national superpave news

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AASHTO Publishes New Provisionals

In April 2001, AASHTO published another set of Provisional Standards for construction materials. AASHTO created the "provisional" category in 1993 to allow early dissemination of products from SHRP and other research. Specifications or test methods can remain on the books as provisionals for up to eight years. During that time, the standards are reviewed and revised based on experience with the protocols. By the end of eight years, the standard must either be adopted as a full standard or it is dropped. Since the category was established, eight provisional standards have been adopted as full standards.

The latest edition contains six new standards, eight standards that have been substantially modified and 17 standards that have been reconfirmed for publication. In the asphalt area, four provisional standards are published for the first time. They include:

- MP1a, Standard Specification for Performance Graded Asphalt Binder
- PP41, Standard Practice for Designing Stone Matrix Asphalt (SMA)
- PP42, Standard Practice for Determination of Low-Temperature Performance Grade (PG) of Asphalt Binders
- PP44, Standard Practice for Quantifying Cracks in Asphalt Pavement Surface

PP42 is based on work done by the Asphalt Institute and Dr. Hussain Bahia, University of Wisconsin, under NCHRP 9-10, *Superpave Protocols for Modified Asphalt Binders*. (See the article by Dr. Bahia and Doug Hanson in the Fall 2000 edition of this newsletter, available online at bridge.ecn.purdue.edu/~spave/newstoc.htm.) Research conducted by the North Central Superpave Center and the Asphalt Institute as part of NCHRP

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SUPERPAVE—WHERE WE'VE BEEN AND WHERE WE'RE GOING

Ray Brown, Director, NCAT

Background

Superpave (superior performing asphalt pavements) is the result of a five year study under the SHRP program that was completed in 1993. As a result of Superpave, we have improved aggregate specification requirements, a new asphalt grading system and an improved mix design procedure. Also as part of Superpave, it was anticipated that methods would be developed to test hot mix asphalt and to use these results to predict performance (rutting and cracking), however these tests have not been finalized.

Aggregate

The aggregate specifications were developed based on experience from a number of engineers and not from research under the SHRP program. The specifications consist of concensus properties such as fine aggregate angularity, coarse aggregate angularity, flat and elongated content and sand equivalent values. There are also test requirements for source properties such as L. A. Abrasion, soundness, etc. It was anticipated that the concensus tests could be specified on a national basis, and the source properties could be specified more locally at the state level. The most controversial aggregate requirements were the restricted zone, which was a part of the gradation requirements, and the fine aggregate angularity.

The restricted zone was meant to be a guide for establishing the gradation of a mixture, but many states adopted this guide as a rigid specification requirement. If used properly, the restricted zone will help ensure that a humped grading will not be used; experience has shown this type of gradation may cause tender mixes. The restricted zone will also help to ensure that sufficient VMA exists in the mix to allow a satisfactorily high asphalt content. However, many states have found that the restricted zone has rejected many mixes that had been used successfully in the past. A sufficiently high asphalt content can be assured by specifying a minimum VMA requirement. The humped grading caused by some natural sands can be eliminated by specifying the quality of the natural sand to be used or by setting a limit on how much natural sand can be used. Elimination of the restricted zone is now being considered since it is really not necessary to ensure a quality hot mix asphalt.

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Dateline Tempe

By Lee Gallivan, FHWA

The first true millennium meeting of the TRB Mixture and Aggregates Expert Task Group was held on the Arizona State University Campus in Tempe, Arizona, on April 3 and 4. The ETG was under the direction of Mr. Jim Musselman, the new Chairman. There was excellent attendance from numerous state DOT's, industry, FHWA, and academia representatives. The agenda consisted of summary reports of the ETG Taskforces, in addition to presentations by the FHWA, NCHRP, AASHTO, NCAT and industry, including a short disclosure by the chairman regarding his recent surgery for a ruptured appendix.

The meeting started with Tom Harman discussing FHWA projects 90-1 (Trailer activities and the AVK, Corelok, mix verification, and PRS work), 90-3 (Mix Tenderness), 90-5 (Fine Aggregate Specific Gravity Testing), 90-7 (Understanding Modified Binders), and 90-9 (Mastic Testing). John D'Angelo then reported on Binder ETG activities and accomplishments such as the approval by AASHTO of the new/updated binder specifications contained in provisional standard MP1a. The Binder ETG also scheduled their spring meeting at ASU in an attempt to have full disclosures on several joint ETG activities.

