FHWA Asphalt Mixture Expert Task Group

Asphalt Mixture 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 70 individuals attended the meeting (23 members, 45 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 Expert Task Group (ETG) members.

Members of the FHWA Asphalt Mixture and Construction ETG that were in attendance included:
Frank Fee, NuStar Asphalt (Chairman)
Ray Bonaquist, Advanced Asphalt Technologies (Co-chairman)
John Bukowski, FHWA (Secretary)
Mike Anderson (Liaison), Asphalt Institute
Haleh Azari (Liaison), AASHTO-ARML
Shane Buchanan, Old Castle Materials
Mark Buncher (Liaison), Asphalt Institute
Audrey Copeland (Liaison), NAPA
Ervin L. Dukatz, Jr., Mathy Construction Company
John Haddock, Purdue University
Kevin Hall, University of Arkansas
Adam Hand, Granite Construction, Inc.
F. M. Rick Harvey, Wyoming DOT/AASHTO SOM liaison
Gerry Huber, Hertiage Research Group
Reid Kaiser, Nevada DOT
Richard Kim, North Carolina State University
Julie Kliewer, Arizona DOT
Todd Lynn, Thunderhead Testing, LLC
Louay Mohammad, LTRC/Lousiana State Univeristy
James Musselman, Florida DOT
David Newcomb, Texas A&M Transportation Institute
Judie Ryan, Wisconsin DOT
Nam Tran (Liaison), National Center for Asphalt Technology

Meeting Coordinator: Lori Dalton (SME, Inc.)
Meeting Notes: Harold L. Von Quintus, (ARA, Inc.)

Members of the ETG that were not in attendance:
Tom Bennert, Rutgers University
Jo Daniel, University of New Hampshire
Edward Harrigan (Liaison), NCHRP
Allen Myers, Kentucky Transportation Cabinet

"Friends" of the ETG that were in attendance included:

Chris Abadie, Louisiana DOT
Satish Belagutti, FHWA/ESC, Inc.
Mark Blow, Asphalt Institute
Sandy Brown, Asphalt Institute
Don Christensen, Advanced Asphalt Tech.
Matthew Corrigan, FHWA
Bill Criqui, Road Science
John D'Angelo, D'Angelo Consulting
Luis Diaz, IPC Global
Raj Dongre, Dongre Lab Services Inc.
Mike Farrar, WRI
Jean-Paul Fort. COLAS
Lee Gallivan, FHWA
Georgine Geary, Georgia DOT
Nelson Gibson, FHWA
Tom Harman, FHWA
Elie Hajj, University of Nevada at Reno
Andrew Hanz, WHRP
Carl Johnson, Northwest Asphalt/Staric
Rick Holmgreen, Phillips 66
Maria Knake, AASHTO
Chuck Maggi, Cannon Instruments Co.
Mihai Marasteanu, University of Minnesota
Kieran McGrane, IPC Global
Ala Mohseni, Consultant
Chuck Paugh, ESC Inc./FHWA
Roger Pyle, Pine Instruments
Roger Olson, Minnesota DOT
Gerald Reinke, Mathy Construction
Ali Regimand, InstroTek, Inc.
Pavel Kriz, Imperial Oil LTD.
Gerald Reinke, Mathy Construction
Geoff Rowe, Abatech
Ron Sines, Old Castle Materials
Annette Smith, PQ Corporation
Richard Steger, INVIA Pavement Technologies
Chris Strack, Sonneborn Inc.
Jill Thomas, Minnesota Asphalt Pav't. Assoc.
Laci Tiarks-Martin, PRI Asphalt Technologies
Kevin VanFrank, Utah DOT
Scott Veglahn, Mathy Construction
Raul Velasqua, University of Wisconsin-Mad.
Eric Weaver, FHWA
Randy West, NCAT
Doug Zuberer, DSI

DAY 1: Wednesday, September 26, 2012

1. Call to Order—Chairman Frank Fee (NuStar) called the meeting to order at 8:10 AM.

Welcome and Introductions – Chairman Frank Fee welcomed the group to the meeting and thanked everyone for coming and asked all members to introduce themselves. Lori Dalton distributed a "sign–in" sheet and asked everyone that wants to be a friend of the ETG to put their name on the list. Copies of the agenda were distributed. Dalton asked the members to make any corrections on the members list.

Fee reported the RAP ETG and WMA Technical Working Group have been integrated into the Mix ETG meeting, so we now have two days for the meeting. John Bukowski made some comments relative to the agenda regarding WMA, RAP, and RAS and that ETG membership will be expanded to better include these topics. He reported Matthew Corrigan is the lead for the WMA task group under the Mix ETG and Lee Gallivan and Audrey Copeland are the co-leads for that RAP/RAS task group.

2. Review Agenda/Minutes Approval & Action Items—John Bukowski (FHWA)

Bukowski reported the minutes from the last meeting were sent out via e-mail prior to the meeting. Any revisions or corrections to the meeting minutes should be sent to him. No corrections or revisions were identified during the meeting.

Secretary Bukowski reviewed the Action Items from the March 2012 Mix ETG meeting. The following is a listing and status of the Action Items from the last meeting.

1. *T 321 – Beam Fatigue*: Geoff Rowe will review T 321 in terms of two major areas relative to the wording. Rowe will make the wording changes to the standard. The revisions to be sent to Bukowski no later than the beginning of May, unless there is a major issue identified from the review, revisions will then be forwarded to the SOM.
   UPDATE: Action item is on the agenda. A red-line marked up version will be presented.

2. *TP 79 Flow Number Criteria:* Corrigan will take the recommendations and criteria presented, including the threshold values and send to Bukowski to forward to the SOM as a suggested appendix to TP 79.
   UPDATE: Action item is on the agenda. Rick Harvey on behalf of the SOM will comment on this one during his presentation.

3. *Air Void Tolerance*: Ramon Bonaquist will continue work related to evaluating air voids in the test specimens to refine the recommended allowable tolerance.
   UPDATE: Action item is on the agenda. Jeff Withee is not present so John Bukowski will make the presentation. Bukowski reported the key issue is the air void tolerance; nothing has been as yet forwarded to the SOM on this.

4. *NCHRP Project 9-33 Products*: Bonaquist and Fee will determine what changes need to be made relative to NCHRP 9-33 products and the approach to advance wider usage.
   UPDATE: Action item is on the agenda. Fee reported; the ETG provided web site information regarding the presentation by Christensen and included information for downloading the reports. Bukowski noted a lot of information from this and related NCHRP studies were utilized for the AMPT training course sponsored by FHWA.

5. *Compaction Needs Document:* The Construction Task Group is to provide a prioritized list of items of concerns relative to compaction. The Task Group will prioritize those needing further efforts decide what can be accomplished as part of the Task Group effort.
   UPDATE: Action item is on the agenda.

6. *NCHRP 9-40*: Louay Mohammad will submit electronic versions of the two test procedures to Fee and Bukowski for forwarding to the SOM.
   UPDATE: Action item is on the agenda. This item went forward to the SOM and Rick Harvey will address this issue in his report.

7. *Longitudinal Construction Joint Final Report:* Mike Anderson will provide a copy of the final report on longitudinal construction joints that has been published to Frank Fee. Fee will distribute it to the ETG for review.
   UPDATE: Action item is on the agenda. Bukowski commented that it is uncertain whether the Best Practices document from this effort have gone forward to the SOM.

8. *IDT E* Ruggedness Study and Revised S-VECD Test*: Richard Kim will resubmit the revised ruggedness plan for the next meeting and submit a copy of the revised S-VECD test protocol to the ETG for review.
   UPDATE: Action item is on the agenda.

9. *AMPT Flow Number Experiment*: Haleh Azari was requested to submit a report on the minimum strain rate (MSR) approach that uses the incremental repeated load permanent deformation test.
   UPDATE: Action item is on the agenda. Rick Harvey will comment on this topic during his report. Bukowski reported the flow number criteria did move forward, which was based on the work completed by Bonaquist under related NCHRP projects.

10. *PP 47 – Comparing SGCs*: Corrigan will forward the final PP 47 document to the ETG and Bukowski will forward to the SOM as a standalone proposed standard. Harvey will decide on the final format.
    UPDATE: Action item is on the agenda. This document on PP 47 did move forward and Rick Harvey will provide comments from the discussions at the tech section meeting.

11. *Low Temperature Cracking Specification Using the SBC Test*: Mihai Marasteanu will add verbiage to the scope of the test standard on how it addresses cracking and how the results will be used. The revised draft test standard will be submitted to Frank Fee and John Bukowski for distribution to the ETG and then to the SOM.
    UPDATE: Action item is on the agenda. Bukowski reported there are comments from the SOM on this topic. Mihai Marasteanu will discuss the comments during his report or presentation.

Frank Fee reminded the ETG, that a principle objective of this group is to provide input to the SOM and introduced Rick Harvey for the next report.

3. Subcommittee on Materials: AASHTO Standards Update Report

Presentation/Report Title: ***AASHTO Standards Update—***Rick Harvey (Wyoming DOT); Liaison for the AASHTO Subcommittee on Materials

Summary of Presentation/Report:
Rick Harvey reported this recent submission is probably the most standards and information that have moved to the SOM from the ETG.

The annual SOM meeting was held on August 5 to 10, 2012 in Biloxi, Mississippi. He went on to identify the items resolved and forwarded to print in July from the 2011 SOM ballot. There

was also a lengthy technical section ballot and discussion, for which items are in various states of resolution.

TP 71 – Evaluation of SGC Internal Angle Using Simulated Loading. This was adopted as T 344 and is now a full standard. There were no comments and it appears in the 2012 publication. Harvey reported that the mold wear measurements are now being required. He thanked everyone for this significant effort.

TP 79 – Dynamic Modulus and Flow Number Using the AMPT. Discussion on the Franken model was prepared by Ray Bonaquist, balloted and accepted as an appendix to the standard.

T 312 – Preparing Specimens with the SGC. Harvey reported T 312 did not include the field preparation section; so two subsections were prepared for HMA mixture preparation considering laboratory and plant prepared specimens. Harvey reported this is being published but there will be additional work needed in this area. He reported there were several comments on the SOM ballot. The procedure is now in the standard no good guidelines on the reheating of the material. Fee's opinion is that this is a difficult issue because of the identification of the additional aging due to reheating. Harvey agreed and noted that the standard remains rather "open" on this requirement.

R 35 – Superpave Design Practice Mix Design Practices for Warm Mix Asphalt. Harvey reported that Bonaquist did a lot of work on this standard and has now been included in the appendix. The appendix is longer than the R 35 method itself. *R 35, Appendix X2*. The name of the standard was changed from Method to Practice. Harvey noted than an appendix is nonbinding but an annex is mandatory. This is in an appendix of a practice. Harvey clarified why this was placed in the practice as an appendix. There are still questions that need to be resolved in the future as a result of the blending charts. There needs to be continuing discussion on this topic. He also stated that M 323 – *Superpave Volumetric Mix Design,* will need revised relative to any changes.

M 323, Superpave Specification – RAP Revisions. Revisions were recommended by the ETG in the mid 1990's as guidelines for blending RAP into HMA. Now that the RAP technology has advanced, we need to start looking at the binder effects on the mix and percent binder replacement that needs to be updated in this standard. Also RAS will need to be addressed.
RAP and RAS may be specified according to percent dry weight or percent binder replacement. Harvey's recommendation was to remove RAS from the specification, for now, so that the RAP recommendations could move to AASHTO for publication. He noted again there will be more future work/comments on this as it is put into practice.

M 323 – 4.75 mm Mixture Revisions. Harvey reported there was little SOM discussion on the revisions made by Randy West, so it will be adopted as recommended. Most of the revisions were minor in the table but other changes, like VMA, were more important.

This ended all of the current revisions that were published through the SOM. Harvey then reported on results from the 2012 Technical Section and SOM ballots and individual standards. The 2012 Technical Section Ballot and 2012 SOM Ballot items included: revisions to TP 79, PP 60, and PP 61.

TP 79 – Determining Dynamic Modulus and Flow Number using the AMPT. Harvey reported some of these items have yet to be worked out, but they moved to a subcommittee ballot. He reported on the changes that were made regarding the requirement for silicone grease as a friction reducer, added precision statements for dynamic modulus and flow number, and the number of specimens needed.

