting N-design, in terms of what agencies need to do. The intent is still to prepare an FHWA technical brief document.
6. Specific Gravity Task Group Report will finalize the E-circular for the TRB web site. A summary of the ETG recommendations and the rationale for those recommendations will be forwarded to Rick Harvey for consideration by the AASHTO SOM.  
**UPDATE**: Action item is on the agenda. The TRB E-circular and recommendations were finalized and forwarded to AASHTO.
7. Frank Fee will bring to the next ETG a research proposal for evaluating the effects of HMA production on asphalt mixture condition aging.  
**UPDATE**: Action item is on the agenda. Fee will give the presentation summarizing the information on this topic and its status.
8. The Construction Task Group (LaFleur (Lead), Dukatz, Kliewer, Lynn, Musselman, and Ryan) is requested to present at the next meeting a recommendation for a possible TRB synthesis on the measurement and acceptance of asphalt pavement density.  
**UPDATE**: Action item is on the agenda. LaFleur will give the presentation on this topic.

9. Mihai Marasteanu will prepare a proposal for BBR procedures and distribute to the ETG for comments. Any comments need to be returned to Mihai Marasteanu before the next meeting.

**UPDATE:** Action item is on the agenda. Mihai Marasteanu will give the presentation on the proposal and status.

### **3. Subcommittee on Materials: AASHTO Standards Update Report—Rick Harvey (Wyoming DOT); ETG liaison for the AASHTO Subcommittee on Materials**

Fee provided background information on this meeting topic and the importance of having Rick Harvey present an update on the different AASHTO standards that are relevant to the ETG.

Presentation Title: *AASHTO Standards Update*

#### Summary of Presentation/Report:

Rick Harvey noted there many action items on different standards from the last meeting. He will review the past 3 years of items.

The subcommittee on Materials annual meeting was held in Anchorage, Alaska on August 2-7, 2009. Harvey summarized and briefly discussed the following action items that were published in 2009:

- T 312; the internal angle is deleted. The standard was approved in 2007 and published in the 2008 edition of the standards. As of this January, ARML has been enforcing the internal angle requirements. Not having the correct internal angle, labs will be noted and after December 2010, labs can loss their accreditation.
- T 209; mechanical agitation is required in the 2009 revision. This was an old ETG recommendation. Harvey noted that Haleh Azari (ARML) is completing a study to determine the effects of agitation because there are different methods and equipment to do the agitation.
- PP 48; evaluation of Superpave gyratory compactor internal angle of gyration. This has been discontinued and is not referenced in M 323 or R 35 since 2008.
- TP 71; evaluation of Superpave gyratory compactor internal angle of gyration using simulated loading. This test protocol now has a precision statement.
- NCHRP 9-29; Asphalt Mixture Performance Tester (AMPT). Four new related provisional standards have been published (TP 79, PP 60, PP 61, and PP 62).

Harvey gave a summary of important dates for this publication cycle (December 2009 – all ballots completed; results from ballots returned to technical chairs by January 2010; any revisions to standards due by February 2010; published standards available by July 2010). The following is a summary of the status of specific standards.

- T 209; Determination of Voidless Unit Weight. Negative ballots received and a compromise was made to address those negatives. Some discussion about getting rid of the hand agitation, however, standard was revised to allow both manual and mechanical agitation. Separate precision statements will be prepared. The precision statements will be based on the results and data from Azari's project.

- TP 79; Determining the Dynamic Modulus and Flow Number for Hot Mix Asphalt (HMA) Using the Asphalt Mixture Performance Tester. Only minor comments from the ETG and ballot. These included adding notes concerning the venting of the sample to atmospheric pressure and the note about air void tolerances was moved to text and is mandatory.
- PP 60; Preparation of Cylindrical Performance Test Specimens Using the Superpave Gyrotory Compactor. Much previous discussion this, but now has been accepted.
- PP 61; Developing Dynamic Modulus Master Curves for Hot-Mix Asphalt Concrete Using the Asphalt Mixture Performance Tester. Note 2 on air void tolerance moved to the text and is mandatory.
- PP 62; Developing Dynamic Modulus Master Curves for Hot-Mix Asphalt Concrete. Note 2 on air void tolerance moved to the text and is mandatory.

2011 Publication Cycle: Harvey reported items that need to be discussed and any additional suggestions need to be included now to enter into the process for AASHTO. For these items, he needs any additional ETG recommendations by April, 2010 to have sufficient time so that action can be taken on any item (technical section ballots are due by June 2010; SOM meeting scheduled for August, 2010 in Madison, Wisconsin; SOM ballot items due by October, 2010; ballot issued in November, 2010). The following are those standards that have input for this publication cycle.

- T 312; SGC Mold Wear. Harvey did receive the ETG's input and added an annex to the procedure for measuring mold tolerances.
- T 166; Specific Gravity. Harvey did receive ETGs input on action from the specific gravity task force. Frank Fee mentioned that if there are any additional questions or comments these need to be passed on now to the ETG or task group. Harvey believes that this will be a very controversial issue.
- T 62; Dynamic Modulus. This one is 8 years old, and will expire or will need to be converted into a full standard. Harvey will put this onto a technical ballot. Bukowski noted that there were a lot of issues on this one, because the TP62 equipment is different than for the AMPT. Harvey just needs to identify any remaining issues that may have come up from users. At this time it is recommended to keep as a standard. Harvey noted that some of the new and old standards that are being used by the research community and need to be retained, even though little input from outside the research community. Harvey reported that he appreciates the ETG helping and assisting with these types of standards so that they are available to the researchers and universities.
- TP 79; Dynamic Modulus and Flow Number. Harvey received recommendations for calibration procedure. Section 8 was revised and that the 4-page annex was added which is now mandatory. If nothing changes from this meeting, Harvey will go ahead and prepare a technical ballot on this one.
- Refinement of 4.75 Mix Design Criteria. Randy West (NCAT) reported that there is ongoing work relative to this item and recommended that this be included as an agenda item at the next ETG meeting for a report on any modifications to the current AASHTO specifications.

Harvey summarized information and proper protocol for use with proposed AASHTO Standards and use of the AASHTO template or logo. Harvey noted that some reports and documents

contain the AASHTO logo and refer to provisional standards that have never been submitted to AASHTO for review. Harvey recommended that a statement be included in those reports to identify that AASHTO has not yet reviewed this item and is in the development/review process. These statements should identify the origin and status of the proposed standard. Harvey provided an example within his presentation on this topic.

#### **4. Update on Related NCHRP Activities—Edward Harrigan (NCHRP)**

Title of Presentation: *NCHRP Update on Applicable Projects*

Summary of Presentation/Report:

Ed Harrigan welcomed everyone to the Beckman Center. All projects included in his presentation are related to asphalt mixtures. Harrigan reported that many of these have been completed or will be completed within the next 6 months. He encouraged everyone to submit potential project statements for interesting issues and problems to be investigated through NCHRP. Rick Harvey also mentioned that any suggestions for projects should have the appropriate subcommittee name attached to it because it will then receive a higher priority and assistance in moving that suggestion forward to a funded project. Harrigan affirmed and acknowledged that item and suggests that the AASHTO subcommittee, ETG, and individual agencies be identified as supporters where appropriate to increase its chance of getting sponsored through NCHRP/TRB.

Harrigan reported that NCHRP 9-26A is an on-going project specifically to assist in preparing precision and bias statements, as well as for other activities in developing standards. He complimented Haleh Azari and her colleagues. Harrigan gave a brief overview and status report on those NCHRP projects related to the HMA mixture area.

#### Quality Control or Assurance Area

- NCHRP 9-22; Performance Related Specification for HMA. This project has been on-going since 2000; the scheduled completion date is July 2010. Fugro Consultants is the prime contractor, with ASU a subcontractor. Harrigan reviewed this project and noted that this will be one of the topics covered during the demonstration workshop on Thursday. This project will be extended to NCHRP 9-22A (Facilitating Implementation of the QRSS) to demonstrate its use for new projects across the U.S. The scheduled completion for NCHRP 9-22A is March 2012.
- NCHRP 9-48; Field versus Laboratory Volumetric and Mechanical Properties. Louay Mohammad at LSU/LTRC is the principal investigator on this project. The scheduled completion date for this project is January, 2012.