Ed Harrigan then provided an excellent summary of current and proposed research activities related to asphalt. Several new studies are now in the process of identifying panel members who will then prepare the detailed scope of the work. The projects are:

- 09-21 Advisory Structure for Superpave Implementation and Related Research
- 09-33 Superpave Mix Analysis Method, Software and Manual
- 09-34 Improved Test Procedure for Determining the Moisture Damage Susceptibility of Bituminous Pavements

Rick Harvey and Haleem Tahir then updated the ETG on AASHTO SOM activities, including the upcoming meeting in Kalispell, Montana, and on the publication of the 2001 Provisional Standards published in April. Jimmy Brumfield also discussed efforts by the SOM to better coordinate the taskforce, technical section and full committee ballots to meet the publishing deadlines for the manuals. The ETG might be asked to adjust their meeting dates in the future to address SOM needs.

Gerry Huber reported on activities regarding the SGC Comparisons and Calibration Taskforce. The taskforce is presenting two alternatives to address current concerns by DOT's and Industry over dissimilar mixture specimens produced by different gyratory compactors. The taskforce is recommending that the following two alternate methods may be used: 1) the FHWA/Corelok Angle Validation Kit (AVK), or 2) calculated offsets between gyratories. These alternatives should only be used after SGC comparative calibrations, mixture sampling, splitting, heating, and charging methods have been confirmed to be the same. Larry Michael also wants the manufacturers to address the issues among themselves.

In short, the AVK is now being produced and distributed by Corelok, who have patented the device for distribution. The cost of the device plus an NIST traceable correlation device will cost $8900. The device is still under testing to establish tolerances and applicability for all SGC's. The Maryland DOT is interested in using the AVK's when disputes arise.

The FHWA has also prepared draft procedures to address developing multiple technicians and/or compactor offset values to be used for all volumetric calculations. Current problems include implementation issues within DOT's to address the administration of contracts. The Indiana DOT indicated they are preparing guidelines to implement the offset procedures for 2001 when disputes arise. The ETG decided not to support either option and only issued a statement that the compactors are different.

Kevin Hall provided the ETG with detailed comparisons of differences in AASHTO T 209-96 (Maximum Specific Gravity of Compacted Bituminous Mixtures) and ASTM 2041-00. ASTM has recently completed a rewrite of specifications that addresses most if not all of the AASHTO concerns. Hall asked everyone to review both documents in detail before the next SOM meeting.

Gerry Huber and Bill Pine then provided the ETG with a follow-up to the ETG question from their last meeting regarding the Bailey Method, an aggregate gradation optimization process on national experiences (MD, IN, AZ, etc.). The ETG felt that additional validation is needed prior to endorsement.

Larry Michael closed out the first day with discussions regarding a Superpave 4.75 mm mixture in MP2, etc. Several states supported Michael's efforts and he "volunteered" to prepare draft specifications for review by AASHTO.

John D'Angelo started the second day with "draft" Field Mixture Verification Procedures that address contractors quality control activities related to Superpave mixtures and volumetric controls as requested by the ETG. Committee members were encouraged to provide any and all comments to D'Angelo and he will attempt to incorporate them prior to submission to AASHTO.

Tom Harman and John Bukowski then discussed the status of the National Pooled funds project regarding the PQI Gauge, Corelok, and E* equipment currently under development or validation testing. Regarding the PQI Gauge, Harman concluded that the study recommends not using the gauge (including model 300) for QC testing since the results are truly random and it gives a false sense of compaction efforts.

Ted Ferragut provided an update of AASHTO's current and future long-range plans on completing Superpave by 2005. Ferragut discussed each of AASHTO's goals and related research in each goal. It is anticipated that all items will be completed by July 2004.

Following the Mixture/Aggregates ETG meeting, the contract staff from NCHRP 9-19 provided a summary presentation regarding the status of the study, entitled "Development of Asphalt Models and Validation of Simple Performance Test," to a joint meeting with the Binder ETG.

The next meeting of the ETG was preliminarily scheduled for the end of August in Washington D.C.

Superpave — Where We're Going

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The fine aggregate angularity test has also been criticized for a lack of data to support its use. Data has been developed that shows this test to be related to performance. This data was primarily developed for pre-Superpave mixes (in most cases fine graded mixes), but it is thought to have some merit with Superpave mixes as well. This test remains in the specifications for Superpave and will likely continue to be a test requirement.

Asphalt Binder

The new asphalt grading system appears to be a significant improvement over the old existing systems. The new system specifies the properties at the highest anticipated pavement temperatures and at the lowest anticipated pavement temperatures so that the binder is stiff enough to help prevent permanent deformation at higher temperatures and flexible enough to resist cracking at the lower temperatures. One of the initial tests was a tensile test but there were problems with the equipment and adoption of this test as a routine requirement was delayed. With the adoption of AASHTO PP42 for low-temperature grading of a binder, the direct tension test will assume a greater role.