Harvey stated there were comments on the requirement of an additional conditioning chamber. He noted that in Corrigan's proposal, should have two chambers for efficiency in performing the testing. Bonaquist agreed that this recommendation is about testing efficiency. Harvey noted that as it would now appear in the procedure this would be a mandatory requirement for two chambers. Harvey reported they do not plan to address the comment now. Bonaquist added that you cannot place the dummy specimen in the AMPT device because it will not fit. Discussion from the ETG is in agreement with this recommendation, because of the importance of temperature.

Harvey reported there still is concern on the friction reducers in comparing Teflon and latex; the Teflon appears to have less variability than the latex. Corrigan mentioned he followed up with Blankenship on this issue. Blankenship used Teflon. Although the data were not comprehensive, it was believed the use of Teflon did make an improvement. However, the greased Teflon was not examined.

PP 60 – Preparation of Cylindrical Performance Test Specimens Using the SGC. This topic was raised by Bonaquist at the last meeting. There were comments on the last ballot and Harvey asked whether the height should be reduced to 160 mm, and asked if anyone had any issue with the 160 mm minimum height. Corrigan stated this is just an absolute minimum requirement to ensure we have the right air void distribution. He also noted about cutting the specimen to ensure the air void distribution is acceptable to establish the proper height. Specifically, one should target a lot taller specimen.

Bonaquist noted that past recommendations have moved to increasing specimen height. He went on to explain the process he used in determining the minimum height requirement. He summarized why this became an issue and gave the reasons he suggested that it be reduced. Harvey asked if a note needs to be added on this issue. Corrigan replied that such a note is already in the standard about checking the uniformity of the air void distribution. He recommended the note be reemphasized in this section to refer to specimen uniformity.

Richard Kim added that the air void distribution becomes a significant issue in fatigue testing, especially if fatigue testing is to become part of PP 60. He reported he will be showing data later in the meeting when he discusses fatigue testing. Harvey commented that since 160 mm is the minimum height, for users it would then not advisable to start at the minimum 160 mm value.

Harvey noted the standard will be printed with a minimum value of 160 mm. Bonaquist commented that this was not a significant effort during the research and referred to what was done during the course of the uniformity study. He noted the taller specimens resulted in less distribution, but there are cases where that is not true, and suggested there should be no height requirement; rather make this a uniformity issue. Fee asked whether the section requiring

specimen uniformity is mandatory. Harvey commented that it is currently not mandatory. Louay Mohammad stated that based on his experience on specimen height, it is difficult to make and trim the specimen to the exact height. His technicians always want to make them taller, usually 180mm high. His experience; the taller the specimen, the more uniform it is. Corrigan referenced the standard and that section 5 mentions specimen height and uniformity. Harvey asked do we want to emphasize this within an appendix or make it a mandatory part of the standard. The recommendation has already been prepared as a ballot item and we will stay as a 160 mm minimum height. Bonaquist noted in the AMPT training course prepared for the FHWA, it is emphasized how to get the minimum height based on air void distribution. Harvey suggested it should be also emphasized in the standard.

Harvey noted the other changes related to the perpendicularity and the use of the piano wire method. This method may be too prescriptive. The suggestion was to allow the other measuring methods.

Harvey asked if there was any discussion at the AMPT pooled fund meeting that needs to be discussed. Bonaquist replied that there appears to be good technology transfer between different organizations.

PP 61 – Developing Dynamic Modulus Master Curves Using the AMPT. Harvey reported this was basically a cleanup of the tables, and references the changes made in TP 79. There were no SOM ballot comments, so this is moving to adoption.

New Appendix to TP 79 – Evaluation of Rutting Resistance Using the Flow Number Test. Harvey stated this includes specifications that might eventually need to be put into M 323. The consensus was to leave this for now in an appendix in TP 79. Some concerns were identified including different criteria for WMA and HMA on conditioning differences, repeatability of the flow number test (guidance is needed here), and change to the upper temperature limit on control chamber from 60^{o} to 70^{o}C. Bonaquist noted that the original development of the flow number test used the effective temperature which is lower than the grade temperature. Bonaquist reported both chambers can achieve this requirement and believes this is not an issue. Harvey asked whether this should be included in TP 79. Bonaquist agreed it should be included in TP 79, because that is where the equipment requirements are located. Harvey noted that now the appendix will move on to the full subcommittee ballot. Bonaquist believed that both current AMPT manufacturers can achieve 70^{o}C, but there could be some software requirements. Ali Regimand responded there is no real problem. Jim Musselman asked would it now be a requirement that all chambers must meet 70^{o}C since very few geographic areas need to test at this high a temperature. Bonaquist agreed with the comment and suggested a note can be added, that while equipment needs to have this capability, it would not need to be used in the majority of applications.

Adopt New Provisional Practice – Troubleshooting Asphalt Specimens Volumetric Differences between Superpave Gyratory Compactors used in Design and Field Management of Superpave Mixtures. Harvey reported Matthew Corrigan was involved in preparing this item but is now being brought back to the ETG since a few items need to be further addressed.

Adopt New Provisional Test Method Determining the Fracture Energy of Asphalt Mixtures using the Semi-Circular Bend Geometry Device. Harvey reported this is being forwarded to the SOM ballot. Bukowski requested any additional SOM comments for this item be forwarded to Mihai Marasteanu. Harvey agreed, and it is planned to move this forward as a provisional standard.

Adopt New Provisional Test Method for Determining the Damage Characteristics Curve of Asphalt Concrete from Direct Tension Cyclic Fatigue Tests. Harvey noted this has been discussed numerous times at previous ETG meetings. He reported there have been comments that require significant changes to this document. These include equipment requirements that limit AMPTs, calculations need clarification, and an example is needed in the appendix. Bukowski asked Kim to discuss these during his presentation planned for later in the meeting. Harvey reported this will not move to a standard until the comments are addressed. Bukowski agreed these would be addressed during this and the spring Mix ETG meeting.

New Provisional Test Method for Tack Coat. This test method will be an item next year on the Technical Section 2c ballot (Tom Baker is the chairman).

MP 15 Specification for Use of Reclaimed Asphalt Shingles in New HMA, and PP 53 – Design Considerations When Using Reclaimed Asphalt Shingles in New HMA. These two items are reaching their life and need to be addressed. The SOM ballot was to extend these one year. Harvey expects both provisional standards will move to full standards in 2013.

2014 Publication Cycle. Recommendations are needed from the ETG prior to May 2013. He recommended this meeting be held about a month earlier. Bukowski noted that this will not be possible for the 2013 meeting, due to needed contract/meeting arrangements, but if needed would be addressed in future ETG scheduling cycles.

Georgene Geary noted they will be doing a webinar for tech section 2d on February 7, which is an open forum. Bukowski asked her to provide information to the ETG.

Handoff of Technical Section 2d. Harvey reported Georgene Geary will become the SOM vice chair as well as taking over as the chairmanship of Technical Section 2d upon his retirement and Chris Abadie will become the new vice chairman. Bukowski thanked Harvey for his effort and recognized Harvey's contribution in creating the strong partnership between the AASHTO SOM and the Asphalt ETGs.

4. Update on Related NCHRP Projects—Edward Harrigan (NCHRP)
Bukowski noted, as similar to the SOM, the continuing relationship between the ETGs and NCHRP. He reported Ed Harrigan had to cancel at the last minute, and sent a summary of current related NCHRP projects. Bukowski gave the summary report for Harrigan.

Summary Presentation: ***NCHRP Update – March 2012***
Bukowski gave an overview of the current NCHRP related projects and anticipated products. Bukowski identified two NCHRP projects that are anticipated: NCHRP projects 9-54 –

"Improved Long-Term Aging of Asphalt Mixture Performance Tests and Cracking Models" and 9-55 – "Recycled Asphalt Shingles in Warm Mix Asphalt Mixtures".

Jim Musselman asked if the two NCHRP projects had been awarded that were identified at the last meeting. Bukowski asked Dave Newcomb to answer that question. Newcomb replied that NCHRP project 9-52 (Short-Term Laboratory Conditioning of Asphalt Mixtures") was awarded to the team of TTI, the Pavement Center at UC-Davis, and NCAT. TTI is the lead for this project. And NCHRP project 9-53 (Properties of Foamed Asphalt for Warm Mix Applications") was awarded to the team of TTI and the Center for Transportation at the University of Texas, with TTI being the lead organization.

5. AMPT Test Development Task Group

Presentation Title (#1): ***Asphalt Mixture Performance Tester Implementation; Status of AMPT Pooled Fund TPF-5(178)***—Jeff Withee (FHWA)
Jeff Withee could not attend the meeting so Bukowski gave his report.

Summary of Presentation:
Bukowski gave an overview of the AMPT pooled fund study and the number of agencies participating. He reported the pooled fund will stay open for another two years and stated an agency may obtain AMPT equipment through the pooled fund study during this time frame. Bukowski reported the AMPT training DVDs encompassing a two day laboratory course are available. Bukowski reviewed the procurement of the equipment and the number delivered to date; the number of training courses delivered; and the implementation support activities that include E* and flow number inter-laboratory study, report on asphalt materials inputs for DARWin-ME, and a national workshop for the AMPT users which was held in Atlanta, GA. Bukowski reported positive input at this user group meeting. Bukowski showed a map of the participant states, many of the participant states are in the SE an NE. They are trying to expand the participants to other areas in the western states.

Bukowski referred to the implementation goals: an exchange of information and familiarization with the equipment. Additional goals are to advance state of the practice with the AMPT, share implementation plans and experience, identify and address implementation hurdles, conduct coordinated pooled fund member inter-laboratory studies, and build agency testing proficiency.

The current inter-laboratory study now includes 27 laboratories. Bukowski reported Nam Tran (NCAT) and Jeff Withee (FHWA) will decide on the schedule, but it is planned to begin in the winter of this year. The goal of the inter-laboratory study will include detailed written instructions, build agency testing proficiency, compare NCHRP 9-29 ILS precision, and provide data on suggested standard changes like specimen air void tolerance. The tests to be evaluated/ included in the study are dynamic modulus and flow number. Dynamic modulus specimens will be prepared from loose mix and tested at different temperatures and loading frequencies in the unconfined condition. The flow number specimens will also be prepared from loose mix and tested using the NCHRP project 9-33 parameters/test conditions.

Bukowski also reported a synthesis report and Best Practices document is under development for determining the asphalt material inputs to the MEPDG (now DARWin-ME). The Best Practices document also includes developing a library of asphalt material inputs and selecting representative materials for testing.

Bukowski reported they plan to post the presentations from the National AMPT workshop held in Atlanta earlier this year (Sept. 2012). The workshop topics at the conference included: AMPT equipment development, test procedures, specimens preparation, data management, and DARWin-ME inputs. There was a roundtable discussion on current issues. Other challenges were also discussed, which included; specimen preparation, staffing levels and turnover, agency resource allocation, and understanding the appropriate test method since a number of organizations are investigating alternate flow number and fatigue test protocols. He also reported that specimen preparation air void tolerance continue to be raised.

Implementation support needs were reviewed by Bukowski regarding training and regional AMPT user group support. Bukowski reported they are planning to work with the Nevada DOT for a western region conference. More information is available at www.pooledfund.org (search for AMPT) or contact Jeff Withee at jeff.withee@dot.gov , 202-366-6429.

Jim Musselman asked the outcome from the different methods defining the flow number? For the round robin testing with the pooled fund/user producer groups, Bukowski commented that the focus will be the NCHRP project 9-33. Musselman asked how training is being handled. Bonaquist replied that they are demonstrating the same criteria (9-33 results) related to the flow number testing; cannot “mix and match” the different test methods and resulting criteria. Criteria and threshold values currently available are only applicable to the 9-33 method (9-43 for WMA). Fee asked about the inputs to the DARWin-ME and how that is being handled. Bonaquist commented that during the research, regarding DARWin-ME the NCHRP 9-33 panel directed the contractor to focus on dynamic modulus. They created the provisional practice to develop the master curve. Fee asked if flow number is more a design tool or rather a mixture analysis tool. If it remains in the pavement design area, it appears that it may have limited use, but may be more useful as a materials characterization tool. Bukowski commented that while focus currently is on mixture analysis, certainly would like to see this tied to pavement design. Fee asked for opinions from the group on this topic.