#### Mixture Design Area

- NCHRP 9-29; Simple Performance Tester for Superpave Mix Design. Advanced Asphalt Technologies is the prime contractor for this project. The AMPT equipment is now commercially available and the ruggedness testing of E\* test method has been completed. The last effort or activity of this project is to determine the precision and bias statement for the AMPT. The scheduled completion date is September, 2010.

- NCHRP 9-33; A Mixture Design Manual for HMA. Advanced Asphalt Technologies is the prime contractor for this project. In summary, the product from the project will be an update to the Asphalt Institute SP-02 manual. The additional information covers refinements in the procedure and includes volumetric criteria from a number of projects. It also has specific sections for the design of HMA with RAP, SMA (gap graded mixtures), and use of the new MEPDG for evaluating asphalt mixtures and to integrate mix and structural design. The scheduled completion date is September, 2010.
- NCHRP 9-46; Improved Mix Design for HMA with High RAP Contents. NCAT is the prime contractor and Andrea Kvasnak is the principal investigator. Results from this project are to adapt AASHTO R 35 (Superpave Volumetric Design for HMA) to high RAP mixtures, include performance-related tests and specification criteria and estimates for durability, and develop practical guidelines for RAP management and processing similar to NAPA QIS 124. The scheduled completion date is October, 2010.

#### Warm Mix Asphalt

- NCHRP 9-43; Mix Design Practices for Warm Mix Asphalt. Advanced Asphalt Technologies is the prime contractor. Ray Bonaquist is the principal investigator. The product from this work is a mixture design procedure for WMA. There is a draft mixture design manual that has been reviewed. The scheduled completion date for this project is October, 2010.
- NCHRP 9-47A; Properties and Performance of WMA Technologies. NCAT is the prime contractor and Andrea Kvasnak and Brian Prowell are the leaders on this project. This project is just getting started. The scheduled completion date is January, 2013.
- NCHRP 9-49; Performance of WMA Technologies: Stage I – Moisture Sensitivity. The prime contractor for this project has yet to be awarded. The two objectives of the project are to assess whether WMA technologies adversely affect the moisture susceptibility of flexible pavements, and develop guidelines for identifying and limiting moisture sensitivity in WMA pavements.

#### Mixture Design

- NCHRP 9-30A; Rutting Performance Model for HMA Mix and Structural Design. Applied Research Associates is the prime Contractor and the final project meeting with the panel was held in December. Harrigan briefly overviewed some of the results from this project. Asked if any changes were going to be made to the MEPDG documents and software currently being developed through AASHTO. The MEPDG version 9-30A will be made available for evaluation.
- NCHRP 9-38; Endurance Limit of HMA Mixtures to Prevent Fatigue Cracking in Flexible Pavements. This project, conducted by NCAT is complete and is documented in NCHRP Project #646.
- NCHRP 9-44; A Plan for Validating an Endurance Limit for HMA Pavements. Advanced Asphalt Technologies was the prime contractor, which developed a plan to validate the endurance limit. The report for this project is published online as a web document.
- NCHRP 9-44A; Validating an HMA Endurance Limit: Laboratory Experiment and Algorithm Development. A contract was awarded late last year to ASU to implement the plan from NCHRP 9-44. The purpose of this project is to carry out the lab experiment for

bottom-up fatigue cracking that can be incorporated into the MEPDG. The scheduled completion date is February, 2012.

#### Other Tests and Procedures

- NCHRP 9-39; Determining the Mixing and Compaction Temperatures of Superpave Asphalt Binders in HMA. The project was completed by NCAT. The project is documented and published in NCHRP report #648.
- NCHRP 9-45; Criteria for Mineral Fines Used in HMA. The University of Wisconsin at Madison is the prime contractor. The purpose of the project was to develop test procedures and specification criteria to characterize the performance of mineral fillers or mixes of binder and mineral filler. This project will also be included in the workshop on Thursday morning. The scheduled completion date is June 2010.

**ACTION ITEM #1: Ed Harrigan is requested to provide the recommendations from the NCHRP 9-39 project related to mixture and compaction temperature for review at the next ETG meeting and subsequent referral to the AASHTO SOM.**

#### **5. SGC Mold Wear Procedure Status Report**—Jim Musselman (Florida DOT) and Erv Dukatz (Mathy Construction)

Presentation Title:     *Annex 1 – Evaluating Superpave Gyratory Compactor Molds*

#### Summary of Presentation/Report (verbal report):

Erv Dukatz led the discussion. Rick Harvey included this topic in his presentation on the AASHTO standards update. In summary, Harvey received the ETG's recommendation and added an annex to the procedure for measuring mold tolerances (T 312). The additional point made by Dukatz is that the sequence of using the 4-legged bore gauge must be strictly implemented and requires training. Training is important, and if the sequence is done properly, the procedure is very quick.

#### ETG Comments, Questions, and Discussion:

Rick Harvey had a question that may come up in the ballot – were all of the internal angle measurements made and run within the test program? Dukatz noted that they were not run on all molds; they were just trying to get the molds accepted. Dukatz noted that it does not take a lot of time; but must have sufficient mixture available. The document submitted tells the user what the issues are and provides guidance on how to make the decision to resolve any issues.

Kevin Van Frank asked how big is the mold variation. Dukatz reported that for the 150.00 mm mold they found or determined that once wear occurs beyond 0.02 mm problems/differences will occur.

#### **6. Semi-Circular Bend (SCB) Mixture Test**—Mihai Marasteanu (University of Minnesota)

Presentation Title:     *Standard Method of Test for Determining the Fracture Energy of Asphalt Mixtures Using Semi Circular Bend Geometry (SCB).*

Summary of Presentation/Report:

The presentation was divided into two parts. The first part was on the background and history of the test procedures themselves, while the second part was focused on interpretation of the test data.

Mihai Marasteanu started with an overview of the background for this test standard for improving the low temperature cracking prediction model. The initial concept was envisioned from Pool Fund Study #776; investigation of low temperature cracking in asphalt pavements. He clarified and acknowledged that the SCB was developed as part of an NCHRP IDEA project, and the plan is to take the test method and specification to AASHTO. The purpose of this report is to discuss the test method and specification.

Marasteanu had prepared a proposal for the SCB test method and distributed it to the ETG for comments. Marasteanu received comments from only a few members. He is in the process of responding to those comments.

The mixture tests performed included the semi-circular bending (SCB) and the disc-shaped compact tension test, DC(T). The DC(T) has already been approved as ASTM D 7313. Marasteanu identified some of the issues with the SCB method, which include;

- Size effects; 25 mm thick specimen for mixtures with NMAS up to 19 mm
- Stress intensity factors based on linear elastic fracture mechanics, especially for heterogeneous mixtures
- Slow loading rate effects that can be significant
- Convex loading head

Marasteanu presented the test standard, “Determining the Fracture Energy of Asphalt Mixtures Using the Semi Circular Bend Geometry (SCB).” Marasteanu noted the allowable test temperature range that is provided in the standard. He overviewed details of the test procedure and why they were included in the standard. Marasteanu summarized the test procedure in terms of how to apply the load, how to apply the seating load prior to the test load, and how to stop the test. He showed the equation that is used to calculate fracture energy. Marasteanu asked for any additional comments from the group on the test standard and specification.

ETG Comments, Questions, and Discussion:

Geoff Rowe asked about the magnitude and stress loading condition, and punching of the specimen from the loading head. He is also concurred that the test temperatures were low, he does not believe the concerns to be significant. Marasteanu reported that there is no precision and bias statement for the IDT or this test method in providing inputs to the MEPDG. Noted concern on the plus 10°C test temperature side. that you may miss some of the toughness part of the mixture or miss some of the critical information to determine mix toughness. Concern was related to stopping at the peak load – where issues may start. In addition, if you go to a higher temperature or lower strength, the material becomes more ductile, but you want to quantify the brittle properties at the lower temperatures. There was more concern about the lower temperature of PG+10°C from a number of ETG members. Rowe was concerned about missing critical information at the transition temperature from ductile to brittle temperature conditions.

