national superpave news

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In this issue:

Winter is the time for various conferences, workshops and meetings for the hot mix industry. This issue highlights some of the major conferences from around the country. Space precludes the coverage of all of the national or regional meetings.

Developments and improvements are being made continually in the industry. We recommend you try to attend one of the many informative meetings held locally, regionally or nationally to get a first-hand look at what others are doing to make asphalt pavements even better.

TRB Publishes Catalog of Practical Papers

Over 1000 papers are submitted each year to the Transportation Research Board (TRB) for presentation at its annual meeting and possible publication. In an effort to assist state agencies in culling the most readily-implementable information out of this vast resource, TRB began asking its various committees to identify those papers that contained practical information states could immediately apply. The fifth Catalog of Practical Papers from the 2002 Annual Meeting is now available on the TRB website at http://www4.nas.edu/trb/onlinepubs.nsf/web/practical_papers.

Copies of most of these papers are available on the Annual Meeting Preprint CD-ROM and many will be published in upcoming TRB Records. The catalog contains the abstract of the papers and author contact information.

This is a useful resource for those looking for up-to-date findings that can be implemented easily.

AAPT Draws a Crowd

The 77th meeting of the Association of Asphalt Paving Technologists drew nearly 300 people to Colorado Springs in March. The group participated in over three days of technical discussions on various topics related to asphalt binders, mixtures and pavements. **Tom Peterson**, Executive Director of the Colorado Asphalt Pavement Association, welcomed the attendees to Colorado.

The technical meeting began with a workshop on permeability and moisture damage. **Allen Cooley** reported on research conducted at NCAT using the field permeameter. Cooley noted that, in general, Superpave mixtures are coarser than Marshall mixes and have larger air voids, even when the overall void content is the same. For 9.5 and 12.5mm mixes, the permeability increases rapidly when the air void content rises above 7.5-8%. For 19mm mixes, the permeability increases when the air void content rises above 6-6.5%. They have data from only three 25mm mixes, but that data shows that 5.5-6.0% air is the critical density.

Aslam Al-Omari, Washington State University outlined a proposed methodology for predicting HMA permeabilty using x-ray tomography and image analysis to characterize the air void distribution in a sample. By comparing the images of two successive slices, Al-Omari, et al., were able to compute the tortuosity and interconnectedness of the voids, which affect permeability by controlling the path of water through the sample. Using this technique, they developed a simplified equation to predict permeability based on percent total air void content and gradation only.

Dallas Little, Texas Transportation Institute, concluded the session with a presentation on the use of surface free energy to predict moisture damage in an asphalt-aggregate system. Surface free energy is fundamentally related to fracture and healing. Little differentiated between cohesive fractures, where a crack initiates and propagates in the mastic (P200 and binder), versus adhesive fractures, where the cracking occurs at the interface between the aggregate and the mastic. Stripping is an adhesive fracture in the presence of water. There may be potential to use this analysis as a source test and establish threshold surface energy values.

The next session focused on binder issues. **Steve Brown** presented a paper by a team from the University of Nottingham in England looking at the linear viscoelastic limits of binders. There had been a concern that the linear region could be significantly narrower for highly modified binders than for unmodified or lightly modified binders. Their data showed there was no significant narrowing of the linear viscoelastic region for the modified binders they evaluated.

Walaa Mogawer, University of Massachusetts, reported on work he and **Kevin Stuart**, FHWA, performed to investigate the binder fatigue parameter, G*sin δ, using accelerated testing. Two different grades of binder (PG58-34 and 64-22), two pavement thicknesses (100 and 200mm) and three test temperatures (10, 19 and 28°C) were evaluated. As expected, the thinner pavement cracked sooner than the thicker pavement. Failure also occurred faster at 19°C than at 10 or 28°C. The parameter G*sin δ, a strain-controlled parameter, is not universally applicable because, although some modes of loading are strain-controlled, others are stress-controlled.

Gayle King, Koch Pavement Solutions, reviewed acid/base chemistry as it applies to asphalt modification. Acids can be used to improve the high temperature properties of an asphalt. The aging of asphalt (oxidation) can add acids. On the other hand, bases, like hydrated lime or liquid amines, are often used to improve the asphalt-aggregate bond. **Glenn Fager**, Kansas DOT,

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outlined a study KDOT initiated to investigate the possible implications of using acidic modifiers and basic antistripping agents (ASA) in the same binder. Their results showed that the acids and bases could neutralize each other causing the loss of the high temperature improvement of the acid and the loss of the moisture protection of the base. Fager suggested checking the high temperature properties of the binder after the addition of the ASA. King stressed the importance of communication between the asphalt supplier and the mix designer.

Dallas Little continued the discussion of fatigue by outlining an approach using dynamic mechanical analysis (DMA) to evaluate both fatigue and healing of binders and mastics. Fracture healing has a significant impact on fatigue life and can be evaluated using this approach.

The next technical session turned to mixture issues. **Mike Anderson**, of the Asphalt Institute, presented the results of NCHRP 9-16, which sought to determine relationships between gyratory compaction properties and mixture rutting resistance. The findings indicate that a parameter called $N\text{-}SR_{max}$ best relates to mixture shear stiffness and rutting resistance. $N\text{-}SR_{max}$ is the number of gyrations at which the stress ratio, the shear stress divided by the vertical stress, peaks. The parameter appears to be suited to use as a screening tool to identify gross mixture instability and to generally indicate, though not predict, an expected range of performance.

