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States Share Superpave Construction Experience at NCAUPG

Rebecca S. McDaniel, Technical Director, NCSC

Implementing Superpave in the field has not been without its challenges, but it has been achievable, according to reports from five states presented at the recent North Central Asphalt User-Producer Group meeting in Kansas City. State and industry representatives from Minnesota, Ohio, Iowa, Kansas and Missouri shared their experiences with construction of Superpave projects.

John Garrity, Minnesota DOT, declared 1998 a success. Challenges in 1998 included achieving density and ride quality with 9.5mm, 100% limestone mixes. They also had sporadic complaints about fumes on some projects with modified binders. Beginning in about July, some workers complained of nausea, headaches and eye, nose and throat irritation.

Testing showed that the fume levels were below levels that would be considered harmful; a preliminary report on the testing is available.

Dave Martini, MinnDOT District 6, was on one of the projects using a PG58-34 where the paving crew complained about the fumes. They even started wearing respirators. Changing the antistrip agent used appeared to improve the fumes situation somewhat. When the binder grade was changed to a PG64-22, the crew dropped the respirators, but still commented occasionally on the fumes.

Compaction difficulties were also noted on this project. Their efforts to resolve the difficulties focused on changes in the rolling patterns. When these were not entirely successful, they added 10% natural sand to the mix, which improved densification somewhat.

MinnDOT expects to have 30 Superpave projects in 1999. They will be allowing up to 10% RAP to be included in Superpave mixtures. They are adopting the Lead State guidance on gyratory compactive effort, voids filled with asphalt and crushed aggregate (see article on page 8). Due to concerns about workability and polishing, they will be restricting the amount of limestone that can be used in surface mixtures.

Larry Nurri, Southern Minnesota Construction Co., shared a contractor's viewpoint on Superpave. He said they learned quickly that the smoother the milled surface you were paving over (related to the number of teeth in the milling machine), the easier it was to get density and ride. They were able to achieve excellent ride quality on the project. He also commented that good stockpile management was key to getting good results. Another key is using a "nuke boy" to check density and change roller patterns as the ambient and mix temperatures change. Use of two smaller pneumatic rollers instead on one large one gave them better densities.

Gary Ferguson, Sharp Testing Services, reported on experiences in Ohio. He stressed the need to manage stockpiles and pointed out a number of other items to consider when producing and placing Superpave mixtures. Ohio has had difficulty with mix tenderness (see related articles on pages 3-5), which they now attribute to binder softness. They initially thought this was a moisture problem; moisture, temperature and aggregate structure are still possible contributors, though they now think binder is the predominant cause.

Mike Heitzman, Iowa DOT, stated that Iowa will design 50% of its projects with Superpave in 1999 and 100% in 2000. Eight local projects will use Superpave on low volume roads. Although the usual aggregates could meet the consensus and source properties, the availability of manufactured sand may become an issue. Mix designs have not changed significantly from those used in the past, so there has not been a significant increase in costs.

Brady Meldrem, Norris Asphalt Paving, described Superpave as a "shock to your system," but noted it was not anything the Iowa contractors could not handle. More time and attention to detail is needed to assure good results. His firm has not had problems achieving compaction; they typically use a vibratory operating at higher frequency, not higher amplitude, plus two pneumatics.

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States, FHWA Investigate Compactor Variability

Rebecca S. McDaniel, Technical Director, NCSC

As more and more projects are constructed with Superpave mix designs   involving more laboratories, people, and equipment - it is, perhaps, inevitable that between-laboratory differences should start to appear. A few states in the North Central region and elsewhere have reported some difficulties comparing the results from different compactors. Missouri was the first state in this region to note a problem when they attempted to verify some contractors' mix designs. Iowa has also observed difficulties in comparing field results, although they get good comparisons between their DOT labs.

