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 83 individuals attended the meeting (23 members, 60 visitors). 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
Tom Bennert, Rutgers University
Mark Buncher (Liaison), Asphalt Institute
Audrey Copeland (Liaison), NAPA
Jo Daniel, University of New Hampshire
John Haddock, Purdue University
Kevin Hall, University of Arkansas
Adam Hand, Granite Construction, Inc.
Gerry Huber, Hertiage Research Group
Edward Harrigan (Liaison), NCHRP
Reid Kaiser, Nevada DOT
Richard Kim, North Carolina State University
Todd Lynn, Thunderhead Testing, LLC
Louay Mohammad, LTRC/Lousiana State Univeristy
James Musselman, Florida DOT
David Newcomb, Texas A&M Transportation Institute
Timothy Ramirez, Pennsylvania DOT
Judie Ryan, Wisconsin DOT
Nam Tran (Liaison), National Center for Asphalt Technology

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

Members of the ETG that were not in attendance:
Shane Buchanan, Old Castle Materials
Ervin L. Dukatz, Jr., Mathy Construction Company
Georgene Geary, Georgia DOT
Julie Kliewer, Arizona DOT
Allen Myers, Kentucky Transportation Cabinet

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

Chris Abadie, Louisiana DOT
Howard Anderson, Utah DOT
Mike Anderson, Asphalt Institute
Satish Belagutti, ESC, Inc.
Tim Ashenbrenner, FHWA
Jason Bausano, MWV
Mark Blow, Asphalt Institute
Alexander Brown, Asphalt Institute
James Budday, North Carolina DOT
Wei Cao, North Carolina State Univ.
John Casola, Malvern
Chris Croom, S.T. Wooten Corp.
Raj Dongre, Dongre Lab Services Inc.
Jean Paul Fort, Colas
Lee Gallivan, FHWA
Tejash Gandlie, MWV
Rouzbeh Ghabchi, Univ. of Oklahoma
Nelson Gibson, FHWA
Elie Hajj, University of Nevada at Reno
Andrew Hanz, WHRP
Cassie Hintz, North Carolina State Univ.
Robert Horan, Asphalt Institute
Ryan Kirkendall, Troxler
Robert Kluttz, Kraton Polymers
Maria Knake, AASHTO
Abhilash Kusam, North Carolina State Univ.
Jian Li, North Carolina State Univ.
Haritha Malladi, North Carolina State Univ.
Ala Mohseni, Consultant
Robyn Myers, Troxler
Amirhossein Norovzi, NCSU
Chuck Paugh, ESC Inc.
Dan Pratt, Troxler Labs
Roger Pyle, Pine Instruments
Dick Reaves, Troxler
Ali Regimand, InstroTek, Inc.
Gerald Reinke, Mathy Construction
Geoff Rowe, Abatech
Mohammadreza Sabouri, NCSU
Donald Siler, Marathon Petroleum Co.
Ron Sines, Old Castle Materials
Nilesh Surti, North Carolina DOT
Christian Swiers, Troxler
Alan Taylor, NCAT
Laci Tiarks, PRI Asphalt Tech.
Kevin VanFrank, CME
Scott Veglahn, Mathy Construction
David Wang, North Carolina State Univ.
Eric Weaver, FHWA
Haifang Wen, Washington State Univ.
Chad Wendell, Road Science
Randy West, NCAT
Todd Whittington, North Carolina DOT
Jeff Withee, FHWA
Tim Yasika, Sonneborn
Habtamu Zelelew, ESC Inc.
Yanyan Zhao, North Carolina State Univ.
Doug Zuberer, Cox and Sons

DAY 1: Tuesday, April 30, 2013

1. Call to Order—Chairman Frank Fee (NuStar) called the meeting to order at 8:00 AM.

Welcome and Introductions – Chairman Frank Fee welcomed the group to the meeting. Dalton distributed two "sign–in" sheets, one for the members of the ETG and the other for friends of the ETG. Copies of the agenda were distributed.

Bukowski acknowledged the new members of the group; Jo Daniel, Tim Ramirez, and Howard Anderson (who is taking the place of Kevin VanFrank). He thanked all members for participating in the meeting and for their effort over the years. He also stated they want to keep

this group to a manageable level, but please contact him if anyone knows of someone who wants to participate.

Fee asked for self-introductions. Chris Abadie noted he is attending for Georgene Geary who had a conflict and could not attend the meeting.

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.

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

1. Richard Kim will provide a revised S-VECD standard to Bukowski for final 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.
   UPDATE: Action item is on the agenda. The S-VECD was circulated among the ETG and received all comments.

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 draft format to Jeff Withee. The panel will present the recommendations at the next Mix ETG meeting.
   UPDATE: Action item is on the agenda.

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.
   UPDATE: Action item is on the agenda. This procedure has been drafted and was submitted to the ETG. The ETG needs to discuss next steps for the procedure.

4. The Task Group on WMA under the Mix ETG will provide an update report on WMA development and issues at the next meeting.
   UPDATE: Action item is on the agenda. In addition, Edward Harrigan will provide comments on this action item during his report on NCHRP activities and projects.

5. Raj Dongre will provide the Mix ETG a copy of his workability procedure presented at the last meeting. Anyone using the procedure is requested to provide Dongre their data/results.
   UPDATE: Action item is on the agenda.

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.
   UPDATE: Action item is on the agenda. Focus and some discussion is needed on data recovery, so we can improve on the accuracy of the test.

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.
   UPDATE: Action item is on the agenda. Information on this topic was submitted to the ETG members. The ETG needs to discuss approaches for dealing with RAP/RAS and possible changes to the standards. In addition, the ETG needs to make recommendations for the existing two provisional standards on RAS that will expire next year.

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.
   UPDATE: Action item is on the agenda. The draft was circulated to ETG members in January, 2013.

Other agenda items will be discussed. Bukowski noted the ETG needs to continue to be cognizant of what recommendation for standards and decisions on whether the group is supportive of moving a new procedure to the SoM. The SoM recognizes the importance of the ETG technical input in decisions to adopt changes/new standards.

Frank Fee reported that Chris Abadie (Vice Chairperson of the SoM, technical section 2d) will be giving the report on the update to the AASHTO Standards and SoM activities.

3. Subcommittee on Materials: AASHTO Standards Update Report

Presentation/Report Title: *AASHTO Standards Update*—Chris Abadie (Louisiana DOT); Liaison for the AASHTO Subcommittee on Materials

Summary of Presentation:
Chris Abadie reported he has been to two AASHTO SoM meetings and one mixture ETG meeting. The meetings have given him an appreciation of what the ETG provides to the SoM. He commented that moving changes through the SoM takes a long time, especially when there is no ETG technical input to them. He thanked the ETG for their efforts to the SoM.

Abadie also reported that Georgene Geary had to attend the Joint Technical Committee on Pavements in Oklahoma and regrets missing this meeting, but looks forward to attending the next meeting. Abadie also acknowledged the past efforts of Rick Harvey and hopes that he and Geary will provide similar efforts.

Chris Abadie reported on the results from the SoM annual meeting that was held in August, 2012. All items in the 2012 ballot passed and are moving forward. He also reported the Tech Section 2d ballot needs be distributed by May 15, so that items can be added to the agenda and discussed at the next SoM annual meeting scheduled for August 2013. The annual SoM meeting will be held in Stateline, Nevada.

Chris Abadie gave the report on items included on the 2012 SoM ballot which are listed below. All of the items included on the ballot passed and the changes made will appear in the 2013 publication. Abadie first reviewed three other items included on the ballot and were identified for information purposes; (1) T 245 – the Marshall Mixture Design Procedure had some minor revisions for the 2014; (2) MP 15 – RAS in HMA was extended 1 year without changes; and (3) PP 53 – Design Considerations for RAS in HMA was also extended 1 year without changes.

- Revisions to TP 79 – Determining the Dynamic Modulus and Flow Number using the AMPT. Abadie listed the changes that were made to the standard:
    - Precision statements were added to the dynamic modulus and flow number tests included in sections 9.7 and 10.6.
    - Removed the number of specimens determined by the coefficient of variation from the mean table – the old table 4 was deleted.
    - A note was added to the conditioning chamber under section 6.3.
    - Kentucky commented on the SOM ballot, relating to section 9.4.1.7; five minutes is believed to be insufficient to transfer the sample from the chamber to the test set up. Kevin VanFrank commented on this issue in that the five minutes should be sufficient but can be difficult to maintain in some cases. Ray Bonaquist reported the five minutes was included in the standard to avoid an excessive change in temperature of the specimen. He requested not to increase the time beyond five minutes. If agencies are having difficulty meeting this requirement, they need to contact the equipment manufacturers. VanFrank noted you have about two minutes to load the specimens because it takes about three minutes to get back to the test temperature. A friend of the ETG stated they can consistently meet the five minutes, so if someone is not meeting that requirement, then there may be other procedure issues in that lab. Opinion remains that five minutes is doable. Abadie will provide this explanation to the SoM.
    - Another change included allowing the spray silicone to be used in place of the greased latex friction reducers in section 6.6 and Annex A. Abadie reported this change was not made to the standard nor included on the ballot after it was discussed with Ray Bonaquist. The end friction reducers will first be evaluated in the round robin testing program by the NEAUPG and SEAUPG.

- PP 60 – Preparation of Cylindrical Performance Test Specimens Using the SGC. Only editorial comments were received from the ballot. Changes to the standard were made and included:
    - Reduced the required height off the specimen from 170 to 160 mm. Richard Kim stated, reducing the specimen height from 170 to 160 mm for the flow number specimens is probably acceptable, but that reduction will result in problems with end failures when testing specimens in tension for fatigue. Kim's opinion is that PP 60

needs to be applicable to both flow number and fatigue test specimens. Kevin VanFrank asked whether this was related to some problem with the details about the jig and gluing the specimen to the platens. Kim replied, no. The taller specimen for tension/fatigue testing is needed to reduce specimen air void variability. Suggested that the standard require 180 mm high specimen preparation when used for fatigue testing.
  - Added the carbon steel wire method to the measurement of end flatness and end perpendicularity.
  - Changed minimum specimen diameter to 98 mm to allow for variation in core barrel diameters.
  - Appendix X1 was revised for achieving the required air voids.

- PP 61 – Developing Dynamic Modulus Master Curves Using the AMPT. No comment/ questions from the SoM ballot other than those that relate to TP 79: deleted table 1 which relates to the number of specimens; and referred to new table 4 in TP 79 for guidance on reproducibility and the required number of specimens.

- New Appendix to TP 79 – Evaluation of Rutting Resistance Using the Flow Number Test. Some concerns were noted with the new appendix. These concerns included; using different criteria for WMA and HMA as related to conditioning differences; repeatability of the flow number test in that guidance is needed; and changing the upper limit of temperature for control chamber from 60 to 70^{o}C. No changes were made to the recommendations. There was one negative on this item. John Bukowski noted the negative was withdrawn with the understanding that NCHRP 9-52 will provide additional information, so the appendix represents the best information on this topic to date. Bukowski also mentioned the aging study, the ETG flow number committee, and other studies that are on-going and could impact this item in the future.

- Adopted new provisional practice – Troubleshooting Asphalt Specimen Volumetric Differences between Superpave Gyratory Compactors Used in the Design and Field Management of Superpave Mixtures. The comments from the SoM ballot were all editorial, so this item will appear as PP 76 in the 2013 publication.

- Adopted new provisional test method – Determining the Fracture Energy of Asphalt Mixtures Using the Semi-Circular Bend Geometry (SCB). This provisional test method will be added as TP 105 to the 2013 publication.

- M 323 – Superpave Volumetric Mix Design. Changes were approved that included: guidance for grade bumping was clarified (table 1), Appendix X2 was rewritten to address the 2011 comments (Procedures for Evaluating RAP Stockpiles), and addressing RAP and RAS in determining the asphalt content.