Work is currently underway to modify the classification system to make it more applicable to modified asphalts. When the initial SHRP study was conducted very little work was performed with modified asphalts so it is not certain how applicable the existing system is when the asphalt is modified. There is some evidence that all asphalts having the same PG grade will not perform the same. This was one of the original goals of the new PG grading system but more work is needed before this goal is achieved.

Mixtures

One primary difference between the Superpave mix design system and previous mix design procedures is the way samples are compacted. As a part of the Superpave method a new gyratory compactor was developed. The primary advantage of the gyratory compactor over the Marshall compactor is that the gyratory compactor orients the aggregate particles more like that observed on roadways. Evidence also indicates that the Superpave gyratory compactors are more repeatable than Marshall hammers. The gyratory compactor is also much quieter during compaction than the Marshall hammer.

One of the criteria with the Superpave system is that each mix be conditioned prior to compaction during the mix design process primarily to simulate the absorption of asphalt that is observed in practice. Initially the conditioning temperature and compaction temperature were different. This required extra handling and time to prepare compacted specimens. After some experience with Superpave the conditioning and compaction temperatures were made the same, thus making sample preparation much more efficient.

Initially there were 28 compaction levels for Superpave mixes. The compaction levels represented seven traffic levels and four climatic zones. These gyration levels were developed with limited data and it was recognized from the start that the recommended number of gyrations for a given traffic level needed to be verified. One study recommended that the number of potential compaction levels be reduced from 28 to four. This recommendation was later supported by the Mix ETG and adopted by AASHTO. This was done by reducing the number of traffic levels to four and recognizing the fact that the differences in climate were actually offset by the grade of binder used and, therefore, did not have to be corrected by varying the number of gyrations. This still did not verify that the number of gyrations were correct; it simply reduced the number of levels. A study is presently underway to verify that the number of gyrations for different traffic levels is correct. This study should be completed in 2003, although some preliminary results may be available before that time.

The Superpave gyratory compactors are designed to apply a gyration angle of 1.25 degrees. There has not been a good way to verify that a particular compactor was in fact providing this angle of gyration. The FHWA has now developed a device that appears to accurately measure the gyration angle by placing the device inside the compaction mold during compaction. Work is still underway to verify that this measured angle is accurate but at this time it appears to be. There have been some observed differences between the densities obtained with different brands of gyratory compactors. It now appears that much of this difference may have been caused by differences in gyratory angles. If the FHWA device is proven to be accurate, it is likely that in the future individual compactors will be calibrated with this device to ensure that the proper angle is obtained. It has also been observed, based on the FHWA device, that the angle applied to a specimen is actually affected by the stiffness of the mix, so it is possible that a gyratory machine may have to be calibrated for significant differences in mix types (for example coarse graded vs. fine graded mixes).

There was not very much initial guidance on the use of recycled materials in Superpave since the use of RAP was not included in the original research. Additional research after Superpave was adopted has made it much easier to use RAP in Superpave mixes. The use of RAP is extremely important and there is no reason that RAP cannot be used in Superpave to the same extent that it was prior to Superpave.

Superpave technology is compatible with mix types other than dense graded mixes, for example SMA mixes. SMA has been shown to be a very good HMA product and these mixes can be easily designed with Superpave technology.

The performance tests that were to be included as a part of Superpave have not been finalized at this time. Additional research is underway through several studies to develop a test(s) that can be used to predict how well a specific mix will perform. The primary area of performance that needs to be predicted is permanent deformation. Two other areas that are also important are thermal cracking and fatigue cracking. Many states have already adopted some sort of performance test, for permanent deformation, with which they have experience, but improved procedures are needed.

The development of Superpave was a major step forward that has provided tools to help improve the performance of hot mix asphalt. However, Superpave is a process that is still being evaluated and modified as new information becomes available. There have been many changes since Superpave was originally adopted and there will be many changes in the future as more experience is obtained with this new mix design system. (See article on AASHTO on Page 3.)

It is important to emphasize that Superpave is a mix design process and not a mix type. This process is used to select the lowest cost materials that will perform satisfactorily for a given project. The best product for a particular job may be a dense graded mix or a gap graded mix such SMA. Regardless of the mix type to be used, Superpave has provided the initial tools to guide in the selection of the proper mix for a specific project and additional guidance will be provided as a part of Superpave as this new guidance is developed.