Hypotheses about the causes of the observed variations include differences in the equipment and compaction procedures. Disparities in temperatures, ovens, molds, and the compactors themselves may contribute to variability. Procedural inconsistencies may also play a role in increasing between-lab variability. Even the release paper used at the top and bottom of the specimen is being scrutinized for possible contributions to variability. Some papers have a coating on one or both sides that may change the frictional properties of the mix sliding across the ends of the mold, thereby affecting the level of compaction.

Compactors may be evaluated under an AASHTO protocol, PP35, *Standard Practice for Evaluation of Superpave Gyratory Compactors*, to ensure that they are capable of producing results that compare favorably to those obtained from one of the original Pine or the Troxler SGC's. Seven of these comparisons have been conducted at the South Central and Southeastern Superpave Centers; an eighth is in progress. These comparisons, however, relate one device against another in one lab with one operator, significantly limiting the sources of variability. In recognition of the fact that comparisons between labs would obviously include many more sources of variation, a second draft protocol, *Standard Practice for the Evaluation of Different Superpave Gyratory Compactors (SGC's) Used in the Design and Field Management of Superpave Mixtures*, has been developed to investigate procedural differences.

As Chuck Paugh, Federal Highway Administration, reported at the North Central Asphalt User-Producer Group Technicians' meeting in January, the FHWA has amassed a large data base of comparisons from their two mobile field trailers. They have previously reported on 18 different plant-produced HMA's above, below and through the restricted zone. (They are currently adding two more years worth of data, including some comparisons with the TestQuip device.) Split samples were compacted in both trailers, one of which has a Pine and the other a Troxler. Although there is a slight bias to be noted, the comparisons are excellent overall. There is a tendency for the Troxler to compact somewhat denser at N_{ini} and the Pine to compact somewhat more at N_{des}; in the FHWA data, these differences are very small. Because of nearly identical equipment and close adherence to standard protocols, however, this is essentially a within-lab comparison.

FHWA has seen cases where their compactors do not compare favorably to those owned by the states or contractors, even when operated by the FHWA technician. They have usually found these incompatibilities to be related to differences between the ovens used. Occasionally, they have observed molds that have been overheated and are warped, affecting the results. Overall, however, Paugh feels procedures make more difference than the compactors. FHWA will continue to investigate this issue and is following up with a comparison of different papers, with the coating up or down, etc. Results are expected soon.

A second comparison steps up the sources of variation from the FHWA work. John Hinrichsen, Iowa DOT, reported at the NCAUPG Technicians' meeting on the preliminary results of a single-lab evaluation of the differences and similarities between four compactors.

According to Hinrichsen, the DOT assumed the SGC would compare at least as well as the Marshall compactor. They have found very good comparisons between seven DOT SGCs in monthly round robins (SD(1S) = 0.0052); these are all Troxler model 4140's, however. Comparisons in the field between different brands were not as successful. The observed differences between Pine and Troxler devices were -0.028 on bulk specific gravity and almost 1% on air voids.

Because of these observations, the Iowa DOT decided to do a comparison in their lab. Three contractors lent their gyratories to the DOT for the evaluation. Four compactors were compared, the original Troxler and Pine plus the Interlaken and TestQuip. Manufacturers were not invited to participate in the evaluation. The AASHTO protocol was essentially followed except that they used 4800 grams of plant-mixed material. Four 19mm mixes were compacted with one above the restricted zone and three below. The same paper was used in all four compactors. Calibration of all compactors was verified prior to the comparisons. A significant difference was observed between the angle calibration of the Interlaken when checked in loaded and unloaded conditions.

In general, the Pine produced the highest densities, the Troxler and TestQuip were nearly identical and the Interlaken was lowest at N_{des} and N_{max}. Results varied somewhat at N_{ini}, though the Troxler tended to produce higher uncorrected bulk specific gravities.