- MP 15 (Specifications for Use of Reclaimed Asphalt Shingles in New HMA) and PP 53 (Design Considerations When Using Reclaimed Asphalt Singles in New HMA) were both extended one year. Both will need to become full standards in 2013 or deleted. Abadie reported the changes are ready for ballot and the RAP task force is reviewing for possible

technical section ballot in 2013. Bukowski reported Lee Gallivan had shared possible RAS standard changes with Georgene Geary, but due to concerns, further ETG discussion and recommendations regarding possible changes were requested.

Chris Abadie overviewed the different items that are expected to be included on the 2013 spring 2d technical section ballot. These items included: MP 15, PP 53 (the RAP task force to make recommendations for changes to MP 15 and PP 53), T 312, T 283 (add a note related to degree of saturation as recommended by AMRL), T 321, and a new provisional test method – Direct Tension Cyclic Fatigue Test.

Abadie provided information on the next SoM meeting location and other items, including important dates. The SoM meeting will be held in Stateline, Nevada on August 4 to 8, 2013.
To meet the 2014 AASHTO publication cycle, the following dates are important:

- ETG recommendations are due by mid-May 2013.
- Tech Section Ballot will be issued on about May 15, 2013.
- SOM meeting ballot items are due by Sept. 15, 2013.
- SOM ballot issued around October 2013
- Ballot items will be reviewed by February 2014 for the webinar.
- Accepted revisions to be published in July 2014.

James Musselman asked about the Spring webinar. Abadie reported the SoM technical section webinars were started so that more members can attend or participate in the sessions.

Bukowski mentioned the SoM has gotten stricter on receiving information by specific dates, so anything on the agenda needs to be submitted to make the technical section ballot/SoM meeting.

ACTION ITEM #1: Recommendation to SoM 2d relative to PP60; while minimum height for specimen preparation is 160 mm for compression testing, the minimum height for specimens subjected to tensile testing should be 180 mm.

4. Update on Related NCHRP Projects—Edward Harrigan (NCHRP)
Fee introduced Ed Harrigan for an update to the NCHRP projects related to this ETG.

Summary Presentation: *NCHRP Update – April 2013*
Ed Harrigan noted that any questions on details of specific projects need to go to the Principal Investigator (PI) for that project. His report on the NCHRP projects was grouped into four parts: (1) Warm Mix Asphalt Projects, (2) Materials and Mix Design, (3) Asphalt Mixture Properties for MEPDG, and (4) Fiscal Year 2014 projects.

Warm Mix Asphalt Projects:
9-47A: Properties and Performance of WMA Technologies. NCAT is the prime contractor. Draft final report is being prepared. Harrigan listed all of the deliverables from this project in his report. The project is ending in June, 2013. Harrigan stated the draft report will be made available on line. Randy West is the PI for the project.

9-49: Performance of WMA Technologies; Stage I – Moisture Susceptibility. This project is to investigate moisture variability and answer the question - do WMA technologies adversely affect the moisture susceptibility of asphalt pavements? This is being conducted by Texas Transportation Institute (TTI) and is ending in September, 2013. Amy Epps-Martin is the PI. Interim reports have been produced. These interim reports are available for review. The contractor is meeting with project panel next month, and the final report will soon be available. Harrigan noted that Dave Newcomb is on the ETG agenda and will report on the status and findings from 9-49 for the PI, Mrs. Epps-Martin.

9-49A: Performance of WMA Technologies; Stage II – Long-Term Field Performance. Washington State University is the prime contractor and Haifang Wen is the PI. This project does not end until July, 2016. He listed the new and older projects the contractor is monitoring over time. A 24-month analysis report is due in May of this year. Harrigan reported there is a lot of data available from this project, and commented the contractor is not finding big differences between WMA and HMA.

9-52: Short-Term Laboratory Conditioning of Asphalt Mixtures. Harrigan reported this is a new project which is related to WMA. TTI is the contractor and Dave Newcomb is the PI. The project is scheduled for completion in November, 2014. The focus of this project is with short-term aging of mixtures. Specifically, the objective is to develop procedures and associated criteria for short-term laboratory conditioning of mixtures that simulate plant mixing and processing to the point of loading in the trucks, and the initial period of field performance.

9-53: Properties of Foamed Asphalt for Warm Mix Asphalt Applications. TTI is also the prime contractor for this project and Dave Newcomb is the PI. The focus of this project is to look at the foamed WMA technology for developing standards for laboratory simulation on what is being done in the field. This project's completion date is December, 2014.

9-54: Long-Term Aging of Asphalt Mixtures for Performance Testing and Prediction. This project to develop and validate a laboratory procedure to simulate long-term aging of asphalt mixtures for performance testing and prediction is pending award, and hoped to start in middle of 2013.

9-55: Recycled Asphalt Shingles in Asphalt Mixtures with Warm Mix Asphalt Technologies. This contract is pending. The objective of this project is to develop a design and evaluation procedure for acceptable performance of asphalt mixtures produced with WMA technologies and RAS, with and without RAP. Harrigan reported RAP was originally excluded from the scope, but the panel decided to look at RAP without violating its initial focus. The project contract should be awarded next month.

<u>Materials and Mix Design Projects:</u>
9-46: Improved Mix Design for HMA with High RAP Content. This project has been completed and the final report will be published as NCHRP Report 752. NCAT was the prime contractor for this project and Randy West was the PI. Harrigan reported West gave a report to the RAP ETG last year, so everyone should be familiar with it. The final project report is in publication and will be available online.

9-48: Field versus Laboratory Volumetrics and Mechanical Properties. The contractor for this project is Louisiana Transportation Research Center (LTRC) and Louay Mohammad is the PI. The project is scheduled for completion in December, 2013. Harrigan reported this project turned out to be very difficult. He also noted a controlled lab experiment is underway for this project.

Asphalt Mixture Properties for MEPDG:
Harrigan mentioned the first project within this category was 9-39, and its objective was related to the HMA Endurance Limit. The prime contractor was NCAT and Ray Brown was the PI. The next project was 9-44A, *Validating an HMA Endurance Limit: Laboratory Experiment and Algorithm Development*. As the title indicates the objective of the project was to validate the endurance limit. He reported all work has been completed. The project panel has reviewed the draft, and the algorithm for computing the endurance limit. Two procedures are developed using results from the uniaxial and beam fatigue tests. Harrigan reported the endurance limit values from both procedures are almost equal. Frank Fee asked if any modified asphalts were used in the work or validation process. Fee thought it was very important to have modified asphalts included in the work.

FY 2014 Projects:
Harrigan listed and briefly discussed the upcoming nine series projects and reported panels for these projects are being formed.

- 9-56: Asphalt and Aggregate Correction Factors in Ignition Furnaces; $500,000.
- 9-57: Experimental Design for Field Validation of Tests to Assess Cracking Resistance of Asphalt Mixtures; $250,000.
- 9-58: Recycling Agents Used for Asphalt Mixtures Containing High Recycled Asphalt Binder Ratios; $1,500,000. Harrigan mentioned this project includes a lot of testing of binder and mixtures and a lot of field testing.

Harrigan also listed and briefly discussed the upcoming "1" series projects.

- 1-54: Pavement Design Guide to Prevent Damage to Asphalt Pavements from Water Intrusion; $350,000. The objective of this project is a guide to reduce the impact of water. Harrigan reported this is an engineering analysis without any laboratory work.
- 1-55: Porous Friction Course Design; $350,000.

Frank Fee asked whether project 1-55 has a mixture or pavement design focus and Harrigan replied the focus is on mixture design.

Richard Kim announced a tour of NCSU laboratory facility is planned for today. A bus will arrive at the hotel at 4:30 PM today to transport members to and from the tour.

5. Report Task Force RAP/RAS

Frank Fee reported: there are issues on this topic that need resolved will need to provide technical input/comments to the SoM.

Presentation Title (#1): *RAP/RAS Task Force Update*—Lee Gallivan (FHWA)

Summary of Presentation:
Lee Gallivan started his report by summarizing what had been agreed at the previous RAP ETG meeting, and again mentioned the related provisional standards will soon expire.

Gallivan summarized the results from the previous NAPA RAP, RAS, and WMA Usage survey. He reported the survey results are available on the web for review and download, and mentioned there are plans for the next survey of 2012 data.

Gallivan reported Jim Pappas provided the results from the AASHTO-SoM RAP Survey effort and summarized the preliminary results. This summary included both RAP and RAS. Gallivan focused on some of the obstacles and concerns noted by the responders. He stated there was a reference to poor specifications on some of the concerns listed limiting the use of RAS. Gallivan reported that the responders did identify research and guidance needs. Some of these included; what are the effects of RAS binder on the blended mix, what are the effects of stiffness at levels at and above 5% RAS, and the successful projects of using RAS in a variety of climates. He acknowledged the 6th National RAS Conference which is scheduled for November 7-8, 2013 in Denver, CO.

The next part of Gallivan's report focused on the AASHTO MP 15 and PP 53 proposed revisions. Gallivan acknowledged the individuals that were assigned to this task force which included: Jim Musselman, Randy West, Audrey Copeland, Gerry Huber, John D'Angelo, and Ron Sines. He also acknowledged others that participated in this effort, including: James Willis, Tom Farris, Greg Sholar, and Tanya Nash.

Gallivan started with the proposed changes to PP 53. He reported many revisions were suggested to the provisional standard and highlighted the proposed major changes/revisions to the PP 53 standard practice.

- Volumetric requirements were clarified.
- Increased binder content needed in mixtures with shingles and provides information to understand the rationale for the extra binder to the mixture.
- Simplified methodology in determining the asphalt binder availability factors
- Expanded text to include mixtures with both RAS and RAP.
- Guidelines included in the protocol for making binder grade adjustments.

Gallivan summarized the proposed major changes and revisions to MP 15, which included:

- Gradation or grind size of the shingles to require 95 percent passing the 9.5 mm sieve and discussion to increase to possibly 100 percent passing 9.5 mm.
- Deleterious requirements were maintained, but clarified and adjusted based on data from NCHRP 9-46.
- Editorial revisions were made to be consistent and have a better match to PP 53.

Randy West mentioned the task force is going to be addressing some of these issues which States are now facing in using MP 15 and PP 53. He reported there will be collecting information from States in addressing these issues.

Gallivan summarized the Research Needs Statements (RNS) and synthesis as recommended by the task force. He reported the task force acknowledged multiple needs for further research regarding the actual RAS binder availability factor and binder grade adjustment. Bukowski noted the importance of the difference between 5 percent shingles versus 5 percent RAP. Gallivan replied this will be addressed in the recommendations. Gallivan asked for a recommendation from the ETG regarding needed research studies in clarifying and providing data on these revisions. Gallivan reported the proposed changes, revisions, and commentaries were sent to all ETG members. He hoped the ETG members had read the commentary of the proposed changes to both standards. The items sent electronically included the commentary to changes proposed for MP 15 and PP 53 and the red-lined versions of each standard.

Louay Mohammad commented on the concern of increasing the RAS binder availability factor and stated this could be a danger if not actually experiencing this amount of binder in the mix. The availability factor is based on many things. Mohammad asked, should a cautionary note be added to the standard on the 85 percent availability factor. Gerry Huber replied to that concern, in his opinion, this will be one of the bigger items to be discussed in terms of whether there should be a number, and if so, what is the number. He reported the adjustment factor provides an estimate of the change in volumetric properties with and without RAP or compared to the mix with shingles. Huber noted the issue that needs to be addressed is the impact of the asphalt shingles because the current procedure noted in the standard is an erroneous approach. In his opinion, we need to understand how we approach this item; maybe we need to add more asphalt binder to offset the impact of the shingles and non-homogeneity of asphalt shingles. Huber discussed the effect of concentrations of the asphalt in different areas of beam specimens; which relates back to the non-homogeneity of the material.