- Raj Dongre; they have used the DARWin-ME and AMPT together. You can use the device to obtain the coefficients for the DARWin-ME.
- Kevin VanFrank commented that he believes pavement permanent deformation is more important than E*, but both properties are important in terms of mixture design.
- Judie Ryan added they are using information from the AMPT. As a highway agency, they are looking beyond volumetric properties. Trying to relate the materials test results from the AMPT to performance, however, is difficult. They are using the AMPT as a troubleshooting tool; using E* and flow number in terms of balancing decisions on expected performance.
- Bukowski noted that is not just a highway agency issue. They are encouraging consultants and contractors to work with their respective agencies.
- Kevin Hall commented the roadway design divisions are doing their work two years ahead of construction, and appear to rely on general/approximate values for input.

However, two years later the exact data values become much more important; so need to be closer aligned. Judie Ryan commented that based on her experience as a mix designer; you cannot separate pavement design/performance from mixture analysis.

Presentation Title (#2): ***S-VECD test Protocol – Direct Tension Fatigue Standard***— Richard Kim (NCSU)

Summary of Presentation/Report:
Richard Kim started his report with defining the S-VECD test method and its applications, and proposed revisions to the AMPT equipment when used for fatigue testing. Kim identified the different properties that are needed; dynamic modulus and phase angle. He presented a graphic plotting "C" and "s" which is the basis of the VECD concept. In this approach, "C" is the materials integrity and "s" is damage. Kim suggested rather than performing all of these individual test conditions, just select one single condition and use the result to predict what happens under the different conditions.

He showed the direct tension test setup which is modified from the current AMPT equipment because of the push and pull needed for fatigue testing. Kim overviewed the direct tension fatigue test protocol, which included the experimental method he described at previous meetings. They describe the mix using the dynamic modulus test at 10 Hz to capture the specimen variability. They also use a four controlled actuator displacement cyclic tests. A single test temperature is used. The total test time is two days for four tests. The final outcome of the test is the damage characteristics curve or C versus s relationship. The appendices contained in his draft test protocol provide procedures for appropriate data filtering and data reduction in a spreadsheet for estimating on-specimen strain levels from crosshead strains.

Kim summarized the applications of the results from the test protocol in terms of development of fatigue cracking performance database for local calibration of DARWin-ME used in North Carolina; determination of fatigue endurance limit; and fatigue life prediction of pavements when combined with the layered viscoelastic analysis program or finite element program. Kim emphasized during his report, you must look at the structure and how the mixture will be used, so the structural and mix design parts need to be tied together. Kim showed the fatigue life prediction and variability for three temperatures, and commented this variability is typical in terms of fatigue testing.

The next part of Kim's report was on the fatigue endurance limit. He summarized their procedure based on the recommendations from NCHRP project 9-38. No additional testing is needed other than capturing and measuring the C versus s relationship. He also showed the effect of mixture variables on the fatigue endurance limit.

Kim then demonstrated how the structural and mixture design would be combined by comparing a thin and a thick pavement section in terms of mix responses. He used one of the FHWA ALF test pads for comparing the observed number of cycles to failure in terms of log field N_f and predicted log N_f. The fatigue performance needs to be included in any design procedure.

The next part of Kim's report addressed the ETG and AASHTO SOM comments on the S-VECD specification spreadsheet. He has revised the test protocols and resubmitted for the ETG consideration. The revision included explanation in the appendices regarding the spreadsheet use. The spreadsheets include; calculating relaxation modulus prony coefficients, calculating pseudo strain, calculating the continuum damage power term (alpha), reducing cyclic data, calculating dynamic modulus ratio (DMR), calculating damage parameter "s", and estimating on-specimen strain levels.

- D'Angelo added that they did the calculations for the critical cracking temperature and went through in detail all of the calculations and established a step by step procedure. Geoff Rowe cautioned about doing some of the steps regarding master curve construction; if you construct master curves in different ways you get different results. His opinion you must explain every aspect exactly how it is performed so you get the same results from different agencies and you must state all of the assumptions for the procedure. Kim agreed with the amount of detail required. Rowe asked and Kim agreed that the method does include the details for individuals that want to create their own spreadsheets.
- Nelson Gibson commented that they took the written method and built the spreadsheet. Gibson stated he is willing to discuss this with others that want to do the same thing.
- Frank Fee commented that while one group is interested in all the calculation details; others may just wand a "black box" to make all the calculations.
- Randy West asked if Kim if thought he had enough data to validate the concept or procedure. Kim replied that probably they do not yet have enough, but are working on getting more validation data. Kim agreed about the importance of validation and using results from the NCAT test track.
- Raj Dongre asked if the procedure will provide the coefficients from the DARWin-ME. Kim replied, no it gives you C versus s and from that relationship you have to predict the fatigue coefficients.
- Matt Corrigan believes the SOM is going to want all the details/explanation of the steps and calculations. He also asked if E* and phase angle could be performed on the same mixture specimen; Kim advised to perform them on separate test specimens.

Kim continued his presentation on the effect of test temperature on the C versus s relationship. He recommended the test temperature be revised below the current specification temperature. The current specification is 10^{o} to 20^{o}C; the proposed change now is 3^{o}C below the middle temperature between the high and low PG grades. Kim explained that this recommendation/change is based upon his current findings/experience.

The next part of his report focused on the energy based failure criteria. Kim explained the variability in the previous failure criteria – his opinion is that it was too high. He discussed the released pseudo-strain energy concept and the difference between the undamaged and damaged relationship between strain and stress. Kim showed the relationship between the number of cycles and total released pseudo-energy. He suggested constructing the failure envelop at four strain levels and illustrated the concept. He applied the failure criteria to two mixtures, as part of the verification process using mixtures from Vermont and Manatoba. Kim reported the amount of RAP content in one of the mixes did not change the failure envelope, but how you obtain the results does change. The current standard uses two replicates at 1,000 cycles to failure and two

replicates at 10,000 cycles to failure. The proposed change is to use one replicate at 1000, 4000, 16000, and 64000 cycles to failure. Kim reported that this failure criteria was not in the previous version of the specification.

The next part of Kim's report was on the effect of end failure on the failure criterion. He reported when the failure is near the end of the specimen that changes the concept, and noted the issues with specimen geometry. Kim identified the difference in types of loading – tension versus compression as related to failure. Air void differences also affect where the specimen will fail – that being the area with the higher air voids. He strongly emphasized the need to improve the uniformity of air voids so that the specimen will fail in the center. Kim discussed cutting the specimen or making it shorter to increase the reliability of failure in the center of the specimen. But, he also noted you can make the specimen too short and end up with a non-uniform stress distribution.

Kim discussed part of his study to better define the effects of specimen geometry. He started with the LVDT gauge length evaluation and explained how the specimen geometry affects the target strain value applied to the specimen. He explained there is a zone where the target strain value is obtained with different diameters. He summarized the study in terms of a tabular listing for the percent error in axial strain for different diameter specimens. Kim then presented data of C versus s in terms of different size specimens and showed there can be a difference as well as a similarity using other geometry specimens. He summarized the study by comparing 75 mm versus 100 mm diameter specimens. He showed a tabular summary of the improvement of the 100 x 130 mm specimen geometry in terms of percent failure in the center. He noted the advantages of using 75 and 100 mm diameter specimens. Kim stated that while 100 mm diameter specimens may be more practical, the benefit of 75 mm is greater accuracy.

- Dongre commented on the smaller sample size effects from a mechanics standpoint and the importance of getting away from end failures. Kim explained gluing to the end plates was done in order to increase the surface area for bonding. A certain type of epoxy should be used. Kim reiterated that the end failure he observed is the end failure in the specimen and not at the contact plates.
- Bonaquist commented that 75 mm will result in a wider range to get to higher stresses from an equipment standpoint.
- Kevin Hall asked how much is the difference in accuracy in terms of fatigue life. Kim is as yet uncertain. Hall commented that if you are using these results for structural design what about a mixes with larger size aggregate. Kim commented that his analysis was on mixtures only up to 25 mm. Kim replied the ratio between aggregate size and lift size can be used. Gibson commented that when they went to 38 mm aggregate size, got better agreement at 110 mm specimens. They shortened the specimen to 110 mm from 120 mm and got better correlations.
- Mihai Marasteanu asked if Kim considered using the bending beam specimens in the procedure. Kim replied they have tried with flexural beam fatigue and it is not that simple. Kim explained what drove his choice was also related to the gyratory compactor in preparing test specimens.

Fee requested Kim to identify the key action items, and distribute again to the ETG for review.

Rick Harvey commented that this proposed S-VECD standard will again go to the 2d technical section for review and ballot in 2013. Fee reiterated the objective is to select test procedure to improve the fatigue characterization of a mixture. After the standard is accepted, the next step is more validation; two stages; publishing the standard and validating its use.

ACTION ITEM #1: Richard Kim will provide a revised S-VECD standard to Bukowski for ETG review. Comments will be provided to Kim prior to the next ETG meeting. The revised standard should be forwarded to the SOM after the spring meeting. All comments should be returned to Bukowski as soon as possible.

Presentation Title (#3): ***AMPT Flow Number Task Group Report***—Frank Fee (Frank Fee, LLC)

Summary of Presentation:
Frank Fee provided an overview of the history and objective of this effort. Fee acknowledged the efforts by Haleh Azari and Elie Hajj for their laboratory work. Bukowski provided a summary report of these results to the ETG for discussion.

Bonaquist reminded the ETG that the focus was to use flow number as part of a mixture design procedure. There were a number of additional procedures that were examined by researchers after completion of the NCHRP 9-33 project. The issue is which procedure should finally be recommended for an AASHTO standard. Bonaquist reported that this was a screening of the various approaches. He noted four procedures were evaluated.

Bonaquist focused on each of the procedures and how they are used. He started with the NCHRP 9-33 procedure, which uses the traditional flow number procedure and identified the conditions of the test procedure, as well its recognized threshold performance values. The next one overviewed was the iRLPD method that Azari created, followed by an approach that was part of the NCHRP 9-30A efforts, and finally the University of Nevada at Reno (UNR) critical temperature analysis method. Bonaquist defined the testing conditions for each procedure and overviewed the concept behind each method.

Bonaquist then overviewed the mixtures used in the experiment – all were anticipated to have good resistance to rutting, but with different traffic levels and placed in different climates. Bonaquist summarized the results from all procedures. Kevin Hall asked about the NCHRP 9-30A and UNR procedures; do you have the actual predicted rutting from both procedures? Bonaquist replied not yet, they still need to be provided.

Bonaquist showed the results in a bar chart for the iRLPD procedure in terms of design values and stated there appears to be an issue with the results. Azari replied that for the iRLPD procedure, the MSR values and criteria were provided based on short term aging and not long term aging. Based on long term aging of the mixtures that failed, the MSR values would now change the results and they would get reasonable values in comparison to the design values. Azari stated that she is now recommending an aging ratio be used which is based on short term aging and 5 days of aging in adjusting the MSR values. She noted that this will be published in an AAPT paper next year. D'Angelo asked about aging the other mixtures; and commented that

you need to do the same aging for all of procedures, and aging needs to be tied to rutting, which can be a short term issue. Azari commented they are considering aging at two temperatures above the PG grade temperatures of the binder. For this analysis they only used one temperature. Raj Dongre; this 5-day at 85^{o}C condition for the iRLPD procedure was selected based on compacted mixtures, and stated that the pavement structure may significantly change that. He stated this may affect your sample, rather than aging. He believes aging is not happening like Azari reported. Azari noted they are explaining the aging at some temperature above the PG grade temperature.

Bonaquist continued his report pointing out that there are also practical issues to be considered when performing each of these procedures. They differ in complexity. Bonaquist mentioned these procedures do not include how repeatable are the methods. Bonaquist went through each procedure in terms of what would be required for future use/development.

- Von Quintus made comments about options in the NCHRP 9-30A procedure based on just using one temperature and standard error from each option.
- Elie Hajj made comments about continuing to build on the UNR procedure and the important of the loading conditions. Bonaquist agreed he did omit the loading conditions being considered through the UNR procedure.
- Don Christensen asked how the mixtures were rated. Bonaquist replied they were all rated based on active projects. Christensen replied you can get a lot of variation in terms of conditions between when the pavement was placed and other conditions, so there is potential for variability in results and stated that can make a difference in the results.

Bonaquist referred back to comments made earlier by Fee and Bukowski in terms of where do we go from here in putting together a recommendation. Bukowski requested that each method be put in a test standards type draft format for comparison prior to the next ETG meeting. This would also allow reviewers to evaluate the procedures completeness as well as complexity. Fee added that the procedures should be submitted as soon as possible for review. They need to be prepared within two weeks.