Kamil Kaloush presented a paper that he and **Matt Witczak,** both from Arizona State University (ASU), wrote to summarize some of the results of extensive research to develop a simple performance test (SPT) for asphalt mixtures. This paper focused on two of the parameters being considered as candidate SPTs, namely the flow time and flow number. Kaloush stated both parameters are excellent discriminators of rutting.

Terhi Pellinen, Purdue University, also reported on work she had done with Witczak using another candidate simple performance test, the dynamic (complex) modulus test. This test is commonly called the E* test and will be used in the AASHTO 2002 pavement design guide. Pellinen found that E* could be used to develop mixture master curves that can account for non-linear behavior at intermediate and high temperatures. Asphalt mixtures would still be analyzed as linear viscoelastic materials at low temperatures. This approach was used to develop a stress dependent equation to predict dynamic modulus.

Rey Roque, **Byron Ruth** and **Bensa Nukunya** attempted to develop a more definitive method for characterizing aggregate gradations and their relation to mixture properties. This research, conducted at the University of Florida, looked at tensile strength, failure strain and fracture energy as determined in the indirect tensile test. Roque stated the results indicate that very abrupt changes in the gradation, as with severely gap-graded mixes, may lead to poor performance.

A symposium session addressed evaluating mixture properties using gyratory specimens. Short presentations were made followed by a lengthy panel discussion. The first part of the symposium focused on tests for rutting. **Matt Witczak**, ASU, discussed the dynamic modulus and uniaxial creep tests. Witczak said that one of the major strengths of NCHRP 9-19 is the possibility of tying the SPT parameter to accurate estimations of field performance. **Don Christensen**, Advanced Asphalt Technologies, covered the field shear and indirect tension tests. Despite some issues with the clamping of specimens, the field shear test has application to rut testing. Using the IDT at high temperatures provides a good measure of mix cohesion. **Bill Crockford**, Shed Works, described the Rapid Triaxial Test, which is a much quicker way to perform triaxial tests like E*. **Mike Anderson** discussed using the Superpave Gyratory to evaluate mixture resistance to rutting, adding more to his earlier discussion of $N\text{-}SR_{max}$. And **Ken Kandhal**, of NCAT, suggested the Asphalt Pavement Analyzer can be used as an interim test until a simple performance test is implemented.

In the second part of the symposium, mixture tests for fatigue were discussed. **Witczak** outlined the use of the E* test for fatigue in the 2002 design guide. It may be possible to use the same test for pavement design as well as performance prediction. **Richard Kim**, North Carolina State University, suggested using fracture energy from the indirect tensile test (IDT) to evaluate resistance to fatigue cracking. **Andre Molenaar**, of the Delft University of Technology, described a semi-circular bending test. He indicated this test is simple and inexpensive. It also produces a clear tensile failure, as opposed to the IDT, which can have a complex stress state. **Bjorn Birgisson**, University of Florida, espoused the use of the dissipated creep strain energy and m-value to predict fatigue. He and Rey Roque used the IDT to measure these parameters. Birgisson averred that this test is the holy grail to link mixture performance and pavement design.

On the final day of the meeting, **Don Christensen** amplified on his earlier discussion of the field shear test (FST). He indicated that the FST is sensitive to changes in mixtures and the repeatability is pretty good. The sensitivity to small changes in mixtures, however, is not good enough for QC/QA testing applications. Repeating measurements by rotating a sample and retesting may help.

Brian Prowell summarized the concerns of the Virginia DOT regarding the use of Superpave mixtures for low volume roads. Prowell, currently with NCAT, formerly worked for VDOT. VDOT was concerned that residents might not like the appearance of the coarser surface mixes, so they developed a 9.0 mm mix and changed the control points to make it a finer mix. They also reverse-engineered some of their successful Marshall mixes to determine appropriate compaction levels. In response to concerns about the possibility of low binder contents in base mixes, they set a minimum binder content in addition to the regular volumetric requirements.

Kim Jenkins, of the University of Stellenbosch in South Africa, reported on work in South Africa and the Netherlands, looking at the use of a so-called Half-warm Foamed Bitumen Treatment. Previous uses of foamed asphalt at ambient temperatures have shown that the temperature of the aggregates at the time of mixing has a great effect on the properties of the mix produced. Heating the aggregates to temperatures below 100°C yielded significant benefits.

The elimination of the restricted zone was recommended by results of NCHRP 9-14. **Allen Cooley** of NCAT said the results show the restricted zone is redundant when the fine aggregate angularity and VMA requirements are met. The NCAT research team advocates eliminating the restricted zone wording in AASHTO MP2 and PP28. Some method for differentiating between fine and coarse mixes will be required if AASHTO approves removing the wording.

The final session of the conference began with a discussion of non-linear behavior in HMA by **Eyad Masad**, University of Washington, and **Hussain Bahia**, University of Wisconsin. They investigated relationships between the mode of loading (shear vs. axial), aggregate orientation and binder nonlinear effects. These three factors are found to have significant effects on non-linearity of the HMA response. If a material is isotropic, the loading direction does not matter, but HMA is not isotropic.