Field Conditioning of Superpave Asphalt Mixes

James A. Musselman, Gale C. Page, and Gregory A. Sholar, Florida DOT

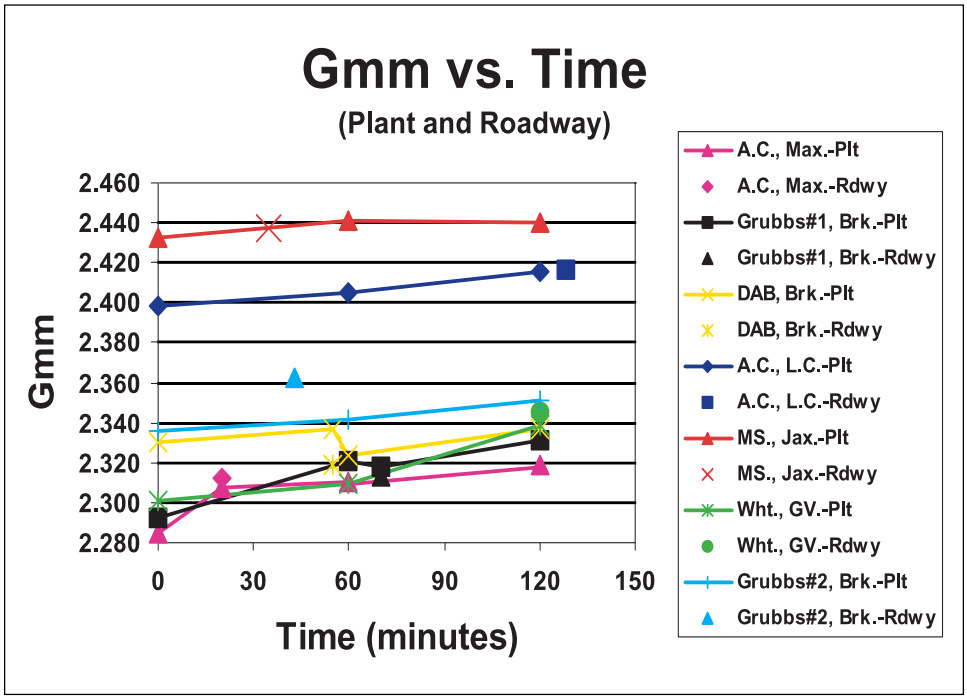
Paper Presented at the 2001 TRB Meeting in Washington, D.C. (Summarized by Greg Sholar)

Over the last several years, a number of Superpave projects under construction in Florida have experienced failing volumetrics (low VMA and air voids) during initial production of the mix. In order to compensate for this reduction in air voids, Contractors frequently request that the design binder content in the mix be reduced to bring the voids back into an acceptable range. Since reducing the binder content in the mix can have an adverse effect on the pavement's durability, the Department has been reluctant to approve many of these requests. Consequently, Contractors have had to adjust the mix by making changes in the gradation, to redesign the mix, or to produce the mix with marginal air voids. In some cases where the Department has approved a reduction in binder content, achieving the specified density on the roadway has become more difficult, due to the reduction in lubrication within the mix.

This problem has also occurred nationally, and a number of possible causes have been identified. The majority of them focus on reduced VMA due to aggregate degradation, rounding of the aggregate, or excess fines (P-200). Other possible causes have included high aggregate moisture contents (resulting in less asphalt absorption), as well as increased aggregate specific gravities (again resulting in less asphalt absorption).

It has recently been hypothesized in Florida that when a Superpave mix is sampled and tested at the plant immediately following production, there is insufficient time for the aggregate to absorb the asphalt binder to the same extent that occurs during the mix design process. This would result in a higher effective binder content, and consequently lower air voids for the compacted plant produced mix. This is significant in Florida, where highly absorptive limestone aggregates are frequently used. Ideally, the best scenario would be to simulate at design and at the plant the conditions that could be expected of the mix at the roadway.

The objective of this study was to investigate the properties of the mix after conditioning at design and after various conditioning times with plant-produced mix, and comparing those properties with the properties of mixture as it is placed at the roadway. Seven separate mixes were evaluated during the course of this study: three of the mixes used central Florida limestone exclusively, two of the mixes used predominantly granite, one mix used predominantly southeast Florida limestone, and one mix used predominantly north Florida limestone. Several scenarios with respect to conditioning times were analyzed for the laboratory and plant produced mixes, with the intent to determine 1) if the two hour force-draft oven conditioning used in design adequately simulates actual roadway conditions, and 2) how can actual roadway conditions best be simulated when the asphalt mixture is sampled and tested immediately following production at the plant.



The results of this study indicate: 1) three hours of conditioning during the design phase best correlated with roadway conditions, 2) a one-hour conditioning time at the asphalt plant resulted in maximum specific gravity values that best correlated with roadway conditions (see figure), 3) one hour of conditioning at the asphalt plant increased the air voids of the mix by 0.5% for absorptive materials and 0.25% for non-absorptive materials and 4) conditioning had minimal effect on bulk density values.

The full report is available on the Internet at: www.dot.state.fl.us/statematerialsoffice/.

