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 55 individuals attended the meeting (17 members, 2 contract personnel, and 36 visitors). Attachment A is the meeting agenda, Attachment B includes a listing of the Mixture Expert Task Group (ETG) members, and Attachment C is a listing of the Mixture ETG Task Force members.

Members of the FHWA Asphalt Mixture ETG in attendance included:

Shane Buchanan, Old Castle Materials (Chairman)
Ray Bonaquist, Advanced Asphalt Technologies, LLC (Co-Chairman)
John Bukowski, FHWA (Secretary)
Christopher Abadie, (Liaison) AASHTO
Howard Anderson, UDOT
Adam Hand, Granite Construction, Inc.
James Musselman, FDOT
Timothy Ramirez, PA DOT
Kevin Hall, University of Arkansas
Gerry Huber, Heritage Research Group
Louay Mohammad, Louisiana State University
R. Michael Anderson, (Liaison) Asphalt Institute
Pamela Marks, (Liaison) Ministry of Transportation
Evan Rothblatt, (Liaison) AASHTO
Mark Buncher, (Liaison) Asphalt Institute
Edward Harrigan, (Liaison) NCHRP
Nam Tran, (Liaison) NCAT

Members of the ETG not in attendance:

Tom Bennert, Rutgers University
Jo Daniel, University of New Hampshire
Ervin Dukatz, Mathy Construction
Todd Lynn, Thunderhead Testing, LLC
David Newcomb, Texas A&M University
Audrey Copeland, (Liaison) NAPA

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

Haifang Wen, WSU
John Casola, Malvern
Lee Gallivan, Gallivan Consulting Inc.

Waseem Fazal, FHWA-Oklahoma
Jean-Paul Fort, COLAS USA
Todd Arnold, Pine Test Equipment, LLC
Dave Mensching, FHWA
Chris Parker, Silver Star Construction
Jeff Withee, FHWA
Tim Aschenbrener, FHWA/RC
Punith Shivaprasad, Shell Bitumen, US
Kevin VanFrank
Eshan Dave, University of New Hampshire
Salman Hakimzadeh, Asphalt Liquids
Hassan Tabatabaee, Cargill Industrial Specialties
Richard Steger, Invia Pavement Tech.
Marko Djukic, APAC Central
Zia Alavi, UC-Davis
Don Powell, San Joaquin Refining Co., Inc.
Al Palmer, Safety Kleen
Alexander Brown, Asphalt Institute
Mark Blow, Asphalt Institute
Danny Gierhart, Asphalt Institute
Tanya Nash, FDOT
Rick Holmgreen, Shell Oil Co.
Ali Regimand, Instrotek, Inc.
Bill Criqui, Ingevity
Kieran McGrane, IPC Global
Amir Golalipour, FHWA
Phillip Blakenship, Asphalt Institute
Gerald Reinke, Mathy Construction
Matthew Corrigan, FHWA
Nelson Gibson, FHWA
Andrew Hanz, Mathy Construction
Bob Kluttz, Kraton Polymers
John D'Angelo, D'Angelo Consulting

Meeting Coordinator: Lori Dalton (SME, Inc.)
Meeting Technical Report: Elie Y. Hajj, (University of Nevada, Reno)

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DAY 1: Wednesday, September 16, 2015

1. Call to Order

John Bukowski (FHWA) called the meeting to order at 1:05 PM.

2. Welcome and Introductions

Bukowski welcomed everyone to the meeting and asked everyone to introduce themselves. Bukowski announced that Shane Buchanan (Old Castle Materials) is the new co-chair for the Asphalt Mixture ETG in lieu of Frank Fee. He noted that Frank Fee co-chaired the ETG for 14 years and acknowledged his help over the years. Frank Fee will continue to be a friend of the ETG. Bukowski also noted that there have been some changes to the Asphalt Mixture ETG memberships. Because of limitations in funds, the number of state and academic members had to be reviewed and reduced. He thanked the past members for their efforts. He also acknowledged the continuous support and help from the friends of the ETG.

Lori Dalton noted the sign-up sheets are being distributed for the ETG members and a separate sign-in sheet for friends of the ETG. Bukowski announced that the meeting reports and the presentations are being posted on the NAPA website (www.asphaltetgs.org). Bukowski noted that for now only the last two meeting reports and presentations are posted but have the ability to go back and post older materials. Mark Buncher asked how long it will take to post the presentations from this meeting on the website. Bukowski responded that presentations will be posted shortly after the meeting; however the meeting minutes' reports require more work and take longer to post.

3. Review Agenda/Minutes Approval & Action Items, April 2015 Meeting. [John Bukowski, FHWA]

John Bukowski noted the technical report from the last meeting is posted online at www.asphaltetgs.org. Bukowski asked if there were any revisions or corrections to the technical report. No corrections or revisions were noted. Bukowski mentioned any corrections or revisions to the technical report should be sent to him.

Bukowski reviewed the Action Items from the April 2015 Asphalt Mixture ETG meeting. The following is a listing and status of the Action Items from the last meeting.

- Action Item #201504-1: Bukowski will send SOM (Abadie) suggested recommendations on the four Provisional Standards where FHWA is listed as steward (T342, PP60, PP61, and PP76).
  Update: Recommendations were submitted to AASHTO.
- Action Item #201504-2: Bukowski will send SOM (Abadie) a list of recommendations on the RAP/RAS sections for AASHTO M323 and AASHTO R35 along with a marked up copy of the standards.
  Update: Several recommendations, changes, and improvements were made and submitted to AASHTO. The two major recommendations were: (1) the binder ratio

term; and (2) the recommended two tiers method for RAP versus the current three tiers method.

- Action Item #201504-3: Jeff Withee will prepare the draft AASHTO provisional specification for the AMPT equipment and share with ETG members and friends for feedback and comments.
  Update: Item is on the agenda.
- Action Item 201504-4: The Asphalt Institute will share the performance test specimen fabrication report with ETG members and friends for feedback and comments.
  Update: Need an update from Mike Anderson (AI).
- Action Item 201504-5: The Bending Beam Fatigue task force led by Geoff Rowe will draft a white paper elaborating on the main issues and potential solutions for the beam fatigue test.
  Update: Item is on the agenda.
- Action Item 201504-6: Richard Kim will submit IDT specifications to the SOM (Abadie) on behalf of ETG for consideration and discussion.
  Update: Specifications were submitted to AASHTO.
- Action Item 201504-7: Members and friends of the ETG will email Copeland if they are interested in reviewing the GTR Best Practice Guide. Reviewers are asked to specify in the email which chapters they are interested in reviewing.
  Update: Nearing completion of the draft copy for the GTR Best Practice Guide. Volunteers are needed to review sections of interest from the draft report.

Bukowski mentioned that there is another high level group called the executives task group which is made up of four chief engineers, representatives of asphalt and concrete associations, and academics. The group discusses among others, several various strategic issues and funding issues. The group asked the Asphalt Mix ETG to look into some specific areas in further details and these will be discussed on Friday.

4. Oklahoma Update. [Kenneth Hobson, Oklahoma DOT]

Presentation Title: *Asphalt Mix ETG – Oklahoma Update, Kenneth Ray Hobson, Oklahoma DOT.*
Summary of Presentation:
Hobson welcomed everyone to Oklahoma and presented an outline of the topics to be covered in his presentation: REOB, Mix Fatigue (LTPP SPS-10 WMA), NCAT 2015 Cycle Sponsorship, HFST, Common Asphalt Spreadsheets, AASHTO T283 Change.

Hobson talked about testing on REOB mixtures: OHD L-55 Hamburg Rut Test, AASHTO T283, and Fatigue. He noted that while all their mixtures pass the Hamburg Rut Test and the AASHTO T283 test at the design stage, they have been observing 34% failure in TSR and 13% failure in Hamburg Rut Test for field-produced mixtures. Mix fatigue testing of REOB mixtures is being conducted at the University of Oklahoma and the research is close to being completed. Fatigue

testing includes AMPT, SCB (LTRC and Illinois method). The project was extended one year to complete the SCB testing for the LTPP SPS-10 project at Yukon, OK. The WMA mix design from the LTPP SPS-10 project resulted in a mixture that is 2% less dense; hence required a 0.5% higher optimum asphalt binder compared to the companion HMA mix (both mixes had the same aggregate source and gradation). The compaction temperature had to be raised from 235°F to 265°F in order to achieve required density.

Hobson provided an update on the high friction OGFSC Sec, No. 9 from the NCAT 2015 cycle. Preliminary results from the dynamic friction tester conducted by NCAT were presented. Hobson showed a picture from the NCAT test track and noted that mixture appeared acceptable during construction. He also showed a picture during construction of the HFST on I-40 west bound. He noted that Personal Protection Equipment (PPE) shown in the picture. Aggregate spreader was used, as mandated for this project.

Next, Hobson reviewed the Common Asphalt Spreadsheets for Hamburg (OHD L-55), Nuclear Density Correlation, PWL (3rd generation), F&T (Acceptance of Contractor Test Results), and Shot Record (LISST?). The R2 is required to be greater or equal to 0.50 for the nuclear density correlation with core data. For the nuclear density correlation, it is important to select diverse air voids locations and limit maximum air voids to 10%. OK DOT Requires 5 to 15 nuclear density measurements. First reading in the direction of travel and the second reading at 180 degrees. If readings are not close take additional two readings and average all four readings.

Hobson presented the anticipated changes to AASHTO T283. They recommend testing control and pre-conditioned specimens at the same temperature and the same day. This can help avoiding overtime hours and minimize variability by testing all specimens at the same time.

Hobson provided a link to the various excel spreadsheets:
http://www.ok.gov/odot/Doing_Business/Construction/Materials_&_Testing_e-uide/index.html.

5. **Subcommittee on Materials Updates/Comments. [Chris Abadie, Louisiana DOT – Liaison for the AASHTO Subcommittee on Materials]**

Presentation Title: *AASHTO Summer Meeting Summary, Technical Sections: 2c – Asphalt Aggregate Mixtures; 2d – Proportioning of Asphalt-Aggregate Mixtures, Chris Abadie, LDOT (Chair of TS 2d).*
Summary of Presentation:
Abadie provided an update from the August subcommittee on Material meeting in Pittsburg. He reported on the Technical Section (TS) 2c (Asphalt Aggregate Mixtures) and TS 2d (Proportioning of Asphalt Aggregate mixtures) under the Subcommittee of Materials (SOM). Abadie noted that no voting occurred on Richard Kim's procedure during the last meeting.

Abadie noted that anyone can make a request through him and become a friend of the committee. By becoming a friend of the committee it allows you to read all of the technical section ballots. As a friend you cannot vote on the AASHTO full ballot. Abadie invited those who are interested to be involved to become a friend of the committee.

Table 5.1 summarizes the completed and proposed Ballots for TS 2d. Abadie noted that he wasn't able to communicate with TS 2c on time for this meeting to check with the chair of what he would like to communicate with the ETG.

Table 5.1 Summary of AAHTO SOM 2d Ballot Review.

ACTION	COMMENTS	BALLOT STATUS
TP-xxx; Determining the Fracture Potential of Asphalt Mixtures Using Semicircular Bend Geometry (SCB) at Intermediate Temperatures	Provisional ballot introduced by Illinois.	Technical section votes: 35 votes for, no negatives. Proceed to full ballot in the near future.
TP-xxx; Determining the Flexural Creep Stiffness of Asphalt Mixtures Using the Bending Beam Rheometer (BBR)	Utah DOT is using the procedure with support from Minnesota DOT.	TS2d chair to post this procedure for TS ballot this fall with discussion of comments at Midyear webinar.
M323 Standard specification "Superpave Volumetric Mix Design"	Decision between three or two tier selection and terminology for binder replacement.	TS2d chair to post this procedure for TS ballot this fall with discussion of comments at Midyear webinar.
R35 Standard Practice "Superpave Volumetric Mix Design for Hot Mix Asphalt (HMA).		
R35 / T283	The mix conditioning requirement in R35 is not consistent with the T283 requirement for mix conditioning.	TS2d chair to post R35 procedure change to reference T283 as requirement for moisture sensitivity in R35. TS ballot this fall with discussion of comments at Midyear meeting.

Abadie noted the provisional procedures implemented during SHRP were for procedures that were not ready for full standards. Research provisional that will only be held at the technical section level were also proposed. The provisional standards were created for the same purpose and AASHTO is collectively moving to use provisional standards for that purpose.

Abadie noted that LTRC developed a SCB procedure that is being used by Louisianan DOT. However, the procedure has been adopted by ASTM and it has been agreed not to duplicate the effort between AASHTO and ASTM.

Abadie also presented the AASHTO aging protocol in T283-14 (Resistance to Induced Moisture), R30-15 (Mix Conditioning), R35-15 (Superpave Volumetric Design), and T312-15 (Preparing Asphalt Mix by SGC). Section 11 in R-35 refers to the R30 aging for evaluating moisture susceptibility. The mix conditioning requirement in R35 is not consistent with the T283 requirement for mix conditioning. The proposed change is to reference T283 as requirement for moisture sensitivity in R35. Ballot the technical section about the proposed changes. Abadie noted the need to able to test the specimens according to T283 in a timely manner.

Abadie mentioned that there is a task force to prepare changes to R68 "Preparation of Asphalt Mixtures by Means of Marshall Apparatus" to incorporate cold mix.

ETG Comments, Questions, and Discussion:
D'Angelo noted that the 4 hours aging at 135°C for mechanical property testing was established based on work done at the Asphalt Institute on modulus properties of asphalt mixtures while NCAT had 2 hours at mix temperature for volumetric properties. Distinct difference was observed between the 2 and 4 hours aging in terms of the binder stiffness. Timothy Ramirez commented that, according to the T283 procedure, the maximum theoretical specific gravity will also have to be conditioned following T283. Also there is a difference in aging in T283 for lab versus field-produced mixtures. Abadie mentioned the two proposed options for technical section ballot- Option 1: refer directly to T283 in R35; Option 2: delete any reference to T283 and write the aging requirement for R35.

Corrigan noted that this discussion has been on-going for two years. He asked why changes were made to T283 conditioning requirement. D'Angelo commented that the changes were based on the NCHRP 09-13 study done University of Nevada, Reno. Corrigan noted that agencies are using inconsistent aging procedures and consistency within AASHTO is necessary. Phil Blakenship commented that AI is leading the revision for the ASTM moisture sensitivity procedure and the recommendation was to use the 4 hours aging. A survey of the states showed that most of the states like T283 but not with the 16 hours aging.

Kluttz commented that there are a few research standards in TS 2b which are still in the research phase and not finalized yet as far as either practice of the procedure or data production. However, once it gets into AASHTO it is locked in for a minimum of a year before there is any mechanism for changes or updates; hence no further development of the test method during that period. Abadie commented that the technical section chair has the ability to post changes as they are received and approved by ballots. By becoming a friend of the committee allows you to provide changes. D'Angelo commented that the subcommittee ballot is only once a year, hence it will take a full year for a change to be included. Abadie responded that a change in the process will take some time and he would like to foster the ability to make changed faster. Kluttz noted that ASTM can change every 6 months. Corrigan noted that AASHTO changed their balloting system to a rolling ballot. Rothblatt noted that it will still be annual but it will break it into two separate groups.

Musselman commented that the AASHTO method needs to evolve as it seems very cumbersome particularly with respect to the provisional standards. FDOT has developmental specifications which are effective immediately without the need to go out for review. Currently any changes to provisional standards would take about 20 months being published. Musselman asked why we can't have provisional standards with the same topic (example SCB test). Richard Steger commented that he is chairing the committee under which the SCB from LTRC is being balloted. The ballot closed today with some negatives. He noted that there is an agreement between ASTM and ASSHTO not to work on the same thing to avoid duplication of effort.