Gerald Reinke commented on the accelerated aging of the mixtures with shingles. It was noted that this could be a significant problem. Also mentioned, that it is not being recognized how these mixtures really age. Kevin VanFrank asked how they aged the specimens. Reinke noted they used the standard procedure for aging the mixtures and that is the uncertainty. Fee asked if we have sufficient knowledge to answer that question about aging or explaining the unknown. Gallivan agreed to include a cautionary note as suggested by Mohammad. Gallivan also reported they are putting together a document explaining why these changes are being proposed.

At the point in Gallivan's report, he took each red-lined recommendation and described the items proposed for revision.

<u>PP53-09 – Design Consideration:</u>
Chris Abadie asked are we moving this standard forward with the proposed changes. Gallivan replied that will depend on the ETG recommendations. Gallivan reported the 2006 version was based on a white paper completed in 2004, but the white paper did not provide sufficient background information.

Under Section 5,"Design Considerations When Using RAS in Asphalt Mixtures" is where there should be a cautionary note if approved by the ETG. Frank Fee asked does this address the difference between manufactured shingles and tear-offs. Huber and Gallivan answered, no, it

does not address that difference. Gerald Reinke noted there are differences between tear-offs and manufactured waste shingles, but the difference is not that great, especially compared to mixtures with and without shingles. In his opinion, this is a minor point and it does not need to be discussed for now in the standard.

Bukowski asked Gallivan whether he received any comments from the ETG prior to the meeting. Gallivan replied, no, he had not received any comments related to the proposed changes.

Musselman asked if the total asphalt binder content is used, even the binder portion that is unavailable from the shingle. Huber replied the 15% binder portion does end up as being considered as aggregate in the calculation of VMA. Gallivan reported the equation was not changed and mentioned they tried to keep the standard as much the same as in previous versions.

Bukowski questioned the design considerations under section 5, from a previous version a cautionary paragraph under section 5.3 was eliminated and asked why. Gallivan replied maybe it should again be included.

Tim Ramirez noted under the first page of PP 53, the asphalt is an unmodified air blown asphalt, so his concern, would this always be true. Randy West replied that comment came from one of the conferences.

Judie Ryan noted, we keep suggesting this standard be moved forward, and there are a lot of reasons for using shingles. However, many States will choose to not use it; they wait until all of the effects are known. Her opinion, these changes help communicating with others on consistency. She asked however is there an upper limit on the higher RAS percentages (below 5%). Is there some percentage of RAS in a mix we are trying to obtain, or is there a limit on the percentage. Gallivan agreed and noted we do not know what will be the performance at higher RAS percentages.

Kevin Hall believes that the entire ETG needs to be comfortable with what is being put forward to the SoM. He noted the task force has done a lot of work on this topic. Bukowski agreed, but stated the entire ETG should get a chance to review the changes and be comfortable with what is going forward. Fee commented that the ETG only received the red-lined version last week, and maybe not everyone has had a chance to review it. However, he maintains it needs to move forward, but just wants to be comfortable with all revisions and cautionary notes added to the standard. Gallivan concurred with that statement and stated that is why we are reporting to the ETG. He referred back to the additional comments that have been recommended during this meeting. Bukowski noted the task force should be commended on trying to move this forward, even though we do not have all of the answers at this time.

Gallivan reported they eliminated note 2 and the table on the gradation of the shingles material that did not really match volumetric design. The important focus is really on the maximum grind size. It would appear that the finer the grind size, the more binder is available in the mix.

Ray Bonaquist commented on the factor set at 0.85 and maybe, instead of a specific value, just give a range of appropriate values.

Gallivan reported a new equation was added to address both tear offs and manufactured shingles, as well as RAP. Nam Tran asked about the equation and how it differed from the previous version. Gallivan replied after the last conference call revisions were made. Equations were included for both RAP and RAS, and some items were all eliminated. Gallivan stated they added a new table 1 from MP 323 at the end to recommend what is used and how to proceed with the design. They wanted to give direction to the designer. Fee recommended, maybe just refer back to MP 323 and add a note on what could be used. The reference to MP 323 was just in concept even though MP 323 does not refer to RAS. Bukowski added that just referencing MP 323 is not valid since now the table in discussion does not refer to RAS. Fee asked Gallivan to reconsider a guidance note and add wording in suggesting how this can be used.

Bob Kluttz commented, assuming you can add the same amount of shingles related to RAP, he is concerned about just replacing the values from RAP to RAS. He does not have the answer. Ray Bonaquist referenced a project in Wisconsin regarding the change in binder grade. The grade changes about twice as fast for RAS as the RAP will change the binder grade. VanFrank and Bonaquist discussed the type of cautionary note to be added; the use of RAS will change the binder grade about twice that of the RAP. Tim Ramirez commented about combining RAP and RAS together and looking at how it affects the mix. Sandy Brown added that the type of shingles also make a difference.

Howard Anderson asked about the fibers in shingles, are they detrimental to the mixture. Gallivan replied no, they are not detrimental. At this point in the meeting, there was discussion on whether the fibers are burned or not. Some members were of the opinion the fibers get burned while others felt they are not burned. Most concurred they are not that important.

Fee asked Adam Hand how shingles are used from a contractor's or producer's standpoint. Hand noted they use the blending charts, but emphasized they are not using big percentages of RAS. Fee asked Ron Sines to comment on what they are doing. Sines commented it depends on the agency. They use RAS in many States and represent the vast majority of the tonnage reported. His opinion there is not one approach. Regarding adjustments of binder, they follow what the state requires. Ryan and Fee asked if they make adjustments to the binder. Sines replied they do what the agency requires related to adjusting the binder.

<u>MP 15-09 – Reclaimed Asphalt Shingles:</u>
Gallivan reported there were not that many changes as compared to the PP 53. He went through each of the changes and gave reasons for the changes. Jim Musselman asked will these standards go to a full standard or be dropped. Chris Abadie noted the provisional standards with or without changes need to be ballot by the SoM or will be dropped.

Bukowski asked Gallivan for an action item on the recommendations to the RAS standards. Gallivan noted from the discussion, while the ETG needs time for review the standards could be sent to the SoM. The ETG can continue to provide suggestions and future recommendations as RAS becomes more widely used. Kevin Hall recommended to add comments made during the discussions today and what has been received to date from any reviews and move forward.

Chris Abadie asked if there is a commentary available that describes why these changes and revisions were made. Gallivan noted the commentary was prepared and submitted prior to the meeting does not include an explanation for all of the changes made to the standards. Bukowski suggested adding some additional commentary.

ACTION ITEM #2: RAP/RAS Task Force will incorporate any comments from the ETG along with the proposed revisions to PP 53 and MP 15. The revised documents will be provided to Bukowski for SoM 2d consideration. A one year time extension as provisional standards will also be requested, if possible to allow time for further evaluation of the proposed changes.

Presentation Title (#2): *Update of NCHRP Project 9-46*—Randy West (NCAT)

Summary of Presentation:
Randy West gave a verbal report on this topic. He reported the final report is being published by NCHRP as Report 752. The report should be published within the next few months. West also reported there is a companion document to the final report on best practices for RAP management. He suggested going to the web site to get the unedited version of the Best Practices document. It provides recommendations on sampling and testing and acknowledged the work done with the University of Nevada at Reno on aggregate specific gravity. The report defines high RAP mixtures are being more than 25% RAP. He summarized the information included in the current standard for back-calculating the aggregate specific gravity. West then referred to the binder replacement ratio which is still under discussion with many agencies. They recommended using a formula which is similar to the blending chart approach.

West then focused his verbal report on performance tests. He identified the tests they recommended and noted fatigue tests as the one with the biggest concerns. West reported they did not make a recommendation on any one specific fatigue test because they felt there was insufficient criterion to recommend one test over another.

ETG Comments, Questions, and Discussion:
Frank Fee asked when the report would be available. Harrigan replied within a month. Chris Abadie asked about any revisions to the AASHTO standards as related to this project. West noted the appendix does include a draft red-lined version to the current standard.

Mark Buncher asked if the recommendation is for no grade change below 25 percent RAP. West replied yes, and Buncher asked if you exceed that limit, then what it recommended. West commented then use the recommended blending equation. Haifang Wen asked about the impact of RAP and adding a soft binder. West noted that is why they added the rutting criterion and information discussion about using a rejuvenator.

Bukowski commented that the ETG should review the report. Harrigan replied the NCHRP panel has completed their review, so the report can be forwarded to the ETG for future discussions.

Frank Fee questioned West about fatigue testing. This question initiated comments between Louay Mohammad, Ed Harrigan, and others relative to other upcoming NCHRP projects. Fee commented that fatigue/cracking recommendations are critical. West referred to some of the workshops that have been conducted and others being planned for advancing fatigue tests.

ACTION ITEM #3: RAP/RAS Task Force will be provided the report from NCHRP project 9-46, and draft of suggested changes to R35 and M323. RAP/RAS Task Force will review and comment at the next ETG meeting.

6. **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 – Practical Applications of RAP Mortar Grading Procedure*

Summary of Presentation:
Andrew Hanz presented an overview of current practice and noted the first part of his report is a repeat of an earlier presentation. He also acknowledged this work is a part of the Asphalt Research Consortium.

Hanz reviewed the related issues; (1) the assumption of 100 percent blending is not necessarily correct – the extent of blending depends on temperature and time, and (2) chemical extraction has technical and practical issues. Hanz noted that an understanding of the blended binder is really important. Hanz noted some of the benefits of the mortar grading and two of the more important ones are; (1) it incorporates effects of blending time and temperature in sample preparation procedure, and (2) chemical extraction is not necessary.

Hanz discussed the procedures for preparing the mortars, two conditions are used: the aggregate without binder burned from the ignition oven and the RAP itself. He included an example in his report on the effect of aggregates on the "m" value. He also overviewed the independent verification study completed by UNR on different materials. Frank Fee asked what was being compared in the example. Hanz explained the RAP specimens were prepared with the softer and actual binder grade.

Hanz mentioned the two objectives of the independent verification study; (1) compare methods for estimating the effects of RAP on the low temperature PG, and (2) compare the binder grading results to mixture performance using the TSRST test. Hanz discussed the low temperature grade changes for different amounts of RAP and binder. Gerald Reinke asked about the criteria being used and how it had been confirmed. Hanz replied the criterion is based on the assumption that the difference is related to the effect of the binder from the RAP. Hanz showed a comparison between the TSRST fracture temperature and binder low critical temperature and concluded the blending chart process and the recovered binder were not as good as the mortar procedure being presented. Tom Bennert asked how the beams were prepared for the mix and mortar and Hanz replied BBR specimens were used.

The next part of Hanz's report focused on estimating the degree of blending in RAP mortars. He started with a review of the blending mechanisms and noted blending is a diffusion-based process that depends on time, temperature, material properties, and concentrations of virgin and aged binder. Hanz then overviewed what he referred to as the proof of concept and concluded the degree of blending is influenced by production temperature and no blending occurs at the service temperature. Huber asked whether the findings would be different relative to different aging levels. Hanz was unsure about the answer to that question and would have to look at the results. Fee and others asked about the difference between the actual thin films in the mix and the films used in this study; they are really different.

Sandy Brown referred to similar work from Canada. In that study Teflon was used to squeeze two discs together at 0.5 mm each in the DSR. Their results did show similarities to the data presented by Hanz and it did stabilize over time. The diffusion occurred at the standard HMA temperatures, but it did not occur at the WMA temperatures. Brown suggested that Hanz look into that effort which is now completed. Brown also recommended letting the material set over time at the test temperature. The limitation of the Canadian work was that only two test temperatures were used to determine if diffusion was more prevalent at the higher temperatures.

Hanz opinion is that these results could be used to define the availability factor that was discussed earlier today. Some of the observations were selection of time and temperature to achieve blending are dependent on RAP binder source and the results are consistent with diffusion concepts. He also suggested a similar study of blending be conducted for RAS.