AASHTO *Continued from Page 1*

9-12, *Incorporation of Reclaimed Asphalt Pavement in the Superpave System*, led to major changes in three provisionals.

- MP2, Specification for Superpave Volumetric Mix Design
- PP28, Practice for Superpave Volumetric Design for Hot-Mix Asphalt (HMA)
- TP2, Method for Quantitative Extraction and Recovery of Asphalt Binder from Asphalt Mixtures

Copies of the Provisional Standards are available from AASHTO at 444 North Capitol Street, N.W., Suite 249, Washington, D.C., phone 202/624-5800, fax 202/624-5806, website www.transportation.org.

Connecticut Puts East Coast on Map For Thermal Segregation Studies

Dr. Leslie Ann Myers, University of Connecticut

In several parts of the country, state materials engineers are working to explain and solve the problem of nonuniform mat temperatures, or "cooler spots," in HMA overlays. In Connecticut, this problem is all too familiar. Research work started in the Fall of 2000 is currently being conducted in cooperation with the Federal Highway Administration and the Connecticut Department of Transportation.

The study employs use of a thermographic infrared imaging camera and digital photography at the paving site. An initial study on this topic was published by John Henault and Connecticut DOT in 1999. The primary focus of the current study is on identifying the effects of cold weather paving and night paving on overall pavement quality. Collection of data from summer paving is also planned to provide a baseline for comparison.

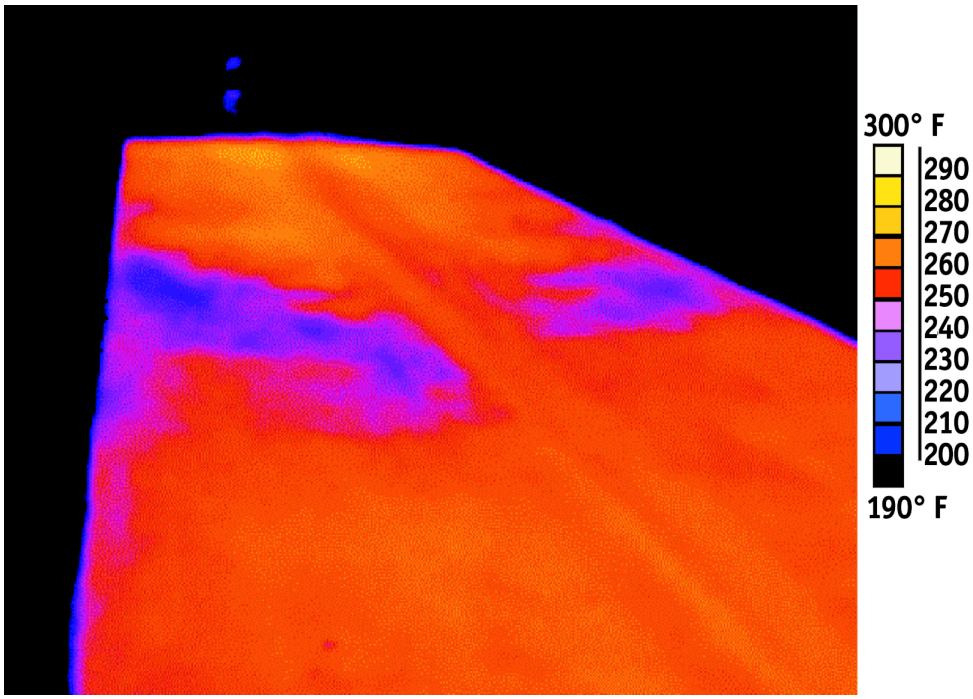
Thermal imaging is used to monitor the temperature of HMA in the mat, hopper and truckbed. Real images are output in terms of a temperature scale, as seen in the figure. Digital images capture construction and placement procedures, laydown and compaction equipment, and various truckbed configurations.

Samples of HMA from truck beds and the overlay mat (prior to compaction) are sometimes taken for gradation testing in the laboratory. A nuclear density gauge is used after completion of rolling to provide data on density. Single density readings are compared to a series of closely spaced readings to determine segregation. As an additional step in the field, the location of cooler spots is documented using differential GPS, in order to provide the DOT with a basis for future performance monitoring of the overlays. All project-specific data and images are entered into a comprehensive Access database, which is updated continually with each project and can be uploaded onto the Internet.

Conversation with Dr. Joe Mahoney of the University of Washington prompted collaboration among researchers on both coasts. Dr. Mahoney has applied thermographic imaging techniques in bituminous pavement research to address a similar problem.