Once ballots are closed, the ones approved should be published in July and will not necessarily be a 20 months cycle. The technical section ballots may happen any time in the year, but the full

subcommittee ballot will happen once a year. And a standard is not published until the full subcommittee ballot. Rothblatt noted that this would be the last year where AASHTO will publish both hard copies along with electronic copies. Abadie noted that the technical section and SOM relies on what is happening at the ETGs and he acknowledged the ETG group effort.

6. Update on Related NCHRP Activities. [Edward Harrigan, NCHRP]

Presentation Title: *NCHRP, FHWA Mixtures and Construction Expert Task Group Meeting, September 2015, Edward Harrigan, NCHRP.*
Summary of Presentation:
Edward Harrigan reported on the progress of the NCHRP projects which are of interest to ETG group and specifically those that are nearing completion. The topics in the presentation were divided into three separate parts: Warm Mix Asphalt, Materials and Mix Design, and Pavements. Harrigan noted that WMA is becoming so accepted that it is probably no need in the future to segregate NCHRP projects.

Part I: Warm Mix Asphalt

- NCHRP 09-49A: "Performance of WMA Technologies: Stage II-Long-Term Field Performance," Washington State University (July 2016). Long-term (> 4 years) field performance. To date, still no significant differences between the properties and field performance of WMA and HMA.
- NCHRP 09-53: "Properties of Foamed Asphalt for Warm Mix Asphalt Applications," Texas A&M Transportation Institute (Completed, NCHRP report 807). Foaming behavior influenced by crude oil slate, refinery production date, and polymer modification. Mix design method determines optimum asphalt content based on coatability and workability. Best coatability and workability at 1-2% water content (noted that sometime field production goes up to 5-6% water content).
- NCHRP 09-55: "Recycled Asphalt Shingles in Asphalt Mixtures with Warm Mix Asphalt Technologies," National Center for Asphalt Technology (September 16). Develop a design and evaluation procedure for acceptable performance of asphalt mixtures incorporating WMA technologies and RAS, with and without RAP, for project-specific service conditions. Testing and analysis of field specimens in progress.

Part II: Materials and Mix Design

- NCHRP 09-48: "Field versus Laboratory Volumetrics and Mechanical Properties," Louisiana Transportation Research Center (December 2015). The objective of this study is to determine sources of variability for volumetric and mechanical properties of asphalt mixtures among LMLC, PMLC, and PMFC specimens. Process-based factors were only significant between laboratory-mixed specimens and plant-produced specimens for air voids (stockpile moisture) and binder content and P200 (return of baghouse fines). No significant effects on differences among specimen types for VMA, VFA, G_{mm}, and G_{sb}. No significant impact on the differences of mechanistic properties among the three specimen types. Draft final report is currently under review.
- NCHRP 09-52: "Short-Term Laboratory Conditioning of Asphalt Mixtures," Texas A&M Transportation Institute (Completed). Effects of plant mixing and processing to the

point of loading in the transport truck: 2 h aging at 275°F for HMA or 240°F for WMA. Findings confirm the results that came out of NCHRP 09-49 which is also done by A&M. The five days at 85°C simulated 1-2 year of initial service depending on where the project is located (climate). WMA and HMA became equivalent in about 17 to 30 months. Changes were proposed to AASHTO R 30 based on the results of the project. NCHRP Report 815 in the process to be published.

- NCHRP 09-54: "Long-Term Aging of Asphalt Mixtures for Performance Testing and Prediction," North Carolina State University (May 2016). The objective of this study is to develop a laboratory procedure to simulate long-term aging of asphalt mixtures for performance testing and prediction. Correlate rheology and kinetics of binders aged in the laboratory and long-term in the field, including ARC, MnRoad, FHWA-ALF, WesTrack, and LTPP SPS-1 and SPS-8. The 5 days at 85°C equivalent to about 1-2 year field aging supporting 09-52 finding on AASHTO R30. The panel agreed to look at higher temperatures and longer times for laboratory aging to target about 10 years in the field.
- NCHRP 09-59: "Relating Asphalt Binder Fatigue Properties to Asphalt Mixture Fatigue Performance," Advanced Asphalt Technologies with collaboration with NCAT (October 2017). Determine asphalt binder properties that are significant indicators of the fatigue performance of asphalt mixtures. Identify or develop a practical, implementable binder test (or tests) to measure properties that are significant indicators of mixture fatigue performance.
- NCHRP 09-60: "The Impacts on Pavement Performance from Changes in Asphalt Production," New Project. Propose changes to the current PG asphalt binder specifications and test methods to remedy shortcomings related to incidents of premature failure of asphalt pavements. FY 2016, $1.0M. Panel meets 5-6 November.

Part III: Pavements

- NCHRP 01-54: "Guidelines for limiting Damage to Flexible and Composite Pavements Due to the Presence of Water," Applied Pavement Technology, Inc. (August 2016). The objective of this study is to develop guidelines for practicing engineers on how to reduce or limit damage due to water while considering pavement structure, roadway geometry, climate, materials, and construction and maintenance practices. Print and software products.
- 20-07/Task 382: "Longer Pavement Life from Increased In-Place Density of Asphalt Pavements," Dale S. Decker, LLC (September 2016). Summarize the current state of knowledge of in-place density of asphalt pavements as well as the current practices of agencies regarding how in-place density is measured and specified.
- NCHRP 20-05: "Synthesis of Information Related to Highway Problems." Objective is to search for and synthesize useful knowledge from all available sources and prepare concise, documented reports on specific topics. Provide a compendium of the best knowledge available on practical measures found to be the most successful in resolving specific problems. These reports have the biggest audience.
    - 456: Non-Nuclear Methods for Compaction Control of Unbound Materials

  - 457: Implementation of the AASHTO Mechanistic-Empirical Pavement Design Guide and Software
  - 463: Pavement Patching Practices
  - 464: Thin Asphalt Concrete Overlays
  - 456: Non-Nuclear Methods for Compaction Control of Unbound Materials
- NCHRP 20-44: "Accelerating the Application of NCHRP Research Results." Currently no mechanism for implementation of research results. Standing committee on research put a lot of emphasis moving forward trying to implement findings from research projects. Harrigan mentioned that ETGs are great method for research results in the asphalt area being put into practice. However, that is not available for other areas in NCHRP. Standing committee on research decided to increase budget for Project 20-44 (FY 2016, $2.0M). Form Project 20-44 panel to review funding requests from research project panels. Provide implementation specialist on NCHRP staff.
  - Dissemination (FY 2016, $0.5M). Targeted publications: Research Makes a Difference, Impacts on Practice, and Paths to Practice, NCHRP Research in Brief. State DOT CEO and specialist staff briefings. Subject matter compilations. Targeted report distribution. Tracking impacts and benefits of completed research. Webinar support
  - Development Assistance Program (FY 2016, $1.5M). Workshops and training programs. Demonstration projects. Pilot projects. Field validation. 1st article products. Manufacturer support.

Harrigan provided the link to the NCHRP website (http://www.trb.org/NCHRP) where the various on-going and completed projects can be found along with associated documents and reports. Harrigan noted that they rebranded to the National Academies of Science, Engineering, and Medicine.

ETG Comments, Questions, and Discussion:

Huber asked whether as part of NCHRP 09-53 a recommendation was made about the need to do foaming in laboratory as part of the mix design. Harrigan responded that it was not observed to be necessary. He also noted that there is a number of different machine foaming apparatus and some of them do give different results. It is a good way to characterize foam for an asphalt material but it was not found necessary for mix design.

Mohammad commented that, under NCHRP 09-48, there was a difference between the three specimen types (LMLC, PMLC, and PMFC) for a given factor. Thereby the study offered a conversion factor between all three specimen types. All was based on 11 field projects. Mohammad mentioned that in general laboratory tends to give higher values than field specimens. Many states don't require mechanical testing for acceptance and once the states do, the calibration factors becomes important.

Hand commented that most of mixes in NCHRP 09-52 had recycled material while SHRP work (A003) did not have any recycling materials; Hence the reason for issues with long-term aging (i.e., the five days at 85°C simulates only 1-2 year). Harrigan commented that the work from A003 also had a lot more data scatter compared to the 9-52 work. West asked whether the study

looked into how to handle the RAP material during mix design (heated or not heated RAP). Tran commented that the 240°F aging is only for chemical additives while the foam aging temperature is 275°F. He also mentioned that RAP was heated using the regular procedure used in the past with the LMLC specimens. Howard Anderson asked what test was used to determine the 2 hours aging. Harrigan responded that all findings were based on resilient modulus test. Harrigan noted that the original SHRP work at Oregon is also based on resilient modulus. Hall asked whether there is a recommendation section in the report on how to implement the findings. Harrigan responded that there are recommendations on how to change/modify AASHTO R30. Buchanan commented that contractors are doing a lot of foaming at hot mix temperature.

Action Item #201509-1. Ed Harrigan will provide, for distribution to the ETG, a copy of the final draft report from the NCHRP Project 9-52, "Short-Term Laboratory Conditioning of Asphalt Mixtures". Each member is to review for potential implementation and effects on existing standards such as AASHTO R30.

7. Overview Mobile Lab Project WI STH 73. [Matthew Corrigan, FHWA]

Presentation Title: *Evaluation of Hot Mix Asphalt (HMA) Mixtures with High Content Recycled Materials Using the AMPT Cyclic Fatigue Test (Part A) – Mobile Asphalt Testing Trailer WII4100, Matthew Corrigan, FHWA*

Summary of Presentation:

Corrigan acknowledged the mobile asphalt demonstration project team including Chuck Paugh (ESCINC), Eyoab Zegeye Teshale (ESCINC), and Nelson Gibson from FHWA. He also noted that Amir Golalipour is a new addition to the team.

The objective of the project in Wisconsin was to assess the feasibility of increasing the content of recycled materials in HMA mixtures, without deteriorating the performance properties of the mixes. The state agency project location is STH-73, Pierce Rd (Edgerton) to Fadness Rd (Deerfield). The scope expanded significantly from 5 mix designs originally to 5 mix designs for surface layer (NMAS 12.5 mm) and 7 mix designs for base layer (NMAS 19.0 mm). Project consisted of 12 miles with different sections with various RBR (different combinations of RAP and RAS), different binder grades and modification, and one section with SonneWarmix additive as a rejuvenator. The FHWA mobile lab was setup at the plant to avoid reheating the plant produced material prior to testing. The AMPT based performance testing consisted of dynamic modulus for stiffness, cyclic fatigue test (AASHTO TP107-14) for cracking, and flow number for rutting. Three different oven conditioning criteria of compacted test specimens were conducted (no oven conditioning, 5 days at 85°C, and 10 days at 85°C). The 10 days of aging revealed issues with the mixtures not seen in the 5 days aging. Work is still undergoing to finalize the analysis of the cyclic fatigue data.

Corrigan provided a background to why FHWA has been working with the cyclic fatigue test using the AMPT. FHWA started working with prototype methodologies in 2005. Corrigan noted that the cyclic fatigue theory goes back to the aerospace industry application for solid rocket propellant (asphalt and rubber were used as mechanism for rocket propellant). The asphalt industry is in need for a performance test that could be defensible and not based on empirical

correlations. Furthermore, he noted that the use of AMPT cyclic fatigue utilizes the investment in AMPTs for the MEPDG and the fact that the AMPT can do much more than dynamic modulus.

Corrigan discussed the testing similarity to that of testing rocket propellant. Fracture mechanism was very critical for solid rocket propellant. S-VECD is based on the early work for solid rocket propellant. Corrigan highlighted the S. R. Swanson paper on the "*Application of Schapery's Theory of Viscoelastic Fracture to Solid Propellant*" Journal of Spacecraft and Rockets, Vol. 13, No. 9 (*1976*), pp. 528-533. Richard Schapery's theories provided the foundation for asphalt viscoelastic continuum damage (VECD) using AMPT cyclic fatigue, and continuing with Kim, Y.R., and Little, D.N paper, *One-dimensional Constitutive Modeling of Asphalt Concrete*, ASCE J. Eng. Mech. 116(4), 751–772 (1990). The AASHTO TP107-14 is the result of work over multiple years since 1990. The AMPT cyclic fatigue test resulted in unified/common AMPT equipment specification criteria and a unified/common compaction control with the gyratory compactor. The extended time-temperature superposition (i.e., shift factors for |E*| vs. temperature are the same for explaining fatigue damage vs. temperature) lead to less amount of testing and time. Corrigan noted that the uniaxial stress state is uniform not like a bending/flexural stress which is different throughout the specimen and the strains are measured on the specimen rather than a beam deflection, avoiding end effects and other effects.

Corrigan presented some benefits to the AMPT cyclic fatigue test such as: response under different strains, structure/traffic; response under different load rates, response under different temperature. More information gained than from a single test at a single rate/temperature. The test connects mix design and construction by means of distress and performance prediction and is not just a pass/fail test.

The test specimen fabrication for the cyclic fatigue test is very similar to the E* test with the specimen being slightly shorter (100 mm x 150 mm for E* and FN versus 100 mm x 130 mm for cyclic fatigue). It is important to core the test specimen out of the center of gyratory compacted sample and it is recommended not to make a shorter specimen for cyclic fatigue (both E* and cyclic fatigue compacted to 180 mm but more end material is cut out of the cyclic fatigue specimen). Different platens are used in the equipment to make up for the difference in height. In PP60 "Preparation of Cylindrical Performance Test Specimens Using the Superpave Gyratory Compactor," a statistical hypothesis test is conducted to determine the significance of the difference in the mean G_{mb} of the top and bottom slices relative to the middle third. For the sample sizes specified, the absolute value of the test statistic must be less than 2.78 to conclude that the G_{mb} of the top and middle slices are equal.

Corrigan reviewed the platens gluing procedure for the cyclic fatigue test specimen. It is possible to glue two specimens in one day with one gluing jig. Glue requires minimum of 4 hour set time but overnight is better. A separate temperature controlled bath (water) or environmental chamber (air) are used to precondition specimens before testing (do not want to use AMPT equipment for conditioning). You need to use a calibrated thermometer to check the embedded thermocouple in a dummy specimen to determine set-point offsets. Running the thermocouple wire for the dummy specimen out the seal of the AMPT chamber is not ideal because it pinches and frays the cord. Putting the thermocouple reader inside the chamber is acceptable but need to ensure that a

high quality reader is used that has a cold junction compensation. Corrigan noted that newer AMPTs have a port inside the chamber.

Corrigan provided the link for the FHWA instructional videos:
(https://www.youtube.com/playlist?list=PLyLypK-v8li-KjQq-Z6lmad4v2o_LcR3b)

ETG Comments, Questions, and Discussion:
Kluttz commented that different results are observed between beam fatigue testing and AMPT fatigue testing. He also asked whether anyone looking at cutting AMPT specimens out of slab. Corrigan responded that the difference in results also influenced by the uniform stress condition in the AMPT geometry versus the flexural stress which is different everywhere in the beam specimen.

Buchanan asked about the time to complete the test from start to finish (including specimen prep, conditioning, and testing). Corrigan responded that for one specimen it will probably be two days total. He noted that the testing itself goes quickly but need to allow for curing of platens after applying the epoxy. Musselman commented that while he likes the test, from the state perspective the time required to complete the test might not be practical other than occasionally using it as a research tool. Corrigan that if the goal is to have something quick during production and as a go/no go during production, this test is not quick in order to accomplish that. If you want to truly understand the materials pavement performance and how it impacts distresses this is a best test to do it.

West asked whether it is necessary to run the dynamic modulus first in order to get the strain levels. Corrigan responded that there is a dynamic modulus finger printing that is done as part of the testing protocol/machine configuration. Nam Tran mentioned that you still need E* master curve data to get the shifting parameters.

Kluttz asked how the AMPT cyclic fatigue does compare to the TTI Overlay Tester under the same mix and conditioning. Corrigan responded that FHWA does not have the data and is not running the TTI Overlay because you don't get all the information needed to understand the material being tested.