Time-temperature superposition has long been recognized as applying to asphalt in the linear viscoelastic region. **Ghassan Chehab**, North Carolina State University, reported on work done under NCHRP 9-19, the "Models Contract," that shows this principle is valid even after some damage has occurred. This can lead to simplifications in the testing programs and analysis to be recommended from 9-19.

Baoshan Huang, University of Tennessee, also addressed non-linearity in hot mix asphalt. Huang and others developed a thermo-visco-plastic model for HMA that takes into account non-linear plasticity and temperature and loading rate effects.

In the final presentation of the meeting, **Jo Daniel**, University of New Hampshire, summarized work she and **Richard Kim** had conducted on HMA fatigue testing. Eight WesTrack mixes were tested in the study. A simplified testing program was developed that can be used to predict fatigue damage. The damage that may occur under different testing conditions – type of loading, temperature, frequency, etc. – can be predicted based on testing under a single set of conditions.

Two papers were presented by title only: "High Temperature Fatigue and Fatigue Damage Process of Aggregate-Asphalt Mixes" by B. Tsai, John Harvey and Carl Monismith; and "Top-Down Crack Propagation in Bituminous Pavements and Implications for Pavement Design and Management" by Leslie Ann Myers and Rey Roque. These papers are on the preprint CD-ROM and will be printed in the journal. You may contact AAPT at 651/293-9188 or on the web at www.asphalttechnology.org for copies or membership information.

The next meeting of the AAPT will be held in Lexington, KY, March 10-12, 2003.

SMA in the USA II

by Bob McQuiston, FHWA-Ohio Division

The Maryland State Highway Administration hosted the "SMA in the USA II" conference, March 25-27, in Frederick, MD. Representatives from 40 State Highway Agencies and 18 foreign countries attended, presented, and/or displayed their products at the workshop. Presentations covered materials, mix design, specifications, construction practices and practical how-to advice.

SMA offers potential benefits to the motoring public by extending asphalt pavement service life, reducing work zone delays and reducing pavement life-cycle costs in the future. It provides a good alternative for a surface course for an extended life (perpetual) pavement.

Event co-sponsors were: FHWA, the International Society for Asphalt Pavements (ISAP), the Asphalt Institute, the Virginia DOT and the state asphalt pavement associations.

Doug Rose and **Nelson Castellanos**, both of the Maryland DOT, welcomed the attendees to the conference and reviewed the use of SMA in their state. Maryland maintains about 16,000 miles of roadways. They anticipate a 50% traffic increase in the next 20 years. Due to the benefits they ascribe to SMAs, Maryland has made fairly extensive use of the material. Currently the Maryland DOT has placed 1400 lane-miles of SMA – or about 9% of their system.

Mike Acott, Executive Director of NAPA, spoke next from the industry viewpoint. NAPA estimates SMA may extend the life of HMA pavements by 20%-40%. Acott also announced the next Superpave conference will be held March 17-19, 2003, in Nashville, Tennessee. Additional Information is available at http://www.asphaltalliance.org/registration/superpave2003.htm. The World of Asphalt Show will be held March 18-20, also in Nashville. The website is http://www.worldofasphalt.com.

The international approach to SMAs was summarized by **Ingeborg Schroder,** from BP Bitumen in Germany. She reported that Sweden, the UK, Poland, the Czech Republic, Switzerland, Slovenia, Turkey, Germany and Austria all use SMA. Germany has developed a variety of mixes with different gradations and bitumens and uses SMA for both intermediate and surface courses.

John Bukowski, from the FHWA Office of Pavement Technology, reviewed the history of SMA use in the USA. The concept for stone mastic asphalt was brought to the USA from the 1990 European asphalt study tour. The mix had a coarse surface texture and contained high asphalt contents with cellulose fiber and mineral filler. The first US test sections were placed in 1991 in Wisconsin, Michigan, Georgia and Missouri. Additional trials were placed in 1992 in Alaska, California, Maryland, Ohio and New Jersey. These trials were evaluated under Test and Evaluation Project (TE) 18. The FHWA formed an SMA Technical Working Group (TWG) and developed an FHWA-NAPA publication. The TWG established criteria for round robin testing and provided guidance for drain-down, model specifications for materials, construction guidelines, a compilation of construction practices and more. An NCHRP study by NCAT published as NCHRP Report 425 summarized current practices.

Ray Brown, Director of NCAT, provided an overview of potential problems with SMAs and their causes. Potential problems include fat spots, longitudinal joint construction and joint density, permeability and low mat density and sensitivity to aggregate gradation, especially fine aggregate. A summary of present practice was undertaken in 2001.

The Canadian experience was presented by Vince Aurillo of the Ontario Ministry of Transportation. The province of Ontario has constructed 30 projects over the past ten years. One project, in 1996, included a three-year warranty. The keys are checking and verifying plant calibration, preventing segregation and avoiding fat spots.

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Government Engineers Share Experiences

by Rebecca S. McDaniel, North Central Superpave Center

Traditionally, each AAPT meeting begins on Sunday afternoon with a Government Engineers' Forum highlighting two or three practical topics of particular interest to agency personnel. The topics for this year's forum included:

- use of contractor test results for pavement acceptance,
- the value of moisture sensitivity tests, and
- the use of warranties and percent within limits (PWL) specifications.