ACTION ITEM #2: A Mix ETG panel will be formed and lead by Jeff Withee and Ray Bonaquist to review various flow number methods and data. Each developer of a procedure is requested to forward a written procedure in AASHTO type format to Jeff Withee. The panel will present the recommendations at the next Mix ETG meeting.

Presentation Title (#4): ***Air Void Tolerance***—Ray Bonaquist (AAT)

Summary of Presentation:
Ray Bonaquist gave a report regarding air void tolerance on preparing test specimens. The issue is does the air void tolerance used in accepting specimens for testing need to be modified. Currently AASHTO TP79 recommends plus or minus 0.5 percent.

Bonaquist explained what “out of tolerance samples” mean using a normal distribution. He presented a histogram on the air void content on the number of samples discarded because they did not meet the specification or would be considered “out of tolerance” specimens. Bonaquist explained out of tolerance specimens were created by using “what if” examples in terms of the

number of samples rejected in answering the question of plus or minus 0.5 or 1.0 percent air voids. In summary, Bonaquist reported if you select 0.5 percent as the tolerance, you need to have the target air void very close which may be difficult for some mixtures.

ETG Comments, Questions, and Discussions

Chuck Paugh commented that if we increase the tolerance to 1.0 percent, how many specimens will not meet the data quality issue for each tolerance. Bonaquist, we don't know, that question is being looked into and it is hoped to have the answer in the near future.

Gerry Huber commented that he does not know whether 0.5 or 1.0 percent is important on the effect of flow number. Bonaquist agreed and requested information from anyone having varying air voids and the associated properties to look at the effects of air void level on the material properties. Huber asked were the samples used in Bonaquist's study tested for flow number. Bonaquist replied yes, but they were tested at different conditions and stress levels for different binders.

Ala Mohseni commented that there is a problem in trying to compact by height and he believes that flow number is dependent on number of gyrations. Bonaquist agreed and stated that now flow number specimens are compared based on height to different number of gyrations.

John D'Angelo disagreed on needing a lot of specimens for looking at the effect of air void variation on mixture properties. His opinion is the trends can tell you something regarding the effect on the properties. He noted in the FHWA mobile lab trailer we could still see a lot of information on the mix properties, even though the number of gyrations needed to compact the AMPT specimens changed from day to day simply from material variation during production. Bonaquist maintains that the number of samples increases substantially if the tolerance goes down for smaller standard deviations.

Bonaquist noted for the mixture preparation, a tolerance of 0.5 percent is very doable, but not sure 0.5 percent doable for SMA and other mixtures with greater variability.

Matt Corrigan asked whether this was really just ends up being an examination on whether how many specimens are rejected at the different tolerance levels. Bonaquist and Corrigan discussed the similarity of this issue to Percent Within Limits (PWL) in what was done in terms of the example. Corrigan commented that at 0.5 percent, he believes about 10 percent of the samples are rejected, and that is still reasonable.

Rick Harvey asked if anyone is really having a problem making or meeting the 0.5 percent tolerance. Bonaquist commented that this has come up at the AMPT user group meeting in terms of trying to meet the criteria. He noted in the inter-laboratory study, individuals had problems meeting the 0.5 percent tolerance. But if you have individuals properly trained in preparing the specimens, then meeting the 0.5 percent air void tolerance is not a problem.

6. Reduced Cycles Fatigue Testing—Don Christensen (Advanced Asphalt Technologies)

Presentation Title: ***Improved Testing Procedure for Uniaxial Fatigue Activities***

Summary of Report:
Don Christensen's report included: reduced cycles, geometric stress progression, testing using rest period, analysis, results, and conclusions. He explained the reduced cycles approach, which was presented at the AAPT April, 2012. Christensen explained the equations being used to predict the fatigue coefficients use the initial modulus of the mixture. He also reported for low volume roadways, really do not need to do a complicated analysis.

Christensen reported they are trying to create a simplistic procedure for technicians, using the same fatigue coefficients, and the Geometric Stress Progression (GSP) approach. He reviewed the procedure with the AMPT, and showed typical results for a Kentucky limestone mix. He also included data on the difference in stress level.

Christensen then examined the GSP with rest periods in the testing. He reported the different rest periods that were used after each loading step. With shorter rest periods, there was little healing, and so decided to exclude them. Christensen illustrated the loading sequence and explained how to consider healing in the process. He also presented the raw data without rest periods and showed what occurred with reduced data. Christensen reported that at the higher temperatures, healing or a change in the mixture responses occurred. At the lower test temperature, however, you do not see healing or the change in mixture response is much less.

Regarding the analysis, they tried many different approaches which is explained in the AAPT paper and found the K1 and K2 equations worked best. The Excel solver was used to determine the values. He compared the damage curves with and without rest periods. He also showed the equations for predicting fatigue damage used in the analysis – which is the most damaged point. He concluded the equations were fairly accurate, but was surprised at how little healing occurred. Christensen reported the rest period did not make that much of a difference in the data curves. Initially they had expected the c-value to be positive,, but found that the c-values clustered around 0, so did not make a difference.

Christensen then explained the relationships between the K1 and K2 parameters that were varied in the relationship and mix properties. He also showed the relationship between the constant in equation for K1 and the alpha term. He then showed the damage at the localization ratio versus the initial modulus. Christensen noted that from this relationship one could predict localization from the initial modulus. One question was why one cannot observe healing in the mix, believing that at higher temperatures with longer rest periods, should observe healing. This suggested the hypothesis that healing may not be important. These findings are different than reported in past studies.

Christensen gave the conclusions and recommendations resulting from this study. There was little to no healing observed for these mixes under the given test conditions, there is a relationship between the fitting constant and alpha which should improve the models for the damage function, and a good relationship was found between C-critical and the initial modulus. He encouraged other labs to attempt to replicate this work and extend their work to see if healing is important at longer rest period, higher temperatures, and different compressive stress. He

concluded his report by acknowledging FHWA/ARC (the sponsor of the study), the Mix ETG, Ray Bonaquist, Don Jack, and other lab personnel.

ETG Comments, Questions, and Discussion
Since Christensen asked that multiple labs should look at the healing aspect and see if the results can be repeated, Fee asked him for a step by step procedure to be followed. Christensen agreed and will provide to the ETG.

Raj Dongre asked if alpha is related to the initial modulus and use the results in the DARWin-ME. Christensen commented that they have not tried it with the DARWin-ME , but believes it would work. However, it is not a direct transfer from one to the other.

7. Status IDT E* Ruggedness Testing—Richard Kim (North Carolina State University)

Summary Presentation:
Richard Kim gave a verbal report on this topic. He reported two laboratories have agreed to make the test specimen (Florida and Virginia DOT), but was unable get a DOT to make a third set. Kim (NCSU) will then be the third lab doing the specimen fabrication. The three testing labs are: FHWA, NCAT and NCSU. Kim will continue share the ruggedness testing plan and information with the ETG.

8. Report Construction Task Group—Cindy LaFleur and Judie Ryan (Wisconsin DOT)

Presentation Title: *Update – Materials Impacting Compaction*

Summary of Presentation:
Cindy LaFleur was unable to attend the meeting, so Judie Ryan made the report. Ryan reported LaFleur asked her to take the lead of this group. Shane Buchanan will be the new co-lead.

Ryan gave the background on this topic and update of the activities of the task group. She acknowledged members of the task group; Mark Buncher, Erv Dukatz, Lee Gallivan, Kevin Hall, Gerry Huber, Julie Kliewer, Cindy LaFleur, Todd Lynn, Louay Mohammad, Jim Musselman, and Judie Ryan.

Ryan reviewed the 2012 action items that are on-going or have been completed. These included:

- Longitudinal joints – update the existing report and training course.
- Tack coat guidance document which was moved to AASHTO SOM. Louay Mohammad participated with task group since he is the principal investigator on the NCHRP project.
- TRB 91st annual meeting – task group helped with session #201 on Advancing Evaluation of Compaction Techniques on HMA. This general session was planned with Lee Gallivan.
- The TRB Synthesis of Highway Practice on Field Compaction – Methods of Measurement and Specifications was presented through TRB AFH 60 Committee.

Ryan reported that another action item was to identify and/or prioritize critical elements of compaction. This document was distributed to the ETG at the March 2012 meeting, and additional items were distributed to the group since the last meeting. Ryan prioritized the actions into the following 5 groups:

1. Publications – FHWA will work with industry partners to develop two publications to include "Materials Guidelines for Improving Compaction on Asphalt Paving Projects," and "Compaction Best Practices for Field Supervisors."
2. Research – TRB Research Needs Statement for "Development of Recommended Compaction Specifications for Asphalt Mixture Paving Materials." This includes lab mix design compaction efforts versus field compaction requirements.
3. Technology Transfer Tools – FHWA Technical Advisory on "Asphalt Concrete Mix Design and Field Control" needs to be reviewed.
4. Training – No immediate action item identified for this group.
5. Miscellaneous Policies – address recommended layer thickness in NCHRP Report 531 for coarse or fine mixtures and their respective NMAS.

Bukowski commented that the FHWA technical advisory, "Asphalt Concrete Mix Design and Field Control" has been eliminated and replaced with updated individual Technical Briefs on related subjects.

The next part of her report was related to new goals. These include current agency challenges that included: accelerated project delivery which is an item that agencies are considering to do things faster; increased recycling with new materials but still limit risk; product performance enhancements; DARWin-ME implementation; sustainability and durability; technology and innovation deployment; and EDC2.

ETG Comments, Questions, and Discussion:
Bukowski commented that in-place density continues to be an important focus, especially in light of WMA. We need to relate compaction effort, achieved density, and resulting pavement performance.

Fee asked about the effort to prepare a needs statement related to methods to get density, but cautioned that this ETG is a materials group focus and should not get overly involved in construction methods. Fee did not know if this was being considered by the SOM or the SOC. Ryan agreed with the previous comment of not getting too involved in construction issues, but need to keep the thread between materials and construction.

Bukowski commented that the task group had identified a lot of topics but should now select a few to focus their activities.

Ron Sines noted that while Ryan was talking about compaction, the focus should really be on pavement impermeability. He suggested the development and use of new methods for measuring permeability on the roadway.

9. Update on Moisture Induced Sensitivity Test—Erv Dukatz (Mathy Construction)

Erv Dukatz started his report by acknowledging the contributors of data: Dr. Scott Schram (Iowa DOT), Dr. Louay Mohammad (LSU), and Dr. Haleh Azari (AAPRL). His report was grouped into three sections tied to the three data groups.

Presentation Title #1: *MIST Update*

Summary of Presentation:
Dukatz started with the Iowa data for replacing AASHTO T 283 with another method. The devices they have considered include the Hamburg wheel tracking and MIST tests, for use in obtaining quick estimates of moisture damage. Iowa has focused on the stripping inflection point which is defined as a stripping slope more than 2 times the creep slope. He illustrated the new equipment for the MIST device.

Dukatz presented some of the Iowa results and reported Iowa is concerned whether the required anti-strip is really being added. He showed some correlations of data produced by different devices, between the MIST and TSR, and MIST and Hamburg device. Dukatz reported Iowa plans to continue with the MIST testing and base their specification on ESAL levels in comparison to the Texas specification based on PG level.

Presentation Title #2: *A New Approach to Characterize Moisture Damage of Asphalt Mixtures*

Summary of Presentation:
The second presentation under this topic was also given by Erv Dukatz, which was on the Louisiana data provided by Louay Mohammad. The test used in this was the Semi-Circular Bend Test (SCBT). Dukatz reviewed the testing and conditioning methods. Three stages are used: unconditioned, freeze- thaw and MIST. He showed a comparison of the data from MIST Jc, rut depth, and other parameters. Dukatz noted the test speed was changed to 2 inches per minute. He showed a bar chart comparing the ultimate strength and percent strength retained, and mentioned the absorption of the Iowa aggregates is relatively high and the stiffness of the binder does have an impact on the results from both studies.

Presentation Title #3: *Suggested Improvements to Moisture Damage Test Method*

Summary of Presentation:
The third presentation by Dukatz was also on the use of the SCB. Haleh Azari explained the bar chart of MIST conditioned IDT samples. She reported they tried the 100 and 150 mm specimens, and initially applied 100 conditioning cycles and then applied different loading cycles. The 150 mm damage ratio was a lot lower than the 100 mm specimen as shown in the presentation. Azari stated they are recommending the smaller diameter size specimen.