Blakenship mentioned that during the AI study on cracking tests the AMPT cyclic fatigue test on specimens was aged for 24 hours did not show good correlations. He followed up with Richard Kim on the matter and it seemed that the test was not meant to be performed on specimens aged only for 24 hours but rather for the 5 days aging. The 24 hours aging samples were breaking at the ends. Corrigan noted that the use of shorter specimens took care of the vast majority of the end break issues and most are in the middle zone. Mohammad commented that based on their experience you will need to prepare six specimens because you might get damage on the E* specimens. Corrigan responded that part of the deformation of E* has been resolved by using the recommendations for testing temperature in the test procedure.

8. REOB Status – AI/AASHTO. [Matthew Corrigan, FHWA and Mike Anderson, AI]

Presentation Title: *Recycled Engine Oil Bottoms (REOB) Status – AI/AASHTO, Mathew Corrigan, FHWA, and Mark Buncher, Asphalt Institute*
Summary of Presentation:
Corrigan noted that Bill Ahern of the Maine DOT prepared recommendations on REOB for the Subcommittee on Materials (SOM) on the following items:

- Past, current and upcoming research efforts regarding the use of REOB in asphalt pavements, including the scope and timing of the research;
- The status of the utilization of REOB in liquid asphalt nationwide including knowledge of presence, pertinent specifications pertaining to its use and existing certification or testing requirements if REOB is allowed;
- Best practices for the identifying the presence and amounts of REOB in asphalt pavements;
- Recommended additional research necessary to fully evaluate the allowance of REOB into asphalt pavement treatments, or mitigation of its use if necessary; and
- A preliminary risk assessment of member States' asphalt binder specification and associated recommendations

In summary, the recommendation to the SOM that also went to the AASHTO Standing Committee on Highways (SCOH) was that there is not enough information to conclude that REOB is whether REOB should or should not be used. However, because of the unknowns and the lack of information many states believe that it is a high risk to continue the use of REOB. There is not yet a final response from the SCOH.

Mark Buncher followed with an update on the AI's REOB Task Force. He noted that there is a bigger issue than just the use of REOB in asphalt binder. This discussion has highlighted the need to better characterizing of asphalt binders in relation to the proper laboratory aging conditions.

Mark Buncher noted that Asphalt Institute supports the responsible modification of asphalt materials for improved performance and better life cycle costs, but does not endorse any specific material or proprietary form of modification. AI does not currently have any official guidance on REOB. In the past AI had information, guidance and studies on other type of modifications (PPA, SEA, and PMA). The REOB task force was formed in August 2014 to develop an Informational Series (IS) document on REOB modification. Buncher acknowledged the members of the AI task force: John Brownie - Chair, Mike Anderson, Sandy Brown, Mark Buncher, Greg Harder, Paul Sohi, Gaylon Baumgardner, Everett Crews, Kevin Hardin, Edgard Hitti, Mark Homer, Gerald Reinke, Bob Hockman, Laurand Lewandowski, Tony Kriech, and Matt Corrigan (FHWA).

Buncher mentioned that the last face-to-face meeting was August 20 in Lake Tahoe, Nevada, and another meeting is scheduled for September 29-30 in Lexington, KY with the purpose of reviewing the first draft of the REOB document. A web meeting was also held on September 10. Buncher stated that the goal is to publish the IS document by May of 2016. He noted that AI is maintaining a public repository of REOB information (http://www.asphaltinstitute.org/re-

refined-engine-oil-bottom-residue/) currently including: sixteen published papers and reports, twenty presentations at public industry meetings, and four REOB manufacturers information.

Buncher next presented the outline of the draft REOB document which consists of six parts: General Overview and Intent of Informational Document; REOB Production and Manufacturing; Material Characteristics and Composition; Literature Review of REOB in Asphalt and Performance; HSE Aspects; Considerations for an Improved Binder Specification (led by Gerry Reinke); and Frequently Asked Questions by Agencies and Answers (led by Matthew Corrigan). Buncher noted that the task force reached out to the National Oil Recycles Association (NORA) (www.noranews.org) for the Health, Safety and Environmental (HSE) aspects.

Buncher presented a schematic slide from Safety-Kleen, one of the leading suppliers of REOB in USA, on REOB manufacturing process. He also presented a schematic diagram from the AASHTO SOM *Recycled Engine Oil Report* to SOM in August 2015 on how to extract REOB from used oil. He also highlighted we are dealing with a very wide range of materials and properties and that REOB is a refined product with many options on its manufacture and characteristics.

A summary of the literature review was presented along with the key findings from the various reviewed publications.

- Sixteen research papers reviewed (performance):
  - All published and/or peer reviewed
  - One in 1993, others from 2009-2015
  - Listed on AI's REOB webpage
  - Authors include academia, consultants, REOB manufacturers, state agencies
  - REOB dosages varied: 5-20%
  - Often very little material characterization of REOB

- Seven papers suggest the use of REOB is detrimental to pavement performance.
- Seven papers suggest the use of REOB is not detrimental and may enhance pavement performance.
- Two papers looked at waste engine oil (not re-refined):
  - One was favorable when used with 100% RAP.
  - One was generally not favorable.

Buncher noted that many names were encountered in the literature for REOB, some are summarized below. He mentioned that REOB term prevalently used by highway agencies while the VTAE term prevalently used by manufacturers

- Re-refined Vacuum Tower Bottoms (RVTB) – Heritage Research Group, 2014.
- Waste Engine Oil Residue (WEOR), Waste Engine Oil (WEO) Residue, Engine Oil Residue (EOR) – Simon Hesp (Queens University).
- Waste Oil Distillation Bottoms (WODB) – Herrington (1993).
- Re-refined Heavy Vacuum Distillation Oil (RHVDO), Re-refined Heavy Vacuum Distillate Bottoms (RHVDB) – John D'Angelo.
- Asphalt Flux, Asphalt Extender, Asphalt Blowdown, Vacuum Tower Asphalt Binder (VTAB), Others, Now VTAE – National Oil Recyclers Association (NORA).

Buncher also presented an update from the industry (ASTM, NEAUPG, ETG, and AASHTO). He mentioned that NORA has developed two draft ASTM specifications on VTAE: one for Roofing and one for Paving. The draft specifications are available on NORA's website and were discussed at the June, 2015 ASTM meeting. He noted that the specification development and ballot process is expected to take approximately 18 months. VTAE is defined as the product of processing used oil using atmospheric distillation followed by vacuum distillation to produce a vacuum residuum meeting certain specifications, which include: flash point, mass change, solubility in TCE, and viscosity (maximum viscosity of 5000 cP at 140°F but no minimum is specified). Also specified that VTAE shall be homogenous, free from water, not foam when heated to 350º F.

Buncher presented a summary update on the North East Asphalt User Producers Group (NEAUPG) efforts. He mentioned that a new document had been developed and approved by the NEAUPG requiring all non-bituminous components added to an asphalt binder to be identified. He noted that it was unclear if all NEAUPG States will require this disclosure; however, many have indicated they would. Reporting shall be as follows:

- Any non-bituminous components added prior to the point where samples are taken for certification purposes must appear on the Certificate of Analysis (COA).
- Any non-bituminous components added after the certification sample point but prior to transport must appear on the bill of lading.
- Any non-bituminous components added at the HMA plant must appear on the HMA producer's documentation.
- The reporting of all non-bituminous components shall only disclose their presence and shall not disclose their dosage as this is considered proprietary.
- Any "special handling" requirements shall be on the bill of lading.
- A representative material list was developed but is not considered as all-inclusive but provides some examples of the different types of non-bituminous components.

Buncher mentioned that the Asphalt Binder ETG has formed a task group on REOB, led by Geoff Rowe. This Asphalt Binder ETG group was asked to summarize information presented at the April 2015 ETG, including how to use Glover-Rowe (G-R) parameters to evaluate REOB, and provide recommendations.

In response to the REOB issue the NCHRP 09-60 project has been funded at one million dollars and the project expert panel has been formed. Buncher also presented the AASHTO report on the status of use of REOB. Approximately half the states are receiving REOB modified binders (AASHTO Survey showed 20 of 43 States; FHWA detection testing showed 18 of 37 States). He noted that most states consider REOB a modifier of asphalt binder and industry has not uniformly reported the REOB when used as a modifier.

Buncher concluded his presentation by stating that the planned AI publication is modeled after AI's PPA Informational Series (IS-220) with the intent to help agencies make informed decisions. Buncher mentioned that until then, AI has no official position on REOB

Bonaquist adjourned the meeting at 5:00 PM.

DAY 2: Thursday, September 17, 2015

9. Call to Order

Shane Buchanan (Old Castle Materials) called the meeting to order at 8:00 AM.

10. Overview of Performance Tests. [Jeff Withee, FHWA]

Jeff Withee presented an update on the AMPT related AASHTO standards: AMPT Equipment Specification (proposed), TP 79 Modulus and Flow Number Testing, TP 107 Direct Tension Cyclic Fatigue, and TP 116 iRLPD. The AMPT Equipment Specification is based on a NCHRP equipment specification that was produced under Project 09-29. He also noted that Ray Bonaquist worked on and helped with the draft AASHTO Provisional Specification (MP-XX). A commentary was added by Bonaquist to provide further clarification in the draft AASHTO.

Withee noted that originally the NCHRP project covered TP 79, Dynamic Modulus and Flow Number. The new equipment description linked to TP 107 (direct tension cyclic fatigue) and TP 116 (iRLPD). The direct tension loading consideration was added since the original equipment requirement and the calibration aspect were developed for dynamic modulus and flow number which compression only tests. Whereas the direct tension cyclic fatigue has a tension side loading. Neither the NCHRP equipment specification nor TP 107 specifically addresses any sort of machine requirement for the actuator going through zero or calibration on the tension side of loading. Effort was made to include these two aspects in the proposed equipment specification. It is mentioned that equipment manufacturers have worked with users and developers of the test to get those things right but it doesn't include specifically what it needs to be there. Withee also referred to Bonaquist discussion in terms of how the specimen is fixed within the AMPT TP 107 in which there is reference to the locking ball on the top and the need based on specimen eccentricity. Withee requested user input.

Withee next discussed the revisions for TP 79. Given that there are now separate procedures for direct cyclic fatigue and iRLP, E* and FN procedures need to be separated; especially since they cover different properties/uses. A standalone E* procedure has been drafted based on TP 79 and the same will be done for the FN. Currently, efforts are underway to include the analysis computations for E* and FN. The calibration element in the current TP 79 will be maintained in the proposed equipment specification.

Withee noted that it doesn't appear to be any major impacts on TP 116 - Rutting Resistance of Asphalt Mixtures using Incremental Repeated Load Permanent Deformation (IRLPD) (SOM steward – VT). He welcomed input and feedback from users of TP 116 on whether there is any impact for the recommended changes on the iRLPD procedure. Abadie identified that the specification steward within the SOM are Texas for TP 107 and Vermont for TP 116.

ETG Comments, Questions, and Discussion:

Mohammad noted that there are other methods that are not AASHTO standards which use the AMPT such as Texas Overlay and SCB. Withee responded that FHWA is certainly open for whoever is interested in putting a draft standard on any of these tests and that was a reason why

it is recommended to split E* and FN. Withee noted that need to make ensure the AMPT equipment specification is broad enough to be able to accommodate such tests. The main focus was the need for a standalone document which is the equipment standard. Withee encouraged feedback on the AMPT specification in order to include any aspects that equipment specification needs to include such as the relation to performing the Texas Overlay test.

Withee mentioned that Bonaquist has been working on drafting the equipment specification, and anticipates distributing to ETG members and manufacturers for review in the next few weeks. Withee also encouraged those who are interested in reviewing the documents to contact him to be included on the list of reviewers. He noted that there will also be another opportunity for States and ETG friends to comment on the proposed procedures when they are submitted to the AASHTO SOM.

Withee proposed having a group of interested individuals review and resolve comments. Accordingly a final draft is anticipated to be ready by the next ETG meeting in the spring.

Abadie suggested including champions from other states. He also recommended having the test developers involved. Bonaquist noted that E* and FN tests received a lot of comments from users however TP 107 and TP 116 have had limited use and he encouraged anyone who is using these tests to put together their experience and highlight areas with problems. Bonaquist noted that during the development of the equipment specification some inconsistencies were noted between theses test methods. Beside the NCSU group, the FHWA mobile lab team has the largest amount of experience with the direct cyclic fatigue test. Bonaquist encouraged everyone to bring their experience to the draft provisional standard and if their experience doesn't fit with what is written in the provisional standard don't just change your procedure but let everybody else know.

Action Item(s)
Action Item #201509-2. Input is requested to be sent to Jeff Withee on the draft AMPT equipment specification standard.

10.1. NCAT Activity, Nam Tran and Randy West (NCAT)

Presentation Title:
Update on Results of Simple Durability Tests on Mixes from the FHWA ALF Experiment and Plans for the MnROAD-NCAT Partnership to Validate Cracking Tests, Randy West (NCAT)

Summary of Presentation:
West presented an update on the results of simple durability tests on mixes from the FHWA ALF experiment. A flow chart for the performance test development was provided. West noted there are several steps that need to be accomplished.

The study focused on the evaluation of simple mix tests to assess cracking resistance. The objective is to determine if results of selected tests correlate with observed cracking performance using 10 mixtures from the 2013 FHWA ALF experiment. Cracking tests selected that are reasonably quick to conduct and could possibly be used for mix design and QA testing.

Additionally the effort is to evaluate the repeatability of the test and whether it can distinguish the performance among the various mixtures.

West reviewed the FHWA ALF facility and noted that FHWA is approaching the end of testing for this ALF experiment. Ten lanes are being tested with the variables on WMA and RAP, RAS, virgin binder grade, and production temperature. West noted it is not a full factorial experiment. All lanes were built to a target a 4 inch asphalt layer thickness on top of a 22 inch thick aggregate base. Testing started in fall 2013 and is planned to be completed in December 2015. The test temperature is controlled at 20°C at 20 mm depth from the pavement surface. The ALF cracking (cumulative crack length) as a function ALF passes was presented for the already tested lanes. Lanes 5 (40% ABR RAP PG64-22), 3 (20% ABR RAS PG64-22), and 11 (40% ABR RAP PG58-28 Evotherm WMA) performed the worst thus far. The best performing thus far was Lane 1 (0% ABR Control PG64-22). West presented the as-built versus perfect construction for asphalt and base thicknesses.

The test conducted as part of this study are Cantabro (ASTM D7064-08), SCB (LTRC method), IDT (NCAT-2 inch/min loading rate), and Overlay Tester (Tex-248-F modified by NCAT). Test specimens were made from SGC samples compacted to N_{design} (65 gyrations). Using N_{design} specimens provides the quickest and simplest path to implementation for any of these durability "performance" tests. Sealed buckets of mix were reheated, weighed, and brought to the compaction temperature before SGC compaction.

For each of the four evaluated tests, West presented the test procedure, the laboratory test results along with a statistical groupings, and the test results versus both the ALF passes to first crack and the ALF passes to 20 feet of cracking. The Cantabro had a COV of 19%. Not a good correlation was observed between test results and ALF results. The failure in the modified overlay test was defined as peak of normalized load times cycle. The overlay test was conducted in the AMPT at 25°C using triplicates. The overlay test had a COV of 32%. One of the mixtures had a large variation and ranked the best. Even if the triplicate with 13,687 cycles was excluded the mix will still outperform other mixtures. No correlation was observed between the overlay test and ALF cracking.