Frank Fee asked for a description of the test equipment. Marasteanu replied that the equipment description is available in the test standard. The standard was written as an AASHTO standard. Marasteanu went on to say that you need a closed loop axial loading device. In preparing the test standard, he followed what had been done for the IDT test.

Fee noted that he did not see anything about air voids in the test procedure. Marasteanu replied that they did not provide that information in the method, but recommended that the air void used was the air void level being used for other mixture tests at design. Noted air void level will be important, so may need to be addressed in the standard.

Richard Kim noted that the test method refers to and uses a biaxial state of stress and asked how these results compared to the values reported by others using the IDT in terms of fracture energy, as originally proposed through the SHRP. How does this impact the fracture energy. Marasteanu noted that this comparison was looked at and the fracture energies compared very well between the test methods.

This initiated a lot of discussion in terms of the differences and similarities between the different test methods or standards and how fracture energy is determined between those methods. The common issue discussed was whether linear elastic fracture can be used for low temperature cracking. A conclusion reached at the University of Illinois (Bill Buttlar) is that linear elastic fracture cannot be used.

Frank Fee asked the future for this topic and what is the action is needed. Marasteanu noted about distributing the standard and specification to the ETG, which was done after the last ETG meeting. Marasteanu is developing an index type test that can be used to evaluate mixtures relative to low temperature cracking. Bill Buttlar is examining a possible recommendation for the use of the cohesive zone model in the MEPDG, and the need for fracture energy which is different from the Paris fracture mechanics type of approach that is embedded in the MEPDG. Raj Dongre commented that the SCB test does not account for the higher deformation materials.

Marasteanu requested feedback from the group on potentially where this can be used such as for high RAP-based mixtures.

**ACTION ITEM #2: ETG members are asked to review the Semi Circular Bend procedure and provide their comments directly to Mihai Marasteanu.**

**7. AMPT Flow Number Test Task Group Report**—Ramon Bonaquist (AAT)

Task Group Members: Ramon Bonaquist, Haleh Azari, Phil Blankenship, Audrey Copeland, Elie Hajj, Kevin Hall, Richard Kim, Nam Tran, Raj Dongre, Kevin VanFrank, and Harold L. Von Quintus.

The proposed work plan and matrix were distributed to all ETG members regarding the flow number test for judging the acceptability of HMA mixtures for rutting. Ray Bonaquist will present the work plan and matrix and will be followed by presentations from individuals on specific procedures being proposed to evaluate HMA mixtures for rutting.

Presentation Title #1: *Work Plan for Evaluation of Flow Number (Repeated Load Test) Criteria for Asphalt Concrete Mixture Design*

Summary of Presentation/Report:

Ray Bonaquist presented an overview of the issues regarding the flow number tests. The key issue is that there is insufficient data in the published data to decide on one particular procedure. Bonaquist reported that the goal of this study is to reach a single testing procedure for flow number. The task group is to produce a document on how to perform the flow number test (or repeated load permanent deformation testing) with an emphasis on mixture design using the AMPT. Ed Harrigan earlier in the day noted that NCHRP Project 9-26 will be conducting some of this effort and also noted that AMRL and possibly the Asphalt Research Consortium.

Bonaquist presented the screening study proposed experiment plan and matrix for evaluating the different procedures. The plan included the traffic level and standard binder grade, in different environments or climates. Bonaquist reviewed the procedure in terms of how the task group will decide on the testing conditions and data interpretation that will be used – amount of error, ranking of the different mixtures, does the data interpretation pick up the difference between the different mixtures.

Bonaquist presented the proposed schedule of activities and issues.

- Is proposed screening study acceptable,
- Identify nine mixtures that can be used and material sources,
- How to sample and ship materials,
- Action on recommendations from the study?

ETG Comments, Questions, and Discussion:

Some concern was noted about the experimental design. Finding nine mixtures, especially for the 30M EALs loadings may be a problem. Bonaquist replied that the PG mixture will vary between the traffic levels. RAP is excluded from the experiment. Two labs will fabricate the test specimens.

Bonaquist noted that the expectation for this matrix is to identify mixes with good performance and to identify differences between each of the mixes related to traffic level. To include mixes with poor performance history related to rutting would be too costly for this pool funded screening study – to identify an adequate approach or narrow down the different approaches. It is hypothesized that higher traffic requires mixtures with greater aggregate requirements. In selecting the nine mixtures, these would be selected to result in different aggregate mixtures for specific traffic levels.

Also commented that highway agencies will not know about the aggregate differences related to traffic planned for this study, and that need to go to the suppliers or contractors to actually design these mixtures. Bonaquist noted the task group plan is that he mixes could be identified by the ETG members to fit within this experimental matrix. It was noted that these mixtures will be restricted to surface mixtures.

Presentation Titles #2 - #6: *Description of Individual Procedures for Rutting Using the Flow Number Test*

After the discussion, questions and comments related to the overall experimental test plan and matrix, Bonaquist then introduced the five presenters for using results from the flow number test for evaluating HMA mixtures for rutting resistance. Presentations included a brief overview of the approach, testing conditions (aging requirements), relationship between parameter and rutting performance, and criteria development for each approach. The following is a listing and brief overview of the five procedures that were presented. Details of each procedure are included as appendices in the work plan that was distributed to the ETG, as reading material.

1. **NCHRP 9-33:** Bonaquist overviewed the procedure and criteria that was put together by Don Christiansen for the NCHRP 9-33 procedure. Approach is documented in NCHRP Report #567.
2. **NCAT Approach:** Nam Tran presented the NCAT procedure that they are recommending from the test track data. This procedure is based on the rate of rutting relative to the flow number. Data from 16 test sections around the NCAT test track were used to develop the proposed evaluation criteria.
3. **NCHRP 9-30A:** Harold Von Quintus presented an overview of the procedure under NCHRP 9-30A. This procedure does not use flow number but is based on the slope and intercept from repeated load permanent deformation testing using the AMPT. It uses the representative or equivalent temperature concept with the exception that the representative temperature is determined from the MEPDG. LTPP SPS test sections were used to develop the recommended criteria for judging the mixture's rutting resistance and to calibrate the MEPDG transfer function for rutting.
4. **UNR Approach:** Elie Hajj provided an overview of the procedure being developed by UNR under the ARC. He reviewed the critical condition concept being used to determine the testing condition which is dependent on the location of the mixture, as well as traffic speed or facility type. Hajj showed and summarized the different equations that are used to evaluate the mixtures.
5. **NCHRP 9-26 Approach:** Haleh Azari with ARML provided an overview of the procedure that is based on the minimum strain rate (MSR) using multiple temperatures, deviator stresses, and loading rates.

Nelson Gibson was asked to also prepare a presentation on the on-going work and tests that have been completed at the FHWA ALF in terms of rutting. This presentation will be made later in the meeting.

**ACTION ITEM #3. Frank Fee and Ray Bonaquist will attempt to obtain suppliers to provide materials to fill all the cells in Table 2 – of the experimental plan for the Flow**

**Number evaluation effort, as presented at the meeting. If this is successful, the experiment will proceed as planned.**

Chairman Fee adjourned the meeting at 5:20 PM.

## **DAY 2: Wednesday, February 24, 2010**

Chairman Fee called the meeting to order at 8:00 AM.

Frank Fee noted that the first item on today's agenda is a continuation of the presentations and discussions from yesterday. The goal of this effort is to provide a method that can be used, after the volumetric design has been completed, to confirm that the mix will not rut. Right now, the plan is to take a threshold value and confirm the mix resistance to rutting. The purpose is to close out NCHRP 9-33 with a flow number test. The purpose of this work plan is to put an experimental matrix together to select the best flow number test and interpretation of data from repeated load permanent deformation tests.

Bonaquist noted that each of the methods presented yesterday has an element to fulfill in terms of what Fee was discussing. Bonaquist summarized each of the approaches and how they relate to the objective and criteria that Fee discussed. He believes that all are relatively easy to implement at some level. Each has some methodology that can be incorporated into the mixture design area. Bonaquist requested the ETG provide or identify potential mixtures that can fill the sampling matrix.