The next part of Hanz's report included an overview of the draft AASHTO standard and spreadsheet analysis tool developed for this project. Hanz reported both were sent for review last year to the ETG. He went through each of the spreadsheets or analysis templates. The template is an excel-based spreadsheet with four tabs; (1) Mortar design tab that requires material weights for mortar preparation, (2) Virgin binder properties tab that includes PG properties at predetermined test temperatures, (3) Mortar properties that includes input testing results for RAP and R100 aggregate mortars, and (4) Analysis results tab, which does not require any inputs. The output from the spreadsheet is the estimated blended binder continuous grade and rate of change of the continuous grade.

ETG Comments, Questions, and Discussion

Bukowski would also like to send this to the Binder ETG. The Binder ETG would send any comments back to Hanz for proceeding forward. Potentially ETG input on this could be provided to the SoM for consideration in 2014.

Hanz was asked about the temperatures for PG grading and Hanz replied the PG binder grading temperature would be used for aging of the mortar.

ACTION ITEM #4: The procedure developed by Andrew Hanz for estimating RAP/RAS binder properties without extraction will be sent to the Binder ETG for comment. This item will be included on agenda for discussion at the next set of ETG meetings for potential forwarding to the SoM after the fall meeting.

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

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

Summary Presentation:
Richard Kim acknowledged Amirhossein Norouzi and others for doing data analysis at NCSU. He started his report with a background on the topic and how it has evolved over time. Dynamic modulus is an important property of HMA for pavement design and analyses. Currently, there are two test standards, AASHTO TP 62 and TP 79, for measuring the dynamic modulus of HMA mixtures, but these tests are inappropriate for forensic investigations. He reported that his proposed procedure is currently undergoing ruggedness. Kim illustrated the test apparatus used that to eliminate rocking and surface imperfections that caused previous problems.

Kim reported they are following ASTM C 1067 in doing the ruggedness study and initially selected 7 factors and two levels for each factor for the ruggedness test plan. Based on previous discussions, they reduced this to using five factors, which include; thickness (38 and 50 mm); air voids contents (6 and 8 percent); LVDT gauge length (2 inches versus 4 inches); temperature (selected to keep it in the viscoelastic range); and applied horizontal strain (40 and 60 micro-strains). Louay Mohammad commented about the gauge length and asked if it is reasonable in terms of applying a load that gives you the strain levels listed. Kim agreed with the comment but noted using 100 mm you have little distance between the pins and ends of the specimens.

Kim showed the experimental plan and identified that NCSU, Virginia Center for Transportation Innovation and Research, and Florida DOT were fabricating the test specimens. The testing laboratories include; NCSU, NCAT, and FHWA TFHRC. He summarized the total number of test specimens per mix per testing lab was 16. Kim reported they only received 8 samples per mix when 16 were required, so they rotated the specimen at 45 degrees and tested the specimens twice. Mohammad asked what was the lowest frequency used and Kim replied 0.01 Hz. Kim showed the results of retesting and concluded it did not make a significant difference, so they adopted that rotation for their testing plan.

Kim summarized the properties of the mixture that is included in this presentation. He noted of the three mixtures, all of the results he is presenting were from the Virginia and Nebraska mixtures. They have yet to complete the Florida mixtures. He also acknowledged the Florida DOT for collecting and preparing the Florida specimens for this effort.

Kim showed some of the results from the experimental ruggedness test plan. He started with the effect of thickness. In summary, the results show thickness had no effect on the results. Kevin Hall asked what are you using as the response value and Kim replied dynamic modulus. Kim then summarized the effect of gauge length on the test results. He also showed the coefficients for dynamic modulus calculation. He reported using the right coefficients gauge length has no effect on the results. The next property was air voids. Kim reported air voids did result in a significant difference in the results. These differences in results were true for the VA and NE mixtures.

Kim showed the matrix of coefficients. The ruggedness analysis was presented in a tabular form in terms of E*. He highlighted those cells that are significantly different using a 95% confidence level. Kim concluded and reported the variability really increases for some of the sets of data regarding the gauge length and strain level used.

The next part of the presentation was to determine the air void limits. When they reduced the air void level to plus and minus 0.2% in air voids, the difference will be insignificant. Kim noted this accuracy or spread was impractical so they went to +/-0.5%. He reported a fewer were less but there was still quite a number found to be statistically different. So from a practical standpoint, they are recommending +/-0.5%. Nam Tran asked about the effect of temperature and frequency in terms of what was different. Kim replied they need to look at some of this data in more detail prior to finalize their recommendations.

Kim then presented a series of graphs showing the effect and limits of each parameter on E* included in the ruggedness experiment. The first was a graph showing the effect of varying air voids on E* variations. Haifang Wen asked about the random versus consistent change in air voids and was there any difference in a pattern of E* versus air voids. Kim answered there is a shift in the master curve, as air voids change in terms of a pattern. He also made reference to the asphalt type in identifying the effect of different air voids.

Kim continued with his report and showed the findings for the effect of the limits of specimen thickness, gauge length, temperature, and horizontal strain level on E*. He reported they used the equation based on 50 mm to calculate the modulus at 100 mm because they were trying to identify the effect of an incorrect gauge length. Louay Mohammad commented they are not seeing the results that Kim presented. Nam Tran asked about the error in terms of an incorrect gauge length. Kim answered by looking at the 50 versus 100 mm gauge length in terms of aggregate size. The follow-up question from Tran was whether the incorrect gauge length makes a big difference in the results for E*. Kim noted this is trying to identify the tolerance of plus and minus a value of one parameter that it has on the final results for E*.

Adam Hand had a concern about making a recommendation with limited data. Kim acknowledged this is really a progress report and they will make the recommendations based on all data. He reiterated this report is limited to results from only a partial group of mixtures to be tested. Ray Bonaquist referred to Hand's comment and acknowledged the importance of ruggedness testing.

Kim presented his preliminary recommendations based on the information collected to date, which were; air voids need to be plus or minus 0.5%, temperature should be plus or minus 1°C, specimen thickness should be 38 to 50 mm, the gauge length needs to be +/- 75, and the horizontal strain level should be 50 microstrains +/-10 microstrains. Kim also summarized the remaining work to be done under this group. Hopefully, all work will be completed by the next ETG meeting and they can make their final recommendations to the ETG. Frank Fee mentioned this test was initiated to allow testing of cores.

ACTION ITEM #5: Richard Kim will report at the next ETG meeting on the status of the IDT ruggedness study.

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

Presentation Title: *Determining Thermal Cracking Properties of Asphalt Mixtures through Thermally Induced Stress and Strain*

Summary of Presentation:
Elie Hajj reported TP10 was the previous test protocol for this method but had been dropped. This project was to take another look at the test standard. Hajj acknowledged the work completed by the UNR and University of Wisconsin at Madison. He reviewed a new draft standard and its purpose. He reported the thermal stress and strain can be measured using one of the two methods; Method A, referred to as the UNR method and consists of uniaxial thermal stress and strain tester (UTSST), and Method B, referred to as the UW-M methods and consists of the asphalt thermal cracking analyzer (ATCA).

- Method A is a closed loop servo-controlled test system. Hajj showed an illustration of the equipment and test. The sample is cored side-ways from a gyratory compacted specimen. This yields two test specimens per compacted sample. While vertically coring test specimens was attempted, the preference was to drill the cores sideways to the compacted gyratory sample, however, both were found to be acceptable.
- Method B is a mechanical test system where two specimens are laid horizontally, one is restrained and the other unrestrained. He showed an illustration of the equipment and test. Hajj also explained the calculations for this method. The coefficient of axial thermal contraction is calculated and the modulus is back-calculated in accordance with Boltzmann's superposition principle.

Hajj illustrated a region they called viscous softening in determining the thermal viscoelastic properties of the HMA mixture from this test method. He also identified the advantages of the test method; high sensitivity to modification effects that clearly detects the difference between the same PG binders, high sensitivity to aggregate gradation and packing, and high sensitivity to RAP and WMA.

Hajj presented the results from the lab work that was completed by Jo Daniel at the University of New Hampshire. This study includes varying percentages of RAP. The results were shown for the critical cracking temperature, the stress build up, and the modulus from the test. In summary, the addition of RAP shifted the crack initiation and glassy hardening temperatures to colder temperatures along with an increase in modulus and thermal stress. He also showed the results in terms of temperature differences. In summary, the addition of RAP altered the fracture behavior of mix from ductile failure towards a brittle failure as observed with the close proximity between cracking initiation and fracture temperatures. An overall summary was that while the fracture properties of an asphalt mixture may not be affected by the addition of RAP, the behavior of the mix when subjected to thermal loading may be different.

The next portion of his report focused on the influence of WMA using the UTSST for evaluating mixtures. The same information is plotted as for the previous study with RAP. The results between the two are that there is a difference in temperature magnitude but once micro-cracks start, the temperature difference is about the same.

Hajj then focused the report on the effect of modification on mixture strength. This included capturing the effect of aggregate packing on thermal cracking. He reported there is a significant difference in the coefficient of contraction between the coarse and fine mixtures. The magnitudes and rates of change are different. This is mixture specific. Hajj noted the model or regression equation in the MEPDG for calculating the coefficient of contraction and noted both the glassy transition temperature and the coefficient of thermal contraction (CTC) of the mixture are needed. He also mentioned using a linear CTC in thermal stress calculation can lead to significant errors and recommended the use of a non-linear CTC. Geoff Rowe noted this emphasizes whether there is a need to determine the failure temperature. If the difference in temperature is statistically insignificant you do not need to go through all of this. He suggested looking at the delta temperature in Hajj's analysis.

Hajj then presented a summary of the draft standard for this test method. He expects the prototype will be released very soon. Hajj ended his report by acknowledging the support of the FHWA and the Asphalt Research Consortium.

ETG Comments, Questions, and Discussion:
Haifang Wen asked about the correction for temperatures related to the LVDTs. Hajj replied they have looked into this, but for now they do not have any adjustments. Wen noted a 10 to 20 percent error may result just through the LVDTs. Hajj agreed with that comment.

Bob Kluttz noted the two binders are failing at the same failure temperatures, this seems to be reversed. Jo Daniel commented that some results represent plant produced mixtures, while others are laboratory produced mixtures. Tom Bennert also commented some are long term aged while others are not. So there are major differences between the different sets of specimens.

Fee suggested anyone that already have this equipment conduct further evaluation.

ACTION ITEM #6: ETG members are requested to forward comments to Ellie Hajj on his draft procedure for low temperature tensile mixture testing, and a summary of comments and potential action will be discussed at the next ETG meeting

9. Progress on New ALF Experiment—Nelson Gibson (FHWA)

Presentation Title: *Progress on the New FHWA ALF Experiment: Combined High Recycle & WMA*

Summary of Presentation:
Nelson Gibson noted that the final report from the previous ALF experiment is on the web at: http://www.fhwa.got.gov/publication/resarch/infrastructure/pavements/11045/index.cfm\.

Gibson reported they have awarded the next construction cycle of the new ALF experiment. It is hoped that the construction could soon start, so that loading could begin in the September time frame. Gibson then summarized the priorities of this ALF cycle:

- Fatigue performance of high RAP HMA and overlays.
- Cracking and durability of ultrathin HMA overlays for pavement preservation.
- Thinner and cheaper perpetual pavements with premium HMA.
- Cost effectiveness of high-modulus high binder HMA base.

He emphasized on the convergence of two initiatives in setting up this ALF experiment, high RAP and WMA. Both of these are related to fatigue testing. The key features of the experiment are to focus on fatigue cracking, temperature controlled at 20°C so no high temperature rutting in the experiment. Another key feature was to plan for three year completion cycles with 2 years of loading using two ALF units to allow simultaneous loading. The experiment was also planned for using unmodified or neat binders for all lanes. Two different grades of binders will be used. Gibson reported the WMA technology selected does not change the binder grade, it is water based, plant foaming, and chemical based – with a control. The load will be a 10 kip single wheel which is equivalent to a 20 kip axle. The HMA will be 4 inches total asphalt thickness. Gibson also noted this experiment was planned more from a production based approach, rather than a research based approach for constructing the pads.