The SCB test was conducted on 50 mm thick specimens so that four specimens could be obtained from a gyratory sample. Notch depths of 38.1, 31.8, and 25.4 mm were used and triplicates specimens were tested at each of the notch lengths. The key parameter from the SCB test is the J-integral which is the slope of the line between area to peak load and specimen notch length. Hence, the statistical comparison is limited as every specimen had one J-integral. Accordingly, the area to peak load was compared among the various mixtures using Maghsoodloo's statistical groupings. The average COV for area to peak load was 27%. The only mixture that was different from the virgin mix was the 40% RAP. No correlation was observed between the SCB-LTRC Jc and the ALF passes to 20 feet of cracking. The results from the IDT fracture energy were presented. No statistical significant difference was observed between the IDT fracture energy of the evaluated mixtures. No correlation was observed between the IDT fracture energy and the ALF passes to 20 feet of cracking. The IDT data was also analyzed following the Illinois approach used for the SCB test. The Nflex factor is defined by the area under the stress and estimated horizontal strain to post peak inflection point divided by slope at

that point. The Nflex factor resulted in a good laboratory sorting of the mixtures with a COV of 11%. Still not a good correlation was observed between the IDT-Nflex and the ALF passes to 20 feet of cracking.

West mentioned that the performance of the ALF sections is confounded by variations in thickness, base stiffness, and age at testing. The ALF mixes were ranked very differently by the five tests used in this study. The Overlay Test and the SCB test had poor repeatability. The Nflex factor, Cantabro loss and the SCB J-integral were able to statistically differentiate the virgin mix from some other mixes.

Remaining efforts include; 1) obtain cracking performance of the remaining ALF lanes and analyze correlations between lab and field results; 2) determine if there is a way to account for variations in layer thicknesses and base moduli; and 3) prepare a final report.

The second part of West presentation was on NCAT+MnROAD cracking group experiments. The project objective is to validate laboratory cracking tests by establishing correlations between the test results and measured cracking in real pavements (test sections). The goal is to evaluate various tests based on criteria related to field performance; practicality of the tests for mix design verification and quality control testing; the ability to accommodate recycled materials, new and future additives, mix combinations; and cost-effectiveness. There are a total of eleven sponsors including FHWA. Seven sections have already been constructed on the NCAT test track and all are instrumented. The sections are designated top-down cracking sections. This is achieved by limiting the cracking to the surface layer. Overall asphalt layer thickness is 6 inch. Based on previous experience it is expected to crack within 2 years of traffic cycles. Trafficking is planned to begin October 1st. A wide range of tests will be conducted on both LMLC and PMLC and at aged and unaged conditions (SCB-LA, SCB-IL, OT-TX, OT-NCAT, Energy Ratio, Nflex Factor, and Cantabro). No testing on cores will be conducted. It is planned to complete the experiment within 3 year cycle. The laboratory aging procedure is yet to be determined. The mixtures for the seven test sections were designed with the intent of having some that are better and some that are worse than the control mix.

West followed with the discussion of the MnROAD-Cracking Group experiment. Work plan has been developed, mainline cells have been identified and there is a plan to reconstruct cells. Nine sections are proposed with varying ranges of fracture energy and binder replacement. The types of cracking to be investigated are low temperature, top down, and fatigue. The following are the planned post-construction testing:

- Low temp: SCB-IL, DCT-MN, SCB-MN
- Top down, fatigue: Overlay Tester, BB Fatigue
- ME Design: E*
- Additional: BBR mix beams (related proposed study)
- Loose mix, cores
- Fracture energy test data analysis: both FE and FI

Mix designs will soon begin and expected completion in early December. Test sections are planned to be built in the 2016 construction season. The sections are to be built on the mainline Interstate 94. Monitoring of performance over several years will be performed using a video-

based automated pavement evaluation van (same as NCAT). West noted that with the eleven sponsors including FHWA the work is being done for a total budget of $6.9M.

ETG Comments, Questions, and Discussion:
Mohammad commented that the field mixtures have higher in-place air voids compared to the mixtures in the laboratory at Ndesign.

Mohammad commented that it is possible to get the potential energy from the SCB triplicates at the given notch depth. Hall asked whether the collected data during the SCB test allow for the calculation of a parameter similar to what Illinois is calculating for the SCB. West responded that they will check. Mohammad noted that the geometry is different between the SCB-LTRC and SCB-Illinois.

Abadie asked about the in-place variation of the layers' modulus. West responded that the modulus COV on the aggregate base is 20%.

It was noted that estimating the Poisson's ratio in order to calculate horizontal strain and be able to calculate Nflex is a concern. Stiffer mixes will tend to give higher values for the Poisson's ratio. It was recommended to do testing with horizontal gauges and compare the horizontal strain calculated form the direct measurements of the horizontal deflection to that estimated from the Poisson's ratio.

Mohammad commented that the 57 mm notch depth length for the SCB specimen came from the ratio of the notch depth to diameter of the specimen and the aggregate size in the mix. He asked whether any work has been done to show the difference in results between using 57 mm and 50 mm notch depth length. Kluttz asked whether there is way to shift the cracking field data to account for differences in strain values due to differences in thickness and modulus of the asphalt and base layers. Buchanan noted that the intent was to get a test that can be implemented during production. Another asked what was the reason behind changing the IDT loading rate to 2 inch /min. West responded because of the labs typical equipment; hence no need to have a high frequency of sampling rate and a Marshall press is suitable. West noted that if ALF testing is completed by December then the report should be ready early January.

Corrigan commented that the ALF appears to have different mixture performance to date while lab is not showing statistical significance among the mixtures and asked whether it means that all mixtures are acceptable. West responded that for the test to be meaningful it needs to have good correlation with field and have the ability to differentiate the mixes.

Hall asked if these tests are for mix design or at the quality control stage for go/no go decisions and if so what is the threshold at the ALF for the go/no go. West responded that having the virgin mix as a baseline is the threshold. Mohammad commented that some tests have criteria and mixes should be grouped by criteria and compared to the field. D'Angelo commented that a relationship might be developed between the lab and the field but the key is that aging is not taken into consideration in the ALF. West responded that the ALF is used to validate the test and the next step is to do the aging and adjust the criteria. Musselman asked whether it would have made a difference if mixtures were compacted in the lab to the in-place density of the pavement.

West responded that the team did not have the time to do that and trying to hit a target air voids are a trial and error which would complicate the specimen preparation.

Action Item(s)
Action Item #201509- 3. Randy West is requested to provide the ETG for review and comment prior to the next meeting, a draft report of the NCAT efforts to evaluate a simplified cracking test.

10.2. LTRC Pooled Fund TPF 5(294), Louay Mohammad (LSU)

Presentation Title: *Develop Mix Design and Analysis Procedures for Asphalt Mixtures Containing High-RAP Contents – TPF 5(294)*
Summary of Presentation: Mohammad provided a link to the pool fund program: http://www.pooledfund.org/Details/Study/536.

He noted that asphalt mixture design needs to be complemented with a mechanical test especially when using recycled materials. The purpose of the study is to evaluate several fatigue/fracture tests that will be collected from the various participating states based on the ability of the test to rank the quality of RAP and or RAP/RAS mixture as compared to virgin mixtures. Each participating state is asked to provide two field projects, with each filed project and have a conventional mixture (could be 15% RAP) and another mix with RAP and/or RAS. Hence, a total of four mixes will be collected from each of the participating states. Mix and pavement designs data will be collected. The plan is to also collect cores which is challenging. Asphalt binders will be extracted from the field mixtures using solvent extraction and tested for rheological properties, GPC, SARA, etc. Mixture testing will be conducted on plant produced laboratory compacted and plant produced field compacted (if cores are provided by the participating states) mixtures. The following tests will be conducted following the latest published testing procedure: semi-circular bend test (SCB), overlay tester test (OT), energy ratio test, beam fatigue test, and direct tension cyclic fatigue (SVECD). Mohammad noted that the energy ratio test does not currently have a published procedure.

Florida DOT is one of the participating states. Mixtures were also received from the ALF. Each test will be ranked and a score card will be developed. Each test will be ranked based on specimen preparation, instrumentation, standard test method, testing, training, interpretation, sensitivity to mix composition parameters, routine application, correlation to field performance, data analysis, repeatability, and cost. No results were provided.

ETG Comments, Questions, and Discussion:
Eshan Dave asked about the source of the recommendations for the tests. Mohammad responded that the recommendations came from a southeast consortium group. Mohammad noted that the participating states are Florida DOT, Colorado DOT, Louisiana DOT, and the FHWA. Other states are interested. Bonaquist asked about the influence of the environment as many of these tests might be conducted at a single test temperature. For instance, Bonaquist asked whether the SCB test will be conducted at the same temperature for all mixtures. Mohammad responded that the SCB test has an adjustment for the intermediate temperature based on the project

location/environment. Bonaquist asked whether all tests have an adjustment for the test temperature. Mohammad responded some might not, for example flexural beam fatigue testing in California is tested at 20°C regardless of location.

Corrigan commented that it is important to be able to predict performance and provide flexibility in designing with different materials. There is tendency to focus on go/no-go tests and easy tests rather than understanding fundamental performance, which should be the long-term goal. There is a need to understand performance if we are ever to use a balanced mix design. Mohammad noted that the work under NCHRP 09-57 is to develop an experimental plan to evaluate and correlate different cracking tests with actual field performance. Corrigan commented that there is a need to focus our effort on understanding mixture performance and materials behavior across the US. Mohammad noted that one of the important items is the correlation to field performance. West agreed that this is an important aspect but he believes the priority from the states is on a go/no go test. Bukowski noted that generally we need first to understand the fundamentals before going to such a simple approach/test. Aging is also a critical factor when looking at and evaluating cracking tests as materials age differently and aging needs to be part of the fundamental procedure. West agreed but the issue is how to correlate lab materials to field aging.

Pamela Marks noted that while mix design is very important, the material used in design are rarely very identical to what is used during production, hence production affects cannot be negated and some issues during construction can accelerate aging. Hall commented that there is an immediate need for a go/no-go cracking test until a better understanding of the fundamentals of cracking. Bukowski commented that both aspects can be done in parallel. Buncher commented that it seems we are focusing on minimizing costs rather than improving performance. Reinke commented that there are some opportunities to look at aged material in the field; for instance WRI has several pavements with loose mixes and performance data. Bukowski mentioned that Richard Kim in the NCHRP study on long-term aging is using samples from the ARC test sections. Musselman noted that during the Superpave implementation we collected materials from several projects and monitored field performance; tying test results to filed performance is a complicated process because it also requires factoring in the stiffness of the base, pavement structure, etc. Musselman commented that a state agency can probably collect samples and test the materials during the construction of new projects. Hall noted that several states are selecting sections for the ME guide calibration. Bukowski noted the need to understand the limitations of the current cracking models in the latest Pavement ME design software and the type of materials input that are really needed for accurate predictions. There is a need to have someone talk about the cracking models. Hall and Tran volunteered to prepare a presentation for the next ETG meeting on the status of the asphalt cracking models in the Pavement ME software.

Action Item(s)

Action Item #201509- 4. Louay Mohammad is requested to present at the next meeting an update on Pooled Fund 5(294) "Design and Analysis Procedures for Asphalt Mixtures Containing High RAP Contents and/or RAS".

Action Item #201509- 5. Dave Newcomb is requested to present at the next meeting an update on NCHRP Project 9-57, "Experimental Design for Field Validation of Tests to Assess Cracking Resistance of Asphalt Mixtures".

Action Item #201509- 6. Richard Kim is requested to present at the next meeting an update on NCHRP Project 9-54, "Long-Term Aging of Asphalt Mixtures for Performance Testing and Prediction".

Action Item #201509- 7. Nam Tran/Kevin Hall are requested to present at the next meeting the status of the MEPDG asphalt cracking models.

11. Task Group Review Update: T321 (Beam Fatigue) [Geoff Rowe, Abatech]

Presentation Title: *Summary of Recommended Changes Consensus Forming Table, Bill Criqui,*
Summary of Presentation:
Bill Criqui presented on behalf of Geoff Rowe. The Task Force is working on a set of proposed changes for the flexural beam fatigue procedure in an attempt to improve repeatability and make both the ASTM D7460 and AASHTO T321 consistent. A table summarizing the recommended changes was presented for the following items:

1. Wave form
2. LVDT reference location
3. Rotational and lateral translation at clamping locations
4. Clamping stress
5. Response sampling intervals and numbers
6. Details calculations of each reporting interval
7. Strain level selection for testing
8. Add discussion about test termination and fatigue life where Nf is desired outcome. Run test to E*n with at least reduction of 15 % beyond failure defined as E*n peak. Currently in AASHTO and ASTM.
9. Add note about NMAS min and max and variability
10. Minimum results that must be reported

Criqui reviewed the results for the Task Force poll on these items. A comparison was made between ASTM D7460 (10) and AASHTO T321 (14). The following is a summary of the proposed changes.

1. Wave form: Move forward with alternatives to use sine or haversine (offset sine). Expect to get same or very similar fatigue results. Strain must be defined for either wave form as peak to peak. Test needs to report which wave form is used.
2. LVDT reference location: use fixed location relative to clamps, not on beam. From target glued on side of beam at neutral axis.
3. Rotational and lateral translation at clamping locations: must have free rotation and horizontal translation at all clamps. Currently no translation of inner clamps in ASTM procedure. Blankenship noted that this seems to make more impact as strain increases and not sure if it matters much at lower strains. However, there is a need to reduce error/coefficient of variation.

4. Clamping stress: Fixed clamping stress, with lowest stress level possible to be determined after consultation with manufacturers. Recommend a one inch contact surface with radius edges that extend beyond the 1 inch width of the clamp. Questions of what clamping stress range to specify and how to check it, and appropriate geometry of clamps (need information from manufacturers to prepare specification).
5. Response sampling intervals and numbers: Use recommended schedule, which is based on decadal increments with sub-decadal increments as repetitions increase. Take initial stiffness at 50 cycles. Add information about changing gain settings to achieve good wave by 50 cycles. Averages should be calculated on logs, need precise calculation method. Need to come up with calculations for averaging logs.
6. Detail calculations at each reporting interval: Defined approach for performing calculations. Fit sine wave to the strain and stress data and use those results for reporting stiffness and energy and other parameters. Use procedure in AASHTO TP 62-07 Section 12. Need to bring in and review AASHTO TP62-07 language (calculation of E* and phase angle) since need to consider if drift is an issue.
7. Strain level selection for testing: Provide non-mandatory alternatives for standard testing and reporting use the defined approach. Provide some guidance for different mix types at different strain ranges. Provide recommendations for replicates after precision and bias completed. Need precision and bias to specify replicates. Should be evaluated in log form.)
8. Add discussion about test termination and fatigue life where Nf is desired outcome. Run test to E*n with at least reduction of 15 % beyond failure defined as E*n peak. Currently in AASHTO and ASTM. Includes definition of when to stop the test for Nf and incremental-recursive uses, and fitting of sine wave to results at increments, and calculation of values from fitted sine wave rather than raw measurements (pros and cons not completely sorted out). Need to provide detailed precise calculation.
9. Add note about NMAS min and max and variability.
10. Specify minimum results that must be reported: Repetitions, load, deformation, strain, stress, phase angle (need calculation from TP 62) and error on strain sine wave and load.

Criqui further elaborated on the Item 2 (LVDT reference location) He showed a comparison of fixed vs. floating reference points. The concern with equipment that references a floating contact point on the beam has to do with assumptions that the beam will bend in a perfect arc while it is being fatigued. He showed data for a sand mix with a high asphalt content which created a representative arc. The results produced a slightly higher cycles to failure for the fixed reference point fixture due to bending the beam against gravitational effects of the viscoelastic material. The floating reference point fixture showed an increase of nearly double the cycles to failure in the same direction of loading for this asphalt mixture. Criqui clarified that the floating reference point is running sinusoidal at 270° phase offset. The concept of a floating reference point is poor in design due to assumptions that the beam does not degrade during the test. Obtaining both fixed and floating reference 4-point beam fixtures allowed Road Science to verify performance differences side by side in the same lab with the same operator. Viscoelastic material does not represent a perfect arc and flattens out with stiffer binders and larger aggregates.

Criqui presented the upcoming steps for the Task Force and are summarized as follows:

1. Report back to FHWA Mix ETG in mid-September.

2. Get information to Texas A&M working on NCHRP 9-57.
3. Get copy of current TP 62 specification. Write draft language where needed as identified in this document and put in both AASHTO T 321 and ASTM D 7460.
4. Obtain from manufacturers any needed information, and also review the draft specs.
5. Report to ETG with update.
6. Go to ASTM (get steps 1 through 5 done before February 2016 ballot) and AASHTO (get steps 1 through 5 done before June 2016) committee ballots. Inform CEN committee.