Unexpected differences were also observed in the correction factors calculated based on the measured and calculated bulk specific gravities at N_{max}. The explanation for these differences was traced back to a difference between the height at N_{max} reported in the SGC printout versus the actual height. The height is printed out before any dwell gyrations are applied (five were used in this evaluation). When the actual heights were used for backcalculation, the Pine results moved closer to the Troxler and TestQuip.

Hinrichsen reported that the magnitude of the differences were definitely mix dependent. The finer mix compared better than the coarser mixes. This was also true in the past with comparisons of Marshall compacted mixes, probably due to higher shear stresses generated within the coarser mixes.

At the time of the NCAUPG meeting, this data had not yet been statistically analyzed. A final report on the comparison is in preparation that will summarize all of the results.

A third level of comparison represents true between-lab variability. The Missouri DOT is currently conducting a round robin comparison of 9 labs with various brands of gyratories. Participating labs include two contractors, six states and the NCSC. The Iowa DOT ran the mixes through the four gyratories they evaluated in their study. The MoDOT batched two different mixes (19.0 and 12.5mm) and sent aggregate and binder to the participating labs for mixing and compacting. Results of this comparison are also expected soon.

Although there are growing reports of variability in compaction results, differences are not seen in all cases. The differences definitely appear to be mix specific and may relate to particular compactor units being compared. Trends do appear to be developing between brands, however, that may help to resolve the causes for, and thereby limit, the variability. In the meantime, keeping compactors and other equipment (such as ovens) in calibration, following standard protocols closely and consistently, and participating in round robin exchanges can help to ensure that your results compare favorably with those of other labs.

In Kansas, five contractors have considerable Superpave experience, according to Wade Calwell of the Kansas Asphalt Pavement Association. They report that compaction is more difficult; production is slowed by as much as 20%, due in part to wetter manufactured sands; cleaner aggregates are needed; some local aggregates are unsuitable, leading to long haul distances for better materials; and costs are up. On the other hand, they have not had problems comparing different compactors, like some states have had. Calwell describes the difficulties as "growing pains," not resistance to change.

For the Kansas DOT, Rodney Maag reported that they are proposing all 1999 jobs with over 20,000 tons of hot mix be Superpave projects. In 2000, "all" projects will be Superpave, although he commented that they are following President Clinton's logic in defining all! Kansas is implementing Superpave and QC/QA on the same projects. The state shares the contractors' concerns about aggregates and adds concerns about the binder, dust to asphalt ratio and permeability. The new binder algorithm now allows the use of _22 grade material in the southern part of the state, which corresponds to what they used to use; transverse cracking has been a problem, however, so they prefer to use _28 material.

Overall the Superpave projects in Missouri have been successful, according to Jim Campbell. MoDOT is pleased with what they see and are convinced they are headed in the right direction, although there is still a long way to go. In 1999, the state is planning 20 to 25 projects on all high and moderate traffic roads. In 2000, they will go to Superpave on low volume roads as well. The biggest problems have related to verification of contractors' mix designs when using different compactors, achieving VMA, meeting compaction requirements of 92-95% of Rice density, and tenderness, particularly on one project. Interestingly, an early project with considerable tenderness problems is showing no rutting after three years in the field; there had been noticeable moisture in this mix during construction. Some of their VMA and mix design problems may be related to the soft aggregates that are available in large parts of the state.

The overall tone of these presentations was that Superpave is doable and is the right way to go. Some changes to the way we used to do things are needed in order to meet the new requirements. The regional experience, then, agrees well with the overall national experience summarized by Ray Brown of NCAT. Brown did a survey of 44 projects in eight states and reported generally positive experiences. Continued refinements may be necessary as we gain more experience with the Superpave system.