Dukatz summarized the conclusions from this work. MIST is a promising conditioning method. He also referenced two ongoing research items: evaluation of the MIST parameters, and evaluate additional moisture susceptible mixtures to verify conclusions. Dukatz mentioned all of the mixtures tested to date include some moisture susceptibility in the lab, but none of the mixtures exhibited stripping or moisture problems in the field.

ETG Comments, Questions, and Discussion:
Satish Belagutti read comments from Gale Page over the internet:

- Real question is not what the relationship is between tests, but what conditioning procedure (i.e., MIST) best reflects the conditions of tire/pavement surface water interaction that actually occurs in the field.
- The UF report includes the "theory" to identify the pore pressures in the pavement with water under a tire.

Elie Hajj asked about any difference in specimen diameter regarding the diameter effect and referred to the study done about 10 years ago through NCHRP on the IDT size effects. Hajj stated the data shows there is a difference. Azari referred back to one of the items for the bar graph of testing wet versus testing vacuum dried. This shows MIST and MSR values. She noted the pore pressures make the sample strength higher and that is the reason why the MSR values reflect higher strengths. So it is important to dry the specimens.

Bukowski asked if this was ready to formalize into a standard procedure, but Dukatz commented that further work is still needed.

10. Proposed Standard for TSRST—Elie Hajj (University of Nevada at Reno)

Presentation Title: *Determining Thermal Visco-elastic Properties of Asphalt Mixtures Using Uniaxial Thermal Stress and Strain Test (UTSST)*

Summary of Presentation:
Elie Hajj started by acknowledging the other individuals involved in the study: Mohammad Zia, Nathan Morian, and Peter Sebaaly. Hajj presented the objective of the study and the reasons for doing this work: approach to characterize thermo-visco-elastic behavior of asphalt mixtures under thermally-induced loading conditions, which requires direct measurements of thermally-induced stress and strain to calculate thermal properties of mixes.

Hajj explained the test provides information to calculate the thermal stress-temperature curve, thermal relaxation modulus (in temperature or reduced time domain), thermal viscoelastic properties (at different stages of the material), and fracture strength and temperature. He also identified the proposed modifications to the TSRST test, necessary because AASHTO TP10-93 has been discontinued. The modifications include: refining the specimen preparation method, adding a modular feature for measuring thermal strain during testing, improvement to restrained specimen platens, improvement of gluing technique (type of glue and specimen alignment stands), and other improvements.

Hajj then showed a snapshot of the uniaxial thermal stress and strain test device and explained the different parts of the device and what they are intended to do. They included a pin connection at the top and a U connection at the bottom which improved on the results – less variability.

Refinement of test specimen preparation includes coring along the diameter of a larger core. Two diameters were used: 45 mm and 57 mm. The diameter of 57 mm was initially used, but they are now using the 45 mm diameter specimens. Hajj noted they looked at coring vertically and along the side and decided to core horizontally or along the diameter. Hajj reported they originally had issues with alignment and were getting a lot of failure near the ends. After they changed the plates and added a pedestal they started getting much less failures near the ends.

Hajj explained the alignment jig in preparing the specimens – 2x2x10 in terms of specimen geometry. More uniform specimens were achieved using one large gyratory specimen. Field cores had more uniform air void distribution and produced more failures near the center of the specimen. He showed some examples between the field cores and lab compacted specimens. Hajj reported they are looking into rodding the specimens to reduce the air void gradient for laboratory prepared specimens.

The second part of his report focused on the calculation of thermal relaxation modulus and thermal visco-elastic properties. Hajj defined the crack initiation state at the point where the modulus starts to decrease. This was a comparison of the amorphous polymer behavior in comparison to the asphalt mixture behavior in terms of temperature versus log E*. Hajj then defined the glassy hardening area. He explained the procedure used to determine each stage, and defined the thermal elastic properties of the asphalt mixture. Hajj stated they wanted to convert that into a modulus master curve but noted this is open to different functions and other parameters and they have yet to define the exact process. This was the development of the thermal relaxation modulus master curve in terms of reduced time and thermal relaxation modulus. They are currently examining the reference temperature and what effect it has on the properties.

The third part of his report was a review of the draft of an AASHTO standard. He asked if others would perform the test and begin sharing data.

Hajj identified the on-going work and future studies including: effect of specimen size, mixture handling during compaction (air voids distribution in the specimen), effect of cooling rates and start temperatures (Elie noted the difference between cooling rates and trying to define its impact and on the starting temperature after the cooling rate has been resolved), evaluate different types of mixtures, evaluate field-produced mixtures an develop a mathematical model of the master curve.

Hajj ended his presentation by acknowledging the sponsor – FHWA/ARC.

<u>ETG Comments, Questions, and Discussion:</u>
Richard Kim asked if a comparison had been made for the relaxation modulus between the two approaches. Kim recommended Hajj look at the NCHRP 9-19. He has done this and was able to predict TSRST from the relaxation modulus. Kim noted if you see a difference between dynamic modulus and relaxation modulus you probably have micro-cracking/damage and if you can account for the difference in damage, the comparisons are very good. Hajj agreed with the suggestions and noted they had planned to do that.

Raj Dongre commented need to have isothermal equivalent conditions and the key is to decide what time to use. He noted the difference in time and stated time is not a fundamental property because it is not isothermal. Hajj agreed that alpha is changing, but noted the key is to simulate field conditions and asked if time and temperature are consistent in the field. Hajj gave the reason why he called it thermal visco-elastic behavior. Dongre and Hajj agreed every step needs to be isothermally equivalent.

Mihai Marasteanu asked about the thermal elasticity and recommended we not shift between thermal elastic and relaxation modulus. John D'Angelo commented whatever you call it, make sure you keep it consistent.

Frank Fee asked Hajj to provide a purpose for this standard in terms of his vision on how the standard will be applied. This is increasingly important especially with using higher amounts of RAP.

D'Angelo agreed with the approach but cautioned that some of these draft procedures are being sent by individuals pre-maturely to AASHTO. D'Angelo acknowledged Hajj efforts and credited the involvement of FHWA, Eric Weaver for initiating this effort.

ACTION ITEM #3: A draft of the revised TSRST procedure will be distributed for review and comment. Comments by the ETG will be forwarded to Elie Hajj prior to the next Mix ETG meeting.

11. Proposed Performance Test—Haifang Wen (Washington State University)

Presentation Title: *A Unified Performance Test for Fatigue and Rutting for Quality Assurance*

Summary of Presentation:
Haifang Wen focused on the potential of using performance tests for mix design. He referred to different tests being used or considered. Wen listed the different tests that are used to characterize and predict different distresses:

- For fatigue; AMPT and S-VECD, beam fatigue, the overlay tester, IDT fracture work and energy;
- For rutting; AMPT or flow number, Hamburg wheel tracking, IDT high temperature strength, and IDT flow number or flow time;
- For thermal cracking; IDT strength, DCT, semi-circular bend test;
- For moisture damage; TSR, Hamburg wheel tracking, and APA.

Wen reviewed the tests from a quality assurance standpoint in terms of testing devices, number of tests, sample preparation, ease of tests, costs, and implementations. He suggested doing the performance tests during construction. His maintains that the IDT is the one common test within each group for the different distresses. Wen showed many correlations between different distress measures and output from the IDT test for different distresses. Some of these included: IDT strength and rut depth; correlations between IDT strength and flow number; and others. His suggestion was that the IDT can be used during construction for QC and QA. Wen reviewed the

double-punch test. Wen then identified the parameters or factors that need to be considered regarding the double-punch test for the different distresses.

ETG Comments, Questions, and Discussion:
Mihai Marasteanu noted the double-punch test method is not new and has been shown to have potential and reported he reviewed it when he was looking at the IDT test. Wen plans to continue to use this approach for testing mixtures from field samples.

DAY 2: Thursday, September 27, 2012

Frank Fee called the meeting to order at 8:00 AM. He started the meeting by announcing the RAP ETG and WMA Technical Working Group have been integrated into the Mix ETG. Thus, the first report today will be made by Matthew Corrigan on WMA activities.

12. Report Task Group WMA, Discussion ETG Challenges—Matt Corrigan (FHWA)

Presentation Title: *Warm Mix Asphalt Technical Working Group*

Summary of Presentation:
Matt Corrigan reemphasized that while the WMA technical working group (TWG) has "sunset" does not mean it is unimportant and/or everything has been completed. He noted the efforts focus on use of multiple materials technologies with WMA, such as RAP, RAS and other materials. He discussed some of the achievements of the WMA TWG and how they will fit into the Mix ETG, as well as items that need to be picked up by the Mix ETG.

Corrigan mentioned the WMA TWG was established in 2005 and acknowledged Ron White's cooperation and effort in making the TWG a success. He also stated; it was a good industry partnership. Corrigan thanked all of the members of the WMA, especially Dave Newcomb, for their participation and acknowledged how well everyone worked together.

Corrigan identified some of the more important accomplishments including the international conferences that were held in 2008 and 2011. He reported the Europeans now believe they need to do a scan tour of the U.S. to see what we are doing with WMA. He referenced the best practices manual and listed the research needs statement now being funded through NCHRP. He showed the listing of projects that are on-going and those completed. Corrigan noted one of the responsibilities of the WMA Task Group in the Mix ETG will be to continue to review the recommendations and products from these projects. He also reported the technical evaluation program developed under NCHRP project 20-07(311) has been completed and taken over by a technical group. This program is not an approval program but an evaluation program.

He specifically referred to NCHRP projects 9-54 and 9-55 which are now being advertised. The final research needs statement for an additional project has been submitted to the SOM by Rick Harvey. This project is related to recycling agents used for asphalt mixtures containing high recycled asphalt binder ratios. Rick Harvey reported this research problem statement is waiting

to be prioritized. Corrigan noted the budget for this project is relatively high in comparison to the previous efforts.

Corrigan referred to a presentation by Randy West on NCHRP project 9-47A given at the last WMA TWG meeting. An element of that project was to look at the design of WMA mixes relative to the appendix to R35. The final report will go to the panel early next year, so findings are still preliminary.

- Specific findings from West's presentation included: need to perform design with WMA additive or lab foaming device; mixing temperature based on coating; compaction temperature based on gyrations to 92% Gmm; and rutting evaluation.
- Preliminary summaries include: optimum asphalt content percent decrease 0.27% for WMA compared to HMA using the appendix to R35. West stated a decrease in the target asphalt content by as much as 0.7%, but the average was about 0.3% because of reduced compaction; binder absorption less for WMA by approximately 0.1% for field samples and 0.16% for lab compacted samples; and the flow number is lower for lab-produced-lab compacted mixtures.

A recommendation that caused discussion was to design the WMA just as HMA for selecting optimum asphalt content, then do coating, compactability, TSR, FN with the WMA at the WMA temperatures; plant mix may be used for checking WMA with water injection foaming technologies. Rutting resistance of WMA in the field so far suggests that FN testing may not be necessary except perhaps for high traffic projects.

Randy West commented that considerable effort went into adding the appendix to R35. He stated WMA has been designed successfully as if it was HMA for over 5 years. State agencies were polled as well as contractors about the change in mix design procedures and most indicate they would like to see some type of rutting test. The work done under this study was to take mixtures with good performance histories and look at the mix designs that yielded air voids of 4 percent. He pointed out that reducing asphalt content with WMA is the wrong direction, because for good performance we have been traditionally trying to get more asphalt in the mixes. He gave reasons for the reduced asphalt content for the WMA mixes used in the study. This decrease was related to absorption but emphasized that does not explain all of the difference.

Dave Newcomb noted that absorption is being looked at under NCHRP project 9-52. He stated one issue is the 4 percent air voids used in design. He commented we now have performance tests that can be used to add asphalt for durability but ensure the content is not too high. Jim Musselman commented that we have used the current recommended practice without problems. West was asked again about the absorption levels used in the study. West replied that some aggregates had absorption above 3 percent but many were considered non-absorptive. Corrigan referred to the higher absorption aggregates in Texas (like limestone) that have been used on other projects and did cause some issues, so the concern is appropriate. Huber commented that in R35, the selection of the target asphalt has to do with the minimum VMA requirement, so he asked; what was the VMA to allow that much asphalt to be removed. West replied that he would have to look back in his report for the requirements on VMA. West commented he understands Bonaquist was not suggesting the target asphalt content be changed from a volumetric standpoint. Bonaquist responded that from a design standpoint, as long as you stay above the

minimum VMA the philosophy under R35 is the amount of asphalt by volume remains the same. Reinke suggested we may need to design to a lower air void level, say 3 percent, because you have a material (WMA) that allows you to compact easier.