ETG Comments, Questions, and Discussion:
Blankenship commented that the purpose of these proposed revisions is to update the procedure and make sure that the data analysis is conducted properly and consistent among different laboratories. Tran noted that historical data would need to be converted for old or existing machines. He asked whether there are any plans to convert from the 50% reduction to the new failure criteria. Criqui responded that Abatech has software that facilitates data analysis. Tran noted that the raw data might not be available. Abadie agreed that the raw data do not exist to run the new analysis method. Bukowski hoped by the next meeting the Task Force can address some of the issues that were brought up and provide recommendations for what the current users need to do in order to be able to conduct the test in accordance with the new procedure. Bukowski commented that a summary is need of what agencies/laboratories need to do, what changes the user has to do to better perform this test. Criqui noted that a lot of problems will be eliminated by having everyone running the test in a consistent manner. Bukowski noted that for some laboratories some substantial hardware changes would be needed. Criqui responded that according to the manufacturer it is not a massive cost to make the changes to reference the neutral axis. Current equipment uses a single probe, hopefully we will be moving to two probes, one on the beam and the other one referencing the beam. Criqui noted that SHRP originally was not going through zero (no plus and negative strain). These original studies used elastic material such as wood fibers and aluminum which bounce back. Another way is to run the specimen vertically, in order to minimize sagging (in horizontal direction the beam starts sagging even without any loading).

Kieran McGrane from IPC Global noted that a retrofit to be able to measure displacement on fixed point in the middle of the beam is possible and should be able to upgrade equipment. For equipment older than ten years it will be a problem in terms of both hardware and software. Criqui also mentioned the need for an inter-laboratory study.

Action Item(s)
Action Item #201509- 8. The T321 Task Force is asked to finalize and present at the next meeting a summary of equipment/software changes needed on existing test devices as a consequence of recent AASHTO changes in the standard.

12. FHWA ALF (RAS, RAP, WMA) Experiment Update. [Nelson Gibson, FHWA]

Presentation Title: *Recycling and WMA Fatigue Cracking Update Accelerated Load Facility, Nelson Gibson, and FHWA*

Summary of Presentation:
Nelson Gibson presented an update on the ALF experiment which included different combinations of RAP, RAS, Virgin Binders, and WMA Process. RAP was requested not to be fractionated. ALF testing is 85% complete. Lane 2 and Lane 8 are being loaded now and Lane 6 is the last lane to be loaded. Testing is expected to be completed in December 2015 with a total testing period of 2 years and 2 months. Cracking measurements are being performed and crack growth is being tracked. The cumulative crack length as a function of ALF passes was presented. In general, the growth was fairly linear for all tested lanes. Gibson noted that a comparison among the various mixtures cannot be made by ranking the mixtures based on the number of cycles to a certain amount of distress. Gibson noted that the three poor performing mixes were the two RAS mixes and the high RAP mix without adjustment to the PG grade.

Gibson next presented the cyclic fatigue analysis with and without structural analysis. Several combinations for the analysis:

- Sample preparation: reheat and compacted without aging or long-term aged and compacted
- Data analysis: C_f failure criteria or G^R failure criteria
- Fatigue performance prediction: strain control, stress control or LVECD structural analysis for perfect construction or as-built.

The "Classic" fatigue life curves representation uniaxial or flexural lab strains are used to interpret a single point in the pavement but not the entire thickness. The LVECD uses the material properties from AMPT and considers effects throughout the depth of the pavement. LVECD provides insight into damage throughout the depth of the pavement.

Nelson presented the fatigue life curves for the C_f failure criteria and the G^R failure criteria for the various lane mixtures and for the as-built and perfect construction. The as built is a predicted strain based on the actual thickness and back calculated modulus. Strain gauges were not instrumented in every lane because of the cost. Gibson noted that past experience showed that the layered elastic solution results in fairly close strain values to the measured ones. The ranking of the mixtures using the AMPT fatigue without structural analysis was presented based on the following three failure criteria: sample break failure criteria, C_f failure criteria, and G^R failure criteria. The sample break criteria occur when the sample breaks in the AMPT machine. The ranking was reasonable to the ALF field performance however the ranking changed between short and long-term aging condition. A better agreement was observed for the G^R failure criteria after long-term aging.

Next Nelson presented the AMPT fatigue analysis with structural analysis which consists of quantifying the damage throughout the whole depth rather than relying on a single point at the bottom of the asphalt layer. A plot showing the percent of nodes with damage below critical C(S) of 0.3 as a function of number of load simulations was presented for the evaluated mixtures from the various ALF Lanes. A C(S) equal to 0.3 means a modulus that is as 30% as stiff as the starting point. The L3, L5, and L7 had high percentage of nodes below the critical value (throughout the whole depth of the asphalt layer). Gibson also showed how many load cycles it took the lane to reach a percentage of nodes to C(S) of 0.3 of 11%. Then a comparison between

the ALF cycles to surface crack initiation and the cycles to 11% nodes below critical damage was presented. A ranking table for the AMPT fatigue with structural analysis was provided. There was considerable consistency in the rank order when using the structural analysis and better agreement at the aged stage.

The laboratory (classic fatigue) versus the LVECD rankings were provided and compared. More consistency is observed in the rank order with the structural analysis. A more consistent agreement was found between the structural prediction of the damage distribution throughout the thickness of the simulated pavement and the measured ALF fatigue cracking (The FE run takes about 15 mins).

The data indicate four data clusters in decreasing order of performance: 0% recycle, 20% RAP-BR 64-22, 40% RAP-BR 58-28, and "Poor": RAS & 40% RAP-BR 64-22. The next step will be to determine how much binder needs to be added for RAS and 40% RAP-BR mixes to exhibit equivalent performance. Performance tests will then be conducted on 40% RAS and RAP-BR + 0.5%, 1.0% binder. The reference mix that should be the equivalent performance target could be the 0% or 20% RAP-BR. Gibson asked for feedback on which reference mix to be used. Gibson noted that FHWA promote recycling as long as performance is not being jeopardized.

ETG Comments, Questions, and Discussion:
Bonaquist asked whether there was an attempt to keep the temperature reasonable during the ALF testing. Gibson responded radiant heaters are located under the ALF and thermocouples are installed in the pavement at 20 mm depth to control the temperature at 20°C. The pavement cannot be loaded when it is being heated since it will be very hot. Depending on the time of the day the bottom of the pavement might be 20 +/- 1°C and on top 20 +/- 0.5°C. Tran asked if the stiffness of the pavement was monitored right after construction and before ALF loading. Gibson responded that FWD measurements were made before and after construction. LWD testing was also conducted after construction and then after ALF loading. Abadie asked whether there were any previous ALF loading performance cracking data. Gibson responded that the last polymer modified binders study was with higher wheel load levels and pavement cracked around 30,000 loading cycles, the crumb rubber never cracked, and another fiber reached 300,000 loading cycles. In essence similar range for the current fatigue cracking performance with the note that a lower wheel load level is used in the current experiment.

Hall asked about the confidence regarding that cracking is bottom-up. Gibson responded that cracks are observed to be wider at bottom than the thinner cracks at the surface. Buncher asked when loading is terminated. Gibson responded that in the past experience a percent cracked area was used and loading was stopped at about 15% percent cracked area. The percent cracking area correlated well to the crack length (linear). Mohammad asked whether other distress data were measured. Gibson responded that rutting measurements and non-destructive modulus testing were also conducted. Qualitatively the results seem to be similar. Keep track of LWD measurements to check for damage. Last experiment was loaded to 16,000 lbs. while on this experiment a load used 14000 lbs. is being used.

D'Angelo asked how to distinguish the difference in the nodes of the 4 inch pavement. Gibson responded that the LVECD analysis is a FE model which had a mesh with 32 nodes for the

asphalt layer. The contour of percent of intact modulus and the contour of loss of modulus can be determined as a function of load simulation repetitions. The LVECD model is not a fracture mechanics model and it attempts to provide a complete picture of the whole asphalt layer.

Tran asked whether in the LVECD analysis the variations in asphalt layer thickness and base modulus are being considered. Gibson responded that a structural analysis for the various layer thicknesses and moduli values for each of the lane is being conducted. The analysis is expected to give an error bar for the average predicted fatigue performance.

Bonaquist suggested changes in the mixes such as the worse ones are as good as the best ones and use the middle mixes for the verification. Hall commented that when making the changes check for the rutting criteria using a balanced mix design approach. Gibson responded that he had been planning on doing this.

Action Item(s)

Action Item #201509- 9. Nelson Gibson at the next ETG meeting will present an update on the status of the FHWA ALF project.

13. Silo Storage Effects on RAP Mixtures. [Eshan Dave, UNH]

Summary of Presentation: *How Does Silo Storage Time Impact Asphalt Pavement Performance and Durability? Eshan Dave, Jo Daniel, Chris Jacques, Chris DeCarlo, UNH.*

Dave presented the objective of the Silo Storage Study and Fracture Testing Study of the presentation in terms of the influence of storage on the mixture's performance, aging effect, and any continued blending of recycled and virgin asphalt binders. Dave acknowledged:

- TPF 5(230): Northeast High RAP Pooled Fund Study
  - FHWA, New Hampshire, Maryland, New Jersey, New York, Pennsylvania, Rhode Island, and Virginia
- UNH Hamel Center for Undergrad Research
- Research Partners
  - University of New Hampshire (lead state on the study)
  - MTE Services
  - Rutgers University
  - North Carolina State University
  - University of Massachusetts Dartmouth

Dave noted that the presented work on silo storage evaluation is a subcomponent of the pooled fund study. The silo storage evaluation included a virgin mixture and a 25% RAP mixture. Storage time varied and the time of discharge of the mix was different. For each mixture and storage type, samples were compacted at plant and (after reheating) compacted in lab. The research approach was presented which included testing of extracted/recovered binder and mixture testing (TSRST, E*, S-VECD, and DCT). Dave noted that the compaction air voids content was different between the two mixes (6 versus 7%). For binder, the analysis was in terms of the critical cracking temperature, CAM model rheological indices, and black space. For the

mixture, the analysis was in terms of black space, Layered viscoelastic continuum damage analysis (LVECD), and fracture data (energy, peak loads, stiffness and softening slopes).

The various test results were presented. The binder black space diagram showed that RTFO aging correlates only after 170 minutes (took 170 minutes in RTFO to get close to virgin mix without silo time). Dave noted that the binders were recovered with no additional conditioning/aging. The virgin mixtures showed an increase in stiffness with storage time. The RAP mixture showed similar trends, but with larger differences and more statistical significance.

Virgin mixture had slightly higher E* ratio ($E^*_{time}/E^*_{0hrs)}$ in lower frequencies, and the ratio increased with storage time. The RAP mixture had higher E* ratios and larger differences across frequencies before converging to about 1.3 times the stiffness. The average ratios showed that RAP is increasing much more than the virgin mixture; the 2.5 hour RAP mixture was about the same stiffness ratio as the 7.5 hours virgin mixture indicating a combination of short-term aging in the silo and blending/diffusion occurring between virgin and RAP binders.

The C-S damage characteristic curves were presented. The C-S at each loading cycle showed how specimens become damaged over the test. A clear increase in the pseudo-stiffness (C) was observed with the increase in silo storage time. With C-S curves, it is important to keep in mind that performance in the field depends on location within the pavement structure

LVECD analysis was completed for two climates (Raleigh and Boston Climate) and two pavement structures (thin and thick). With the increase in amount of time in silo more propensity for cracking is observed using LVECD. In all cases, the damage to 7.5 hours is much greater than 0 hours, with 2.5 and 5 hours being similar. Dave noted that the comparison cannot be made based on C-S curve only because of E*; hence the need for the LVECD analysis.

TSRST test results were presented. Dave noted that the variability with the test results was high. In the case of RAP mixture, the increase in storage time (past 7.5 hours) showed warmer cracking temps. Trends were not apparent in the virgin mixture. DCT Test (ASTM D7313-13) was conducted on the mixtures. Dave presented the procedure for DCT specimen preparation. Recently, MnDOT worked with a saw manufacturer to make it easy for making the notch on the sample. Another change was the test temperature which originally was similar to BBR test temperature. With mixes it is difficult to define the low temp of the binder because of the RAP and RAS in the mix. The test temperature is now based on the 98% reliability PGLT and then tested at 10C warmer. The test threshold value is based on Minnesota data from Phase I (blue diamonds) and Phase II (red square) was provided and fracture energy of 400 J/m^2 was reasonable to differentiate good from bad performing mixtures (TPF-5(080)). The fracture energy criteria were validated with field cores from TH371 sections in Minnesota. Field core (sampled from five different sites in Minnesota) results from MnDOT Lab performance study. DCT based specifications are currently being implemented by Minnesota DOT, Wisconsin DOT, Chicago DOT (ASTM version), and Illinois Tollways (ASTM version). MnDOT acquired DCT equipment themselves as well as for two labs in the state that do a lot of testing for the DOT. Dave presented the ASTM D7313-13 procedure along with the modified changes by each of MnDOT and WisDOT. The DCT test results for the two mixtures at different silo storage times were presented.

Dave concluded his presentation with a summary of the findings based on the binder and mixture test results. He noted that RTFO aging of the virgin binder showed that current laboratory conditioning times do not necessarily simulate asphalt plant production. Increase in dynamic modulus (stiffness) was observed for both virgin and RAP mixtures with increase in storage time. The 7.5 hour stored virgin mixture was much more susceptible to fatigue cracking than the 0 hour mix. Trends for TSRST results are not consistent but in general up to 2.5 hour silo storage time there seems to be minimal to no change. DCT testing some provided insight into changes to mixture's mechanical response at low temperatures

ETG Comments, Questions, and Discussion:
Adam Hand asked about the type of the plant used in the silo storage evaluation study. Dave responded that it is a drum plant but not sure if it was parallel flow or counter flow. Haifang Wen asked whether there is any oxygen in the silo to expect aging. Dave responded that this cannot be verified but the modulus results showed a stiffening effect which could also be due to a prolonged absorption.

Bonaquist asked whether the number of failure points is the same as what Nelson Gibson was referring to as the number of points to a certain C value. Bonaquist questioned whether there is another component involved. For example a stiff mixture with a C value of 0.3 is completely cracked versus another soft mix with a C value of 0.3 where you can still go for another 10,000 cycles. In other words, Bonaquist questioned whether there should be a damage tolerance component to the viscoelastic continuum damage analysis and it is not C which is the level of damage. Gibson commented that another way of looking at it is by doing a contour of S to keep track of amount of damage versus the amount of modulus loss. For instance you can have a mix that can take a lot of damage but doesn't lose its modulus much versus a brittle mix which can take just a little of damage and loses the modulus significantly. Bonaquist asked whether under this analysis every mixture always fails at C = 0. Gibson responded that materials will crack at different C values. Bonaquist commented that the damage parameter S is then a book keeping number that tells you how much damage accumulated so far. While C is the integrity of the material and some material will crack with C = 0.5 and others at 0.2. However, in flexural beam fatigue analysis the failure criteria are set constant at 50% reduction in initial stiffness. Hence by cutting at a specific C value you are not accounting for the mixture damage tolerance. Amir Golalipour noted that there is another parameter that the NCSU group is using which is the endurance limit. Dave noted that using the C-S curve you will be looking at the release of energy to how many cycles it took to failure.

Reinke commented that the RAP mixes were produced on November, 2011 and the mix discharge temperatures were 340°F (0 hrs), 310°F (2.5 hrs), 350°F (5 hrs), 350°F (7.5). The 7.5 hour was produced at 350°F and remained in the silo for 7.5 hours. The virgin mixture was produced in December, 2011 and the temperatures were very high and were 325°F (0 hrs), 360°F (2.5 hrs), 360°F (5 hrs), 360°F (7.5 hrs). Hence, the results are highly affected by the production temperatures. Musselman asked how the mixtures were actually produced and whether any data for volumetric and gradation is available to check for consistency. Dave wasn't aware if such information is available.