The State Pavement Technology Consortium (SPTC), which consists of a collaboration of the states of Washington, Texas, California, and Minnesota, is investigating the issue of temperature differentials. This group shares information on pavement practices including new design, rehabilitation, decision-making and research. They also host an online forum on how pavement-oriented research studies are identified, conducted and implemented. The SPTC also discusses potential pavement-oriented pooled fund studies of mutual interest, such as a recently sponsored study that addressed the issue of end-of-load segregation and compiled a sophisticated database of thermal images.

The SPTC welcomed the addition of Connecticut to their web-based thermal database, which can be viewed at http://www.wsdot.wa.gov/fossc/mats/pavement/sptc.htm on the Internet. Addition of the Connecticut data to the internet site is planned for early April 2001. ConnDOT's involvement in teaming with other parts of the country and sharing their up-to-date research findings will contribute to the quest for identifying the specific causes of cyclic cooler spots and for finding ways to eliminate their occurrence in the future.



Thermal Image Taken From Interstate 395-S in Connecticut

AAPT Showcases Latest Research in Binder, Mix

The Association of Asphalt Paving Technologists held its 76th annual meeting in Clearwater, Florida, March 19-21. Over 350 people from 12 countries set a new attendance record for the meeting.

As usual, a Government Engineers' Forum kicked off the meeting on Sunday afternoon. In years past, attendance at the Forum was open to all, but only government engineers were allowed to speak. This gave the local, state and federal engineers a chance to share information and concerns from their unique perspectives. This year, the forum was opened up to allow and encourage industry to also share their views and to respond to comments from the government engineers.

This year's forum topics included measurement of density and joint construction. States shared their specifications and testing procedures. Many states reported using nuclear gauge results, calibrated to core densities, for quality assurance while others use only cores. Experience with other methods for determining density has been mixed.

Business

Monday morning began with the business meeting. New members of the association were welcomed and scholarship winners were announced. In 2000, scholarships were awarded to Fenella Long, of the University of California – Berkeley, Zhiming Si, Texas A&M University, and David Timm, University of Minnesota. The scholarships are funded by member contributions. The Southeastern Asphalt User-Producer Group gave the scholarship fund a big boost by contributing $10,000. Mary Stroup-Gardiner and M. Law were awarded the W. J. Emmons award for best paper presented at the 2000 meeting.

Results of the election of officers for 2001/2002 were announced. The new officers are President Gerry Huber, Heritage Research Group; First Vice-President Larry Michael, Maryland State Highway Administration; Second Vice-President Erv Dukatz, Mathy Construction; Directors-at-Large Ron Cominsky, Pennsylvania Asphalt Pavement Association, and Rey Roque, University of Florida. Ken Kandhal and Ray Brown, both of NCAT, are the past presidents.

Testing and Field Control

The technical meeting began with a workshop focusing on testing and field control issues. Adam Hand presented *A Comparison of HMA Field Performance and Laboratory Volumetric Sensitivities* that he and co-author Amy Epps had conducted on the WesTrack mixes. Epps and Hand examined the sensitivity of the WesTrack mixes to changes in binder content and percent passing the 0.075mm sieve. They found that variations in these factors had a significant effect on mixture volumetrics (air voids) and rutting. Coarse mixtures were more sensitive to changes in the binder content, especially decreases in binder content, than fine mixtures. All mixtures showed some sensitivity to increases in binder content. They suggested these results underscore the need for a performance test to be used during mix design to preclude the use of mixes that have acceptable volumetrics but do not perform well in the field.

Stacy Williams and Kevin Hall presented a paper comparing a new infrared ignition oven to the more common forced air furnace. They found the infrared oven to be an acceptable alternate. Testing of paired samples found that the two types of ovens yielded comparable results and had similar accuracy. The average error, when testing samples of known binder content, was less than 0.2% for both types of ovens.

Tom Harman, John D'Angelo and Chuck Paugh reported on the relationship of volumetric data (VMA and air voids) to binder content and mixture gradation for actual plant-produced mixtures. They also investigated the possibility of using the slope of the gyratory compaction curve for quality control. Although some mixtures showed good relationships between the slope and mix properties (binder content and gradation), others did not. Gyratory slope did not appear to be a good quality control tool since the relationship was not clear and did not indicate what changes to make to improve the mixture properties.

VMA

VMA was the main topic at the next technical session. A paper by Mike Anderson and Ross Bentsen compared the fatigue and rutting characteristics of fine and coarse 12.5mm mixtures with different VMAs. In this study, four different mix designs were developed – two fine mixtures above the restricted zone and two coarse mixtures below. Each type of gradation was used to design one mix at a VMA of 13 and one at 15%. Rutting and fatigue were then evaluated using beam fatigue and shear testing. Shear test results were found to reveal more significant differences between the mixtures than did beam fatigue testing. Shear tests showed that increasing the VMA from 13 to 15% improved the performance of the fine mix, but was detrimental to the coarse mix. The coarse mix showed less rutting than the fine mix at the same VMA, but was more sensitive to changes in VMA.