Fee commented that the mix design procedure based on volumetrics has been rather well established and it will be difficult to change, rather we need to use performance tests to resolve these issues. He suggested we need to keep focus on tests to estimate how the mix will perform – rutting and cracking.

Adam Hand maintains that while there have been a lot of mixtures produced at the lower WMA temperature level, production temperatures are now increasing for WMA. He is an advocate of keeping it as is: designing WMA as HMA. West asked if you are not reducing mixture temperature, then is it a WMA, or only just a compaction aid.

Huber is of the opinion to keep the asphalt content the same, not reduce it. The question is whether the additional asphalt content is causing any problems/issues with performance. So we are decreasing the air voids by about 0.5 percent at the beginning. Is this a long term absorption issue. D'Angelo commented, that regardless whether WMA and HMA, the asphalt contents do get changed in the field, asphalt content gets reduced during construction. This is typically based on volumetric properties. Musselman does not believe they are changing asphalt content in the field. His point; where do you draw the line when the changes get made – they are not seeing the issue but maybe when they see the greater temperature reductions maybe they will see a reduction in asphalt content. Adam Hand also disagrees with D'Angelo because taking asphalt out can affect the mix in other areas, so the contractor's risk goes up, and most will not allow that to happen. Rowe commented that when you design the mix based on volumetric properties you know you will typically lose asphalt content during construction. He maintains that mix design should be based on plant produced material.

Richard Kim had the opportunity to test a wax based additive with WMA and the asphalt content was about 0.7 percent lower than HMA. Absorption was lower in the WMA, so they did performance testing (rutting and cracking tests) and moisture susceptibility tests at the lower values. The results were as expected using lower asphalt content. The most dramatic difference was related to moisture susceptibility. His recommendation to North Carolina was to keep the asphalt content the same between HMA and WMA.

Gaylon Baumgardner asked if the difference in absorption relates to all technologies. West believes it does. Reinke commented that we have forgotten that all WMA technologies do a better job of coating the finer aggregates. The design asphalt content gives us a value but that does not mean it is the correct value. He believes the plant does a better job of coating the aggregate than lab mixers. We should not be penalized for having lower air voids in the WMA mixtures during QC and QA. That is why we need to test and design WMA mixes at the production temperature and plant conditions.

West referred to foam versus other technologies and noted foaming is used 90 percent of the time. In their study, two of the mixes used foam, and the reduction was less than for the other technologies.

Georgene Geary asked if this means the SOM should remove the appendix from R35. Harvey noted there would be a lot of concern related to removing the appendix from R35. Corrigan replied that everyone needs to wait for final comments from the NCHRP panel and report and then decide where to go from there.

Corrigan continued with the final part of his presentation. Other items include: standardize the reheating procedure for WMA mixtures for volumetric and performance tests; use of RAS, RAP, GTR, alternate binders, and combinations used with WMA technologies, rejuvenating agents marketed as WMA technologies, use of WMA to remove SMA fiber requirements, incentives and motivation for improved density. Fee referred to some successful SMA projects without fibers when using WMA. Corrigan, however, mentioned some projects that had problems in Texas. West commented that we need to be careful about removal of SMA fibers. Bukowski referred to trying to measure performance of gap graded gradations that are difficult to quantify as well as any performance contribution caused by fiber. Yes the drain down test can be passed without fibers if run at the lower WMA temperatures, however that is not the direction we may want to go with SMA. SMA is a good mix with a gap gradation. He noted we need to be careful about removing and replacing items on one project and translating that effect to other conditions with different site features or conditions.

Corrigan continued with his discussion on the other items for continued involvement: conditioning of WMA performance testing, need for WMA specific mix design, evaluation of asphalt foam characteristics, local agency WMA acceptance and training

Ron Sines commented that there been debate on R35 and NCHRP project 9-47A, but what action is needed. Corrigan again commented that need to wait, that project has yet to be completed and the panel has yet to formally review the results. He believes it is only fair to wait until we get the final recommendations and use those final products to move forward for developing a plan of action.

ACTION ITEM #4: The Task Group on WMA under the Mix ETG will provide an update report on WMA development and issues at the next meeting.

13. **Workability and Field Compaction Temperatures**—Raj Dongre (Dongre Laboratory Services)

Presentation Title: *Workability Test "Calibration Shovel"*

Summary of Presentation:
Raj Dongre acknowledged Eugeniu Morari who was involved in this project. Dongre gave the background on the project. He defined workability and overviewed the objective of the study, which was to develop a simple, low cost, easy to use method to measure workability of HMA mixtures. He identified the torque meter's use in the bucket mixer. He also noted the procedure allows you to use the PaveCool software.

Dongre went through the steps used in the study: testing various unmodified, PMA, WMA binders; testing different aggregates and gradations; evaluating both field and lab mixes; determining the field compaction temperature range; mix workability, and then deriving a method to determine the field compaction temperature range.

Dongre gave details of the test method referred to as the DWT – Dongre Workability Test. He showed the accessories for the test equipment. The offset plate is not used because of temperature reduction issues. He stated all of these accessories are easily purchased. The testing protocol consists of testing loose mix at 0.05 mm/second ram rate; 4800 grams of aggregate plus optimum asphalt per replicate; the top plate and mold are all heated to the test temperature plus the offset; initial seating load is applied; the test is stopped at 950 kPa; and workability is determined as the slope of the volumetric strain and stress at 600 kPa stress level. He also reported that the test method appears very repeatable. Dongre reported the initial seating load is very important and affects the repeatability of the test.

Dongre illustrated the workability curves. He included different curves to illustrate the repeatability of the test. He then showed the effect of temperature on the workability of the mix. He defined workability as the stress or volumetric strain at 600 mPa stress.

Dongre explained how he determined the limits for the upper and lower values of 150 and 170 kPa for field compaction temperature limits. He also showed the connection with PaveCool by predicting the time available for compaction. In summary, Dongre stated the DWT is simple, low cost, easy to use test method to measure workability.

ETG Comments, Questions, and Discussion:
Fee commented that this needs to be put into a step by step procedure. Then it could be distributed to the group. Dongre noted he has a TRB paper on this topic which could also be distributed to the group. Fee urged Dongre to develop this procedure so that others can use it.

West complimented Dongre on this work. He mentioned David Timm published a paper that showed the temperature drops are the same between HMA and WMA but you need to determine the lower temperature at which compaction no longer occurs.

Huber added a comment and Dongre agreed on water changing the properties of the foamed mix. It appears there is a physical softening process from the foaming. It is interesting that we are using water to soften the asphalt as a workability aide and it appears that it is reversible and does not damage the asphalt or final mix. Huber referred to the research done and with small amounts of water being added, the stiffness (E* measurements) dropped as much of 75 percent.

ACTION ITEM #5: Raj Dongre will provide the Mix ETG a copy of his workability procedure presented at the meeting. Anyone using the procedure is requested to provide Dongre their data/results.

14. **Update Semi-Circular Bend Draft AASHTO Test Method**—Mihai Marasteanu (University of Minnesota)

Presentation Title: *LTC-II Project Summary and Significant Contributions*

Summary of Presentation:
Mihai Marasteanu summarized the status of the study. He focused on the hypothesis the asphalt binder testing alone does not give the full accuracy for predicting low temperature cracking. Marasteanu then focused on the pooled fund study 776 which was published in 2007. This was a comprehensive national pooled fund investigation of low temperature cracking of asphalt pavements. Marasteanu referred to the benefit of MnRoads for getting the necessary field data.

Marasteanu overviewed the test methods which included SCB (semi-circular bend), IDT (indirect tensile test), and DCT (Double notched test). Marasteanu then overviewed an issue with the IDT test which is the size effect. With the IDT you cannot come up with a clear equation to explain size effects. Marasteanu also reported they looked at the TSRST specimen shape effect and tested circular and rectangular specimens.

Marasteanu identified the materials used in the study, and presented a tabular summary of the LTPPBind low pavement temperature at 50% reliability level for the different areas from which the materials were collected. He showed an example of fracture energy comparisons between transverse cracking and SCB fracture energy. He then defined fracture energy – load versus load line displacement – the fracture energy is the G_f or area under the curve. This issue with the IDT is you can only get data up to the peak load and not the damage or softening part.

Marasteanu then gave the pooled fund study 776 conclusions: field performance correlates best with fracture parameters for both asphalt mixtures and binders; the PG specification for binders provides a good start, however, other factors such as aggregate type and air voids affect fracture resistance; at low temperature, asphalt mixes are complex viscoelastic composite materials that are significantly temperature/loading rate dependent; and there is a need to develop mixture selection criteria similar to the PG system. He then addressed results from the current pooled fund study. A concept for a new mix low temperature cracking specification will be proposed and mix selection criteria are similar to the PG system. The main focus was on fracture energy as measured by the DCT or SCB test, and SCB fracture toughness limit may be added to complement the energy criterions. He suggested a limit on creep stiffness and possibly the m-value by using the current IDT method, using BBR tests on mixture beams, use the SCB or DC(T) tests and estimated from the binder and mix E* model.

Marasteanu identified the two mixture fracture tests: the semi circular bending (SCB) and disc-shaped compact tension test (DC(T)). Marasteanu noted the main problem is defining the mix and how it will be prepared relative to the mix specification. For fracture energy, lower limit of 350^oF to 450^oF appears reasonable at the PG+10 temp. The main difficulty in implementing a mix specification is related to the mixture preparation procedure and aging condition. As more data become available, relationships to take into account other sample preparation and aging condition combinations will be developed and implemented.

He presented a tabular listing of the recommended values for the low temperature cracking specification for loose mix with DC(T). He then presented a similar table for the SCB and noted

the difference between the two. Two parameters were listed by Marasteanu: the fracture energy and optional fracture toughness.

Marasteanu then summarized the significant contributions from the pooled fund study: two fracture testing methods were proposed and specifications were developed for mix selection. He thanked Rick Harvey and the SOM for moving this test method forward. He also noted the work done by Hussain Bahia in Wisconsin that improved the test and procedure. Marasteanu reported alternative methods were proposed to obtain mix creep compliance needed to calculate thermal cracking. Mix dilatometric measurements results in a set of coefficients of thermal contraction that can be used to more accurately predict thermal stress. Physical hardening further evaluated and improved the model proposed to take these effects into account.

ETG Comments, Questions, and Discussion:
The report for this study is available on the pooled fund site and the Minnesota web site, which is: http://www.pooledfund.org/details.study/395 under TPF-5(132).

A number of comments on this procedure had been received from a previous 2d technical section ballot. Marasteanu will provide a response to 2d technical section chair, Georgene Geary.

Fee recommended the effort continue and complimented Marasteanu on their work and potential implications on predicting low temperature cracking.

15. Task Group Review Update on T 321 (Beam Fatigue)—Geoff Rowe (Abatech)

Presentation Title: *Update Review of Bending Beam Fatgigue Test – AASHTO and ASTM Methods*

Summary of Presentation:
Geoff Rowe asked for additional input to the task group. A meeting on this topic had been held earlier but results were too late for consideration prior to this meeting. There are a number of states using the beam fatigue test. He would like to get more accurate information from the agencies using the test, which include: Kentucky, Iowa, and California. He plans to get their state specifications for critical evaluation.

Rowe first acknowledged the others involved in this work, including: Louay Mohammad, Richard Steger, Tom Bennert, Richard Willis, and Phil Blankenship. The objectives of this effort is to improve the definition of fatigue life as defined by AASHTO and ASTM methods and fatigue testing, to define a fatigue relationship, and to validate a mixture's suitability at a given strain level. He also identified some of the issues: ASTM and AASHTO standards have different definitions of fatigue life, and AASHTO standard gives significantly different life depending upon how the method is implemented. Rowe listed the differences in the data analysis which can produce large differences. Rutgers University provided data and information to illustrate the differences using three examples. His point was that the data selected for the analysis method affects the results. Since last meeting they are working on producing a "red line" of the AASHTO specification.