Randy West mentioned work done at NCAT years ago and the issues they had with unconfined tests. He wanted to know if those results (unconfined tests) should be addressed here, especially for SMA mixtures. Frank Fee noted that that both unconfined and confined tests were included in this testing plan. Bonaquist also replied that those issues will be considered and that SMA mixes can be one of the mixtures selected. He noted that SMA mixes will not be excluded, but SMA mixes will have stiff binders – not a PG64 type binder.

### **8. AMPT Flow Number Testing—Nelson Gibson (FHWA)**

Presentation Title:     *MEPDG Rutting Prediction with Flow Number Permanent Deformation Curves*

#### Summary of Presentation/Report:

Nelson Gibson identified the results of recent ALF efforts:

- Same ranking of mixtures observed in ALF rutting experiment with unconfined and confined flow number tests. (This contradicts some of the observations and comments made yesterday by ETG members on the value of confinement testing).
- Incorporating flow number tests in MEPDG improves predictions of HMA rutting.
- Impact of temperature exponent in MEPDG transfer function seems minimal but not well understood.
- Larger deviator stress may favor better rutting predicted at lower temperatures.
- Smaller deviator stress may favor better rutting predicted at higher temperatures.

Motivation for this study using the ALF at FHWA was based on observations that the rut depths predicted by the MEPDG were unrealistic. It was hypothesized that using mixture specific permanent deformation parameters would increase the accuracy of the transfer function. Gibson announced that the Models ETG meeting is sponsoring a workshop on fully mechanistic analyses for predicting rutting at next year's TRB meeting and wanted everyone to be aware of that workshop.

Gibson showed the variability of measured rut depths and repeatability of the flow number test. Gibson's point is that you get more accurate rutting predictions using realistic mixture test data, as compared to using the global calibration values for all mixtures. He showed high rut depth predictions that exceed the maximum rut depth calculated by the MEPDG.

Gibson's final point is that need to performance test mixtures. Gibson's opinion is that confining pressure is not that important and he had the same pecking order regardless of using confined or unconfined flow number tests. AAPT paper from last year is a good source for this data; multi axial behavior of mixtures.

ETG Comments, Questions, and Discussion:

Frank Fee asked if rutting included in Gibson's presentation include rutting in the unbound layers. Gibson answered that the rut depths shown in his presentation only includes rutting in the HMA layers. He noted that rutting between the HMA and unbound layers was 50-50 or about equal.

Gibson distributed a survey questionnaire seeking response for the next full scale pavement testing at the ALF. This input will help with future plans of FHWA's ALF.

**ACTION ITEM #4 ETG members are asked to provide feedback to Audrey Copeland on potential areas to study under the next FHWA Accelerated Load Facility (ALF) project.**

**9. Report on IDT E\* Ruggedness Testing Plan – Richard Kim (NCSU)**

Presentation Title: *Ruggedness Testing for IDT E\* Specification*

Summary of Presentation/Report:

Richard Kim noted that his presentation was to respond to questions and comments from the last meeting on the plan for determining the ruggedness of the IDT.

Kim started with reporting on their verification of E\* from IDT testing in comparison to the standard E\* uniaxial testing method using 24 different mixtures from NCDOT and with additional mixtures from FHWA, 9 mixtures with different aggregate characteristics. Kim showed some examples from this data on comparing the E\* values from both tests (TP 62 to the IDT). He concluded that the E\* values are statistically the same as from TP 62.

Kim explained he was looking into using the IDT test for measuring E\*. The basic reason was for forensic investigations and field studies where field cores are typically only 1 to 2 inches in height.

The second objective of Kim's presentation was to review the different factors considered in developing the ruggedness study for the IDT using ASTM C 1067, Standard Practice for Conducting Ruggedness or Screening Programs for Test Methods for Construction Materials. Kim noted and reviewed the different items that were considered in the plan.

Kim identified the different type of devices and reviewed some of the problems with each. His team decided to use the two column device since they believe that was the best. Kim overviewed the specification factors and experimental design parameters. He explained why those parameters and their range of values were selected for the experiment. The plan considers 8 different combinations of parameters. He also overviewed the different type of mixtures, and reported that all test specimens will be fabricated at ARML.

Kim acknowledged that NCSU, FHWA, NCAT, and ARML have all volunteered to do the testing under this plan.

#### ETG Comments, Questions, and Discussion:

Frank Fee asked if the plan was now ready to be moved forward. Kim answered; yes, as soon as the mixtures have been identified.

Comments were noted about the difference between the target or design air void content and field air void content, in terms of which air void content will be used to compact the laboratory test specimens. Kim agreed with using a higher air void content, but noted that air void is not a part of the experiment. A higher air void content may capture more variability in the test results.

Kim confirmed that Ed Harrigan has asked ARML to supply the mixtures. Harrigan noted that the ruggedness plan is different from the flow number plan because contractors are supplying those mixtures. Harrigan suggested that this plan would need to wait until the mixtures have been selected for the low number study. Kim acknowledged that having E\* values on the flow number mixtures might be good, so they will wait.

ARML will only prepare the specimens for all cells but that the four volunteer organizations will do the actual testing.

Asked if any work been done to confirm the differences in air voids or difference between the target/design air void of 4 versus a field value of 7 percent. Kim answered that he used up to 8 percent and down to 4 percent and they compared very well. Todd Lynn asked whether the experiment should be expanded to include an additional air void level – is the variability the same at different air void levels because the bulk of work was done at 7 percent. Kim mentioned that this work is related to forensic investigations where the air voids are lower. There was discussion on what air void level should be used for the experiment; the target or field air void level after construction? Kim may decide to use this as one of the experimental parameters.

Raj Dongre asked about working this into the current AMPT so that you do not have to purchase additional equipment. Kim agreed that this may be possible.

Another question related to understanding that the ruggedness test or plan is to consider parameters that the equipment can withstand, so should we open up the variability in selected parameters? Kim explained the value of the experiment in identifying the parameters based on the current specifications.

Ray Bonaquist reminded everyone on the purpose of this experiment, and to think about how this will be used in the field. Bonaquist noted that you are going to discard many specimens because of the 0.5 percent requirement. Bonaquist's opinion is that air voids will be a more important factor than you can control in the laboratory. Randy West thought that was the purpose of the ruggedness test. Bonaquist went through this process with the E\* test using Matt Witczak's data.

Kim noted the purpose is to find out what parameters need to be controlled tighter because of the effect on the test results.

**ACTION ITEM #5: Richard Kim will proceed with the IDT E\* ruggedness effort as presented at the meeting, any additional comments should be forwarded directly to him.**

#### **10. Fatigue Testing Task Group Report – Richard Kim and Shane Underwood (NCSU)**

Presentation Title:     *S-VECD Fatigue Test Protocol and Analysis Software*

Summary of Presentation/Report:

Richard Kim reported that the draft S-VECD Fatigue Test Method and Analysis Protocol (Simplified Visco Elastic Continuum Damage) was sent to the ETG before the meeting as reading material. Kim expressed a concern that the AMPT equipment may not have the capability for testing strong mixtures.

Kim overviewed the reasons and evidence for using the S-VECD parameters for estimating fatigue properties and damage to specimens. The following is a summary of the points provided by Kim within his presentation:

- Why S-VECD -- It permits:
  - Prediction of fatigue performance at different loading conditions from a test at a single actuator displacement amplitude and single temperature.
  - Prediction of the endurance limit.
  - Combination with a pavement analysis model to predict fatigue performance.
- What do we need to measure?
  - Dynamic modulus and phase angle.
  - A unique damage characteristic curve for each mixture.
- How to measure the parameters?
  - Use the AMPT
  - S-VECD test protocol and Amy fatigue software for data analysis.
- What can we do with it?

- Determination of tensile strain-based fatigue life in both controlled-stress and controlled-strain modes.
- Determination of fatigue endurance limit.
- Prediction of fatigue life and performance of flexible pavements.

Kim noted the test protocol and then asked Shane Underwood to explain the test protocol and analysis software.

Shane Buchannan gave the second part of this presentation, which was an overview of the S-VECD test and analysis protocol. He requested input or feedback from the ETG on the analysis software. Buchannan reported that they had not looked at the TP 79 protocol. Agree to review to remove any overlap between the two test protocols. Underwood noted that there are 4 appendices that go with the test protocol that walk the user through the process on how to handle the data, what data should be gathered, and how to gather it [as discussed by Kim in the first part of the presentation]. The protocol also provides recommendation on the minimum data needed.