Bensa Nukunya, Rey Roque, Mang Tia and Bjorn Birgisson evaluated the effects of VMA, film thickness, binder content and aggregate surface area on durability (as indicated by binder age-hardening), fracture resistance and rutting resistance. They measured the mechanical properties of various 12.5mm mixtures with different VMAs. They also evaluated binder aging by extracting and recovering the binder after short and long-term oven aging. They found that binder hardening was independent of VMA and conventional film thickness but was related to the fine aggregate content. They concluded that the current method for computing film thickness does not adequately describe the binder-fine aggregate matrix and they offered a modified procedure that considers the fine aggregate properties as well as the coarse aggregate. Their results again underscored the need for a performance-related test to supplement volumetric design.

Brian Coree and Walter Hislop reviewed the history of the development of the VMA requirements and pointed to several problems with its current usage. They then went on to evaluate mixtures as they go from stable (or sound) to unstable behavior at increasing binder contents. This critical state was defined using repeated load triaxial testing in the Nottingham Asphalt Tester (NAT). They found that VMA alone cannot differentiate between sound and unsound mixtures.

The volume of effective binder and voids filled with asphalt appeared to be critical parameters affecting this transition. Aggregate gradation, shape and texture influenced the volumetric properties at the critical state. Fineness modulus, coarse aggregate percent crushed and fine aggregate percent crushed were found to be significant factors.

The influence of gradation on VMA was also discussed in a paper by Bill Vavrik, Bill Pine, Gerry Huber, Sam Carpenter and Robert Bailey. This paper summarizes the Bailey method for analyzing an aggregate gradation considering its packing characteristics, then evaluates the effect of the gradations quantified using the Bailey method on the resulting VMA. The Bailey method uses loose and rodded unit weights for fine and coarse aggregate fractions to quantify the packing characteristics and optimize gradation.

Cracking, Variability, Bias and Stripping

Shirley Zhang reported on research she had conducted with Rey Roque, Bjorn Birgisson and Boonchai Sangpetngam regarding the development of a crack growth law for asphalt mixtures. The law uses dissipated creep strain energy, determined in the Indirect Tensile test, to explain both crack initiation and propagation. The new model allows consideration of healing of cracks, which has been observed in asphalt mixtures, but is not accounted for by the current fatigue approach. Under the new model, microcracks can heal if the dissipated creep strain energy limit is not exceeded. A fracture mechanics model based on this crack growth law shows promise for predicting cracking in asphalt pavements.

John Haddock and Brian Prowell summarized four years of binder testing results from the Virginia DOT and its suppliers. Their data showed decreasing test variability as the comfort level of the DOT and suppliers increased. The supplier and DOT test results are similar, however, the state shows a smaller variability than the suppliers. In fact, the DOT data has a lower coefficient of variation than the AMRL round robins on three of the seven binder tests. Haddock and Prowell suggested states maintain their own database to establish fair tolerance levels based on test variability in their own state. They also supported the effectiveness of round robins to identify and resolve testing discrepancies.

Another type of variability was the subject of a paper by Robert Schmitt, Awad Hanna, Jeff Russell and Erik Nordheim. They evaluated bias in split sample testing on 16 projects in six states. Bias is a systematic error that is constant in direction. They identified bias in test results between state, contractor and third-party labs for gradation, asphalt content and mix volumetrics. They then offered a procedure that could be used to incorporate considerations of bias in Independent Assurance and Quality Assurance testing.

AAPT President Ray Brown presents W.J. Emmons award to Mary Stroup-Gardiner. (Photo by G. Huber)

Ken Kandhal presented four case histories of stripping he investigated. Ian Rickards was his co-author. The four case studies showed that moisture saturation of the pavement layer was a prerequisite for stripping, but there were different causes for the high saturation level observed. Excess moisture could be caused by capillary action from an inadequately drained subsurface or it could enter the pavement from above. In cases where an open graded friction course is to be placed over a dense graded HMA, the authors recommend the HMA surface should be sealed either by the action of traffic or by a fog seal to prevent this moisture intrusion. Thermal pumping of water vapor can also cause stripping. Kandhal and Rickards made a strong case for an improved moisture sensitivity test that realistically and reliably predicts stripping.

Specifying Performance

The symposium session focused on "Specifying Performance into Asphalt Mixtures." Carl Monismith, Fenella Long and John Harvey reported on the specifications used for mix design, structural design and construction of Interstate 710, a design-build contract in California. Eric Harm discussed how to specify performance from the state perspective. Dave Newcomb addressed the issue from the industry perspective. Stephen Seeds summarized the development of performance related specifications based on the WesTrack research. Erv Dukatz and John Volker related the experiences with warranty contracts by looking at one project in Wisconsin.