Engineers from all levels of government took the lead in the discussions. In a recent departure from tradition, industry representatives, academics and others were allowed to participate with formal presentations as well as general comments from the audience. In the past, discussion throughout the forum was limited to only the government engineers.

Dean Maurer outlined the history of recent changes in the PennDOT testing and acceptance program for pavement density. They began the changes in 2000 with optional participation in one district. The density acceptance program called for contractors to prepare separate quality control plans and correlate nuclear density readings against field cores. It was quickly learned that there were too many samples to test in one lab in a timely manner, so they moved to local acceptance and a scaled-down testing plan. In 2001, the lot sizes were increased and non-nuclear density gauges were allowed. Consideration is now being given to implementing the program statewide, though there are concerns about manpower in some districts, the equipment calibration and verification procedures, management of the large amount of data generated, and whether the program is applicable to all projects. **Vince Angelo**, a Pennsylvania contractor, commented that industry thinks the program is a good step forward and would like to see it implemented statewide.

Erv Dukatz, Mathy Construction, then presented a summary of Wisconsin DOT's use of contractor test results for pavement acceptance. Wisconsin uses contractors' tests for acceptance 100% of the time. They are now moving to a verification program. The verification program requires the testing of split samples by an independent third party lab when results are not comparable within an established range.

During the discussion period, **Gale Page** of the Florida DOT stated that FDOT is going to use contractor tests for acceptance on asphalt, concrete and earthwork. This is due in part to the facts that the DOT staff has been cut 25% but the construction budget remains at or even above previous levels. The agency determines where the contractor will take the tests. FDOT is adopting the AASHTO PWL specs for this program. **Mike Heitzman** of the Iowa DOT commented that his state has used contractor tests for acceptance if the contractor's tests agree with the state's QA results. They are expanding the program for 2002. **Jimmy Brumfield** of the Mississippi DOT stated that quality has improved in his state due to the contractor being involved. **Roger Henrichsen**, Nebraska DOR, added that they are very satisfied with their program for air voids and density.

The next topic before the forum was the question "Moisture Sensitivity Tests – Do They Work?" **Gale Page** opened the discussion with a review of the development of the commonly used stripping tests. Page questioned the relationship of the test results to field performance and noted a number of other issues with the tests. He pointed out that AASHTO T283 had been revised to allow the use of 150mm gyratory samples, but ASTM D4867 had not. Proposed changes were voted down by ASTM members, who cited a lack of supporting data. The current project NCHRP 9-34 will focus on conditioning specimens that will be tested using the simple performance test from 9-19. One possible reaction to the continuing questions about moisture sensitivity testing, Page noted, is simply to add lime to every mix.

John Cheever, of Aggregate Industries in Colorado, questioned whether the addition of lime might stiffen a mix and exacerbate top-down cracking. He went on to outline the Colorado DOT's use of a modified version of T283. CDOT does require 1% hydrated lime, as do many municipalities.

Animated discussion followed with many state representatives pointing out various modifications they had incorporated or alternate tests they were using or considering. Some of the alternates include the Hamburg Wheel or APA, micro-Deval test and a boiling water test. **Dean Maurer** pointed out that in every stripping failure he has investigated, there was also a problem with low density, which would facilitate stripping.

The last topic of discussion at the forum was the use of warranties versus percent within limits (PWL) specifications. **Chris Abadie**, Louisiana Transportation Research Center, discussed Louisiana's QA/PWL approach. They have used QC/QA and contractor mix designs since 1973. They are now implementing a PWL specification based on NCHRP 9-7. Abadie said that Louisiana contractors are producing consistent mixes because the specs require it.

Lee Gallivan, FHWA Indiana Division, closed the forum with a summary of the benefits of warranties. (See Gallivan's Top Ten Benefits of Warranties in the sidebar.)

Next year's Government Engineers Forum will again focus on hot topics of practical interest not only to agency engineers, but also to the industry and academic people who work with them to achieve a quality product.

ISAP Announces Meetings

Steve Brown, Chairman of the International Society for Asphalt Pavements, announced the schedule of upcoming meetings being planned by the organization, which is closely aligned with AAPT. The next two regular meetings will be held in Copenhagen in August 2002 and Quebec in 2006. ISAP will host their first themed symposium in Atlanta in 2004; heavy-duty asphalt pavements may be the theme.

ISAP was established in 1987 as an outgrowth of the "Ann Arbor" conferences on structural design of asphalt pavements. More information is available at www.asphalt.org.

Gallivan's Top Ten Benefits of Warranties

10. Loss of Expertise in the DOT
Reduced DOT staffing means they need to be able to rely more on contractors.

9. Improves Contractor Personnel
Contractors learn more when they are responsible for their own product.

8. Builds Trust between State and Contractor
They come to understand each other's needs.

7. Increased Profits
Allows more flexibility and speed while maintaining or improving product quality.

6. Level Playing Field
Eliminates those who take short cuts that compromise quality or forces improvement.

5. Balanced Risk
Shifted from 100% DOT risk to 50-50 contractor and DOT.

4. Improves Competition with PCC
Makes HMA a quality product.

3. Non-Confrontational Construction
Fosters working together, not against each other.

2. Innovation Encouraged and Rewarded
Gives contractors the incentive to improve operations and product.

1. Quality Construction!
Success of contractor = good performance.

Lee Gallivan, FHWA Indiana Division, developed this list of the top ten benefits of using warranties with the help of Gerry Huber, Heritage Research; Dave Andrewski, Indiana DOT; John D'Angelo, FHWA; and Jim Delk, Milestone Contractors in Indiana.