West asked about the COV for the DCT test. Dave responded that COV is typically around 10% or less.

14. Design of High RAP Mixes. [Haifang Wen, WSU]

Presentation Title: *Performance-based Design Method of Asphalt Mixes that Contain Reclaimed Asphalt Pavement (RAP), Haifang Wen, Kun Zhang, Washington State University; Fouad Bayomy, Ahmed Muftah, University of Idaho.*

Summary of Presentation:
Wen noted that the blending mechanism is not well understood and there is lack of performance tests. He noted that the current mix design is based on volumetric properties and not performance-based. Two sources of RAP were used. Lab mixtures were prepared for 0, 17, 30, and 50% RAP binder replacement ratio for north mixes (N) and 0, 17, 26, and 50% RAP binder replacement ratio for south mixes (S). The experimental plan include a field mixture from each north (NF) and south (SF) at 30 and 26% RAP binder replacement ratio for north mixes, respectively. The experimental plan included: dynamic modulus test, rutting resistance (Flow number test), fatigue cracking resistance (indirect tensile test (IDT) at 68ºF, bottom-up cracking resistance: fracture work density, Top-down cracking resistance: vertical failure deformation), and thermal cracking resistance (IDT at 14ºF, Fracture work density).

In general an increase in FN was observed for mixes with RAP binder replacement ratio greater than 17%. North mixes had comparable resistance to bottom-up and top-down fatigue cracking. For south mixes S0 and S17 performed identically, and significantly better than S26, S50, and SF26. The inclusion of RAP affected thermal cracking performance of asphalt mixes, but was mix-specific. Wen noted the need for cracking performance tests at the mix design stage.

The measured properties are used to develop a regression model FWD (fracture work density at 14°F). The model was a function of RAP content, VMA, and the low and high PG of the virgin asphalt binder. The RAP PG was not in the prediction equation (was not statistically significant). The predictive model was moderately effective. Wen presented the suggested procedure for a performance-related empirical mix design. The performance-related empirical mix design is based on fracture density at 14^oF and allows for the determination of the required low virgin binder PG without the need for a performance test. The procedure consists of selecting the low temperature PG of the virgin binder for a mix with RAP using the developed predictive equation for a target FWD value. Two mix designs need to be conducted: control mix without RAP and a RAP mix. The procedure is based on the attempt to controlling the performance of RAP mix to be similar to that of the virgin mix. The following are the steps involved. Wen believes this shows that that binder extraction, recovery, grading of RAP binder, and performance tests of RAP mixes are not needed when using his method. Steps include;

(1) Design a control mix without RAP using target PG of virgin binder.
(2) Estimate FWD_{low} of the control mix.
(3) Design a RAP mix to meet volumetrics specification by using target high temperature grade of virgin binder with any low temperature PG.

(4) Determine the low temperature PG of the virgin binder based on developed predictive equation.

ETG Comments, Questions, and Discussion:
Bonaquist asked whether there are any recommended criteria for the fracture work and vertical failure deformation. Wen responded that a criterion is not available and the properties are just used for relative comparison at this point.

D'Angelo commented that the predictive model is highly influenced by the binder grades used in the study to develop the model. Bumping down the grade might sometimes end up with the use of more polymer in the binder. Reinke commented that depending on how the binder is formulated going from a 64-28 to a 58-34 might not result in losing the polymer concentration.

Kluttz asked whether the performance-related mix design method was checked with a mix that was not part of the mixtures used to develop the procedure. Wen responded that this has not been done yet and the purpose of the presentation is to describe the approach and it should be considered as not yet final. Tran questioned the rationale behind having the mixture air voids and VMA influencing the required PGL of the virgin asphalt binder. Wen responded that cracking resistance is function of mixture volumetrics and PGL. Gibson noted that based on the presented relationship it would appear to indicate that there is no need for a better quality virgin asphalt binder if a higher VMA (which means a higher AC) was targeted. In other words, using the predictive equation, instead of using a PGL of -40°C one can simply use more asphalt binder in the mixture. West noted that this is also with the premises that FWD is related to field performance which is at this moment has not been verified/determined. Wen commented that the NCHRP 9-49A results showed a good correlation between FWD and field performance.

Wen noted that his willing to work with whoever is interested to have their RAP mixes evaluated in order to improve the confidence in the developed predictive model.

15. Update 9-49A WMA Long-Term Performance. [Haifang Wen, WSU]

Presentation Title: *NCHRP 9-49A Project, Performance of WMA Technologies: Stage II – Long-term Field Performance, Haifang Wen, WSU*
Summary of Presentation:
Wen presented an update on the preliminary findings from the NCHRP 9-49A study. He acknowledged the other team members of the project: Louay Mohammad-Louisiana State University, Shihui Shen-Penn State University at Altoona, Braun Intertech, and Bloom Companies. This is a 5 year project duration (from 04/2011 to 07/2016). The objectives of the study are to identify the material and engineering properties of WMA pavements that are significant determinants of their long-term field performance, and to recommend best practices for the use of WMA technologies.

A total of 22 field projects and 1 HVS are in-service resulting in a total of 40 HMA-WMA pairs. Projects distribution was provided in terms of the WMA technology, pavement age, traffic, and pavement structure. Wen noted that most projects ranged between 5 and 10 years age and most

were overlays. Field samples were collected and mixtures were evaluated for: IDT Dynamic modulus/creep compliance, IDT fracture at room and low temperature, and Hamburg. For binder the following tests were conducted: PG, MSCR, Monotonic at room and low temperature.

A field distress survey was conducted with the first round being in 2011 and the second round in 2013 following the LTPP distress identification manual for cracks and rut depth. Cores were also taken at the tip of the crack. The results of the first survey for transverse cracking were provided where 14 out of 28 projects exhibited transverse cracking (21 H-W pairs). Overall HMA showed comparable or more/longer transverse cracks than the companion WMA. The results of the second survey for transverse cracking were also provided where 22 out of 28 projects exhibited transverse cracking (35 H-W pairs). Overall HMA showed comparable or more/longer transverse cracks than the companion WMA. The second objective of the project was to look into engineering properties that can correlate with field performance. The significant determinants of transverse cracking were determined by comparing material properties to field performance. The mix work density at 14°F and dynamic modulus were found to be the most determinant factor for transverse cracking. In terms of binder, the BBR binder stiffness was found as a reasonable determinant factor. A regression predictive model was presented for the mixture fracture work density at 14°F as a function of VFA, Gse, binder failure strain at 41°F, asphalt content, and percentage passing the No. 50 sieve size. The model can be implemented at the mix design stage. Wen noted that a higher FWD can be achieved with: a ductile asphalt binder (i.e., a higher level of failure strain), relatively more asphalt (i.e., higher asphalt content, VFA), more aggregate passing the No. 50 sieve, and harder aggregate (high G_{sb}). The fracture work density was found to be very sensitive to air void and asphalt content.

The results of the first survey for top-down longitudinal cracking (wheel-path) were also provided where 8 out of 24 projects exhibited top-down cracking (17 H-W pairs) in the first round. Overall HMA had comparable top-down cracking performance when compared to WMA. In the second round, 14 out of 28 projects exhibited top-down cracking (24 H-W pairs). Overall WMA had slightly more top-down cracking performance than HMA. The mixture IDT strength and the mixture vertical failure deformation at 68°F were found to be the most determinant factors for top-down cracking. No binder properties correlated with top-down cracking. A regression predictive model was presented for the mixture vertical failure deformation (VFD) at 68°F as a function of asphalt binder content, binder shear strength, percentage passing No. 30 sieve size, and Gsb. The model can be implemented at the mix design stage. Wen noted that a higher VFD can be achieved with: a relatively higher asphalt content, lower binder shear strength, finer gradation (more aggregate passing the No. 30 sieve), and harder aggregate (high G_{sb}). The VFD was found to be sensitive to air void and asphalt content.

In the case of rutting, HMA and WMA are shown to be comparable in terms of rut depth for the various WMA technologies. A total of 23 projects (42 H-W pairs) exhibited measurable rut depths. The rutting resistance index (RRI) from the Hamburg test results, the Low and high PG were found to be the most determinant factors for rutting. A regression predictive model was presented for the RRI as a function of percentage passing No. 100 sieve size, percentage of recovery of binder at stress level of 3.2 kPa from MSCR, percentage passing No. 16 sieve, and asphalt binder absorption. The model can be implemented at the mix design stage. Wen noted

that a rutting resistant mix can be developed by having a high percent recovery from MSCR test, a low VFA, a high asphalt absorption rate, and a gap-graded aggregate.

No moisture damage was observed in the field. For the projects that showed SIP in the Hamburg test, it was found that anti-stripping agents were not applied in most cases. Hence, a mix without anti-stripping agent was found to likely have a stripping inflection point.

Wen followed by the effects of WMA on construction practices. As a whole, WMA has a tendency to have slight higher air void and lower asphalt content. The mix design results in the laboratory based on gyratory compactor may not be translated into the field. The compaction pressure may be too high and does not distinguish different mixes.

Wen discussed next three projects for which data were collected from the beginning: MT I-15, TN SR 125, and IA US 34. The MT I-15 project was ship sealed. The results for the TN SR 125 project were presented for the mixture dynamic modulus as well as the PG grading of the recovered binders from 2014 and 2011 field cores for both HMA and Evotherm. The creep compliance data for the field cores from 2014 and 2011 were also presented. The IDT test results (IDT strength, work density, vertical failure deformation, and horizontal failure strain) for the TN SR 125 project field cores from 2014 and 2011 were also presented at intermediate and low temperature. The MSCR and binder fracture tests on the extracted and recovered asphalt binders from field cores were presented. Overall, the results showed that the effect of aging was obvious in the case of the TN SR 125 project for both the HMA and Evotherm mixtures. A summary of material properties comparison between HMA and Evotherm was presented (TN SR125 Project). In summary, the oxidation leads to higher modulus, smaller creep compliance and slopes, higher PG, compromised cracking resistance and improved rutting resistance. The application of chip seal significantly slowed down the oxidation (case of MT I-15). There is no clear trend of significant change of ranking between HMA and WMA after 2 or 3 years in service.

Wen concluded his presentation with a summary of the preliminary findings as follows:

- In general, there is no significant difference of field performance between HMA and WMA pavements.
- Fracture work density, vertical failure deformation (and/or dynamic modulus), and rutting resistance index are recommended to be the significant determinants of transverse cracking, top-down fatigue cracking and rutting, respectively.
- Reducing the asphalt content based on laboratory compaction may compromise the cracking performance of a mix and should be discouraged.
- A mix is more resistant to transverse cracking if it has a relatively high binder content and VFA, a ductile binder, hard aggregates and a fine aggregate gradation.
- A mix is more resistant to top-down cracking if it has relatively high binder content, a soft binder, hard aggregates and a fine aggregate gradation.
- A mix is more resistant to rutting if it has a binder with high percent recovery, a low VFA, a gap-graded aggregate gradation, and a high asphalt absorption rate.
- Use of anti-stripping agent may be beneficial to avoid the moisture damage.
- The aging of HMA and WMA does not significantly affect the property ranking.

Recommendations for implementations were also presented and are summarized below.

- Develop mix design criteria based on significant determinants: Fracture work density for transverse cracking; Vertical failure deformation or horizontal failure strain for top-down cracking; and Rutting resistance index for rutting
- Use of anti-stripping agent but dosage rate needs to be determined.
- The procedure need to ensure that WMA has sufficient asphalt content.
- Adjustment of laboratory compaction (compaction pressure) might be needed.
- Use the material and field data to calibrate the Pavement ME models for rutting, top-down cracking, etc.
- Develop binder specifications based on binder, mix and field data.

ETG Comments, Questions, and Discussion:
Bonaquist asked how the transverse cracking comparison was made. Wen responded that the comparison was based on the crack length using the t-test for the total crack length within a 200 feet section.

Kluttz asked whether the specific gravity in the VFD predictive model is being influential because of the aggregates being harder or because of its effect on the mix design. For the same asphalt content you could have different mixture volumetrics. Tran commented that a statistical analysis should be conducted to check whether there is any statistical dependency between binder content and specific gravity (GSb). Gibson asked why in VFD model P30 was used while in FWD model P50 was used. Wen responded that the results are purely based on the statistical analysis which resulted in the influential factors for the various predictive variables.

Antistripping was found as an important factor. All of those with inflection point did not use antistrip. West asked whether the mixtures that did not use any antistripping and had a Hamburg inflection point will exhibit moisture damage in the field. Wen responded that as of now the mixtures did not show any moisture damage in the field. Hand commented that Evotherm is an antistrip. Wen responded that most of the projects used the older generation of the Evotherm and not the new generation. Bonaquist asked how moisture damage was assessed in the field. Wen responded that it was based the observation of the sampled cores and field raveling.

Adam Hand asked whether the same rolling pattern was used during construction for HMA and WMA. Wen responded that such information for the already in-service projects was not available.

Kevin Hall commented that a number of studies were presented with totally different mix design approaches. Bonaquist commented that he would like see the diversion in the various approaches at the moment especially that a proper cracking test has not yet been identified. Bukowski noted that the NCHRP 09-57 study should help in that aspect. D'Angelo commented that we do not have a good understanding for the different types of cracking yet and individual tests have been developed for a specific narrow purpose. As mentioned by Dave Anderson before, we need to decide what cracking mechanism we are trying to solve, before simply running tests. He noted that a test might work well for one situation in a state but not necessarily for another state.

16. Update on the WMA Task Force/LTPP Experiment. [Ray Bonaquist, AAT; Jim Musselman, FDOT]

Presentation Title: *LTPP SPS-10, Warm Mix Asphalt (WMA) Overlays of AC Pavements, Jim Musselman, Florida DOT.*

Summary of Presentation:
Musselman presented the historical statewide performance in Florida between 1995 and 2015. The data for cracking, ride, and rutting performance as a function of years was presented. Significant improvement in performance is observed with time due to the implemented surfacing program. Musselman noted that the performance is really good even though the dollar amount of the maintenance is being reduced. Musselman noted that even though the Rey Roque IDT test is complex but we had enough data to realize that using PM binder helps reducing cracking and started using it which led to better performance.

Musselman presented next an update on the LTPP SPS-10. He noted that for some agencies Superpave implementation was very slow when it was the most needed while on the other hand WMA was used as a demo for a year and then it was part of the specification. The LTPP SPS-10 study was funded around 2011-2012. A contractor was hired to develop a work plan. It was developed based on the need to investigate long-term performance of WMA due to the original concerns with higher potential for rutting and increased risk of moisture damage. Every LTPP SPS-10 project will have a HMA, a WMA foaming, and a WMA chemical section. Four projects have been constructed and six additional projects have been nominated and accepted by LTTP staff. The experimental plan includes a total of 16 different projects. Thirteen out of the sixteen projects were selected (5 Western Region, 5 Southern Region, 2 North Atlantic Region, and 1 North Central Region). Four projects completed, two will be constructed in late 2015, and seven in 2016. No wet/freeze projects yet in the U.S., this has been a focus during state visits. The following is a list and description of the projects:

- New Mexico - I-40 (Constructed October 2014)
  - WMA with chemical additive (Cecabase)
  - WMA with chemical additive (Cecabase) and PG 70-28+ binder (standard binder is PG 70-28 binder)
- Texas - US-277 (Constructed February 2015)
  - No Supplemental Sections
- Oklahoma - SR-66 (Fall 2015)
  - Stone matrix asphalt with chemical WMA additive
    - No fibers, RAP, or RAS
  - PG 64-22 binder with 10% - 25% RAP/RAS
    - standard binder is PG 70-28
  - PG 58-28 binder with 10% - 25% RAP/RAS
- Georgia – US-84 (Spring 2016)
  - 1.5” overlay (standard overlay is 2”)
- Florida – SR-77 Jackson County (Spring 2016)
  - Chemical at HMA temperature
  - Foaming with >35% RAP
  - Chemical with >35% RAP

- Washington: (Constructed Summer 2015)
  - 1 HMA section with ½" NMAS and 60 gyration mix
  - 1 foaming section with ½" NMAS and 60 gyration mix,
  - 1 HMA section with 3/8" NMAS and 100 gyration mix,
  - 1 HMA with 3/8" NMAS and 60 gyration mix
- Arizona: (2016) - Both projects will have the same supplemental test sections
  - 1 foaming section with increased RAP,
  - 1 chemical section with increased RAP,
  - 1 HMA with increased RAP.
- Nevada: (Spring 2016)
  - 1 organic WMA section,
  - 1 foaming additive,
  - 1 foaming additive with TBR (terminal blend rubber),
  - HMA with TBR
- Oregon: (Spring 2016)
  - 1 foaming section produced at hot mix temperatures,
  - 1 HMA section with increased RAP
- Manitoba: (Constructed August 2015)
  - HMA Control Section
  - WMA with Foaming process
  - WMA Foaming process with chemical additive
  - WMA with chemical additive 0.3% Evotherm
- Ontario (2):
  - WMA Chemical Additive test section (Rediset),
  - WMA Organic Additive test section (SonneWarmix).