Rowe explained the "red line" changes regarding the data collection format. He noted the individuals working on this topic and mentioned Tom Bennert and Phil Blankenship. A suggestion is to change to 2000 micro-strain, rather than the current 750 micro-strain. He is unaware of anyone using more than 2000 micro-strain. The analysis section has been completely removed from the document. He asked the equipment manufacturers to track the modulus change and when it peaks, that defines failure. Rowe explained the rest of the document and the changes being proposed.

Rowe maintains that these changes take the test results closer to where need to be more uniform results. Future efforts include working with ETG/AASHTO on further refinement of the standard, possible need to produce an appendix with analysis examples like data curtailment and interpretation, and further work needed as more states implement the standard.

ETG Comments, Questions, and Discussion:
Richard Kim commented on failure criteria related to interlayers – Modulus versus N just keeps going up. In those cases, the phase angle was used to define failure. Geoff Rowe has never seen that type of condition with flexural beam testing. Kim recommended the standard be noted as being restricted to selected mixtures.

Fee noted that this procedure does not include sample preparation, but only the testing. Rowe commented that for now they just focused on the testing issue and agreed later they could look at other areas such as sample preparation.

Bukowski added that this was sent to all ETG members and Rowe also recommended all equipment manufacturers get a copy of the standard.

ACTION ITEM #6: A copy of the revised T 321 procedure (Bending Beam Fatigue) will be distributed for review and comment. All comments provided to Geoff Rowe will be discussed at the next meeting with the anticipation of forwarding this procedure to the SOM.

16. Inter-Laboratory Study of AASHTO T 324 "Hamburg Wheel Tracking of Compacted Hot Mix Asphalt (HMA)"—Haleh Azari (MRL)

Summary of Presentation:
Haleh Azari gave the report on the inter-laboratory study of AASHTO T 324 Hamburg wheel track test of compacted hot mix asphalt and the variability of this method.

Azari identified the types of materials used in the study. The two materials were a 19 mm field mix from Virginia defined as a good performing mix and a 9.5 mm Wyoming mixture defined as moisture susceptible. The two types of specimens included gyratory specimens and slabs. Azari presented the results from the test program in terms of deformation versus number of passes for all mixtures compacted with the gyratory compactor. She reported one outlier was identified in the group. Azari then presented the results from the test program for the slabs. She reported that

the poor performing mixtures had some interesting results. She showed the scatter in the data between the sensors.

Azari summarized the properties used in the comparisons, which included the rut depth at: 5,000, 10,000, 15,000 passes, and 20,000 passes, as well as the creep slope, strip slope, and stripping inflection point. The number of maximum deflections and where the maximum deflections occur were illustrated in her report. She was expecting the maximum values at sensor #6 but saw it can occur in different locations or sensors. Azari noted that for the poor performing mixtures, the higher deflections were for the gyratory prepared specimens and not the slab specimens. Azari then showed the number of passes and deflection at the inflection point and pointed out the deflections at the inflection point were about the same but the number of passes to get there were significantly different.

Azari showed the results for the different slopes (creep portion of the test), and pointed out the differences between the gyratory and slab compacted specimens were significantly different between the right and left specimens from the gyratory.

Azari reported some of the observed shortcomings from the test, which included: misalignment of trays which can result in difference wheel locations; high confinement at the ends results in small wear at the ends; insufficient confinement at the joints result in excessive wear at the midpoint; cutting samples creates weak areas, shortens distance to the edge, and spacers become necessary; and anomalies with sensor location and spacing (actual location of sensors do not agree with the design locations, sensors too close at one end and too far apart at the other end, maximum deflection was not reported at sensor #6 – it was reported at sensors #7 and 8), and the deflection profiles were not symmetric.

Azari then showed the profile of the Wyoming gyratory and they expected to see symmetric profiles but that was not observed which was due to spacing of the sensor and misalignment of the tray. Azari showed where the sensors are and summarized the issue of misalignment on the readings. Azari reported they changed the location of the bar and found that the location of the sensors was found to be in error – about 2 mm off. This had to do with the location of the sensor.

AASHTO T 324 specifies the test should be run with a smooth movement across the test specimen, only deflection measurement in the middle 20-mm., and maximum speed of the wheel at the midpoint. In addition, she emphasized the following: high confinement at the ends causes less wear and low confinement at the middle causes excessive wear which results in slope in the wheel track and plowing action of the wheel.

Specific recommendations made by Azari include: need to standardize factors affecting the performance before determining precision estimates of the test; cutting or no cutting of gyratory specimens; gap spacing between molds (a smaller cut pushes the molds back so wheel stays on the specimens); confinement around the joint for gyratory specimens, and confinement at the ends- currently more confinement at the ends compared to the middle.

ETG Comments, Questions, and Discussion:

Fee asked if the precision results of the test are available. Azari replied that they will be available in the next couple of months. She will add the precision in the report, but is not recommending the values from the study because of the problems reported. Fee noted that based on the equipment used, the precision values become very important. Ruggedness is a separate item which should have been resolved even before the standard was prepared. Fee suggested getting the ruggedness done first and then the ILS. But since the ILS has been done, the results should now be distributed for review.

Kevin VanFrank commented that there is no requirement for the 11 sensors and that only the center half of the specimen is monitored. The miss-location of the sensors was within the required tolerance. Van Frank was concerned with the results. Azari noted that in her evaluation there were no real problems with the slab specimens where a linear compactor was used, but only with gyratory prepared specimens.

Adam Hand asked about sample preparation. Azari commented that all samples were prepared by her lab and sent out for testing. Hall noted that while the same gyratory was used, specimens were cut by the individual labs included in the study. D'Angelo asked about the gap on the outside edges and about the confinement effect relative to the maximum deflection will shift. Azari replied that she is recommending consistent confinement throughout the sample. Hall referred to data from Stacy Williams that was reported about 10 years ago on the effect of cutting the specimens for use in the Hamburg test. If properly cut, you then want to observe the maximum deflection to occur at the center of the core and not between two cores. The idea of controlling the maximum deflections at a specific location should not be defined because it varies throughout the core. He believes we should not artificially set where the maximum deflection occurs. Hall noted that they add extra sensors so the location of any one sensor is not that important.

Reinke noted that very specific recommendations for cutting the specimen are provided. If individuals cut them differently, then the test/results are not valid. He also noted that he does not understand why we do not use all sensors and average the response rather than using only specific sensors. The test is not that sensitive or precise. He suggests averaging the data across the center sensors. Azari replied they did average the sensors and dropped the outside sensors. VanFrank noted that this effort will continue and asked if Hall and Reinke could be involved.

Corrigan commented that cannot ignore this problem in the evaluation about the confinement and the cut sections touching one another. Harvey suggested that the evaluation may be using an older version of the standard. He noted the first version was for slabs and not cutting test specimens. As the gyratory became the preferred lab compactor the standard was modified.

Corrigan asked for more information on how the specimens were cut and then tested. Azari commented that they followed the Texas method for creating the cuts and matching the joint. But by not cutting the specimens there is more variability.

Fee suggested that Azari and Kevin VanFrank get together and identify the future course of the evaluation and working with the other groups involved in the testing. Bukowski noted that while

this is not an ETG effort, he requested that Azari contact him prior the next ETG meeting, should she have any new information to present.

17. Report Task Group RAP, Discussion ETG Challenges—Lee Gallivan (FHWA) and Audrey Copeland (NAPA)

Presentation Title: *Reclaimed Asphalt Pavement (RAP) Task Force Summary 2012*

Summary of Presentation:
Gallivan reported some of the accomplishments of the RAP ETG and those items that need to be acted on within the Mix ETG. Gallivan reported the RAP ETG has now ended after 5 years. He listed the RAP ETG membership and identified and acknowledged those members that have participated in the ETG over the years.

Gallivan identified some of the more important accomplishments of the RAP ETG, which included: AASHTO M 323 modifications to allow for binder replacement; states have changed specifications to allow more RAP by targeting low RAP usage states such as California and Arizona which expanded their use of RAP. Gallivan also mentioned West Virginia as expanding their use of RAP. Gallivan reported multiple research efforts have been completed which are very important, and the RAS issues defined. The RAS and RAP issues accomplished include: how to increase RAP usage and ensure pavement performance (NAPA publication PS 34), designing HMA mixtures with High RAP content (NAPA QIP-124), and the webinar on the design and production of high RAP pavement mixtures. Gallivan also highlighted the document by FHWA, RAP in Asphalt Mixtures; State of the Practice which was completed and published – FHWA Publication FHWA-NRT-11-024.

Gallivan reviewed some of the accomplishments related to AASHTO M 323, including: added new section entitled binder percent replacement and note 6. He noted they did not include a table like table 5-1, but included note 6, and referred to the step by step procedure for categorizing their RAP materials for making an informed judgment decision on what to do or how to use their materials. Gallivan noted this is not to be performed on every individual project, but rather to categorize groups of material within a state.

Gallivan identified the top recycled asphalt pavement items for the Mix ETG future discussions and noted they were categorized in four groups: outreach, research, technical information, and standards. He then went through each one individually.

1. Outreach: He noted that NCAT agreed to keep the RAP webpage for continuing what has been done previously. The web page is www.morerap.us; and includes case studies on the use of high RAP, RAS, RAP/RAS/WMA, and RAP/Rubber mixtures. Gallivan overviewed what NCAT has done with the website.
2. Research: Field monitoring of the MnROAD RAP section; monitoring of the RAP accelerated loading facility experiment. The northeast study on high RAP pool fund project by Jo Daniels, and Chris William's efforts at Iowa State University on the performance of recycled asphalt shingles in HMA. Gallivan mentioned the NCAT study on NCHRP 9-46 for improved mix design, evaluation, and materials management

practices on hot mix asphalt with high reclaimed asphalt pavement content. Research needs statements have been written on experimental design for field validation of tests to predict cracking in asphalt mixtures; use of soft recycling agents in HMA and WMA containing high asphalt binder replacement ratios; and NCHRP 9-55 on recycled asphalt shingles and reclaimed asphalt pavement in HMA mixtures.

3. Technical Information: This includes: the NAPA-FHWA usage survey on RAP/RAS/WMA, AASHTO State RAP use survey; shingles best practices guide by NCAT; RAP in rubber modified mixes; comprehensive RAP best practices report/guide by FHWA; and the proposed Technical Brief on Shingles Best Practices Guide also by FHWA.
4. Standards: Including: M 323 modifications – binder replacement revisions for RAP and /or RAS (part 1 completed); PP53/MP 15 modifications regarding RAS which needs work; and the development of technical information on shingles to replace the existing standards.

Gallivan summarizes some of the information from the 2011 NAPA-FHWA survey statistics' and reported RAP is growing and he gave the increases in percent of use.

Gallivan then focused on the Mixture ETG RAP task force group discussions. The first item discussed was the list of members. He asked for volunteers and recommendations for new members. Bukowski noted that Task Group participation is not just limited to ETG members. Harvey suggested that Gallivan may want to contact Missouri (Joe Schroer) and Pennsylvania (Tim Rameriz) who during the SOM ballot had many comments. Bukowski noted that Tim Rameriz has been asked to join the ETG but has state agency travel issues that need to be resolved. Bukowski reported that to have increased emphasis on RAP and WMA in the ETG, Jo Daniels and Tom Bennert have been added as new members.

Gallivan noted the first priority for the Task Group is the MP 53 and M 323 standards.

Jim Musselman reported NCHRP project 9-46 is wrapping up and some of the recommendations Need to be reported back to the ETG.

Fee commented that with the increased use of high RAP need a better cracking test.

ACTION ITEM #7: The task force on RAP/RAS will report on developments and issues under this topic at the next meeting. This includes items from NCHRP project 9-46 that need ETG discussion.

18. PP 53 and Methodology to Determine Asphalt Availability—Gerry Huber (Heritage Research)

Presentation Title: *Evaluation of Shingle Asphalt Binder Availability Factor*

Summary of Presentation:

Gerry Huber made a presentation on the contribution of shingle asphalt binder as contained in AASHTO PP 53, section 6. Huber overviewed the calculation of the asphalt contribution from the shingles. He explained the equation to define the availability factor, Fc. This defines the calculation factor to estimate how much asphalt binder is being contributed into the mix from the shingles.

Huber discussed the formula and went through some example illustrations. He went through the process of explaining what he believes is wrong with this calculation.