Multiple Approaches Address Training Issues

by Doug Hanson, NCAT

Training is becoming a significant issue for the HMA industry. The experience level within the industry is constantly changing – the senior experienced personnel are moving into management positions or are retiring, and the experienced field construction and quality control personnel are moving on. Data from the National Asphalt Pavement Association indicates that the average work life for individuals in the HMA industry is approximately five years. This loss of experienced, trained personnel is complicated by the sophistication of the new construction (computerized plants, computerized pavers, material transfer units, etc.) and quality control equipment (Superpave Shear Testers, Asphalt Pavement Analyzers, gyratory compactors, etc.) Thus, there is a need within the industry to develop and provide the skills training needed to develop the personnel that can build the quality HMA pavements that this country needs and demands.

There are a number of things happening to develop and present the needed training programs. As a result of the FHWA Regulation 23 CFR, Part 637, which requires that all sampling and testing be done by qualified sampling and testing personnel, there has been an increase in the development of cooperative regional programs for training quality control technicians. They have been generally developed as a cooperative effort of the industry and DOTs with the DOTs pushing for the development of the programs. On a national level the Transportation Curriculum Coordination Council coordinates these programs. These programs generally require that the trainees attend classroom training and that they accomplish a demonstrated abilities test where they prove to the examiner that they can actually run the tests. These have proven to be very successful in training new personnel and in correcting bad work habits of existing personnel.

This last year the HMA industry has started the development of a framework for the skills training of their personnel. This is to include a standardized program for plant operators, grounds men, paving machine operators, lutemen, etc. Work is being done to identify the skills that these individuals need to do their jobs and then to determine the mechanism for delivering these skills. The current concept is to create an HMA Training Academy that would develop the training materials, train the instructors, and maintain a database of individuals who have been trained and their skill levels.

The National Highway Institute (NHI) has generally done the development and presentation of training materials for senior technicians and engineers. These materials are very professionally done and are presented by experienced professionals. The materials are made available to DOTs and other industry personnel for inclusion in their programs. (This is one of the most valuable aspects of the NHI program.) The courses are updated on a periodic basis. Currently the three backbone courses for HMA construction — HMA Construction, HMA Plant Production Facilities, and HMA Materials, Characteristics and Control — are being updated and will be made available through NHI after July 1. The contact for these NHI courses is Chris Newman at 202-235-0524.

There are three training issues that still need to be addressed: lack of standardization of training materials, reciprocity between the states, and transferring the technology to consultants and local governments. The standardization problem is being worked on through the Transportation Curriculum Coordination Council and the involvement of NAPA and the HMA industry in the development of skill courses for construction workers. Continued effort is still needed. For example, it does not make sense for three different groups to be making digital videos on the conduct of an AASHTO test procedure for inclusion in a class. A professional video made through a pooled fund activity makes more sense. Personnel in the HMA industry are becoming very mobile and many contractors are working in a multitude of states. It does not make sense to have them attend a course on, for example, Superpave Mix Design in three states – the mix design process is the same. The current programs do a good job of reaching DOT and HMA contractor personnel. But, about 50% of the HMA placed in the US is placed on private or municipal streets and is specified and inspected by personnel who may not be technically qualified to do the work. The transfer of knowledge to these personnel is essential. A good example of how this can be done is the program put on by the Colorado Asphalt Pavement Association called Local Agency Asphalt Forums, which offers forums throughout Colorado to discuss new developments and issues related to the design and construction of HMA pavements.

Asphalt Community Gathers in Austin by Katherine Petros, FHWA

On November14-16, 2001, over 400 individuals representing State DOTs, the hot mix industry, federal and local governments, consultants and academia gathered in Austin, Texas, for the Asphalt Pavement Conference. The conference was sponsored by the Asphalt Pavement Alliance in association with AASHTO, FHWA, TRB, Texas DOT, the International Society for Asphalt Pavements and the National Association of County Engineers. The conference theme was *A Lifetime of Smooth Performance.*

The first technical session focused on safety and user satisfaction. **Harold Von Quintus** from Fugro-BRE gave a presentation on the impact of initial smoothness on performance. Long Term Pavement Performance (LTPP) project SPS1 data shows that those sections with asphalt treated permeable bases had a benefit in terms of initial and long term smoothness, as measured by International Roughness Index (IRI). He also showed that based on the LTPP SPS5 data, thicker overlays had a greater benefit in terms of long term IRI, and the use of RAP or overlay mix type did not affect the initial or long term IRI. Thermal cracking, followed by fatigue cracking, had the biggest impact on long term IRI.