ETG Comments, Questions, and Discussion:
Musselman noted that there is a nomination process and states are encouraged to participate by getting in touch with one of the regional contacts:

- Jason Puccinelli, LTPP Western Region: jpuccinelli@ncenet.com
- Gabe Cimini, LTPP North Central and North Atlantic Regions: gabe.cimini@stantec.com
- Thomas Burchett, LTPP Southern Region: TBurchett@Fugro.com
- Jack Springer, FHWA-LTPP: Jack.springer@dot.gov

West commented that there is confidence that questions related to any supposed higher potential for rutting and increased risk of moisture damage with WMA mixtures have been answered. However, the test sections might help us answer issues related to cracking. Bonaquist asked how to encourage states to look at various cracking tests besides modulus, Hamburg, and basic mixture testing. Musselman noted that the ETG provided a list of recommended tests which was provided to each of the participating states for their consideration. Musselman mentioned that there are nine more projects remaining that provide the opportunity for materials.

Bonaquist adjourned the meeting at 5:00 PM.

DAY 3: Friday, September 18, 2015

17. Call to Order

Ray Bonaquist (AAT) called the meeting to order at 8:00 AM.

18. Report Task Force RAP/RAS. [Jim Musselman, FDOT]

Presentation Title: *Report Task Force RAP/RAS, Jim Musselman, FDOT, and Gerry Huber, Heritage Research Group.*
Summary of Presentation:
Musselman acknowledged the task team members. A background of the issue was presented. The previous Asphalt Mixture ETG Task Team reviewed PP 53: "*Design Considerations When Using Reclaimed Asphalt Shingles (RAS) in Asphalt Mixtures*" and MP 15 "*Reclaimed Asphalt Shingles for Use in Asphalt Mixtures*" and made a number of revisions. Provisional standards were modified and subsequently sunset by AASHTO and reissued as PP 78 and MP 23. The main issue now to be addressed by the current group, are of the RAS asphalt binder availability and the binder grade adjustment guidelines.

The first issue is how to address the stiffness and brittleness of the RAS binder, in other words the quality of the asphalt binder. The second issue is how much of the RAS binder becomes effective asphalt binder. Current approach is to use the RAS binder availability factor of 0.7 to 0.85. The second part of the current approach is to use the binder grade adjustment guidelines (three tiers depending on the RAS or RAS + RAP binder percentage). An alternative approach was proposed focusing on the brittleness of the blended binder using the BBR test. BBR testing is to be done at two temperatures bracketing the specification requirements from which the temperature where the criteria are met can be interpolated. The characteristic that will be looked at is the ΔT_c which is the difference between the stiffness critical temperature and the relaxation (m-value) critical temperature. Previous work by Mike Anderson and Tom Bennert indicates that when ΔT_c "exceeds" -5°C there is a significant loss of cracking resistance. If assuming the "worse-case" scenario (from a binder perspective) then if blending is less than complete, the impact of the aged binder on stiffening and relaxation is less than the laboratory would predict; and if blending is completely homogeneous, the impact on stiffening and relaxation would be accounted for. The positive aspect of to this approach is the relatively simplicity for the state to perform and allows for informed decision on setting RAS limits based on available virgin binder and existing RAS binder. The negative is that it doesn't address mixture issues (VMA) if the RAS binder does not become fully blended, then the binder volume would be less than calculated. Binder availability of 0.70 could result in a VMA reduction of ~ 0.50%; and could have a mix with better quality binder but insufficient quantity. There are also some potential issues with virgin binders meeting the -5°C criteria.

The Task Group is looking at even further simplifying the proposed approach by setting a maximum recycled binder ratio (RBR) for mixtures with RAS (possibly a RBR of 0.10 which corresponds roughly to 3% RAS with ΔT_c = -5°C). States that want to exceed this amount would need to evaluate ΔT_c or possibly use tiered approach. Musselman noted these suggestions are a starting point and need for feedback and data to refine the idea further.

The Task Group will be working on revising PP 78 and MP 15 to reflect the ΔT_c criteria. There is a need to have the revisions for the provisional standard ready by March 2016 in order to be published by July 2017. The Task Group will continue to address the volume of effective binder issue and the recommended performance test.

Musselman presented the cracking map for two test sections from the last round of NCAT test track: 25% RAP with a PG76-22 SBS modified asphalt binder; and a 20% RAP + 5% RAS with the same PG76-22 SBS modified asphalt binder. The crack maps showed significantly more cracks in the 20%RAP + 5% RAS section.

ETG Comments, Questions, and Discussion:
D'Angelo noted that the ΔT_c of -5°C limit is based on work done by Mike Anderson and Thomas Bennert where up to -5°C there wasn't significant amount of cracking observed using different mixture testing.

Huber commented that he envisions that the ΔT_c of -5°C cannot be measured on every mix design. Rather, the state agency would collect and test regional materials and set the limits for the allowable recycled shingles in a mix. Reinke commented that a contractor can characterize the asphalt shingles and virgin asphalt binders to be used in a season and provide the data for the contracts on which RAS will be used. Reinke noted that the binder availability factor doesn't matter whether it is TOAS (~PG160) or MWAS (~PG140) since both are similar in terms of softening points. He also noted that the high temperature grade and the stiffness low temperature grade doesn't seem to change much with aging however the m-value low temperature grade is what changes significantly.

Buncher commented that the ΔT_c is not affected by the type of RAS. West commented that additional data is needed. D'Angelo responded that everyone agrees that mixture testing for performance evaluation is the next step however there is an immediate need for quick modification to the procedure to limit the use of RAS in a mix. West suggested sending, along with the recommendations to AASHTO, a commentary about the need for mixture testing. Mike Anderson commented that the approach is good with a simple limit on RAS binder along with a recommendation to consider mixture testing to further evaluate the material. Mohammad suggested to just provide a guidance on the RAS binder content and leave it up to the state highway agency to select the mixture test for further evaluating RAS mixtures. Mohammad noted that he has data for mixtures with RAS that he will share with the Task Group.

Hand noted that with the tier approach in the same specification, using 15% RAP without changing the grade is acceptable in some cases but not always. He noted that the tier approach is not a good approach since dealing with different RAPs and using the ΔT_c is a better approach. Kluttz asked to clarify the aging conditions. D'Angelo responded that one approach is to recover the RAS binder and blend it with the expected virgin binder to get the %RAS needed for the final grade then conduct a full grading of the blend with the 20 hours PAV and check for the ΔT_c. Kluttz asked about the aging condition for mixture testing. D'Angelo responded that no recommendation will be provided at this point. Bukowski noted that the Task Force is attempting to improve the specification and will not be able to initially address all the problems/issues.

Musselman asked if after the full grading the low PG will still need to be met. Huber commented that in addition to meeting the low PG grade, the ΔT_c will need to be met. Musselman noted that this is not currently necessarily reflected in the proposed changes. D'Angelo noted that meeting the low PG grade might not be necessary in some cases. For examples an agency might be using a -22°C low PG grade for virgin binders but the climatic grade does not require a -22°C, hence it can sacrifice some of the reduction in the low PG while delta Tc is still within -5°C.

Gierhart commented that it is unlikely that an agency will be determining ΔT_c at an individual mix design level. Marks commented that as an agency she hasn't looked at ΔT_c alone but needed to combine the ΔT_c with other measured properties. Ramirez supported the tier approach since it allows for additional testing. He also noted that targeting 3% RAS might be difficult to target during production and the 5% RAS maybe the minimum to have consistent production. Anderson noted that Utah DOT is not set up to do extraction and recovery and that is why he supports the tier approach.

Musselman questioned whether using VMA for binder quantity is appropriate instead of using the asphalt binder availability. Hand commented that the current availability approach calculation is confusing for the average lab technician. Gibson suggested using mixture performance testing to determine what that availability might need to be. Bukowski agreed with the mixture testing approach however there is an immediate need for making the changes regarding binder in the current specification. Buncher noted that when introducing RAS to the mixture there will be an increase in VMA requirement proportional to RAS binder. West commented that the mix design should assume at 100% effective and Gse of the RAS is recommended to be used for specific gravity. West noted that typically a 1/10 of VMA increase is observed with every 1% of RAS increase. Tran suggested that ΔT_c has to be tested on the blended binder. D'Angelo commented that since RAS binder alone is hard to test at low temperature, then a 50/50 blend is prepared and tested to get the low PG properties and then develop the blending chart between 0 and 50 (instead and not 0 and 100). Reinke mentioned that all work for ΔT_c is on PAV at 40 hours aging. D'Angelo commented that data from Bennert were based on ΔT_c at 20 hours. Bonaquist noted that a lot of work needs to be done on the recovery process because the binder in RAS is difficult to extract. Hence, if ΔT_c is going to be the specification then there is a need for serious changes to the recovery process otherwise need to do testing on the mixture.

Action Item(s):
Action Item #201509- 10. Input is requested, by the end of September, to be sent to Jim Musselman regarding changes under consideration by the RAS/RAP Task Force on the current RAS standards.

19. Construction Task Force Update [MTE Services Inc.]

Presentation Title: *Construction Task Force Update, Andrew Hanz, MTE Services Inc.*

Summary of Presentation:

Hanz outlined the discussion points: 1) High recycled Projects and Performance Testing, 2) Joint Density in-Progress Research, and 3) Solicit Mix ETG for future task force activities.

Hanz first presented the high recycled projects: STH 77 Ashland CTY WI. Part of WisDOT High Recycled Asphalt Material Pilot Program (2014), and three projects in NC WI and Central MN (2015) which consisted of one state road and two county highways. The percent binder replacement was approximately 40%. Performance testing is incorporated as part of mix design and production testing and consisted of DC(t) (thermal cracking), semi-circular bend-LSU and UIUC (fatigue), and Hamburg (rutting). Long-term aging for SCB and DC(t) testing consisted of loose mix aging for 12 hours at 135°C instead of 5 days at 85°C. Asphalt binder was recovered from long-term aged specimens and graded and tested for ΔT_c. The high recycled general approach was presented for materials selection (characterize recycled material, select PBR and virgin binder, and volumetric design) and mix design and performance testing (verify binder properties, evaluate Hamburg, cracking resistance). The testing plan during construction was implemented for the first 600 ton of production and every 10K ton after. Field performance surveys and coring and analysis of mixture modulus, cracking tests and recovered binder properties are all planned activities.

As an example, results from the STH 77 comparison to control mix were presented. At a minimum the expectation was that the high recycled mix would perform as well as conventional mixes placed in WI. Primary distress in WI is cracking, hence comparison focused on recovered binder grading, DCT testing, and sensitivity to aging. A Comparison between the two mix designs was presented. A PG58-34 was used with control mix (12.5 mm) and a PG58-40 was used with the high recycled (12.5 mm) mixture. The PG58-40 required more polymer which resulted in lower Jnr value. The control mix has 24.5% binder replacement while the high recycled mix has 36.7% binder replacement. Test results for binders recovered from mixes subjected to loose mix aging at 135°C were presented. Based on the binder test data, high recycled mix was softer after 12 hours loose mix aging, mixes behave the same at 24 hour aging. Differences in R (2.8 vs. 3.0) and cross over frequency (61 rad/s vs. 12 rad/s) observed for high recycled mix. The DC(t) test results for the average of four replicates were provided for 12 and 24 hours loose mix aging. Hanz showed pictures for both control and high recycled mixtures pavements from STH 77 one year after construction (From august 2015). The high recycled section is 4 miles long while the control section is 9 miles. Overall the pavement is performing well and no difference in performance between the two sections is observed. However, there were very few transverse cracks on both sections.

Hanz summarized the first part of his presentation by concluding that performance testing has evolved from a research tool to part of conventional practice in their lab and they found performance testing to be beneficial to adjusting mix designs or materials selection. With this set of projects there is an opportunity to compare actual field performance to laboratory test results and possibly to lab conditioning to field aging.

Hanz noted the performance testing challenges which included

- Test procedure harmonization: conditioning, sample geometry, etc.
  - Example: WisDOT vs. MnDOT DCT, notch depth/width for different cracking tests.

- Repeatability within lab and between labs.
  - ASTM working group for SCB, cracking test study with Rutgers.
- Aging: Protocol and relation to field.
- Selecting tests and performance criteria
  - Use "standard" mixes as a baseline.

Hanz presented the comparison between the ΔT_c of the binder recovered from top ½ inch of core to the ΔT_c of the binder recovered from 12 hours and 24 hours loose mix aging at 135°C for the mixtures from Minnesota (Reinke 2015 ETG). Hanz noted that the long term aging was based on the work conducted by Phil Blankenship on aging of loose mixtures. The aging is intended to match what is happening in the top of the mix and not the whole mix in the layer.

Hanz next presented an update on the longitudinal joint density research. The project is the WisDOT Funded 0092-15-09: Asphalt Mixture New Specifications Implementation – Field Compaction and Density Validation. Two specific initiatives that require additional field research and evaluation: 1) special provision for Thin Layer Overlays, and 2) evaluate density measurements of longitudinal joints to assess construction and compaction. Mathy is also collecting joint density data on projects in WI, MN, IA, and MI.

ETG Comments, Questions, and Discussion:
Mohammad asked whether it was difficult to compact the mixtures to the target air voids after the extended loose mix aging at 135°C. Hanz responded that no issues with compaction were encountered however the mixtures had soft binders. All performance tests were conducted at 7% air voids. Huber commented that when doing loose mix aging for extended time, the maximum theoretical specific gravity (Gmm) needs to be monitored and taken into consideration when compacting specimens for performance tests. Hanz responded that this has not been done as part of this work effort. Gierhart noted an error in the presented calculation for the volumetric of the control mix (in particular the Vbe calculation).

Mike Anderson commented that Asphalt Institute observed more aging and better and quicker results with the loose mix aging for 24 hours at 135°C. He also noted that sometimes the air voids are out of target when compacted mixtures are aged for 5 days at 85°C.