Gibson showed the experimental plan and factorials. RAP content includes 0 and 20% only, 20% RAP+RAS, 40 to 50% RAP by weight and 40 to 50% ABR (asphalt binder ratio). Gibson reported they have 12 test slots but are only going to fill 10 to achieve the 2 year goal.

Fee asked about the temperature range for WMA. Mixture produced with the foamed technology will be at 270°F and mix produced with the chemical technology will be around 240°F.

Ala Mohseni asked about controls on storage times of the mixture. Gibson noted they did not include that parameter, but plan to record the compaction and production process. Mohseni commented on the differences between production, placement, and loading. Gibson stated for this ALF we have small quantities and we cannot consider everything.

Gibson then overviewed the expected timing for placing the different pads. He asked for input on how to recommend the stage loading of the different pads related to aging. They expect to be taking a lot of cores, but are still refining their work plan in terms of testing and materials characterization. The testing plan was shown in Gibson's presentation. He also reported a lot of field samples will be taken and tested as well as a lot of plant produced mixture will be sampled and tested. Gibson noted only one lane of each mix will be tested so they later can explore the use of the other three lanes. He mentioned the possibility of using these other lanes for rehabilitation studies.

<u>ETG Comments, Questions, and Discussion:</u>
Randy West asked would it be better to let all sections wait for 2 months prior to loading rather than loading some immediately and some much later after placement. Alternately, he also

suggested loading some and then letting those sections wait while loading another pad, similar to what Florida does with their ALF. Gibson will consider this suggestion. Richard Kim suggested if waiting between loadings and healing could present a problem, because the test pads will last longer than you anticipate by testing in summer conditions. He noted FHWA TFHRC cannot cool down pavements, but they do have the capability to heat pavements.

Gibson commented that for the three RAP levels – 0, 20, and 40% RAP he is planning evaluating at 200 to 400 micro-strains. West opinion was that those were not very high strain levels. Gibson suggested this may be re-evaluated.

10. Report Construction Task Force—Judie Ryan (Wisconsin DOT)

Presentation Title (#1): *Roadmap to Improved Compaction of Asphalt Pavements Update*—Judie Ryan (Wisconsin DOT)

Summary of Presentation:
Judie Ryan referred to any earlier discussions on numerous potential items for consideration, and commented that the task force narrowed those down to a manageable few. She reiterated the importance of compaction and enhanced compaction equals enhanced durability.

Ryan identified the factors that affect the compaction and noted these factors were included in a document submitted to the ETG. A total of sixteen factors were identified in that document. She summarized these items and what has been completed regarding proposed research studies. Ryan then identified five action items to move forward.

ETG Comments, Questions, and Discussion:
Fee asked Ryan to distribute a copy of the synthesis of critical items. One area included a compiling a list of the various states' on compaction requirements. Ed Harrigan mentioned this might be more than just a summary of current requirements, but needs to include other information.

Kevin Hall asked if this would include both joint and mat compaction. Most agreed that mat density/compaction needs to be examined. Especially since the Asphalt Institute has already completed a ½ day seminar which includes a synthesis of joint compaction, as well as an associated publication. The seminar has been delivered to about half the States. Hall asked how many states have longitudinal joint density specifications and Buncher replied about 1/3. Buncher reported Pennsylvania is now getting nearly 91.5% at the joints, while 6 years ago they were getting less than 88%. Connecticut was another success story of increasing the joint density. He also mentioned other success stories in terms of the longitudinal joint specification. The longitudinal joint specification has been written and is being used by more and more States.

Chris Abadie asked if the ETG was going to propose a synthesis on compaction to the AASHTO SoM and/or SoC. Bukowski replied if we are going to request a synthesis on compaction and want the SOM to review, then it has to be put together fairly quickly because of the August deadline.

Fee noted this ETG is concerned with materials and if something is related solely to construction, then it has to be under a construction group. There was some discussion between Jim Musselman, Ed Harrigan, Chris Abadie, and Judie Ryan on what topic and how best to do a syntheses and if they should be administered and completed through the NCHRP 20-7 type of projects.

DAY 2: Wednesday, May 1, 2013

Frank Fee called the meeting to order at 8:00 am.

11. AMPT Test Development Task Force

Presentation #1: *AMPT Pooled Fund Inter-Laboratory Study, Preliminary Results TPF-5(178)*—Nam Tran (NCAT)

Summary of Presentation:
Nam Tran acknowledged the effort support by Adam Taylor (NCAT) and Jeff Withee (FHWA). Tran reported Taylor did most of the statistical analysis, while Withee was involved in calibrating the AMPTs and coordination of the ILS.

Tran listed the objectives for the ILS, which are: (1) assist and encourage agencies to start using the AMPT, (2) determine the variability of dynamic modulus (E*) and flow number (Fn) test results in comparison to those from NCHRP 9-29, and (3) to quantify the effect of specimens air voids on the test results. Twenty-nine labs participated and were divided into three groups and each group performed the tests at different air voids levels. One group tested specimens compared to 6%, air voids, while the other two groups tested specimens at 7 and 8%. The tolerance for each group of air voids was +/-0.5 percent. Tran discussed the testing plan used in the ILS. For each lab a total of twelve samples were prepared at the target the air void level.

Tran reported results have been already been received from nineteen labs; five from the group testing specimens with a 6% target air void level, six from group with 7% air voids, and eight from the third group with 8% air voids. He also reported the testing was delayed in ten labs for various reasons, which included; the AMPT was still being installed/calibrated, the specimen air void level missed the target value, staffing limitations, and waiting for software updates.

Frank Fee asked if the labs provided guidance on preparing the specimens. Tran answered yes, considerable guidance was given for preparing and compacting the specimens. The procedure was very detailed. John D'Angelo asked if the number of gyrations required to achieve a selected height was recorded and Tran answered that it was. Tran commented a lot of information was recorded, which is not yet included in this report. All of the specimen preparation and compaction data will be included in the final report for the ILS.

The next part of Tran's report included a review of the preliminary results received. He started with showing the repeatability of E* and phase angle. In summary, the within laboratory

coefficient of variation (COV) was higher for the ILS when compared to the results from NCHRP 9-29. Conversely, the between laboratory COV (reproducibility) was generally lower from the ILS in comparison to NCHRP 9-29. Tran thought most labs would not have any issues with running the tests because FHWA and Ray Bonaquist had provided extensive training to personnel on the use of and calibration of the equipment.

Tran then focused on the effect of air voids on the measured E* values. He reported there was no good correlation between E* and air voids. He stated, as you move to higher temperatures, the dispersion in the data increases; in fact, there are no correlations at the higher temperatures.

Geoff Rowe asked about the error analysis for the more outlying points. Tran replied they did a statistical analysis on the outliers. Adam Hand commented for some of the outlying points were due to problems with the AMPT equipment. Hand noted they only removed a few data points. Tran clarified they did the statistical analysis of the outlying points but they did not remove any data (other than those related to machine problems) simply because they were outliers. Hand noted they would get feedback from the labs when screening the data.

Rowe asked, relative to the measured COV, were you able to determine how good the data fit from the mean value. Tran answered the data quality did deviate from the mean value. Bonaquist clarified this was not part of the ILS. Bonaquist stated you will have to look at this issue later. Rowe asked when you look at COV versus E*, do you see more deviant points from the mean at particular E* values. Tran replied they have not looked at the data from that respect at this point in the study.

Tran then presented the results from flow number test. He showed the Fn COV for all labs in a bar chart. He stated they thought the variability was good with only one lab exhibiting high variability. The next bar chart presented was the COV for the target air voids levels. Tran also included graphs showing the Fn values as a function of air voids. Louay Mohammad asked about the magnitude of the Fn value used in determining the COV for the chart of Fn versus air voids with all data combined. Tran thought air voids had a more significant effect on FN than on E*.

The final part of Tran's report summarized their preliminary findings from the ILS, which were:

- Participating labs were able to prepare and test specimens in accordance with the AASHTO test method.
- For the E* results: the air voids have no effect on E* within or between the target air void levels. In comparison to the NCHRP 9-29 result, repeatability was higher and reproducibility difference was lower.
- For Fn results there is a clear difference in Fn results between the target air void levels, but no apparent effect of air voids on Fn for the same target air void level. In comparison to NCHRP 9-29, repeatability and reproducibility are lower.

<u>ETG Comments, Questions, and Discussion</u>

Louay Mohammad asked how many specimens were used to average the results for COV determination. The COV was computed using four specimens for Fn and three for E*. Mohammad asked why three for E* and four for Fn. Tran answered this was based on the repeatability of specimens from the NCHRP 9-29 study. Bonaquist added you need to be very

careful in reporting these values in terms of repeatability and reproducibility. Bonaquist asserted the values included in the graphs prepared by Tran on Fn repeatability and reproducibility were the COV of one test.

Bukowski asked about the schedule for completion of the ILS. Tran replied that testing should be done by mid-June. He expects the draft final report to be available by end of July/August. Tran reported the data and report will be sent to Bonaquist for his comments on reporting and validating the data. Tran also reported testing is being done to evaluate the effect of friction reducers. Withee stated Adam Taylor is coordinating related efforts with the Southeast User and additionally an AMPT training workshop will be held at the Nevada DOT during September.

Presentation Title (#2): *Revisions to S-VECD Specification*—Richard Kim (NCSU)

Summary of Presentation:
Richard Kim reviewed the test method for E* measured in accordance with TP-79 using the AMPT; controlled crosshead direct tension cyclic test at a single temperature and three strain levels using a S-VECD analysis, and a linear viscoelastic pavement analysis. Kim stressed the importance of obtaining the damage characteristic curve which he illustrated on a graph. This is the "c" value (material integrity constant) versus "s" value (amount of damage) relationship. Each mixture has a unique relationship between material integrity and amount of damage. Kim reported there have been sufficient research for predicting fatigue life in terms of measured versus predicted number of cycles to failure. He noted they have used this relationship in calibrating the MEPDG so they did not have to perform many fatigue tests.

Kim reported comments were received from the AASHTO SoM on the draft standard and have been addressed and are presented as part of his report as follows.

Test Temperature should not exceed 21°C. Kim showed examples of three asphalt grades in terms of calculating the test temperature. John D'Angelo asked what environmental temperature was used. His stressed the difference between the climate and pavement temperature. Kim explained we need to keep the viscoplastic strain minimal, because once it starts to occur the procedure fails. Thus, temperature needs to change with binder grade. He reiterated they are not trying to capture the field temperature because the methodology will capture the effects of the field temperatures in the response computations. Rowe asked if testing was at some equiv-stiffness value. Kim replied no that is not what is being done. There was discussion whether temperature and stiffness of the binder is varying. Raj Dongre noted to avoid grade bumping is the reason why the upper temperature should not be used. Bob Kluttz recommended using the low temperature grade plus 40 degrees. There was agreement on this point.

Number of tests - one replicate at each of the four cycles to failure or strain levels. Kim noted the proposed revision is to test a total of three specimens at a single test temperature. He also noted there is a much lower probability of end failure from the 180 mm tall specimens.

Strain levels - the number of cycles to failure. Kim reported they removed the number of cycles to failure and changed to a strain level. Raj Dongre commented relating to very stiff samples,

the testing machine operation is very important because overestimating will damage the specimen. His noted the need to base the target strain based on stiffness. Kim replied that some of the AMPTs have taken care of this issue but agreed it is more of an equipment issue, and stated they have equations for determining equipment compliance.