Von Quintus was followed by **Pat Gardner** of Penn DOT, who described PennDOT's transition to lightweight profilers. PennDOT is paying smoothness bonuses on 90% of their interstate work and paid bonuses on 30% of projects for $IRI_0 < 35$. The statewide average IRI in 2000 was 45. **Larry Michael** from the Maryland SHA then told the group about the next generation SMA. MDSHA is placing 9.5mm, 12.5mm and 19mm mixes. MDSHA is putting all of their SMAs into a database maintained by Washington DOT. MDSHA has not used RAP in SMA mostly because they have minimum friction numbers and the RAP is generally polished.

Wayne Jones, Asphalt Institute District Engineer, made a presentation on pavement noise. He told the group that increasing the decibel level by 10 is perceived by most people as doubling the noise and that a decrease in noise by 3 decibels is the same as doubling the distance from the noise source. Europe and Japan are studying the effect of physically cleaning and vacuuming their OGFCs every six months to maintain the pavement's acoustic characteristics.

Next, a session on open graded friction courses was held. **Don Watson**, NCAT, discussed the next generation OGFCs. The design air voids are typically in the range of 18-22%. NCAT did some work in the late 90's to develop an OGFC design method. NCAT is currently involved with a pooled fund project in which 13 SHAs, representing all of the SHRP climatic zones, will construct OGFC projects for evaluation. **Randy West**, APAC, gave a presentation on contractor's experience in producing and placing OGFC. He said the biggest difficulty is draindown, due to fiber dispersal problems. He also cautioned that rolling should only be to seat the mix, otherwise there is a risk of breaking the aggregate from overrolling.

The second conference session focused on durability. **John Bukowski**, FHWA, presented an approach to mixture/material selection. His talk highlighted a recently issued NAPA guide that provides a rational approach to mix selection based on traffic and where a given layer is in the pavement structure. He also informed the group that the TRB Mix/Aggregate ETG is currently working to define coarse vs. fine mixes, should the restricted zone be eliminated.

Following Bukowski, a number of states presented what is working for them. **Ron Sines**, formerly of NYSDOT and now with PJ Keating, discussed issues in the Northeastern US. Superpave predominates on high volume roadways, but Marshall is still used on low volume roads because of the potential reductions in binder content and concerns with durability. The Northeastern states are seeing a reduction in thermal cracking due to the selection of appropriate binders using the Superpave PG grading system.

Julie Nodes spoke on behalf of the Arizona DOT and said that rutting is their most critical performance issue. Many of their decisions (like designing at a higher air voids and a higher corresponding VMA) are based on minimizing rutting. Except for their asphalt rubber specifications, ADOT specs have evolved over the last 20 years to end result specifications. Incentives in their density spec have dropped the in-place air voids average by about 1.5%, from 8.5-9% to about 7.5%. Currently, though, the ADOT smoothness incentives overshadow the incentives/disincentives for materials aspects, so contractors are paying less attention to materials. ADOT would like to work on creating a balance.

Florida DOT's perspective was given by **Jim Musselman** who stated that cracking and durability are much bigger issues for them than originally thought. Over 18% of FDOT's system is deficient in cracking, and much of it is surface initiated. It is thought that they have extreme tensile stresses at the pavement surface related to tire tread configuration and steel belted radial truck tires that are pulling the pavement apart.

The final state presentation was from **John Volker** who talked about Wisconsin DOT's experience with HMA warranties. To date, they have done a total of 24 warranty projects. After five years the IRI and pavement distress indices on the warranty projects are lower than on typical projects of the same age. They are currently considering instituting seven-year warranties or possibly tightening the distress criteria.

The durability session then continued with presentations on the use of laboratory wheel tracking tests as a mixture screening tool. **Donna Harmelink**, Colorado DOT, said that they have both the French and the Hamburg rut testers and use them to validate specification changes. A key to CDOT's use of these tests is that they have adapted their testing criteria for aggregates and binders used in Colorado. **Dale Rand**, TXDOT, said that they have an APA that they use for research and a Hamburg device that they use for production. TXDOT specifies Hamburg testing on projects with traffic greater than 30 million ESALs. With their Hamburg test, TXDOT uses Superpave gyratory compacted samples that are sliced and butted together. Rand noted that adding lime usually improves the Hamburg results, mostly because the mix is stiffened. He also stated that fatigue cracking is increasingly becoming Texas' biggest problem.

Following Rand, there was another presentation by TXDOT, this time by **Ken Fults**. Fults discussed TXDOT's requirements for joint density. Their joint density spec is based on a differential mat density, with the difference limited to 3 lbs/ft^3. They place the center of the nuclear gauge 8 inches from the joint and compare that to the reading in the middle of the wheelpath. The morning ended with a presentation on field tests to identify segregation and density profiles by **Dean Word** of the Dean Word Company. He stated that maintaining the hopper level is critical to successful paving and stressed the importance of proper truck loading (multiple drops) at the plant. Tarping and insulating trucks and uniform paver speed are additional economical means to produce good pavements.

The third major topic of the conference was on innovations and developments. The session was divided into developments in the laboratory and developments in the field. **Haleem Tahir**,

AASHTO, discussed recent and proposed changes in the AASHTO Provisional Specifications. Most notably, the days of the restricted zone may be numbered. This issue will be balloted by the states in 2002. Additionally, there will be a better test to measure and specify flat and elongated aggregates, and a precision statement on uncompacted voids in fine aggregate, T304, has been developed.