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NCSC Superpave Training

March 10-12 Superpave Mix Design - West Lafayette, Indiana
March 22-26 Volumetric Mix Design - Ames, Iowa

For information on these courses, contact NCSC, (765) 463-2317

March Iowa DOT Training Courses

Mar. 22-26 Superpave Mix Design - Ames, Iowa
Mar. 23 Bulk Specific Gravity Seminar - Ames, Iowa

For information on any of these courses, contact chris Anderson, Iowa DOT, at (515) 239-1819

Although the official NCSC training schedule draws to a close this month, we are still available to help you meet your training needs. If you would like to schedule hands-on mix design or binder training, seminars for consultants or local agencies, or other customized training, contact the North Central Superpave Center. We will gladly work with you to arrange the training you need at your location or ours.

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Calendar of Events

March 8-10, 1999	Association of Asphalt Paving Technologists Palmer House, Chicago, IL Contact: AAPT, (651) 293-9188 FAX: (651) 293-9193 e-mail: Aaptbev@aol.com
March 18-19, 1999	Mix ETG Meeting Phoenix, AZ Contact: John Bukowski, FHWA,(202) 366-1287
March 24-25, 1999	Flexible Pavements, Inc. Annual Meeting and Equipment Exhibition Greater Columbus Convention Center, Columbus, OH For information contact Flo Flowers at (614) 221-5402
April 13-14, 1999	Binder ETG Meeting Salt Lake City, UT Contact: John D'Angelo, FHWA, (202) 366-0121

May 10-12, 1999	ASCE Materials Engineering Division Fifth Materials Engineering Conference "Materials and Construction _ Exploring the Connection" Cincinnati, OH Contact: ASCE, (703) 295-6000
July 16, 1999	North Central Steering Committee Meeting Wintergreen Resort and Conference Center Wisconsin Dells, WI For reservations call (800) 648-4765 For more information contact: NCSC, (765) 463-2317
October 18-20, 1999	International Conference on Accelerated Pavement Testing Reno, NV Contact: Nevada T2 Center, (702) 784-1433
October 27-29, 1999	7th Annual U.S. Hot Mix Asphalt Conference Orlando, FL Contact: NAPA @ 1 - 888 - HOT - MIXX
January 18-20, 2000	North Central Asphalt User/Producer Group Meeting Kansas City, KS Contact: Ken Archuleta, FHWA, (816) 276-2732

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Tenderness in Superpave Mixtures

One of the most widely reported problems with Superpave mixtures is compaction difficulties in the so-called tender zone. In a recent NAPA survey, reported by Dale Decker at the Rocky Mountain Asphalt Conference, two-thirds of those surveyed had observed tenderness on their projects.

The following two articles offer different perspectives on the tenderness issue. In the first, Rich Wolters, Minnesota Asphalt Paving Association, discusses the tender zone and suggests some possible causes. In the second, Chuck Deahl, of Compaction America, offers suggestions for how to select compactors to achieve density in Superpave mixtures.

Tenderness is not unique to Superpave mixtures, but it does appear to be more prevalent than in the past. The problem does not occur at all on many, if not most, Superpave projects. On other projects, it tends to occur sporadically during particular times of the day. High fluid content (binder plus moisture), variable moisture in the mix and high ambient temperatures appear to be significant contributing factors. Although we do not yet have a definitive answer to the cause of tenderness, we are learning how to cope with it. In the NAPA survey, nearly everyone who reported having seen tenderness also reported that they had learned to deal with it by attention to detail.

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Tenderness of Hot Mix Asphalt

Richard O. Wolters, P.E.
Director of Engineering/Training
Minnesota Asphalt Pavement Association

Meeting compaction requirements can be very challenging. Successful compaction encompasses a host of factors (and responsibilities) such as base foundation support, placement of the mix, characteristics of the mix, lift thickness, base and air temperatures, wind velocity, equipment used, specification appropriateness and binder characteristics. Well-documented testing procedure(s) to monitor and measure density changes and expertise of individuals (buyer and seller) associated with the process of mixture densification can help improve the process.