Modified Binders

The third technical session dealt mainly with modified binders. Arif Khatri, Hussain Bahia and Doug Hanson presented a method for determining mixing and compaction temperatures for mixes containing modified binders. The current viscosity ranges were developed for unmodified binders and often require excessively high temperatures to bring modified asphalts to those viscosity levels. The new procedure still uses the rotational viscometer, but acknowledges that mixing and compaction can be accomplished at much higher viscosities.

Mike Anderson then gave an overview of the research conducted under NCHRP 9-10, *Superpave Protocols for Modified Asphalt Binders*. That project was the basis for the next two papers. Nine modified binders produced from one base asphalt were evaluated in the study.

Menglan Zeng reported on rheological modeling of modified binders and mixtures as presented in a paper he wrote with Hussain Bahia, Huachun Zhai and Pamela Turner. They developed a rheological model that can be used to characterize both modified binders and mixtures using dynamic shear loading.

NCHRP 9-10 also lead to the work reported by Hussain Bahia, Huachun Zhai, Menglan Zeng, Yu Hu and Pamela Turner. They investigated the use of damage behavior of modified binders to characterize rutting and fatigue cracking. Under their proposed protocols, the DSR is used to measure creep compliance to determine the rutting parameter and to measure the cycles to

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damage propagation (N_p) for the fatigue parameter. These parameters are purported to model rutting and fatigue better than the currently used $G^*/\sin\delta$ and $G^*\sin\delta$ parameters.

Gerry Reinke and Steven Engber presented the results of their work with determining the glass transition temperature for modified and unmodified binders. The glass transition temperature has previously been shown to predict the temperature at which a binder will fracture due to thermal changes. Their research optimized the test conditions for determining the glass transition temperature. Results correlated well with mixture low temperature cracking as measured in the Indirect Tensile Test.

Other Issues

Amy Epps, Tazeen Ahmed, Dallas Little and Magdy Mikhail used the Model Mobile Load Simulator (MMLS3) to evaluate four pavement sections at WesTrack to correlate the MMLS3 to field rutting performance. The MMLS3 is a one-third-scale model accelerated pavement testing device. MMLS3 performance rankings were compared to field and laboratory test results. The researchers presented a method for using the MMLS3 results to predict rutting performance.

Another common distress type, reflective cracking, was the subject of a paper by Steve Brown, N. H. Thom and P. J. Sanders. They looked at grid reinforcement in asphalt pavements and how it acts to control reflective cracking. Grid reinforcement serves to redistribute strains and changes the failure characteristics of the pavement.

Adam Hand fields a question from the AAPT audience. (Photo by G. Huber)

Rutting was also the focus of a study conducted by John Harvey, Shmuel Weissman, Fenella Long and Carl Monismith. They summarized studies of the Superpave shear test to evaluate rutting behavior and also looked at uniaxial and triaxial tests for rutting. The researchers concluded that shear deformation is the key component in rutting, not volume change, and that repeated load constant height shear testing is the most efficient way to measure rutting resistance.

The efficacy of the Superpave Gyratory Compactor (SGC) to simulate field compaction was evaluated in a study by Laith Tashman, Eyad Masad, Bob Peterson and Habeeb Saleh. They used image analysis and X-ray tomography to analyze the internal structure of cores of field compacted mixtures and SGC compacted specimens from the same mixtures. They found that different field compaction patterns produced similar aggregate structures, but that the internal structure of SGC specimens varied when the angle and specimen height were changed. An angle of 1.5° and specimen height of 50-75mm best simulated field compaction for the mixture evaluated in this study. These findings need to be verified for other mixtures.

Several other papers were presented by title only but are available on the preprint CD-ROM and will be published in the Journal. These papers dealt with mix design for full-depth reclamation, measuring bulk specific gravity of compacted specimens, effects of fillers, and measuring complex modulus.

The Future

Next year's AAPT meeting will be held March 18-20 at the Doubletree Hotel in Colorado Springs, Colorado. In 2003, the meeting will be March 10-12 in Lexington, Kentucky.

AAPT has moved to putting all pre-prints on CD prior to the meeting. Journals will still be published following the meeting and will include written discussions as well as the question and answer sessions. Eventually, the journals will be available on CD as well. In fact, the last five years of journals are now available on CD. These CDs and past journals may be purchased from the AAPT. Contact the AAPT at 651/293-9188 or aapt.asphalttechnology@worldnet.att.net for more information. Abstracts of the papers presented this year and in previous years are available on-line at www.bridge.ecn.purdue.edu/~spave/.