John D'Angelo, FHWA, discussed innovations in PG binder testing and specifications. The direct tension test run at very low temperatures will be able to distinguish modifiers. He emphasized that future changes in the binder specification will be based on existing binder equipment. LTPPBind will be improved to incorporate the Integrated Climatic Model to better distinguish between different climates.

Ray Brown, NCAT, talked about new lab equipment for specific gravity measurements on materials and mixtures. NCAT is working on a prototype test to determine when a sample reaches the saturated surface-dry (SSD) condition to determine the bulk specific gravity for fine aggregates. They are working with three manufacturers who are using three different approaches and plan to complete round robin testing this summer. NCAT is also analyzing the data from a round robin study that they are conducting on the Corelok device.

The final laboratory innovations presentation was made by **Mike Anderson**, Asphalt Institute, who talked about the development of a simple performance test. He provided updates on several NCHRP projects. The NCHRP 9-19 (Superpave Models) team is in the process of developing mix criteria for the tests they have identified as candidate simple performance tests, and 9-29 is looking at the commercialization of those tests. NCHRP 9-16 (Gyratory compactor as a simple performance test) and 9-17 (APA) are in the final report stage, and the final report on 9-18 (Field Shear Test) has been submitted.

Mary Stroup-Gardiner, Auburn University, led off the presentations on innovations in the field by presenting techniques for identifying segregation using the ROSAN unit. The ROSAN was used to evaluate seven projects in six states, both during and after construction. The results matched well with Ontario's sand patch test segregation criteria, but the ROSAN can be fooled by handwork, i.e., fines thrown over segregated areas. **Kim Willoughby**, Washington DOT, discussed techniques for identifying segregation using the infrared camera. With the camera, they have looked at temperature differentials of 25°F to identify density differentials. They have also found that no significant compaction takes places at temperatures below 175°F. Handheld infrared guns, which are significantly cheaper than the cameras will work, once the user knows what to look for.

Ray Brown, NCAT, discussed results from the NCAT Test Track. The track had carried 10 million ESALs, half their target, as of 11/11/01. They have observed significant differences among the test sections during wet weather – the sections with OGFC have the least splash, followed by the SMA and then the dense graded sections. The coarse graded mixes are doing as well as or better than the fine graded mixes, the modified asphalt sections are exhibiting improved performance, and the maximum rut depth measured on the track is 0.3inches. NCAT is planning the next construction of sections in 2003 and will use those future sections to verify the 2002 Pavement Design Guide.

The final major session topic of the conference was economy, and it included presentations on life cycle cost analysis, overlay performance and reconstruction experiences. **Michael Smith**, FHWA, began the session by presenting the concept and approach of life cycle cost analysis (LCCA). Both the Asphalt Pavement Alliance and the American Concrete Pavement Association have developed LCCA models based on the concepts demonstrated under FHWA's Demonstration Project 115. FHWA is in the process of developing a hybrid model, also based on DP 115. Eleven SHAs are looking at that model, which runs in Excel, and it is expected to be completed in the next few months. Smith also pointed out a need to coordinate the LCCA approaches being incorporated in the 2002 Pavement Design Guide and in HMA performance related specifications. **Dave Timm**, Auburn University, then discussed the LCCA software developed for the Asphalt Pavement Alliance. The software is capable of evaluating up to four alternatives, either deterministically or probabilistically, and they have included some default values for user costs.

The overlay performance presentations were led off by **Amy Simpson**, Fugro-BRE, who discussed the results of the LTPP GPS-6 analysis. This analysis determined performance trends of rehabilitated AC pavements. The analysis showed that overlay designs that were consistent with traffic expectations can last more than ten years with respect to fatigue. The degree of transverse cracking was related to the condition of the pavement prior to the overlay. Rutting was not a significant problem in the LTPP sections.

Robert Parsons, University of Kansas, followed with a presentation on the evaluation of expenditures of rural interstate pavements in Kansas. The evaluation looked at 184 miles of PCC pavement and 244 miles of AC pavement, all rural, without multiple interchanges and with similar truck traffic. The HMA typically had overlays at 10 and 17 years and the PCC typically had overlays at 18 years. The HMA had some sort of maintenance at 10 and 18 years, and the PCC had some sort of maintenance at 11 years.

The final group of presentations on reconstruction experiences began with a presentation by **Jimmy Little**, Louisiana DOT, on the use of rubblization/HMA overlays on rural interstates in Louisiana. Louisiana has ten projects (90 miles) of this type of rehabilitation. They feel that their PCC is in such bad shape that it is more cost effective to rubblize it rather than rehabilitate it. The average bid cost for rubblization is $\$2.25/yd^2$, which is higher than in neighboring Arkansas, but the Louisiana gravels are harder than the Arkansas limestones. They have also observed that the top 3 inches of the rubblized section is generally permeable, so you need to make sure that your drainage comes up that high to catch the water.

Kevin Herritt, Caltrans, talked about the I-710 experience in urban highway reconstruction. The I-710 design criteria include a 30-35 year performance period with minimal maintenance during its life. The mix must meet performance tests for shear and fatigue. The construction schedule consists of ten weekend lane closures, and future rehabilitation must be done in off peak hours. There is an incentive/disincentive of $100K for each weekend reduced/increased up to $500K.