Average strain from the 1st 5 cycles of strain versus number of cycles to failure. Kim noted to start the first test at 300 microstrains and use a stepwise approach: compute the machine compliance factor from the fingerprint dynamic modulus test, compute the actuator displacement for specimen peak to peak strain of 300 microstrains using the determined k values, conduct the cyclic fatigue test using the first displacement amplitude and determine the Nf1 using the phase angle drop point, use criteria in the specification to determine the 2nd and 3rd on specimen strain levels, and compute the actuator displacements for both strain levels and conduct the fatigue test at those displacements. Tran asked whether these equations were in the specification, and Kim replied that they now have been included. Kim showed the criteria included in the specification, which is table 4 to determine the 2nd and 3rd strain levels to be used and are based on the number of cycles to failure using 300 microstrains.

Kim concluded his report by listing some of the other questions from the SoM ballot.

- Is one test enough to construct the damage characteristics curve? Kim answered yes, but you need at least three to develop the failure criterion.
- Is a fingerprint E* test needed? Kim replied yes, since it is used to account for specimen variability.
- Are spring loaded LVDTS needed? Kim answered both spring loaded and loose core LVDTs are included in the revised specification.
- Are spreadsheets for data entry/calculations available? Yes, they are also in the appendices.
- Appears specimen storage requirements are too strict. Kim: has revised to make this only a recommendation, not a requirement.
- Is there temperature monitoring of the specimen in AMPT? Kim replied, temperature monitoring of the specimen is recommended when an external chamber is used for temperature conditioning.

ETG Comments, Questions, and Discussion:
Kevin VanFrank asked about the status of this analysis with the AMPT manufacturers. Kim noted some of the manufacturers have now included software to make the computations. Rowe was concerned about arbitrary choices in the specification. Fee noted if something is critical to get good repeatability, it needs to be mandatory, but if it is for information purposes, then it is not mandatory. Fee asked Kim and Rowe to get together to sort out the items. Rowe said he would work with Kim to identify those parts that are unclear. Bukowski reported there has been considerable effort/discussions on this topic and eventually need to get this information to the SoM.

ACTION ITEM #7: Richard Kim's revised draft procedure for cyclic fatigue tensile testing with S-VECD will be forwarded to the SoM 2d for further consideration

Presentation Title (#3): *Field Verification of S-VECD Model*—Nelson Gibson (FHWA)

Summary of Presentation:
Nelson Gibson presented on a method for measuring E* using small samples for forensic investigation and in evaluating in place mixtures. Gibson will show data on materials tested from Nebraska and Connecticut, and North Carolina.

Gibson started by showing distress surveys from North Carolina completed by Kim. This relates to E* and damage properties of the I-540 mixture. The I-540 simulations were made with the EICM. Two other North Carolina projects were summarized and compiled by Gibson: NC-24 and US-74 routes. The NC-24 mixtures exhibited top down cracking while the US-74 mixtures exhibited bottom up cracking. Kim reported both of these pavements had similar structures/ thicknesses but exhibited different types of cracking. Gibson reported the materials testing using small samples and analysis with the S-VECD model explained the difference in performance.

Gibson then focused on the Nebraska I-80 project which was 10 years in age and exhibited reflective cracking. Two sections were identified with different amounts of cracking and investigated. Section A had reflective cracking while Section B had no or little cracking. The next project summarized was the LTPP SPS-9 in Connecticut. Gibson showed the ranking of the mixtures included in the experiment. The mixtures included different amounts of RAP and other materials. He also mentioned this information was presented at AAPT this past year. All testing was done on small scale samples for both E* and cracking characterization. He included a table in his report summarizing the statistical analysis comparing the test results and predictions for the different mixtures and sections. The conclusion from the statistical analysis is that full scale and small scale sample test results gave similar results, but some cells did show statistical differences. He has confidence is using this method and is including it in the current ALF experiment.

Gibson provided some possible implications for the method and where it could be used. In particular, it has application testing prisms and cylinders from field cores.

ETG Comments, Questions, and Discussion
Frank Fee maintained that this method needs to be further pursued. Fee also referred to the ASTM work that is on-going on this topic.

Presentation Title (#4): *AMPT Flow Number Test Protocol Evaluation*—Jeff Withee (FHWA)

Frank Fee overviewed the creation of this task force and the objective to examine current and proposed methods for measuring mixture rutting potential using the AMPT.

Summary of Presentation:
Jeff Withee identified the participants, scope of the evaluation, testing protocols, a summary of the evaluation, some implementation considerations, and the current task force status.

The objective of the flow number test protocol evaluation was to recommend one flow number test protocol that can be used in mixture design to characterize the rutting potential of HMA mixtures. Withee acknowledged the task force members; Jim Musselman, Kevin Hall, Mike Anderson, and Erv Dukatz. He also thanked Phil Blankenship, Gerry Reinke, and Scott Veglahn for providing assistance to the group, and noted Ray Bonaquist was the technical resource to the task force. Withee also recognized all of the researchers in writing the test protocols, doing the analyses and rankings and especially Elie Hajj and Haleh Azari for performing all of the tests.

Withee then identified the nine mixtures included in the study, as well as the traffic levels, location, asphalt binder grade, and mixture NMAS.

Withee presented the general considerations for selecting the test protocol, which included five categories; protocol usage, evaluation approach, required inputs, test temperature, and confinement. As part of his report, Withee reviewed the different test protocols and procedures.

- NCHRP 9-33 approach – HMA criteria and WMA criteria provided, criteria based on flow number and traffic level, LTPPBind 50% reliability testing temperature, unconfined testing for which a data set is available, this criteria is the published approach in appendix of AASHTO TP 79-13.
- NCHRP 9-30A is the revised MEPDG rutting model and requires an intercept and slope from the permanent strain relationship, it links mixture and structural design, uses a relatively low equivalent annual temperature as option B (option A requires three test temperatures), and requires significant data analysis effort to determine the field adjusted values.
- UNR – Asphalt mixture critical temperature concept: data included from two Westrack mixtures used in its development, critical flow number at T effective by traffic level, project specific inputs required, project specific loading parameters (deviator stress, confining stress, pulse duration), comparatively moderate test temperature, and additional validation of rutting criteria pending.
- Incremental repeated load permanent deformation (iRLPD) – minimum strain rate with minimum slope of permanent deformation curve, criteria based on MSR at 500 cycles, LTPPBinbd degree-day based testing temperature, three testing options are available (level 1 – one 500 cycle test for mixture evaluation, level 2 is multiple stress levels in terms of MSR versus TP curve, level 3 incorporates various stages of laboratory aging, and criteria assumes representative pavement thickness.

Withee provided a summary of the evaluation and comparison of the procedures, which were presented at an earlier meeting. He reported that one complication in the ranking of the mixes by each procedure was that all of the mixtures resulted in good pavement performance.

The UNR and NCHRP 9-30A procedure ranked all of the mixtures as good performers but one, while the iRLPD and NCHRP 9-33 procedures ranked three of the mixtures as susceptible to rutting or not meeting the criteria for good resistance to rutting. Withee explained why some of the results from the procedures did not match up to observed experience.

Withee referred back to the original considerations and objectives of this task force, the two most important options were mix design evaluation and using a pass/fail basis as the criteria. He reported the LTPPBind – temperature based approaches and using confined tests represents an improvement. The task force recommendation was to further evaluate a procedure based on a modification of the iRLPD method. Additional benefits with this approach are that it compliments TP 79, uses flow number test terminology, test parameters include the use of temperature degree day equation from LTPPBind, uses a confining pressure, and uses repeated axial stress. It also includes a single temperature and stress level. The task force is continuing to examine the level 1 which is pass/fail basis in the method.

Withee summarized the implementation considerations recommended by the task force, which included; investigate the base and intermediate mix applicability, review the MSR versus ESALs criteria computation including pavement structure thickness input and conversion from ESALs to strain per cycle (MSR), applicability of Francken model fit parameters, variability of MSR between samples when averaging; and consideration of existing test condition data (10 psi confinement, 87 psi repeated axial stress, evaluate at 500^{th} cycle). Withee mentioned even with other data sets that went much further than 500 cycles that data can still be used. One concern is that the test method has only been performed extensively in one laboratory. The ETG decided to consider the procedure for additional evaluation by other labs for comparison testing, perform a ruggedness study, and perform an inter-laboratory study.

ETG Comments, Questions, and Discussion:
Bukowski thanked the task force for their efforts. He would like more discussion from other ETG members on this proposed method. There should be more rationale on why this approach is believed to be an improvement over the Fn methodology and criteria developed from NCHRP research projects 9-33 and 9-43. Also any changes that would be needed to modify existing AMPTs.

Withee stated the task force thought the 9-33 procedure was more like the Hamburg and APA procedure. The group liked the MSR procedure because that is the area where the rutting is occurring and the task force believes this is a more fundamental approach. Withee also noted that changes to the AMPT if only focus on the level 1 (pass/fail) approach can be done with existing software and the Francken model parameters being calculated.

Ray Bonaquist mentioned the iRLPD did provide a closer ranking to the ranking of mixture by experience, as compared to 9-33. Gerald Reinke commented that the use of confining pressure in this new procedure was a positive approach. Jim Musselman also noted the repeatability of the iRLPD was lower.

Kim asked if three stresses were used or just one for the iRLPD method. The reason why he asked that question was if it is based on one stress and need to make sure that three stresses are required. Azari mentioned she only provided the data at 600 mPa, but showed all test results are along the master curve for all three stress states.

Kevin VanFrank asked if the master curve that was developed, translates vertically with temperature. Azari noted they used a temperature shift factor, so they only need to run it at one test temperature.

Fee asked the task force to review the comments from the meeting. Kevin Hall recommended that a ILS testing plan should be adequately developed before performing full ILS. Jim Musselman noted Azari prepared a report on the procedure and suggested it go to the ETG for review.

Bonaquist noted the information could be taken from the ruggedness study from NCHRP 9-29, but was unsure whether the 9-29 testing was at the same stress level.

ACTION ITEM #8: The Flow Number Task Force's proposed draft procedure/criteria (Incremental Repeated Load Permanent Deformation) on a new method to characterize the rutting potential of asphalt mixtures will be distributed to ETG members for evaluation by additional laboratories. ETG members are requested to conduct evaluation before any final recommendation in 2014 regarding possible replacement of the existing TP 79 criteria.

12. Task Force Review Update on T 321 (Beam Fatigue)—Geoff Rowe (Abatech)

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

Summary of Presentation:
Geoff Rowe gave a verbal report on this topic. He fist overviewed the objective of this effort for improving the definition of failure in fatigue tests. He considers the standard complete and is finalizing the redlined version for going forward to the SoM.

Bukowski noted if revisions based on the newer comments have been made then it is ready to forward this year to the SoM. Rowe noted the revisions will be submitted before next week.

Rowe noted there are two other areas under this topic that need to be reviewed, so he suggested the task force stay together. The standard was written in the early 1990's, so he would like to work with existing manufacturers for improving the equipment portion of this standard. The second part is to look at specimen preparation for improving the test results – more consistency in the data. Rowe requested anyone with the bending beam equipment become involved and provide their input.

ACTION ITEM #9: Proposed final revised version of T 321 (Beam Flexural Fatigue) and commentary will be sent to the SoM 2d for consideration.

13. BBR Mix Testing Method—Mihai Marasteanu (University of Minnesota) and Raj Dongre (Dongre Laboratory Services)

Presentation Title: *Update on Asphalt Mixture Low Temperature Creep Testing using Bending Beam Rheometer*

Summary of Presentation:
Raj Dongre gave the report for Mihai Marasteanu. He is requesting direction on the next step since this has been presented prior to the ETG.

Dongre gave a review of the NCHRP Idea 133 for testing small asphalt mixture specimens at low temperatures to obtain creep compliance and strength for possible use in material selection and pavement design in accordance with the MEPDG. This initial project was conducted between 2008 and 2009.