The placement of Superpave mix has made a big impact on the industry. The "tender zone" has generated national discussions. The "tender zone" is the Hot Mix Asphalt (HMA) pavement temperature zone in the range of 250° to 170° F (121° to 77° C). In the "tender zone" compaction effort does not result in any significant additional density in the mixture. Rolling can resume after the mix cools below the "tender zone" and continue until density requirements can usually be met. With a tender mix the rollers simply cannot be fully utilized on the mat for rolling activities until the viscosity of the binder matrix increases sufficiently to support the roller without excessive shoving. Adequate compaction may even then be difficult to achieve. Another reason is that there are zones of decompaction generated in front of and behind a moving roller. Figure 1 illustrates where these decompaction areas occur.

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Figure 1

Usually decompaction and recompaction reach a stage of equilibrium after a number of roller passes. However, with tender mixes, horizontal movement of the mix particles does not allow confinement of the mix under the roller face (steel drum or pneumatic tires) and decompaction prevails.

The introduction of the vibratory drum roller some years ago (and more recent models) has improved the chances of obtaining satisfactory compaction of tender mixes provided sufficient mixture temperature is present for workability. The amount of time to achieve density can double or even triple with final compaction being achieved four hours after initial placement of the mixture, as in the case with many Superpave mixtures. An adequate lift thickness, when compared to the aggregate nominal size, is currently unresolved in the construction community. Nominal aggregate size for Superpave is defined as one sieve size larger than the first sieve which retains more than 10%. Minimum lift thickness ratios of 4:1 vs. 3:1 of the nominal aggregate size are being encouraged for placement. These values should help with compaction.

Delaying rolling operations until some cooling of the mat has occurred allows the development of some stability in the mix through the increase in the binder mixture viscosity. There may then be sufficient stability in the mix to allow rolling provided there is an adequate lift thickness to support the dead load of the roller. Procedures and type of roller usage will vary based on the factors referenced earlier. Some procedures and corresponding equipment techniques will only be acceptable as long as adequate (or optimum) density can be achieved without detriment to the mixture. Construction experience in Minnesota has demonstrated vibratory breakdown rolling right behind the paver and two lighter-weight compactors as opposed to one heavy roller may be the key for an intermediate rolling pattern as a means of compacting tender mixes without damaging the mat. Finish rolling can be accomplished with static steel rolling when the mix cools and becomes stable again.

Many different factors may have the potential for promoting tenderness in asphalt mixes. Potential tender mixes may be identified by closely examining:

1. Aggregate characteristics (i.e. gradation, quality, particle shape, texture, etc.)

2. Properties of the asphalt binder (temperature of which viscosity is good for compaction)

3. Mix criteria for the facility

4. Tensile or resilient modulus tests on laboratory mixes

5. Slope of the gyratory compaction curve

Tender mixes may pose problems at the construction stage or the in-service performance stage or both. The potential causes are many, but the more likely reasons are:

1. Aggregate shape and texture, sand/filler characteristics and contents in the mix

2. Moisture in the mix

3. Excess additives or incompatibility (ie. silicon, anti-strip, modifier material)

4. High rolling temperatures

5. High ambient temperatures with humidity

6. High asphalt binder content (film thickness)

7. Binder characteristics (i.e. temperature susceptibility, setting, etc.)

8. Voids in the mineral aggregate (VMA) or voids filled with aphalt (VFA) criteria for the facility

Most tender mixes eventually "set-up" in due time, although they may tend to shove and rut under heavy traffic conditions. The biggest problem is evident at the construction stage for the contractor in that tender mixes are difficult to compact and long roller trains require more traffic control. For mixes that exhibit tender characteristics under the rollers, it is important to get the breakdown roller(s) close behind the paving machine to obtain as much compaction as possible before it cools to the tender zone temperature range. Two vibratory double drum rollers operating in tandem have proven to be very successful. When a mix becomes tender, steel wheeled rolling should be stopped or the mix will be damaged. A pneumatic roller(s) has also been used effectively in the tender zone usually without damaging the pavement. Attempts to recompact with high pressure tire rolling may actually induce decompaction. When the mix cools and becomes stable again, a steel wheel roller can be used to finish the job of compaction and roll out pneumatic tire marks.