Bukowski suggested for the Construction Task Force to focus on few critical areas. He noted that FHWA has an executive task group that looks into FHWA programs. The group is made up of concrete and asphalt association leaders, contractors, and the executive director at Utah DOT, head of research at SDDOT, the highway commissioner of the GDOT, and deputy secretary from Vermont. Kevin Hall is part of this group. The group met about a month ago and the group is aware of the Asphalt ETGs and Task Groups efforts. The group focused specifically on two areas. Under the first area, the group asked specifically FHWA to ask the construction group to look into improvements in the construction methodologies for asphalt pavements. Among others, the group was interested in looking into better ways to monitor quality control during construction. The group also mentioned NCAT work of looking at better monitoring of the production process. Bukowski recommended for the Construction Task Group to look into that area again and what can be improved during the production and construction process. Kevin Hall noted that the idea was on how to better monitor the production process so that a quality product

is being produced. Hall gave the NCAT study on monitoring and controlling the stockpile moisture content as an example. The question was whether there are things that can be done during construction process to get a better consistent product both at the plant and maybe on the roadway. Bukowski suggested for the Task Group to look into the whole system of what is being done during the quality control and what is available during the process but then target a few focus items that are doable and make a difference. However it is up to the Task Group to discuss and decide on how to move forward. Hall noted that the charge given to the Pavement Implementation Executive Task Group was what technologies exist that can be rapidly taken to practice.

Bukowski noted that the next meeting for the Pavement Implementation Executive Task Group is scheduled for August after the ETG meeting in April hoping the group will have some ideas from the ETG Construction Task Group (things that can be implemented relatively rapidly and affect construction).

Under the second area of interest, the Pavement Implementation Executive Task Group asked FHWA to create a task group on balanced mix design. Bukowski suggested creating a Task Group from not only ETG members but also friends of the ETG of 6-8 individuals to start by defining balanced mix design, goals, and how to achieve those goals. Hall noted that the Executive Group is looking for solutions, tools that can be done immediately and not for five years of research. For example, how to address cracking and what can be done at the mix design stage to minimize cracking and how to provide a state with a guidance to characterize cracking. It is not about a specific cracking test rather if a state already have a cracking test how would the state use the test at the design stage to balance the mix and minimize cracking. Bukowski mentioned that a discussion also on balanced mix design took place during the SOM meeting in Pittsburg. He noted that the new ETG Task Group needs to formulate suggested guidance about balanced mix design and provide a clear direction based on the various available methods and information. Hall suggested to think about the direction as almost like a road map for balanced mix design (where we want to be and how to get there). Hall noted that ultimately we need fundamental tests and analysis but what can be done in the meantime as part of the road map (what is available and what is not available). Musselman recommended the approach needs to stay practical.

Action Item(s):
Action Item #201509- 11. Balanced Mix Design Task Force to provide update at the next meeting on a definition and outline of needed efforts.

Action Item #201509- 12. Construction Task Force to provide update at the next meeting on "Improvements on Rapid Asphalt Production & Construction Control".

20. FHWA Pavement Density Initiative [John Bukowski, FHWA]

Presentation Title: *FHWA Pavement Density Initiative, John Bukowski, FHWA*

Summary of Presentation: *Enhanced Durability Through Increased In-Place Pavement Density, John Bukowski (FHWA).*

ETG Comments, Questions, and Discussion:
Bukowski mentioned that FHWA has already met with NAPA, NCAT, and contractors and will be contacting state agencies about a possible project on improved compaction. The assumption for this project is that pavement density can be increased (to a degree) with a minimum of additional cost. If possible, then we can convince the states to increase their in-place asphalt pavement density requirements which would result in increased pavement life.

Bukowski presented the FHWA's strategic goal for the Pavement Technology Program, "Provide leadership and technology for the delivery of **long-life pavements** that meet our customers' needs and are safe, cost effective, and can be effectively maintained." He also noted the Part 626.3 Policy on "Pavement shall be designed to accommodate current and predicted traffic needs in a safe, **durable**, and cost effective manner." Some of the premise to this is that typical asphalt pavement density requirements in some part are based on what was achievable in the past. Bukowski noted that recently significant advancements in material and construction technology and techniques have been. The challenge is whether today's technology and techniques can be used to raise-the-bar on in-place density to improve durability and extend pavement service-life. Bukowski mentioned that half of the state highway agencies are not satisfied with the overall performance of longitudinal joints (according to the 2011 FHWA Division Office Assessment). There have been efforts to improve longitudinal joints density and best practices were developed. A 2013 NAPA Industry Survey revealed that more than 30% of asphalt materials are produced using WMA technology. Warm mix in theory would allow us to have better workability and better compaction. Many state target density requirements are 20+ years old. Bukowski showed a chart for the various tools/technique/technologies that may lead to a better compaction. These technologies consisted of: Warm Mix Asphalt, Intelligent Compaction, Longitudinal Joint Best Practices, Tack Coat Best Practices, Asphalt Mixture Performance Tests, and the IRBar. With the various tools there is an ability to improve density (increase compaction) at a minimum of extra cost and accordingly be one of the biggest improvements on durability.

Bukowski noted that FHWA is working with NAPA and NCAT on updating available information. He noted that several states have an average mat density of 91.5 and 92% and the question is whether this can be increased 1-2%

Bukowski presented several considerations such as how density is measured (Percent within Limits, Minimum with Maximum, Running Average, Target with Tolerances ± 0.2%). Other important considerations are related to the appropriate lift thickness for NMAS and coarse gradations, appropriate mix design requirements, appropriate test methods for measuring compaction (both G_{mm} and G_{mb}), density only a surrogate for permeability (density and permeability are not always the same thing), appropriate acceptance criteria that properly motivates and rewards the contractor to reach the desired level of compaction as opposed to just the minimum. Bukowski noted that the attempt is not to try to solve all the various problems. Bukowski presented that a 2% increase in field compaction claimed to increase asphalt pavement

service life from 5 to 10+%. So can we increase today's target density of 92% by 2% and get better durability and extend pavement life.

Bukowski presented a preliminary schedule for the Increased Density Pavements Project. Within the next 12 months 10+ SHAs will host an "Increased Density" Asphalt Construction Workshop. It is anticipated to have SHA, contractors, equipment suppliers, and academia attend the workshop. The Asphalt Institute is developing a training course on overall importance of compaction and what it means and how to achieve. NCAT is looking at work that has been performed on the impact of density on the change of pavement performance life. FHWA will fund 10 State highway agencies to place an "Increased Density" pavement section. The project won't be a standalone project but will be working with existing projects and setting up a section within the existing project on which the target density will be increased. The first step in to increase the density with the existing equipment but with only more compaction. If the projects turn out to be a success the documented information will be used to target States in an attempt to convince them to increase density requirements.

The following are the possible next steps:

1. Webinars (NAPA), On-site training (AI), Information search (NCAT)
2. Fund State Agency trials/reports on feasibility
3. Encourage State Agency standards changes (1- 2% increase in MTD)

In summary Bukowski noted that the effort is to increase in-place densities which is believed can be done with current technologies and practices.

ETG Comments, Questions, and Discussion:

Abadie asked whether FHWA will be designating the method of measure in-place density. Bukowski responded that the goal is not to change the state method or practice for in-place density measurements. A discussion for changes with the state will be initiated only if it is determined that a state is doing something questionable for measuring in-place density. Abadie commented that it will be good to have the same measurement methods at least on the control sections. Bukowski responded the purpose is not necessarily to change existing practices but improve asphalt pavement density with current practice.

Bob Kluttz commented that along with the concept of balanced mix design it is important to understand what is happening in the lab and how does it translate to the field. Bukowski noted that FHWA is not going to overly prescribe what the state has to do; rather FHWA will work with the states along their best practices in order to achieve the simple goal of this project. The main question that we are trying to answer as part of this project is whether we can improve in-place density with minimum to no additional cost. Bukowski mentioned that FHWA is trying to have states reach a desirable density target with the least amount of changing everything. Musselman commented that this is an excellent idea and there are two things that need to be focused on in order to achieve a better performance life: 1) raising the target density and 2) the specific gravity when calculating things like VMA. Several State DOTs are not using the appropriate specific gravity and end up having a lower VMA and accordingly less asphalt binder in the mix. These two points are very simple and would result in a great improvement in the quality of asphalt pavements. Bukowski noted that FHWA will fund the project and it will be the

state decision for what changes/modifications to make. Bukowski noted that this project is not an effort to make use of intelligent compaction but if a state is already using it, it can well be part of this project.

21. Other Topics

Adam Hand suggested that it is worthwhile to conduct a review on the aging conditions being used for different mixtures' type (LMLC, FMLC) by surveying different state agencies. Hand volunteered to draft a need statement. Bukowski commented that an AASHTO SOM survey might be conducted to check what state agencies are doing and whether they need to do something different. Abadie commented that he can help sending out the survey through AASHTO SOM. Hand and Tran volunteered to draft the questions and send them to Abadie for conducting the survey.

22. Action Items and Next Meeting—Shane Buchanan (Old Castle materials) and John Bukowski (FHWA)

Action Items:

Action Item #201509-1. Ed Harrigan will provide, for distribution to the ETG, a copy of the final draft report from the NCHRP Project 9-52, "Short-Term Laboratory Conditioning of Asphalt Mixtures". Each member is to review for potential implementation and effects on existing standards such as AASHTO R30.

Action Item #201509-2. Input is requested to be sent to Jeff Withee on the draft AMPT equipment specification standard.

Action Item #201509- 3. Randy West is requested to provide the ETG for review and comment prior to the next meeting, a draft report of the NCAT efforts to evaluate a simplified cracking test.

Action Item #201509- 4. Louay Mohammad is requested to present at the next meeting an update on Pooled Fund 5(294) "Design and Analysis Procedures for Asphalt Mixtures Containing High RAP Contents and/or RAS".

Action Item #201509- 5. Dave Newcomb is requested to present at the next meeting an update on NCHRP Project 9-57, "Experimental Design for Field Validation of Tests to Assess Cracking Resistance of Asphalt Mixtures".

Action Item #201509- 6. Richard Kim is requested to present at the next meeting an update on NCHRP Project 9-54, "Long-Term Aging of Asphalt Mixtures for Performance Testing and Prediction".

Action Item #201509- 7. Nam Tran/Kevin Hall are requested to present at the next meeting the status of the MEPDG asphalt cracking models.

Action Item #201509- 8. The T321 Task Force is asked to finalize and present at the next meeting a summary of equipment/software changes needed on existing test devices as a consequence of recent AASHTO changes in the standard.

Action Item #201509- 9. Nelson Gibson at the next ETG meeting will present an update on the status of the FHWA ALF project.

Action Item #201509- 10. Input is requested, by the end of September, to be sent to Jim Musselman regarding changes under consideration by the RAS/RAP Task Force on the current RAS standards.

Action Item #201509- 11. Balanced Mix Design Task Force to provide update at the next meeting on a definition and outline of needed efforts.

Action Item #201509- 12. Construction Task Force to provide update at the next meeting on "Improvements on Rapid Asphalt Production & Construction Control".

23. Next Meeting Location and Date:

The next meeting date was coordinated with the Binder ETG and will be during the week of April 25th. Currently two potential meeting locations: Reno, Nevada and Salt Lake City, Utah. Bukowski noted that probably this would be the last meeting for SME supporting the ETGs and there will be a new contract for next year (SME is not on the specific contract list). He thanked SME and Lori Dalton for their help and support throughout the previous years.

24. Meeting Adjournment

Shane Buchanan and John Bukowski thanked all attendees for their participation on the ETG and attending this meeting. The meeting was adjourned at 10:30 am.

ATTACHMENT A

Asphalt Mixture Expert Task Group
Oklahoma City, OK
September 16-18, 2015
Meeting Agenda – Draft

Day 1 – September 16, 2015

1:00 pm	Welcome and Introductions	**Buchanan/Bonaquist**
1:15 pm	Review Agenda/Minutes Approval & Action Items April, 2015 Meeting	**Bukowski**
1:30 pm	Subcommittee on Materials Updates/Comments	**Abadie**
2:30 pm	Update Related NCHRP Activities	**Harrigan**
3:00 pm	Break	
3:30 pm	Overview Mobile Lab Project WI STH 73	**Corrigan**
4:00 pm	REOB Status – AI/AASHTO	**Corrigan/Anderson**
5:00 pm	**Adjourn for the Day**	

Day 2 – September 17, 2015

8:00 am	Overview of Performance Tests	**Withee**
	• NCAT Activity	**Tran/West**
	• LSU pooled Fund TPF 5(294)	**Mohammad**
10:00 **a**m	**Break**	
10:30 am	Task Group Review Update T-321 (Beam Fatigue)	**Rowe**
11:00 am	FHWA ALF (RAS, RAP, WMA) Experiment Update	**Gibson**

Noon - Lunch Break

1:00 pm	Silo Storage Effects on RAP Mixtures	**Eshan Dave**
2:00 pm	Design of High RAP Mixes	**Wen**

3:00 pm	**Break**	
3:30 pm	Update 9-49A WMA Long-Term Performance	**Wen**
4:30 pm	Update on the WMA Task Force/LTPP Experiment	**Bonaquist/Musselman**
5:00 pm	**Adjourn for the Day**	

Day 3 – September 18, 2015

8:00 am	Report Task Force RAP/RAS	**Musselman**
9:00 am	**Break**	
9:30 am	Construction Task Force Update	**Dukatz**
10:30 am	FHWA Pavement Density Initiative	**Bukowski**
11:00 am	Action Items and Next Meeting Planning	**Bukowski**
Noon	**Adjourn**	

ATTACHMENT B

FHWA Asphalt Mixture & Construction Expert Task Force Members

Chairman: **Shane Buchanan** Asphalt Performance Manager Old Castle Materials 133 Sheffield Lane Birmingham, AL 35242 Cell: 205-873-3316 Shane.Buchanan@oldcastlematerials.com	Co-chairman: **Ray Bonaquist** Chief Operating Officer Advanced Asphalt Technologies, LLC 40 Commerce Circle Kearneysville, WV 25430 Phone: 681-252-3329 aatt@erols.com
Secretary: **John Bukowski** Asphalt Team Leader FHWA Federal Highway Administration 1200 New Jersey Ave., SE; E75-332 Washington, D.C. 20590 Phone: 202 366-1287 Fax 202-493-2070 John.Bukowski@dot.gov	
Members:	
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ATTACHMENT C

Task Force Members and Assignments
FHWA Asphalt Mixture & Construction ETG

Task Force Identification:		Members Assigned to Force:
1	Performance Test Review	Mike Anderson (Lead), Ray Bonaquist (Lead); Richard Kim, Elie Hajj, Haleh Azari, Audrey Copeland, Kevin Van Frank, Phil Blankenship, Nam Tran, Raj Dongre, Nelson Gibson, Harold Von Quintus
	T 320; Simple Shear Test	Louay Mohammad, Tom Bennert, Richard Steger, Becky McDaniel
	T 321; Bending Beam Fatigue	Geoff Rowe, Tom Bennert, Phil Blankenship, Bill Criqui, John Harvey, Kieran McGrane, Mike Mamlouk, Richard Steger, Louay Mohammad, Elie Hajj, and Andrew Copper
	T 322; Indirect Tension	Jo Daniels, Becky McDaniels, Rey Roque, Richard Steger
2	WMA Mixture Design	Matt Corrigan (Lead): Louay Mohammah, Charlie Pan (for Reid Kaiser), Gerald Reinke, Kevin Hall, Dave Newcomb, Randy West, Tim Ramirez, Walaa Mogawer, and Jason Lema.
3	Construction Task Group	Erv Dukatz (Lead); Jim Musselman, Kevin Hall, Gerry Huber, Adam Hand, Ron Sines, Audrey Copeland, Tom Harman, and Mark Buncher.
4	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.
5	RAP/RAS	Jim Musselman (Lead): Timothy Aschenbrener, Audrey Copeland, John D'Angelo, Lee Gallivan, Danny Gierhart, Gerry Huber, Timothy Ramirez, Ron Sines, Hassan Tabatabaee, Randy West, and Richard Willis.
6	LTPP WMA Group	Jim Musselman (Lead); Ramon Bonaquist, Adam Hand, Georgene Geary, Audrey Copeland.
7	Balanced Mix Design	Shane Buchanan (Chair), Kevin Hall (Co-Chair): Chris Abadie, Andrew Hanz, Gerry Huber, Lee Gallivan, Pamela Marks, Louay Mohammad, Randy West and Tim Aschenbrener.