Dongre explained the sample preparation and loading procedures developed for the creep test to measure and obtain the required properties. The draft BBR creep mixture test method was developed as part of the IDEA project deliverables. The current AASHTO method for binders was used as a template and only the sample preparation and loading procedures were replaced. This method was presented to the ETG in September 2009, and a few comments were received. Based on those comments, a final draft of the procedure was completed in August 2011. It has been discussed for the past 3 years and comments were received and incorporated into the standard. In addition, it was the result of extensive research and validation and individuals are now using it.

ETG Comments, Questions, and Discussion
Fee asked about the cooling medium differences. Dongre noted the cooling medium affects strength but not necessarily the stiffness. He also noted ethanol is used here which has no effect on stiffness measurements. Dongre stated virtually no modifications are needed to the BBR equipment. Fee stated he was unsure whether the ETG received the latest revision of the standard. Bukowski commented there has been no presentation/updated document to the ETG on the procedure in the last year. It was anticipated with additional labs now performing the test that more data would be gathered and presented at the ETG. Fee requested the latest version of the standard be submitted to the ETG.

Kevin VanFrank commented on what he did in Utah using this standard. The issue is with the data interpretation. Kevin Hall asked even if we have a method for testing small mix samples with the BBR, do we know how to use the results. Richard Kim asked if these results have been validated. Bonaquist stated there was a field validation effort and that field validation is included in the published report. VanFrank stated the variability has been reduced, which was reported in previous meetings.

Since the draft BBR creep compliance testing method for mixtures has been reviewed multiple times by the ETG and the method has been used over the years by a number of laboratories, it was suggested that the test method be sent to the SoM for consideration.

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

Presentation Title #1: *Dongre Workability Test – DWT*

Summary of Presentation:
Raj Dongre thanked Roger Pyle for help with the report. He also acknowledged Eugeniu Morari support in the preparation of this effort. Dongre acknowledged other involved in this effort: Pine Instruments, Josh Thompson, Glorida Burke, Kevin VanFrank, Larry Michaels, Bob Kluttz, Richard Steger, Jason Bausano, and Ron Holsinger.

Dongre summarized the test and provided the background. The objective was to develop a simple, low cost, easy to use method to measure workability of asphalt mixtures. He emphasized some features of the test; it is based on existing equipment, it is simple and repeatable, it is sensitive to HMA and WMA, and it can be used to establish the temperature range for field compaction. He also emphasized the use of the device and method to determine the reduction in compaction temperature produced by the addition of various WMA technologies. The approach in developing this test was to first define workability of asphalt mixes. Dongre defined workability as the rheological state of the asphalt mix where the mix consolidates or compacts rather than shoves.

The next part of Dongre's report was on the test method in terms of cost, testing protocol, and data analysis. The equipment required for the DWT test is software and a gyratory compactor. His development of the method was with a Pine gyratory compactor. Dongre overviewed the test protocol and the steps. He showed examples from the test in terms of volumetric strain versus stress. The workability is defined as the slope between stress and strain at 600 kPa. Gerry Huber asked how and where is the stress measured. Dongre replied it is an axial stress. Dongre also explained no gyrations are used, so you do not end up with a compacted specimen. It is only loose mix under an axial load. Gerald Reinke asked about the mix being put into the mold, if there is a time requirement of getting the mix in the mold and applying the load. Dongre replied, after the mix is put into the mold, the load applied as quickly as possible. Roger Pyle commented the loose mix is also rodded prior to applying the load. Roger Pyle noted the amount of rodding is not currently specified.

Dongre's presented some results and comparison of mixtures. The first comparison he showed was between different asphalt grades or asphalt sources for a Virginia diabase aggregate. The next comparison of results was for different aggregate sources using PG 64-22 asphalt. Much larger differences in the defined workability were observed for the different aggregate sources and gradation rather than for different sources of asphalt. Dongre then discussed different applications of the test's sensitivity. The DWT test can be used to determine the field compaction temperature, the temperature reduction obtained using some WMA technology or additive, etc. As part of his report, Dongre showed the differences in the predicted field compaction temperatures for finish and breakdown rolling using the DWT test for various mixtures and asphalts.

Next he overviewed the ruggedness testing that has been completed in accordance with ASTM C 1067. Dongre reported seven factors were selected for the ruggedness study and two levels were selected for each factor: rodding, rod type, tamping, specimen mass, stress at 0.05 mm per

second at the start, final stress, and the offset temperature. The experiment design included one asphalt mixture (a 12.5 mm fine mix using a Virginia limestone and a PG 64-22 unmodified binder), three temperatures (135, 180 and 225 °F) and one laboratory. Dongre showed some of the results from this ruggedness experiment. The first was a graph comparing the DWT value and temperature. He summarized the results in a tabular format with a summary on whether the differences were significant. The conclusion he reported from the ruggedness test program were:

- Rodding pre-compaction proved to be extremely significant.
- Rod type is important and Dongre suggested using a blunt, round rod.
- Tamping with a rubber mallet is snot important when the blunt rod is used.
- Specimen mass is significant over the tested high and low limits.
- Stress at 0.05 mm per second start range of 40 kPa to 80 kPa is reasonable.
- The final stress range of 700 kPa to 950 kPa is acceptable.
- Offset temperature range control of 10°F plus and minus 5°F us adequate.

Dongre gave his recommendations, which were in a tabular version for the specific ruggedness factors. He noted the ruggedness testing was confined to one lab and is seeking other labs to examine the method prior to going to the ILS.

ACTION ITEM #10: ETG members are requested to provide Raj Dongre comments on his workability procedure and presentation at the next ETG meeting

Presentation Title #2: *Introducing Laboratory Rolling Compaction Simulating Field Conditions – Sample Preparation Requirements*

Summary of Presentation:
Doug Zuberer gave the report regarding the introduction on a laboratory rolling compaction device to simulate field conditions. Zuberer reported this was a presentation on rolling wheel compactors that are available in the lab and the results in compacting lab specimens have been found to reproduce field compacted mixtures. His report was to focus on the improvements made to the laboratory devices.

Zuberer provided the history and integration of hydraulic roller compactors. He referred to the equipment developed by Nottingham University in the 1980's. Zuberer reported all existing lab rolling wheel compactors at that time met the European standards. He showed an illustration of the three options of the equipment currently available for rolling wheel compaction in the laboratory, and the equipment vibration and temperature controls.

Zuberer noted some of the difficulties with using gyratory compacted samples, and countered with the advantages of using these other rolling wheel type compactors with preparing slabs for the Hamburg and APA tests, as well as for flexural fatigue tests. In addition, many more test specimens can be prepared because of the larger slabs that can be compacted so you reduce the waste by being able to cut many more cores for more of the traditional tests. In closing, Zuberer provided a summary of advantages for this type of laboratory compaction equipment.

Presentation Title #3: *Bailey Method Experiment*

Summary of Presentation:
Raj Dongre gave a short presentation on the Bailey method in comparison to the use of the DWT test. Dongre first described the Bailey method. He then focused on an experiment to determine whether the DWT test values can be used as a quality control tool to determine if the gradation is changing and to compare the values for mixtures designed with the Bailey method. Two aggregate gradations were selected for the experiment: a fine and a coarse graded aggregate blend.

Dongre presented results that showed the effect of how the fine and coarse graded mixes vary in terms of the DWT value for both the dry aggregate blend and asphalt mixture. He included graphs for the DWT values for the dry aggregate and asphalt mixtures as a function of VMA, percent passing the primary chosen sieve (PCS), and asphalt content. From the data collected within this Bailey experiment, Dongre concluded the following:

- Dry aggregate and asphalt mix DWT values are sensitive to percent passing the PCS, VMA, VFA, Air Voids and Mix type.
- Asphalt mix DWT values are sensitive to asphalt content, mix type, VMA, VFA, and air voids.

Dongre suggested the DWT test can be used to evaluate the aggregate blend and asphalt mixture prior to compacting any test specimens. The DWT test can also be used as a quality control tool for monitoring changes in the aggregate during production that is meaningful to the mixture. He also reported there is an ASTM draft method that the ETG might review and possibly provide comments. In addition, the ruggedness phase I has been completed and the ILS will be initiated after the ruggedness has been completed.

ETG Comments, Questions, and Discussion
Howard Anderson asked Dongre if the DWT test could be used to develop minimum asphalt contents so that their mixtures do not become drier. Dongre thought that was a possibility.
Ala Mohseni commented on the shape of the aggregate in terms of rodding the specimens and asked how this was done. Dongre noted there are no specific test protocols for the rodding, but that needs to be specified and included in the standard.

15. Report Task Force WMA—Matt Corrigan (FHWA)

Presentation Title: *Warm Mix Asphalt Update*

Summary of Presentation:
Matt Corrigan referred to what had been done within the task force and its inclusion in the Mixture ETG. He reported there has not been a much task force activity since the last meeting. Corrigan noted the research statement that was approved through NCHRP as project 9-58 on recycling agents used for asphalt mixtures containing high recycled asphalt binder ratios. Corrigan thanked Ed Harrigan for his effort in overseeing these projects. He showed the projects

included under the WMA technology that have been completed, or are on-going. Corrigan then focused on specific projects and the results from those projects. Those projects highlighted by Corrigan included:

- 9-43 which resulted in an appendix to AASHTO R35 with a commentary entitled Special Mixture Design Considerations and Methods for WMA. Ray Bonaquist was the PI.
- 9-47A, some preliminary findings;
    - Optimum asphalt content on the average decrease for WMA compared to HMA using R30 Appendix, binder absorption is less for WMA, and the Fn is lower for lab produced mixture. Some of the preliminary recommendations from this work included: continue drop-in approach for selecting optimum asphalt content then doing the coating, compactability, TSR, FN; and the excellent rutting resistance in the field suggests that Fn is unnecessary except for high traffic level. Randy West was the PI.
    - Other recommendations for WMA mix design changes from the 9-47A project: bucket versus planetary mixer – most of the work was done with a planetary mixer. It was recommended that the note about planetary mixer be removed.
    - Laboratory foaming – project recommended including an option of using mix produced during a trial run at the asphalt plant in lieu of lab produced mix.
    - Design – recommend selection of a mixes optimum asphalt content based on traditional volumetric criteria per AASHTO R 35 without using the WMA technology. Additional mix evaluations should then be conducted using lab or plant produced WMA. While there are possible justifications for lower asphalt content in WMA, none were confirmed.
    - Mixture evaluations – AASHTO R 35 appendix section 8.4 samples for evaluating moisture sensitivity, based on WMA field rutting performance to date, additional testing beyond what is required for HMA seems unwarranted.
- NCHRP 9-43: Most of the original work under 9-43 was limited to 1% asphalt absorption. Corrigan noted Bonaquist was asked to go back and include some higher absorptive aggregates to about 2 % absorption.

16. NCHRP Project 9-43 Follow-Up Information on Absorptive Aggregates—Ray Bonaquist (AAT)

Presentation Title: *FHWA Expansion of NCHRP 9-43 Mix Design Study to Higher Absorptive Mixtures*

Summary of Presentation:
Ray Bonaquist stated this report will include a brief overview of the 9-43 experiment, and expanding that experiment to higher absorption mixtures. He summarized the experimental plan for the expanded mix design study. Bonaquist noted mix design was only one part of the study, the second part was a field study to develop the appendix to AASHTO R35.

Bonaquist showed the mix design study sampling matrix. The design was equally balanced for RAP and non-RAP mixes. The experiment was design based on using a paired t-test of WMA to

HMA mixture properties. Bonaquist noted that FHWA asked them to consider expanding the experiment to include mixtures or aggregates with higher asphalt absorption. He then showed the experiment design for the expansion. Bonaquist noted he designed the experiment around the use of the foaming process and added mixes #7, 8, and 9. Bonaquist noted the plant foaming part has yet to be completed so any results from that part will be presented at later meetings.