Underwood demonstrated the program (Asphalt Mixture Analysis Fatigue Model). He used test results from TP 62 test for the demonstration. The software also allows you to make predictions of fatigue life for different conditions. The software has different fatigue transfer functions built into the program.

Richard Kim reiterated that the software or analysis protocol has 4 appendices that describe the technology behind the software. Fee suggestion was to distribute the software and information to the ETG and asked Kim put together the questions he wants answered and issues to get feedback from the ETG and send those out with the software.

**ACTION ITEM #6: Richard Kim has asked for input on his VECD analysis software. A new ETG task group (West, Reinke, Scarpas, Rowe, Daniels, Bennert, Gibson, VonQuintus, Mogawer) was formed to accommodate this. Richard Kim will provide the spreadsheet for the protocol or analysis software and a list of specific questions for the TG's input.**

## **11. Short-Term Conditioning of HMA Mixtures – Haleh Azari (ARML)**

Presentation Title:     *Effects of Short-Term Conditioning on Asphalt Mixture Performance*

### Summary of Presentation/Report:

Haleh Azari reminded the ETG that this relates back to the Minimum Strain Rate (MSR) concept that was presented yesterday, as part of the AMPT flow number task group. The purpose of this presentation was to show some results from their work on the effect of condition time on laboratory simulations, the effect of conditioning temperature on laboratory simulations, and the effect of short-term conditioning on long-term performance estimated in the laboratory.

Azari selected the MSR as the parameter directly related to rutting performance through the flow number. She showed the effect of conditioning time and short term conditioning temperature on the MSR. The presentation and work was focused on what type of conditioning should be used in

making the test measurements. She also provided some future study recommendations; conditioning time between plant and laboratory, effect of conditioning time on mixtures with absorptive aggregate, quantify the effect of conditioning temperature, correlating conditioning time and temperature with long-term aging, and evaluate the effect of conditioning on fatigue.

**ACTION ITEM #7: Haleh Azari is requested to provide a copy of the interim AMRL report on mixture aging/conditioning impact on testing of E\* and Flow Number. This will be distributed to the Group for review.**

**12. Construction Task Group Report** – Cindy LaFleur (Callanan Industries) and Mark Buncher (Asphalt Institute)

Frank Fee reported that two presentations will be given from the task group. The first will be on in place density practices and specifications by Cindy LaFleur and the second will be on longitudinal joint construction best practice by Mark Buncher.

Presentation Title #1: HMA Field Density In Place Practices and Specification; Construction Task Group Report

Summary of Presentation/Report:

Cindy LaFleur acknowledged all members of the task group (Mark Buncher, Erv Dukatz, Julie Kliewer, Todd Lynn, Jim Musselman, and Judie Ryan). She acknowledged Chris Euler with NYSDOT for providing data to the group.

LaFleur gave the background and focus for this task group (integrate construction issues into the Mixture ETG), and mentioned Judie Ryan's comment of "industry being unable to reliably construct an HMA pavement even with all of the new technology." She summarized the action items that have been completed and outlined the current activities of the task group.

LaFleur noted some of the Superpave Mix Design changes that NYSDOT made in 2006. NYSDOT has not seen significant differences in mixture volumetric properties. She overviewed data provided by NYSDOT; frequency distributions, lot averages, and standard deviations have changed over time. She showed a summary of the effect of these changes on the average lot density variability (standard deviation) since 2006. She also showed the frequency distribution of the average lot density over time, and presented both how the mean values and standard deviations have changed over time. NYSDOT uses a PWL type specification related to density.

LaFleur identified and listed the conclusions based on NYSDOT experience related to density of HMA and AASHTO R-42. The conclusions were:

- Mix changes have lead to real improvements in density levels in New York (no widespread rutting failures).
- Standard deviation has improved at the higher compaction levels.
- AASTHO R-42 standard deviation from roadway cores is sufficient; thus, compaction ranges of 2.0% from the target value are appropriate.

ETG Comments, Questions, and Discussion:

Asked from where the maximum theoretical specific gravities for the specification data were obtained? LaFleur replied that these are provided each day from samples recovered during construction. Three samples per day production.

Noted that one of the action items in the minutes from the last meeting was to pull together a synthesis on this topic. Fee does not remember anything being done recently in the area. He suggested a synthesis, in terms of what is being done. Judie Ryan asked; how do we evaluate the effect of changes that are going on right now in the lab, and how those changes impact construction. The group decided that they will continue to meet and go forward with this topic. Fee commented that he believes the idea of a synthesis on what is going on related to construction is still a good idea and suggested that the task group consider it as an action item.

Rick Harvey suggested doing the synthesis through NCHRP. Fee agreed with that suggestion and approach. Fee requested that the group consider this suggestion to identify what data is missing and how to go forward, and volunteered to work with them on this topic. Kevin Hall thought Fee meant; how is density measured? Fee was really talking about how is density measured and accepted.

Louay Mohammad noted that they collected a lot of information and data from states under NCHRP 9-48. He asked Ed Harrigan if the interim report could be sent out after the panel has reviewed it. That was agreeable to Harrigan.

**ACTION ITEM #8 The ETG task group on construction is asked review and if needed prepare a proposal for a potential TRB/NCHRP synthesis of practices to measure and accept in-place pavement density.**

Presentation Title #2: *HMA Longitudinal Joint construction Best Practices; Co-Operative Effort Between AI and FHWA*

Summary of Presentation/Report:

Mark Buncher reported on the task order under the cooperative agreement between the Asphalt Institute and FHWA for preparing a document of best practices for specifying and building longitudinal joints. He acknowledged Tom Harman's effort on helping to improve longitudinal joints.

Buncher focused his presentation on answering the question why this is needed? During the presentation, he acknowledged Dave Newcomb's effort through the Asphalt Pavement Alliance on his effort related to perpetual pavements and factors that are limits to "perpetual." Newcomb noted that the number one threat to early rehabilitation was longitudinal joints.

Buncher listed the project activities. He mentioned the survey was completed and reported at the last ETG meeting. The survey was a good starting point, but no definitive answer to many questions. Buncher grouped most issues under two categories: what we know and things we don't know. He listed the expert consultants and contractors that will be interviewed to answer or quantify those issues.

Buncher overviewed many of the issues related to placing and rolling a longitudinal joint and the different opinions on those issues. He ended his presentation with a review of the task group's plan for the final report and their final recommendations on placing and rolling a longitudinal joint. Buncher mentioned that a workshop is being planned at the next TRB meeting on longitudinal joints. This workshop will focus on specifications for longitudinal joints but not so much construction. Buncher recommended that this effort should be coordinated with the ETG's construction task group.

ETG Comments, Questions, and Discussion:

Randy West agreed that this is an excellent topic and thanked the ETG for taking on this topic. One of his specific comments; there have been projects in the past and believes that it would be a good idea to follow up on those projects. West asked; is it air voids or is permeability the more important property that should be measured. Buncher agrees that permeability is important, but how do you accurately measure it for acceptance.

**13. E-Circulars Status/Remaining Issues**—Randy West (NCAT) and Kevin Hall (University of Arkansas)

Presentation Title #1: *Specific Gravity Task Group Status Report*

Summary of Presentation/Report:

Randy West noted that he is giving a report on what has happened since the last ETG meeting. He thanked Kevin Hall for giving the report at the last meeting in his absence.

West overviewed the action item from the last ETG meeting (summary of recommendations on specification changes), and is giving an update on that action item. West noted that the document or summary of recommendations was submitted to the group as part of the reading materials for this meeting. For completeness and the minutes, West presented the recommendations, their rationale, and discussion. There were three basic recommendations, which were:

1. AASHTO T 166; delete AASHTO T 275 from sections 2.1, 6.3, and 9.3 and replace with AASHTO T 331.
2. AASTHO T 166; change water absorption limit in sections 2.1, 6.3, and 9.3 from 2.0 percent of water by volume to 1.0 percent of water by volume.
3. AASHTO T 166; replace the incomplete precision statement contained in the current method with the precision estimates recommended by NCHRP 9-26.