In summary, the effects of tender mixes on compaction can be overcome best by:

1. Use of a vibrating double drum roller before the "tender zone" temperature is reached. The can entail two double drum vibratory rollers operating in tandem for some Superpave mixes.

2. Stop steel-wheeled rolling when mix becomes tender.

3. Use pneumatic roller(s) carefully when mix is in the tender zone. Usually a pneumatic roller(s) with modified PG binder has a tendency for mixture pick-up or it may be difficult to roll out tire marks.

4. Use steel wheel roller to finish compaction and roll out tire marks.

5. The vibratory roller manufacturer can also be contacted to verify optimum vibratory efficiency in the field.

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Selection of Compaction Equipment

Chuck Deahl, Compaction America

Experience with compacting Superpave mixtures has shown that the primary roller utilized as the breakdown, or front, roller is a tandem vibratory with a drum width of 66", 78", or 84". These rollers have the advantage of covering a standard paving width of 12 ft. in two coverages. The placement of this roller behind the paver in relationship to mat temperatures, base temperatures, ambient temperatures and lift thickness is critical. We want to keep this roller in the 285°F to 300°F mat surface temperature zone with a rolling zone of no more than 200 ft off the screed of the paver.

The vibratory roller should be placed in this zone with both drums vibrating. The selection of vibrations per minute (VPM) and amplitude varies according to the controls on the roller. On a two-amplitude machine with variable frequency up to 3400 VPM, we are using high amplitude on 19 mm material (3" lift thickness) at 3000-3200 VPM; and low amplitude on 9.5 mm (1 ½" lift thickness) at 3000-3400 VPM.

In selecting VPM and amplitude, we should set up the controls with the highest VPM and lowest amplitude setting we can to compact the mix in the fewest number of passes. There are several reasons for running higher VPM's and lower amplitudes:

1. We want to maintain a minimum of ten impacts per 12" of asphalt mat or a 1.2" impact spacing. The higher VPM rate allows us to travel faster with the roller and:

• stay in the 285°F-300°F temperature zone,

• gain density in the fewest number of passes to maintain production and smoothness, and

• help set a higher production rate (10 impacts at 2500 VPM=250 feet per minute (FPM) travel speed; 10 impacts at 3400 VPM=340 FPM travel speed).

2. A vibratory roller compacts by particle rearrangement. With a larger column of coarse aggregate in a Superpave design, higher VPMs set the aggregate in motion faster and obtain initial lock up of the aggregate particles at higher

mat temperatures.

3. We do not want to pound this mix in the breakdown rolling phase by using high amplitude ranges. Trying to obtain 100% of specified density during breakdown rolling can cause smoothness problems, fractured aggregate particles with high permeability, and high voids to density relationship. We will literally pound the life out of Superpave pavements trying to achieve specified density levels during the breakdown rolling.

In order to discuss the intermediate and finish rolling phases, we need to discuss the three temperature zones we may have with Superpave mixes on the coarse-graded side below the restricted zone. On a number of jobs with this mix design we have the following rolling and mat surface temperature zones:

1. Breakdown rolling - Initial rolling uses a tandem vibratory in the range of 285°F to 300°F.

2. Intermediate rolling - In a temperature zone from 200°F to 250°F, we have sometimes identified a *tender zone*. The mix can be compacted above this range or below this range, but the mix is tender within this temperature range and cannot be compacted, at least not with a steel-wheeled roller.

3. Finish rolling - From 120°F to 170°F, we are obtaining final density with a tandem vibratory roller rolling in the static mode, or utilizing a static tandem roller.

On actual jobs requiring 92% maximum theoretical density for 100% pay, we are obtaining 92%-93% density in the breakdown rolling phase with one or two tandem vibratory rollers. We have established some patterns with two tandem vibratory rollers rolling in echelon, or side-by-side, in order to cover the mat and make the initial passes in 285°F-300°F mat surface temperature zone.