Aggregates used in the study included PA gravel, VA diabase, VA limestone, FL limestone for the coarse aggregate and different fine aggregate. Bonaquist noted that Jim Musselman provided the FL limestone that had nearly 4% absorption, so they combined that aggregate with the VA limestone to end up with just over 2% absorption. Mohammad asked if any of the mixes were used in the field. Bonaquist replied mixes 1 through 6 were used in the field. Mixes #7, 8, and 9 were not.

Bonaquist showed data comparing WMA to HMA. They did a paired t-test with different confidence intervals. The properties selected and used in the comparison were design binder content, binder absorption, effective asphalt content, VMA, VBE, compactability is the methodology included in the appendix to R 35, moisture sensitivity, and rutting resistance.

For the design binder content by weight, no difference was observed for low absorption aggregates while high absorption aggregates are clearly different. Regarding binder absorption, there were significant differences for both mix or aggregate. For effective binder content, as well as VMA, no difference between WMA and HMA for both low and high absorption.

Moisture sensitivity differed among materials with low absorptive aggregate, but was indifferent for high absorptive mixtures. Mohammad asked about the conditioning of the samples. Bonaquist replied dry is the unconditioned tensile strength, while conditioned is the wet tensile strength values between the WMA and HMA mixtures. For TSR there was a difference for the low absorption mixes and no difference for the high absorption mixes.

Bonaquist provided a summary of the results:

- Decreased binder absorption when designed as WMA.
- Compactability less sensitive to temperature when designed as WMA.
- Potentially lower WMA when designed as WMA – potentially lower effective binder contents for WMA.
- Moisture sensitivity and rutting resistance are materials and mixture dependent.

Potentially there are plans to expand the study to emphasize need to use WMA process in design of mixtures – binder absorption does not account for all volumetric differences, 0.5 to 0.75% reduction in VMA is possible in some mixtures and moisture sensitivity and rutting resistance materials and process specific.

ETG Comments, Questions, and Discussion

Gerry Huber noted that designing to a specific VMA is not troubling. He noted designers will design to a specific VMA and change the target based on whether it is a WMA or HMA. The only place where this may become an issue is for the drop-in additive situation where it is designed as an HMA. If we have a criterion that makes the producer responsive to VMA,

Huber's opinion is that concern goes away. Noted perhaps VMA should be an acceptance criterion during production.

Gerald Reinke noted the information on moisture sensitivity has been known since WMA started. That is why some agencies change their acceptance criteria.

Randy West noted we have always known there is a difference between lab and field produced mixes. Some states deal with this better than others.

D'Angelo believes we are leaving out a major point. We do have good performance in the field. This is bringing out more fundamental issues – most agencies are of the opinion that they are not getting the performance because too low asphalt is being used. He believes we need to start with the fundamental properties for estimating performance.

Fee asked about which test was used for rutting. Bonaquist replied the flow number and the samples were aged for both the WMA and HMA. There is a difference between the aging of the WMA and HMA. Sandy Brown noted when preparing and aging the mix in the lab, we know everything can be controlled, but in the field things are not done exactly the same. Cannot assume the lab and plant are the same. He does not dispute looking at VMA in the field, but believes you need some allowance for VMA differences between the field and lab.

Kevin Hall noted Arkansas calculates the specific gravity to identify whether something has changed between lab and field. Jim Musselman noted he has not seen a decrease in binder content over his WMA projects. His concern is how do you control the aggregate specific gravity. They control air voids and binder content but they can increase it if they have adequate VMA. Chuck Pugh noted one item tracked in the FHWA mobile laboratory is the Gsb in comparison to the apparent and bulk specific gravity. When the Gsb starts to increase to the apparent or bulk specific gravity then there have been changes. Gerry Huber also noted if we have an aggregate that has moderate absorption and it gets stored for production until the next morning that will result in significant differences in the properties. Sandy Brown noted maybe you need to increase the asphalt content for that situation.

Bonaquist agreed with Huber, mix design is just a starting point. You will have to make an adjustment to gradation if you want to keep the VMA the same, etc. Bonaquist's point for the mixes used, those with lower VMA should have been redesigned or use a different gradation so that the VMA meets the criteria. Tim Ramirez asked Bonaquist what approach would he take. Bonaquist answered, you design it to a minimum VMA.

17. Status of NCHRP Project 9-49 WMA Moisture Sensitivity Study—Dave Newcomb (Texas Transportation Institute)

Presentation Title: *NCHRP Project 9-49, Performance of WMA Technologies: Stage I – Moisture Susceptibility*

Summary of Presentation:

Dave Newcomb provided an update and status report on NCHRP 9-49. The objectives of the project include; obtain a combination of conditioning temperature and time for preparing lab mixed lab compacted and plant mix lab compacted specimens calibrated to early life, compare WMA and HMA in terms of moisture susceptibility and evaluate the effect of anti-stripping agents as a minimization strategy, and evaluate the evolution of WMA performance with field and laboratory aging in terms of stiffness and moisture susceptibility and recommend a laboratory long term over aging protocol to simulate field aging.

Newcomb summarized the results of laboratory conditioning and testing. He also discussed the recommended conditioning protocols to simulate early life stiffness. Aggregate orientation and total air voids seem to have a greater effect on mixture stiffness as compared to binder stiffness. Newcomb suggested that the ETG and other researchers need to look at aggregate orientation.

He presented the experimental design related to moisture susceptibility and listed the agency mixtures, and what type of tests were completed. Newcomb went over the type of tests that were performed. Another part of this study was to look at anti-stripping agent and evaluating the parameters being used in the study. Conditioning the loose mix was an issue. Iowa and Montana mixtures were included in the study. The Iowa mixtures were found to be susceptible to stripping while the Montana mixes did not exhibit that condition.

Newcomb summarized the results in terms of moisture susceptibility. HMA sometimes performs better than WMA initially in the field and lab in terms of moisture resistance. Field aging not only stiffness the mix but enhances their resistance to moisture. The Iowa mixes consistently exhibited poor performance. The Texas mixes exhibited more variability across the specimen types. WMA mixes with Evotherm may not need other anti-stripping additives because they are already contained in that material.

The next item included in Newcomb's summary report was on WMA performance evolution in terms of how long does it take for WMA to catch up with HMA in terms of aging. Newcomb included some graphical illustration of the results. The Iowa HMA starts out higher and stays higher. The TX mix exhibited a different response over time and become indifferent over the long term. The results from the Hamburg wheel tracking tests were graphically illustrated at different times and conditions. Field aging and lab LTOA are able to increase mix stiffness and moisture resistance.

The recommendation for moisture susceptibility testing during mix design WMA includes:

- LMLC loose mix for short term oven aging at 2 hours at 240^{o}F;
- Moisture conditioning per AASHTO T 283; IDT strength per AAASHTO T 283 and resilient modulus per modified ASTM D 7369
- HWTT per AASHTO T324; stripping inflection point and stripping slope.

The future work includes:

- NCHRP 9-52 will pick up where 9-49 left off.
- Revised analysis of HWTT results. May be more useful if the results from this device are looked at differently.
- Additional moisture conditioning protocols

ETG Comments, Questions, and Discussion

D'Angelo asked about the recommendation that everything is at 240°F. Newcomb noted need to start at some point, so looked at compaction temperatures initially using 240°F. From the standpoint of doing this in a nonstandard research laboratory he believes you will need one temperature.

18. 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. Recommend to SoM 2d: for PP60, while minimum height for specimen preparation is 160 mm for compression testing, the minimum height for specimens subjected to tensile testing should be 180 mm.

2. RAP/RAS Task Force will incorporate the comments from the ETG along with the proposed revisions to PP53/MP15. Revised documents to be provided to Bukowski for SoM 2d consideration. A one year time extension as provisional standards will also be requested, if possible, to allow time for further evaluation of the proposed changes.

3. RAP/RAS Task Force will be provided the report from NCHRP project 9-46 and draft of suggested changes to R35 and M323. RAP/RAS Task Force will review and comment at the next ETG meeting.

4. The procedure developed by Andrew Hanz for estimating RAP/RAS binder properties without extraction will be sent to the Binder ETG for comment. This item will be included on agenda for discussion at the next set of ETG meetings for potential forwarding to the SoM after the fall meeting.

5. Richard Kim will report at the next ETG meeting on the status of the IDT ruggedness study.

6. ETG members are requested to forward comments to Ellie Hajj on his draft procedure for low temperature tensile mixture testing, and a summary of comments and potential action will be discussed at the next ETG meeting.

7. Richard Kim's revised draft procedure for cyclic fatigue tensile testing with S-VECD will be forwarded to the SoM 2d for further consideration.

8. The Flow Number Task Force's proposed draft procedure/criteria (Incremental Repeated Load Permanent Deformation) on a new method to characterize the rutting potential of asphalt mixtures will be distributed to ETG members for evaluation at additional laboratories. ETG members are requested to conduct evaluation before any final recommendation in 2014 regarding possible replacement of the existing TP 79 criteria.

9. Proposed final revised version of T 321 (Beam Flexural Fatigue) and commentary will be sent to the SoM 2d for consideration.

10. ETG members are requested to provide Raj Dongre comments on his workability procedure and presentation at the next ETG meeting.

Next Meeting Location and Date:
Bukowski reported the next meeting is scheduled for the week of September 16, 2013.

19. Meeting Adjournment—Frank Fee and John Bukowski adjourned the meeting at 3:23 PM and thanked everyone for attending as well as their participation on the ETG and in the meeting.

ATTACHMENT A

Asphalt Mixture Expert Task Group
Raleigh, North Carolina
April 29 to May 1, 2013
Meeting Agenda – Final Draft

Day 1 – April 30, 2013

8:00 am	Welcome and Introductions	**Fee/Bonaquist**
8:15 am	Review Agenda/Minutes Approval & Action Items September, 2012 Meeting	**Bukowski**
8:30 am	Subcommittee on Materials Updates/Comments	**Abadie**
9:00 am	Update Related NCHRP Activities	**Harrigan**
9:30 am	**Break**	
9:45 am	Report Task Force RAP/RAS • PP 53 RAS • Update of 9-46	**Gallivan**
11:00 am	Estimating the Effect of RAP/RAS Binder	**Hanz**
Noon	**Lunch – on your own**	
1:30 pm	Status IDT E* Ruggedness Study	**Kim**
2:30 pm	Proposed Standard for TSRST	**Hajj**
3:00 pm	**Break**	
3:30 pm	Progress on New ALF Experiment	**Gibson**
4:00 pm	Report Construction Task Force	**Ryan**
4:30 pm	**Adjourn for the Day**	

Day 2 – May 1, 2013

8:00 am	AMPT Test Development	
	• AMPT Pooled Fund ILS	**Nam**
	• Direct Tension Fatigue Standard (sVECD)	**Kim**
9:30 am	**Break**	
10:00 am	AMPT Test Development (continued)	
	• AMPT Flow Number Task Force Report	**Withee**
11:00 am	Task Force Review Update T-321 (Beam Fatigue)	**Rowe**
11:30 am	BBR Mix Testing Method	**Marasteanu/Dongre**
Noon	**Lunch – on your own**	
1:30 pm	Report Task Force WMA	**Corrigan**
2:00 pm	9-43 Follow-up Information on Absorptive Aggregates	B**onaquist**
2:30 pm	Status of 9-49 WMA Moisture Sensitivity Stud**y**	**Newcom**b
3:00 pm	**Break**	
3:15 pm	Workability and Field Compaction Temperatures	**Dongré**
3:45 pm	Action Items and Next Meeting Planning	**Fee/Bukowski**
4:00 pm	**Adjourn**	

ATTACHMENT B

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ATTACHMENT C

Task Force Members and Assignments
FHWA Asphalt Mixture & Construction ETG

Task Force Identification:		Members Assigned to Force:
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