ETG Comments, Questions, and Discussion:

Frank Fee mentioned that one goal was to have this document on the web so that anyone can go to it for reviewing and getting a summary of issues related to the specifications, and that has been done. He thanked the task group for putting a large effort in this topic and in preparing the best practices document or circular.

Presentation Title #2: *E-Circular on the Gyrotory*

Summary of Presentation (no presentation, only a verbal report):

Kevin Hall reported that the e-circular on gyratory has been submitted and will be published.

ETG Comments, Questions, and Discussion:

Frank Fee thanked Hall and other members of the task group for getting this completed.

**14. MIST Test**—Erv Dukatz (Mathy Construction)

Presentation Title:     *Status of the MIST Tester*

Summary of Presentation/Report :

Erv Dukatz gave an overview on the status of the MIST Tester. He noted the advantages of the test, but was unsure about significance of individual test values. The test adds a hydrostatic pressure that causes the specimen to dilate during the test. Dukatz reported one of the issues of the test was related to – what is the pressure that should be used, so they ran a mini experiment in trying to determine that pressure. There appears to be an interaction between the pressure, asphalt grade, and other items. Dukatz and Tom Bennert have been considering how this relates to AASHTO T 283 in terms of freeze thaw cycles and other conditions of the test specimens.

Dukatz recommended and suggested to Rick Harvey and Ed Harrigan that this topic could be a project that NCHRP could sponsor.

**15. N-Design Task Group Status Report**—John Bukowski (FHWA)

Summary of Task Group Report :

John Bukowski summarized the intent of this effort and task group in the gyratory compaction area. This effort relates to preparing a document to assist agencies in changing or revising N-design. In other words, the focus of the document is to assist agencies in making any revisions to N-Design. The document will be a technical document to provide guidance on what should be done if an agency is considering lowering the N-design value. The document will be drafted by John D'Angelo, and submitted to the group for review.

Anyone wanting to participate should contact John D'Angelo. The intent of the document is to list the steps and items to consider once the decision is made to change N-Design.

Action Item:

**ACTION ITEM #9: John D'Angelo will prepare for ETG review a draft document to provide technical guidance to agencies for making changes to the N-Design value.**

**16. Superpave Gyratory Compactor**—Chuck Paugh (ESC, Inc.)

Presentation Title:     *Superpave Gyratory Compactor*

Summary of Presentation/Report:

Chuck Paugh overviewed and summarized the routine activities that are completed when the FHWA mobile laboratory is on a project site. He noted the references that are used to check the gyratory compactors to ensure that the results can be compared between different compactors, as

well as the routine internal checks used to verify the calibration and use of the compactors (PP 47-02).

Paugh reported on a recent comparison of different compactors that identified a problem. Paugh's comment was that there are no criteria in judging whether the compactors provide similar results or not. There is no current criterion and since PP 47 is no longer available, his question was; what should be used in comparing different gyratory compactors to determine whether the results from the compactors are the same or different?

Paugh ended his presentation and report with a comment on what recourse is available to agencies to prevent the use of compactors that provide questionable results. Should PP 47 be revisited or reconstituted, add more guidance to T 312, or add an e-circular. These are the questions that need to be answered.

ETG Comments, Questions, and Discussion:

Matt Corrigan summarized some of the issues on this topic. Rick Harvey referred to what Kevin Hall provided in his work and the planned e-Circular, but stated that many agencies would like to see additional guidance and literature on this issue. Harvey was asked what he thinks is the better approach. Harvey replied; if it were a couple of pages, an appendix to the standard would suffice, but if it were longer, it should be a separate standard or document. Harvey noted that we are starting to get different annexes and appendices related to this item, so it may start to get confusing. Bukowski requested comments from the group on this topic, and noted they could assist with writing or developing a technical guide.

Kevin Hall commented that any written document outside of T 312, you still have to consider the precision and bias that is now included in T 312. One reason why the item was included in the discussion was to identify whether it was angle related. Hall believes that this comparison needs to be in T 312. Fee's opinion is that it should be in the standard, but asked if there was a way to get around that if T 312 gets too large.

Hall noted that there are additional gyratory manufactures are coming on the market – he knew of at least one. Hall's lab did the comparison on the new gyratory compactor to provide a report on comparing its results to the standard. Hall believes that both new gyratory and existing gyratory compactors can be handled within the current T 312.

Rick Harvey questioned Azari about this item through ARML. Azari replied that comparing different gyratory compactors was not in the original plan, but the comparisons could be added without any problem. ARML is currently looking at different compactors. Hall's opinion was that ARML has all the data necessary to do this comparison. The issue is mining the data to do this comparison, in addition to preparing and compacting the specimens using different compactors. Azari felt that they have the data to do this. Harvey is unsure whether the precision statement has been revised, since the gyratory angle requirement was added. The existing precision statement was based on results without verifying the internal angle.

Matt Corrigan commented that the current document is excellent but to redo this to ensure you are getting the same result will be a lot of work. Bukowski noted that the effort would be similar

to the effort of mold wear, but maybe now the precision statement needs to be revisited. There was discussion on what data was used to determine the precision of T 312 and whether those parameters are still available. Paugh recommended that PP 47 should be reconstituted for this comparison check.

Sandy Brown noted a similar issue in Ontario. They are looking into the difference between different compactors and the values are different; they are facing this issue right now. Hall asked whether there was a new value for the precision statement for the gyratory - 0.02 was the old number. Azari noted that the new value is 0.017. Paugh had noted a difference of 0.015. So Hall asked; where is the difference, in T 312 or in T 166?

Bukowski stated that this needs more study and information to decide where we go from here. Bukowski requested that the draft document be sent to the ETG for review. Paugh reminded the ETG that this presentation was requested by the ETG to provide additional information. Harvey commented that he just checked and the precision statement for T 312 was still based on the external angle. The standard should be updated to include verification of the internal angle. Paugh thought ARML only has a limited data based on the internal angle requirements. Fee requested that Azari include a check box to add or determine when and how the verification for compactors was based.

**ACTION ITEM #10: Matt Corrigan and Chuck Paugh will prepare a draft for a potential appendix to T312 on the comparability of different gyratory compactors.**

**ACTION ITEM #11: Haleh Azari is requested to have ARML revisit and possibly update the precision statement for T312 considering recent improvements in the procedure and the development of the internal angle measurement. Report back at the next ETG meeting on the effort.**

#### **17. Mixture Planar Imaging Procedure—Enad Mahmoud (Michigan State University)**

Presentation Title:     *Mixture Planar Imaging Procedure*

Hussain Bahia will give this presentation in the place of Enad Mahmoud.

Summary of Presentation/Report:

Bahia acknowledged the sponsor (ARC) and where this work was done – in cooperation between the two universities; Michigan State University and University of Wisconsin at Madison. He acknowledged those that have participated in the work and identified why this is becoming so important in future work.

Bahia is proposing an AASHTO standard for imaging. He noted that his presentation and report will explain why we need this and then provide a draft to the ETG for review.

They initially looked at the importance of aggregate structure and used imaging to try and explain or quantify the structure. The two parameters initially looked at were the aggregate orientation and aggregate contact points.

Bahia summarized the aggregate structure visualization, and listed the different steps in the study and the status of each. The team has completed most of the imaging steps, and the two remaining steps will be completed this year. Bahia reported that the draft standard was submitted to the ETG earlier. They have had other organizations use the software. Most of the issues and problems previously reported have been resolved.

Bahia reported on the outcome from the software that does the imaging analysis. This includes the angle of orientation and estimated gradation. He summarized the software updates that have been made this previous year and showed example output from the software. Bahia noted that his presentation was about presenting a tool that he believes can be very useful – not about which compactor is the correct one to simulate field conditions, but in comparing different aggregate structures.

Bahia noted the web site for which the software can be obtained. He requested some of the ETG members use the software and provide feedback on its ease of use, because only a few have participated in evaluating the software to date.

Bahia presented the draft standard that he mentioned at the beginning of the report. He said that the draft was sent to the ETG members about 6 weeks ago but will resend it to the ETG for review and comment.