In the *tender zone*, we are either not rolling or are utilizing a pneumatic tired roller or rollers. The sizes of pneumatic tired rollers used range from 12 ½ ton to 25 ton ballasted weight with a compactive effort of 80 to 90 psi (pounds per square inch). The pneumatic tired roller, like the gyratory lab compactor, compacts with confined manipulation and pressure. By utilizing the pneumatic tired roller in the *tender zone*, we are confining the mix and not allowing the horizontal and lateral displacement we have seen under steel vibratory or steel static rollers. The pneumatic tired roller might have a problem with modified asphalts if proper procedures are not utilized to keep the mixture from adhering to the tires. There are non-adhering pneumatic tires available to the industry that have been tested on both neat and modified asphalt mixtures without having "pick-up" problems.

We have achieved some additional density in the *tender zone* with the rubber tired roller from 92% behind the breakdown roller. We have seen an increase of 0.5 to 1 lb. per cubic foot of density.

In the finish rolling zone, from 120°F to170°F mat surface temperature, we are gaining 3-4 lbs. of density; from 92-93% to 95-97%. We are utilizing tandem vibratory rollers in the static mode or static tandem rollers. We are not vibrating in this temperature zone. If we do not apply a pneumatic roller in the tender zone, our choice is to wait for the mix to cool to the temperature range where it can be confined and compacted in this finish rolling zone.

If the tenderness problem yields a pavement with poor in-place density, or if the paving train is excessively long due to the time required for the mixture to cool, adjustments to the mix design must be made to eliminate or reduce the temperature *tender zone*.

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Team Summarizes Forensic Analysis of Early Rutting at WesTrack

Ray Brown, Director

Southeast Superpave Center

After approximately 2.7 million ESALs, some of the pavement test sections at WesTrack had experienced more rutting than anticipated. As a result of this early rutting, the Federal Highway Administration (FHWA) selected a forensic team to investigate the causes of this early rutting and to make recommendations to improve the performance. The team consisted of Ray Brown, NCAT; John D'Angelo, FHWA; Erv Dukatz, Vulcan Materials; Gerald Huber, Heritage Research Group; Larry Michael, Maryland DOT; Jim Scherocman, consultant; and Chris Williams, FHWA.

Many of the original sections at WesTrack were designed to fail early so the early rutting was not a complete surprise. However, contrary to expectations, the fine-graded mixes appeared to perform better than the coarse-graded mixes. After reviewing the test sections and reviewing the available data, it was concluded that the major cause of the early rutting in the coarse-graded mixes was the high VMA resulting in high optimum asphalt content and the relatively low binder stiffness (PG 64-22). It was also recommended that some type of performance test be used to help evaluate mixture quality.

The binder stiffness can be increased by bumping the asphalt binder grade or by increasing the percentage of material passing the No. 200 sieve. As recommended by Superpave, the asphalt binder grade should be bumped for higher traffic levels. For the high traffic rate at WesTrack the binder grade should have been bumped at least one grade. New Superpave guidance presently being considered also recommends that the dust to asphalt binder ratio be increased up to 1.6 for coarse-graded Superpave mixtures. These increased fines will result in a stiffer binder and improved resistance to rutting. It is essential that air voids and VMA criteria be met when using higher filler contents.

Four types of wheel trackers and the Superpave Shear test were used to evaluate the performance at WesTrack. Each of these devices, when used correctly, provided some indication of performance. Work is on-going under an FHWA contract to develop performance tests and criteria. Until test methods are accepted nationally, local experience must be used with any testing device.

A final report by the forensic team is being completed and is being published by FHWA. This report provides detailed findings of the forensic team and specific recommendations to improve resistance to rutting.