Huber went through a hypothesis of adding shingles and his experiment. He showed the virgin design which was the original mix design. The stone, sand and natural sand which are broken down into 3 sizes, and the baghouse fines. He then showed the shingles and noted they break down into different sizes. A high speed centrifuge was used to extract the asphalt from the shingles. To extract 50% asphalt form shingles they combined 50% total extraction with 0% extracted shingles. Humber showed the extracted shingles for some of the shingle sizes.

Huber then presented the volumetric properties of the mixes in a tabular version. Huber moved on to the evaluating the volumetric properties. Randy West asked Gerry to use the terminology of Vba versus Pba which is on a weight basis. Huber agreed with the recommendation and will make the correction in his report.

Huber suggests the ETG make a recommendation to the SOM to remove the shingle binder availability factor from PP 53. Kevin Hall stated Arkansas is using this procedure in PP53 because they are paying for asphalt separately. Hall asked Huber to send him the information. Huber noted that this shingle binder availability factor came from a 2003 research report. Corrigan noted that the calculation of the binder availability factor is just used as a starting point in the procedure and not a final value. Huber realizes that it is only an initial estimate and there are other corrections in section 7 based on whether you get a + and then a – value.

Reinke disagreed with the prior suggestion by Huber and maintained that you should not completely eliminate the asphalt availability factor. We need to determine the binder availability and this is just the initial starting point. Huber's suggested approach is to determine the binder contribution from the shingles in terms of the mixtures volumetric properties. He disagrees with using the current practice of the correction factor as a starting point and wants to have it eliminated.

Gale Page disagreed with Huber's approach that all the binder in the shingles should be considered as binder in the mix. Page maintains that a portion of the asphalt binder in the shingles should not be considered as binder but rather as black rock and considered as aggregate in all of the calculations. Huber held to his opinion that this does not describe what is happening because of the two different properties between the rock and black rock.

Jim Musselman going along with Gale Page's comment and noted that they would like to use shingles but the shingles look like pieces of glass and believes it is closer to rock rather than to asphalt. He believes we may find out something that is significantly different in 10 years or so. He does not believe it will act like a viscoelastic material. Huber answered; we do not know what

impact it will have on the properties of the mix in terms of aging, thermal cracking, fatigue cracking, etc.

Mostafa Elseifi asked is it is possible that the mixing temperature when RAS is used should be raised to allow for the binder in the RAS to interact with the virgin binder. We had to raise temperature to blend RAS binder with virgin binder. Huber replied yes, but also believes that at some lower temperatures also have a migration from the RAS binder into the virgin binder

West noted that volumetric properties are not the complete answer, rather need mixture performance tests on durability and other distresses.

Corrigan again referred to Joe Schroer (Missouri) and Herman Claros (Texas) and they both maintain they are not getting 100% contribution from the shingles. There is a percent differential that is occurring. They have seen only about 70% on the contribution from the shingles and that has caused some performance issues. He believes there is sufficient information to maintain that 100 percent of the asphalt binder in RAS is not available in the final mix. Huber would like to tie all of the comments together and instead on using contribution would rather say or ask what impact does these materials have on our mixtures. He hopes that the new NCHRP project will start providing information and data to determine what is the impact. Corrigan noted that the 8 year criteria for an AASHTO provisional standard has been reached and need to move to full ballot to accept as a standard. Also noted that that manufactured and reused shingles are different.

Gale Page commented that he agrees with Corrigan. The factor is just a starting point to come up with the portion of the RAS binder contribution to total binder content of the mix and the portion that should be considered as aggregate. Jack Youtcheff noted he would characterize it more as a fine suspension in the binder.

Fee asked if we could get the report used to generate the binder replacement from shingles for distribution to the group. Georgene Geary replied that she would look into finding the report.

Bob Kluttz commented that in the "roofing world", a lot of roofing materials are placed by mopping at 400^{o}F and still do not see total adhesion in some cases. He noted that the idea that asphalt in the shingles not completely mixing with virgin asphalt is viable.

Fee noted PP 53 is a provisional standard and pointed out the mixtures with RAS are being designed successfully However, as recommended by Randy West and many others, we really need to start performance testing.

19. Estimating the Effect of RAP/RAS Binder—Andrew Hanz (University of Wisconsin at Madison)

Presentation Title: *Procedure for Estimating the Effect of RAP/RAS on Binder PG Without Extraction*

Summary of Presentation:
Hanz gave the background on this topic, and acknowledged the individuals involved. He started with the motivation of the alternative test method in terms of the objectives and test output. He also referred to the previous work completed on this topic. Hanz noted that they are now at the next stage for it to be put into an AASHTO format.

Hanz noted two important goals of the report: present an overview of test procedure and solicit feedback and support from the ETG in finalizing the standard. Hanz noted the concepts of procedure which include: the effect of RAP/RAS on PG can be estimated without extracting and measuring the PG properties of conventional binder and properties of two different mortars; difference in mortars is the effect of or the RAP binder, and use the factor to shift the performance versus temperature plot for conventional binders.

Hanz then showed an example on the effect of the RAP on the m-value by testing mortars in the BBR at two temperatures. Hanz then went through the materials and testing process. The testing capabilities can determine the full PG grade using the same thresholds as Superpave and adjustment to test for mortars.

Hanz then gave a summary of the testing procedure and aging conditions. He overviewed the test process. He identified the adjustments for testing the mortars. These include: a gap of 2 mm use for the 25 mm and 8 mm geometries of the DSR. Hanz then showed the applications for the test, which included: determine the effect of recycled binders on continuous grade and determine the rate of change in performance to define binder replacement threshold values. He gave an example on how it is used and what it represents.

The current practice of the tiered system is to have an allowable percent binder replacement. The possible reasons for the tiered system being insufficient are that the variation in RAP source is differences of RAP binder due to time in service. Hanz noted the sensitivity summary was reported in a TRB paper last year and can be provided to the ETG. This had to do with RAP source sensitivity summary and grade change rate was presented in a tabular summary. The next part showed typical data generated from the procedure. He defined the value of the procedure in that there is scientific evaluation of RAP in terms of properties of recycled binders vary significantly, thus it is necessary to measure performance impacts and optimize use of RAP/RAS using grade change rate and method to justify use of PBR higher than state thresholds; and the elimination of the need for binder extraction process.

Hanz noted the products that are available and can be shared with the ETG. These include the draft procedure in AASHTO format, spreadsheet tool to conduct analysis, journal papers and references. The next steps are to solicit feedback and get ETG support. Volunteers are needed to help review and simplify the procedure and analysis tool, as well as define the requirements for ruggedness and verification testing.

ETG Comments, Questions, and Discussion:
Fee asked Hanz to provide the standard for ETG review. Also, the ETG would like to see the background and other information on the standard.

ACTION ITEM #8: The procedure for estimating RAP/RAS properties will be sent to the Mix ETG for review and comment. Comments will be sent back to Andrew Hanz, which will be discussed at the next Mix ETG meeting.

20. Action Items and Next Meeting Planning—Frank Fee (Consultant) and John Bukowski (FHWA)

Action Items:
John Bukowski reviewed the action items from this meeting, which are:

1. Richard Kim will provide a revised S-VECD standard to Bukowski for ETG review. Comments will be provided to Kim prior to the next ETG meeting. The revised standard should be forwarded to the SOM after the spring meeting. All comments should be returned to Bukowski as soon as possible.

2. A Mix ETG panel will be formed and lead by Jeff Withee and Ray Bonaquist to review various flow number methods and data. Each developer of a procedure is requested to forward a written procedure in AASHTO type format to Jeff Withee. The panel will present the recommendations at the next Mix ETG meeting.

3. A draft of the revised TSRST procedure will be distributed for review and comment. Comments by the ETG will be forwarded to Elie Hajj prior to the next Mix ETG meeting.

4. The Task Group on WMA under the Mix ETG will provide an update report on WMA development and issues at the next meeting.

5. Raj Dongre will provide the Mix ETG a copy of his workability procedure presented at the meeting. Anyone using the procedure is requested to provide Dongre their data/results.

6. A copy of the revised T 321 procedure (Bending Beam Fatigue) will be distributed for review and comment. All comments provided to Geoff Rowe will be discussed at the next meeting with the anticipation of forwarding this procedure to the SOM.

7. The task force on RAP/RAS will report on developments and issues under this topic at the next meeting. This includes items from NCHRP project 9-46 that need ETG discussion.

8. The procedure for estimating RAP/RAS properties will be sent to the Mix ETG for review and comment. Comments will be sent back to Andrew Hanz, which will be discussed at the next Mix ETG meeting.

Next Meeting Location and Date:
Bukowski reported the next meeting is scheduled for Raleigh, North Carolina and the tentative date is April 30 to May 1. The Binder ETG will start on May 2 and end on May 3 (noon). Please

let him know if anyone has a problem with those dates. From This date is later than usual, but scheduling conflicts and arrangements for a new meeting contractor necessitate the later date.

Recommendations to the AASHTO SOM from this meeting may present a timing problem. Any recommendations to standards that need to be forwarded to the SOM for technical section ballot will need to be submitted immediately after the meetings.

21. Meeting Adjournment—Frank Fee and John Bukowski adjourned the meeting at 3:25 PM.

ATTACHMENT A

Asphalt Mixture Expert Task Group
Minneapolis, MN
September 26-27, 2012
Meeting Agenda – Final Draft

Day 1 – September 26, 2012

8:00 am	Welcome and Introductions	**Fee/Bonaquist**
8:15 am	Review Agenda/Minutes Approval & Action Items September, 2011 Meeting	**Bukowski**
8:30 am	Subcommittee on Materials Updates/Comments	**Harvey**
9:00 am	Update Related NCHRP Activities	**Harrigan**
9:30 am	Break	
9:45 am	AMPT Test Development • Status AMPT Pooled Fund TPF-5(178) • Direct Tension Fatigue Standard • AMPT Flow Number Task Group Report	 **Withee** **Kim** **Fee**
Noon	**Lunch – on your own**	
1:00 pm	Reduced Cycles Fatigue Testing	**Christensen**
1:30 pm	Status IDT E* Ruggedness Testing	**Kim**
2:00 pm	Report Construction Task Group	**LeFleur/Ryan**
3:00 pm	**Break**	
3:30 pm	Update on Moisture Induced Sensitivity Test	**Dukatz**
4:00 pm	Proposed Standard for TSRST	**Hajj**
4:30 pm	Proposed Performance Test	**Wen**

Adjourn for the Day

Day 2 – March 27, 2012

8:00 am	Report Task Group WMA – Discussion ETG Challenges	**Corrigan**
10:00 am	Break	
10:30 am	Workability and Field Compaction Temperatures	**Dongré**
11:00 am	Update Semi-Circular Bend Draft AASHTO Test Method	**Marasteanu**
11:30 am	Task Group Review Update T-321 (Beam Fatigue)	**Rowe**
Noon	**Lunch – on your own**	
1:00 pm	Report Task Group RAP - Discussion ETG Challenges	**Gallivan/Copeland**
2:30 pm	PP53 and Methodology to Determine Asphalt Availability	**Huber**
3:00 pm	**Break**	
3:30 pm	Estimating the Effect of RAP/RAS Binder	**Hanz**
4:00 pm	Action Items and Next Meeting Planning	**Fee/Bukowski**
4:15 pm	**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	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
2	Superpave Performance Test Review	Mike Anderson (Lead)
	T 320; Simple Shear Test	Louay Mohammad, Tom Bennert, Richard Steger, Becky McDaniel
	T 321; Bending Beam Fatigue	Geoff Rowe, Richard Steger, Louay Mohammad, Richard Willis
	T 322; Indirect Tension	Jo Daniels, Becky McDaniels, Rey Roque, Richard Steger
3	WMA Mixture Design/9-43 Comments	Matt Corrigan (Lead)
4	HMA In Place Density Practices & Specifications	Cindy LaFleur (Lead); Erv Dukatz, Julie Kliewer, Todd Lynn, Jim Musselman, Judy Ryan, Chris Euler
5	S-VECD Alpha/Beta Testers	Richard Kim and Shane Underwood (Leaders); Tom Bennert, Jo Daniels, Geoff Rowe, Tom Scarpas, Harold Von Quintus
6	AMPT, TP 60: Air Void Tolerance and Sample Preparation Issues	Ramon Bonaquist (Lead); Haleh Azari, Matt Corrigan, Richard Kim, Gerald Reinke, Richard Steger, and Randy West