**ACTION ITEM #12: A copy of the draft procedure for “Determining Aggregate Structure in Asphalt Mixes by Means of Planar Imaging” will be sent to the ETG members for review and comment to Husain Bahia.**

**18. Gyrotory Pressure Distribution Analyzer (GPDA)—Hussain Bahia (University of Wisconsin at Madison)**

Presentation Title:     *Gyrotory Pressure Distribution Analyzer – GPDA to Estimate Compaction Resistance and Stability of HMA*

Summary of Presentation/Report:

Hussain Bahia gave the presentation and report for Phase 2; Gyrotory Pressure Distribution Analyzer – GPDA to Estimate Compaction Resistance and Stability of HMA.

Bahia summarized the background behind the study, and presented the problem statement and hypothesis. The primary question was whether the SGC can be used to address compactive effort or workability and aggregate interlock or stability of HMA mixtures. The purpose of this presentation is to identify the tool that can be used to determine the stability and workability from the gyrotory compactor densification curves.

Bahia summarized that what we are using the gyrotory for volumetric properties, and those properties do not tell us much about how the mixture is going to perform. However, the gyrotory has the capability to measure other response properties that can be used to evaluate a mixture’s performance. Bahia report included an overview of the forces generated in the specimen during

compaction and showed the GPDA that is placed in the SGC compaction mold to make specific measurements of specimen behavior during compaction.

To demonstrate this issue of compaction resistance, Bahia presented two examples with mixtures produced using aggregate from the same quarry and the same asphalt. The only difference between the mixtures was different gradations. Bahia concluded that the SGC with the GPDA can be used, without modifying the SGC, as a tool for getting a measure of workability and stability in designing HMA mixtures. Bahia's opinion is that none of the current performance tests are good for QA (control and acceptance), and we must use some other test to estimate the stability and workability of the mixture. The GPDA is one device that fits these requirements. His opinion and recommendation was that the GPDA is a potential tool for evaluating the effect of gradation and WMA additives on workability and estimating rutting resistance or stability.

ETG Comments, Questions, and Discussion:

Might be interesting to use to evaluate workability related to WMA. Randy West noted the comparison with the Corp of Engineers device, and mentioned some of the items that NCAT did in comparing the gyratory index and pressures to performance and compactibility of HMA mixtures during construction. West recommended that the work be continued.

Kevin Hall commented that the next generation compactors should be able to look at this and asked Bahia if he compared those devices that have already built this element into the gyratory versus those that have the device external to the compactor. West also mentioned that they found specimen height needed to match the lift height being placed in the field. Bahia concurred that height is very important, but all of his measurements were done at a standard height. Bahia did not go back and answer Hall's initial question.

Roger Pyle, Pine Instruments prepared comments, submitted after the meeting, are as follows:

Dr. Bahia neglected to note in his presentation on the GPDA that the gyratory shear is fundamentally the same measurement. Pine Instrument Company has instrumented Superpave Gyratory Compactors for many years with load cells for measuring the resistance to compaction, also referred to as gyratory shear. Pine has many SGC units equipped with shear instrumentation in service throughout the world. There are a variety of other manufacturer's providing that signal as well. This is not a new concept nor is it new technology. What is new is the means to extract this measurement in the package Troxler has chosen. Gyratory shear as applied in a Superpave Gyratory Compactor is simply a measurement of the tilting moment required to achieve the constant strain (angle of gyration) at a given compaction pressure (force). The GPDA simply measures this tilting moment as compaction progresses. The term  $e$  (eccentric) is used, which can be traced back to John McRae and the Corp of Engineers Gyratory machine. The data can also be presented in a multitude of ways. Dr. Bahia has also chosen to present the data in three dimensional graphical representations but 2 dimensional graphs provide equal information. McRae converted the measured force into a kPa stress value, but the root measurement was a force at a distance, tilting moment. The McRae's machine simply operated in a constant stress rather than constant strain, as Randy West noted in his comment. Whether you use the tilting moment, the stress, or the eccentric, the core information is the same. The shear stress as calculated by McRae normalizes the signal for specimen volume so was a useful way to look at

the data in an absolute form. Some methods look to the change in forces over the compaction curve so this normalization is perhaps not needed. If the area under the curve is used for a work calculation, some type of normalization is required. Dr. Bahia claims that the Troxler device is better since it "resides within the mold". This is a bold statement in that there are quite a number of issues that this configuration raises. Dr. Bahia only noted the wall friction and discounted it as irrelevant. Is the unit properly temperature compensated? Is the side loading presented within a gyratory mold properly accounted? How do you verify the device calibration to ensure it is providing correct information? Over the operating temperature range? Does the unit, in the mold, influence the internal angle such that the compaction density curve is impacted? Density most certainly has an influence on the resistance to compaction. The list goes on. Pine Instrument uses two known tilting-moments (Newton-meters) applied within the mold to calibrate and verify the shear signal. There is no black box. While this system also has advantages and disadvantages of its own, to have no mention of this alternative means to obtain this compaction signal at an ETG presentation is providing less than a complete picture to the group. It is intriguing as to what this type of signal can produce for the industry. Mix stability, workability, QC/QA signals, compactability and other possibilities exist for using this signal, but the GPDA is far from the only way to obtain this information. Idaho DOT is one agency investigating the use of the "shear" signal based on Dr. Bayomy's work at the University of Idaho. There are alternatives for obtaining this signal, which have advantages of their own. The ETG meeting should present unbiased technical information regarding this and other technology applications.

#### **19. Gyratory Lock Point**—Nelson Gibson (FHWA)

Title of Presentation: *Exploratory of Locking Point in the Gyratory for HMA Mix Design*

Summary of Presentation/Report:

Nelson Gibson overviewed the objective of the research. The specific objective of the study was to look into different approaches for gyratory levels in the SGC.

Gibson identified the aggregate quarries used in the study and where they came from (Indiana, Florida, and New York). He overviewed the aggregate properties for each of the aggregate sources and presented a summary of the mixture design with the different aggregate sources.

Gibson reported that this project and Hussain Bahia's project, previously discussed, have a lot of similarities. FHWA is looking at comparing some of the Gyratory compactors with and without the ability to measure shear forces. Gibson mentioned that they are trying to define the locking point or how to define the locking point. He reviewed the concept that was used in evaluating and comparing mixtures to determine the locking point and if that concept was valid. The concept and its use were included in his presentation.

Gibson mentioned that they probably will not come up with a locking point, but rather a locking range. He presented the equipment, visual images, and types of measurements that they are using. He acknowledged that industry has been concerned about using constant volumetric conditions for performance testing, but not so much for mix design. A summary of Gibson's preliminary observations are:

- It appears that the center of standard SGC mix design samples reach design density before the entire sample reaches 4% air voids on a global basis.
- Mechanistic definition for “locking” seems sensible and indicates that this occurs before N-Design.
- By mid-March, potential recommendations on best definition of locking point or range.

**20. Planning for the Next National Accelerated Pavement Test—Audrey Copeland and Nelson Gibson (FHWA)**

Title of Presentation: *Planning for the Next National Accelerated Pavement Test*

Summary of Presentation/Report:

Audrey Copeland gave the report and presentation, which was planning for the next ALF testing requirements. She briefly reviewed and listed the previous initiatives that have been accomplished at the FHWA’s National Accelerated Pavement Testing facility. She also summarized the reasons and benefits for continuing with this program, which lead into the survey questions that were included in the questionnaire. Copeland noted that all participants have a copy of the questionnaire Gibson passed it out earlier in the meeting. She reviewed the basic survey questions and its purpose. Three basic questions were included on the survey: (1) what do you want to see for the next ALF experiment; (2) are you from an agency, contractor, or other; and (3) what are some suggested topics that you would like studied? Copeland also presented some suggested topics that had already been recommended from the Southeast Asphalt User Producer Group and Nebraska Asphalt Paving conferences.

At the end of the presentation, Copeland referred back to the purpose of this presentation which was to bring the participants up to date on what is going on with the ALF and being planned.

ETG Comments, Questions, and Discussion:

Matt Corrigan asked; were these questions included in the questionnaire passed out at previous conferences. Gibson replied where some of these questions came from; some were from the Nebraska and other meetings. Gerald Reinke asked; what do you mean by the performance of reclamation techniques and changes in emulsified binder. Gibson replied he was talking about cold in place recycling.