The final technical presentation was made by **Gerry Huber**, Heritage Research Group, on the economics of perpetual pavements. Perpetual pavements have structural lives of 50 years with surface renewal during that performance life. Some keys to perpetual pavements are properly addressing drainage, using durable materials and addressing fatigue resistance.

The conference was concluded with closing remarks by **Tony Kane** of AASHTO who thanked everyone for participating. The next Asphalt Pavement Conference will be held March 17-19, 2003, in Nashville, Tennessee.

SMA in the USA II

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Larry Michael, MDSHA, amplified on the earlier report of Maryland's use of SMAs. The state is currently designing SMAs in the Superpave system, though the original developments, from 1992-95, used 50-blow Marshall designs. The state switched to Superpave designs rather than maintain two mix design systems. To date they have completed 85 projects. They typically use PG 76-22, 70-22 and 64-28 binders in various parts of the state. Michael recommended checking for aggregate breakage behind the rollers and limiting the flat and elongated ratio to 3:1. They have used SMAs on roads with up to 2000 ESALs/day (or about 15 million ESALs over 20 years) and speeds of over 55 mph.

SMA Placement Workshop

An SMA Placement Workshop focused on practical placement experiences and advice. **Rob Scrivener**, Reliable Contracting Co., and **Milt Simmons**, MDSHA, shared their experiences. Scrivener said that building project teamwork – including truck drivers through people doing laydown, compaction and QC/QA – is critical. Production should be balanced with laydown. A plant breakdown can be a big problem because having a backup is usually not feasible because of the need for a fiber machine and feeders. Soap/soap powder can be used for a release agent, but more is not better. Scooping, not shoveling, produces more representative samples.

Turning to laydown, Scrivener recommended using three big rollers, minimum, up tight behind the paver. Density is achieved with first two rollers; the third roller takes out the marks. Having a fourth roller as a backup is a good idea. Initially they did not use vibratory compaction, but have recently done some. They have not experienced tender zone problems. Temperatures are typically in the range of 325°F at the plant, 210°F behind the screed and 210°F (minimum) at final compaction. Cores have correlated well to thin lift nuclear gauges. Trucks should be tarped with "Delaware" tarps stretched over sides and back of mix to avoid contamination and minimize heat loss. Trucks with smooth steel beds should always be used to avoid the mix sticking to plywood beds. One key to avoiding fat spots and roughness is not to stop the paver.

Milt Simmons added the stockpiles should be covered to prevent contamination. Two loaders should be used to feed material slowly into the plant. Mix that is too hot can cause fat spots and should be wasted. Trucks should be loaded with three dumps from the silo (front/back/middle or back/front/middle) to minimize segregation. Simmons said consistent temperature is the key. While mat temperature can be checked with a gun, probes should be inserted to measure mix temperature in the truck

The workshop concluded with a discussion of the necessity of trial sections when placing SMAs. **Barney Barnhart**, formerly with the Virginia DOT and now with the Virginia Asphalt Association, said common sense rules should apply. Trial sections are recommended to work out any problems before placing too much mix.

Specifications and Job Mix Formulas (JMF) Workshop

Other topics were addressed in the concluding workshop on specifications and job mix formulae. In discussing the selection of mineral fillers, it was pointed out that mineral fillers provide the cohesive properties of an SMA. Some of the fillers commonly used in Maryland include Class F flyash, trap rock dust, hydrated lime, limestone dust, agricultural lime and cement kiln dust (which is mainly silica /alumina). It is important to know both the gradation and material properties of the mineral fillers. For example, slag dust is coarse and angular, but flyash is spherical; these will act differently in the mix.

In open discussion the group briefly discussed specifications related to profiling, traffic control, day vs. night operations, SMA vs. other dense-graded mix ride requirements, incentive/disincentive ride specs, and current and proposed roughness indices.

Larry Michael, MDSHA, spoke for Richard Schreck, of the Virginia Asphalt Association on what to do and not to do with SMA. This talk summarized experience gained from "Americanizing" SMA. First, pick the right project applications. For example, SMAs should not be used on small quantity projects, like intersection repairs, since it is difficult to provide a consistent, uniform mix unless an adequate quantity is produced. For compaction, provide a minimum of three 10-ton rollers. Use of a Material Transfer Device (MTD) is mandatory in Maryland and would be recommended for use elsewhere. The grade of binder used should be one to two grades stiffer than normal. In addition, the minimum binder content should be based on nominal maximum aggregate size; 19mm and 12.5mm mixes should have a minimum binder content of 6.0% and 9.5mm mixes should have 6.5%. SMAs should be designed for 3.5% VTM (total voids in the mix) at 75 gyrations. Aggregate quality is critical, which may be a difficulty in some parts of the country.

Ray Brown, of NCAT, summarized SMA research needs. These include determining SMA structural coefficients (AASHTO Design), evaluating fiber types; investigating filler types and properties; developing mortar tests and criteria; defining minimum aggregate properties, further developing 4.75mm surface mixes; implementing a method to determine the amount and distribution of fibers; evaluating the effects of RAP in SMA, as well as the use of SMAs as future RAP sources; evaluation of the noise properties and surface drainage of SMA surfaces; determining the number of gyrations for design; monitoring long-term performance; and correlating laboratory results to long-term field performance.