**21. NCHRP 9-29 Inter-Laboratory Study—Ray Bonaquist (AAT)**

Frank Fee asked Ray Bonaquist to give an update on the calibration of the NCHRP 9-29 inter-laboratory study. This was a verbal report request. Bonaquist briefly reviewed the information that was provided to Rick Harvey, and noted that is going to ballot in the near future. Harvey will contact Bonaquist if there are any comments or questions about the annex that was prepared.

**22. Research Proposal Mixture Aging in Production—Frank Fee (NuStar)**

Title of Presentation: *Aging Proposal*

Summary of Presentation/Report (only a verbal report):

Frank Fee distributed a proposed aging study that was discussed at the last meeting. Fee asked for any comments on the draft problem statement. Fee noted it is a draft and subject to change and comment. Any suggestion on completing the draft and wrapping up the end of it is appreciated and open for discussion.

There was discussion of the format of the problem statement and how to finalize the proposal. Most of the discussion was focused on giving researchers guidance on how to approach the problem – a task-based or driven problem statement. Ed Harrigan suggested; rather than preparing a task-based statement, just note the desired outcomes from the project. Harrigan mentioned that the panel set up for this problem statement will do that. Fee noted that he understood that, but wanted to provide some of the tasks.

**ACTION ITEM #13. ETG members are asked to send Frank Fee their comments on the proposed research needs statement on developing a new Lab Short Term Aging Procedure that Correlates to Various HMA Plant Processing. Louay Mohammad to review the draft problem statement and identify any redundancies between his NCHRP 9-48 project and the one being proposed. .**

### **23. Next Meeting Location and Date**

Chairman Fee reported that the next ETG meeting is scheduled for September 20 and 21 in Madison, Wisconsin.

### **24. Overview of Action Items**

Secretary John Bukowski overviewed the action items from the meeting, which are:

1. Ed Harrigan is requested to provide the recommendations from the NCHRP 9-39 project related to mixture and compaction temperature for review at the next ETG meeting and subsequent referral to the AASHTO SOM.
2. ETG members are asked to review the Semi Circular Bend procedure and provide their comments directly to Mihai Marasteanu.
3. Frank Fee and Ray Bonaquist will attempt to obtain suppliers to provide materials to fill all the cells in Table 2 – of the experimental plan for the Flow Number evaluation effort, as presented at the meeting. If this is successful, the experiment will proceed as planned.
4. ETG members are asked to provide feedback to Audrey Copeland on potential areas to study under the next FHWA Accelerated Load Facility (ALF) project.
5. Richard Kim will proceed with the IDT E\* ruggedness effort as presented at the meeting, any additional comments should be forwarded directly to him.
6. Richard Kim has asked for input on his VECD analysis software. A new ETG task group (West, Reinke, Scarpas, Rowe, Daniels, Bennert, Gibson, VonQuintus, Mogawer) was formed to accommodate this. Richard Kim will provide the spreadsheet for the protocol or analysis software and a list of specific questions for the TG's input.

7. Haleh Azari is requested to provide a copy of the interim AMRL report on mixture aging/conditioning impact on testing of E\* and Flow Number. This will be distributed to the Group for review.
8. The ETG task group on construction is asked review and if needed prepare a proposal for a potential TRB/NCHRP synthesis of practices to measure and accept in-place pavement density.
9. John D'Angelo will prepare a draft document to provide technical guidance to agencies for making changes to the N-Design value.
10. Matt Corrigan and Chuck Paugh will prepare a draft for a potential appendix to T312 on the comparability of different gyratory compactors.
11. Haleh Azari is requested to have ARML revisit and possibly update the precision statement for T312 considering recent improvements in the procedure and the development of the internal angle measurement. Report back at the next ETG meeting on the effort.
12. A copy of the draft procedure for "Determining Aggregate Structure in Asphalt Mixes by Means of Planar Imaging" will be sent to the ETG members for review and comment to Husain Bahia.
13. ETG members are asked to send Frank Fee their comments on the proposed research needs statement on developing a new Lab Short Term Aging Procedure that Correlates to Various HMA Plant Processing. Louay Mohammad to review the draft problem statement and identify any redundancies between his NCHRP 9-48 project and the one being proposed.

Ed Harrigan announced the NCHRP workshop topics for Thursday morning.

## **25. Meeting Adjournment**

Secretary John Bukowski and Chairman Frank Fee thanked everyone for attending the meeting and thanked NCHRP for hosting the ETG meeting. Fee adjourned the meeting at 4:25 PM.

## **ATTACHMENT A**

### **FHWA Asphalt Mixture & Construction ETG Meeting Agenda**

Irvine, California

February 23 & 24, 2010

#### **Meeting Agenda- Draft**

##### **Day 1— February 23, 2010**

1:00 pm	Welcome and Introductions	<b>Fee</b>
1:15 pm	Review Agenda/Minutes Approval & Action Items February, 2009 Meeting	<b>Bukowski</b>
1:30 pm	Subcommittee on Materials Updates/Comments	<b>Harvey</b>
2:00 pm	Update Related NCHRP Activities	<b>Harrigan</b>
2:30 pm	Procedure to Measure the SGC Mold Wear	<b>Musselman/Dukat</b>
3:00 pm	Break	
3:15 pm	AMPT Flow Number Testing Task Group Presentations AMRL Activity FHWA Evaluations from the ALF	<b>Bonaquist Azari Gibson</b>
5:00 pm	Adjourn for the Day	

##### **Day 2— February 24, 2010**

8:00 am	Report on IDT E* Ruggedness Testing Plan	<b>Kim</b>
9:00 am	Semi Circular Bend (SCB) Mixture Test	<b>Marasteanu</b>
9:30 am	MIST Test	<b>Dukat</b>
10:00 am	Break	
10:30 am	Mixture Planar Imaging Procedure	<b>Enad Mahmoud</b>
11:00 am	E-Circulars Status/Remaining Issues	<b>West/Hall</b>
Noon	Lunch	
1:00 pm	SGC Commentary Task Group Report	<b>D'Angelo</b>

1:30 pm	Gyratory Pressure Distribution Analyzer (GPDA)	<b>Bahia</b>
2:15 pm	Gyratory Lock Pont	<b>Gibson</b>
3:00 pm	Break	
3:30 pm	Research Proposal Mixture Aging in Production	<b>Fee</b>
4:00 pm	Construction Task group Update	<b>LaFleur</b>
4:45 pm	Action Items and Next Meeting Planning	<b>Fee/Bukowski</b>

Adjourn

## ATTACHMENT B

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## ATTACHMENT C

### Task Group Members and Assignments FHWA Asphalt Mixture & Construction ETG

Task Group Identification:		Members Assigned to Group:
1	Gyrations Level Commentary	John D'Angelo (Lead); Gerry Huber, Brian Prowell, Randy West, Frank Fee, Kevin Hall, Julie Kliewer
2	E-Circular Preparation	Gyratory Compactor Ray Bonaquist (Lead); Randy West, Erv Dukatz, Frank Fee, Adam Hand, Jim Musselman
3	E-Circular Preparation	Specific Gravity Ray Bonaquist (Lead); John D'Angelo, Adam Hand, Julie Ryan, Shane Buchanan
4	Specific Gravity	Randy West (Lead); Erv Dukatz, Nelson Gibson, Kevin Hall, Chuck Marek, Jim Musselman, Julie Kliewer, Roger Pyle
5	Guidance for Flow Number Testing	Ray Bonaquist (Lead); Richard Kim, Ellie Hajj, Haleh Azari, Audrey Copeland, Kevin Van Frank, Phil Blankenship, Nam Tran, Raj Dongre, Nelson Gibson, Harold Von Quintus
6	HMA In Place Density Practices & Specifications	Cindy LaFleur (Lead); Erv Dukatz, Julie Kliewer, Todd Lynn, Jim Musselman, Judy Ryan, Chris Euler
7	S-VECD Alpha/Beta Testers	Richard Kim and Shane Underwood (Leaders); Tom Bennert, Jo Daniels, Geoff Rowe, Tom Scarpas, Harold Von Quintus