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The 2nd Asphalt Technology Conference of the Americas

Mansour Solaimanian, Project Manager
South Central Superpave Center

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After a successful first conference in 1996, the 2nd Asphalt Technology Conference of the Americas was held in Austin, Texas, from October 12 to 16, 1998. Over 370 engineers, technicians, and managers from 21 countries attended the conference and exhibit hall. While most of the participants were from Latin America and the United States, there were also representatives from Canada, Germany, Spain and Sweden. The exhibit hall was occupied by more than 40 exhibitors, including indoor and outdoor machinery exhibits, in order to allow the participants to inspect the latest industry equipment in paving research and design. The presence of the FHWA Superpave Trailer was a favorite exhibit since it displayed the latest Superpave equipment used in pavement testing and design.

During each presentation, participants were invited to ask questions of the presenters and share the latest information related to design, construction, maintenance, and rehabilitation of asphalt pavements in their countries. Presentations were made in the areas of pavement management and maintenance, materials and paving asphalts, asphalt emulsion storage, hot mix asphalt, asphalt pavement drainage and cold in-situ recycling for bituminous pavement rehabilitation. Presentations were also made by Greg Speier, Pan American Institute of Highways, on Technology Exchange Activities, and Joe Ringer, Export-Import Bank of the United States, on Infrastructure Financing.

The program included a tutorial on the Superpave System, which was moderated by Gary Henderson, Federal Highway Administration. A *Superpave Overview* was presented by Dr. Thomas Kennedy of the University of Texas, followed by *The Evolution of Superpave Testing Equipment and Procedures and Implementation* presented by Mr. John Bukowski of the Federal Highway Administration. Mr. Larry Michael from Maryland State Highway Administration presented *The States Experience with Superpave*, and Mr. James Madden from Madden Construction presented *The Contractors Experience with Superpave*. Mr. Harold Von Quintus. from BRE-Fugro, presented *Superpave-Current Research Activities*. Many participants took advantage of the opportunity to tour the South Central Superpave Center while in Austin.

The conference was sponsored by the Department of Continuing Engineering Studies, College of Engineering at the University of Texas. Major cooperative efforts were contributed by the Federal Highway Administration, Akzo Nobel Asphalt Applications, Inc., Asphalt Institute, and Pan American Institute of Highways. Corporate support was provided by Akzo Nobel Asphalt Applications, Inc., Chemcrete International, CITGO Asphalt Refining Company, Eastman Chemical Company, Federal Highway Administration, and Koch Materials Company. The Conference Steering Committee, chaired by Dr. Thomas W. Kennedy, included various officials from state and federal agencies, and industry. Services were also donated by Fugro-BRE of Austin, Texas.

Professionals interested in future asphalt conferences should contact the website of Continuing Engineering Studies at www.utexas.edu/academic/ces, or contact Sharon Campos at (512)471-3396. For technical information regarding Superpave, please refer to the South Central Superpave Center website at www.utexas.edu/research/superpave.

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Mix ETG Approves Recommended Changes

Doug Hansen, Manager
Southeast Superpave Center

The most recent meeting of the Superpave Mixture Expert Task Group (ETG) was convened in Baltimore, Maryland, on September 22 & 23, 1998. It was attended by approximately 25 members representing state DOTs, universities, consultants, industry groups and FHWA. Meetings are open to the public and some 20 guests from various DOTS, universities, equipment manufacturers and private consultants were also present. A meeting of the Superpave Lead States Team was held on the day after the ETG. Copies of the ETG meeting proceedings are available from members or by contacting John Bukowski, ETG Chairman, at 202-366-1287, e-mail: john.bukowski@fhwa.dot.gov.

The Superpave Mixture ETG was formed in May, 1994, to discuss and evaluate technical uncertainties related to the

Superpave mixture design system, to address emerging issues and provide technical guidance to government agencies and the industry in their use of these procedures.

At the recent meeting discussion focused principally on proposed changes to the N_{design} table and related criteria. The AASHTO Subcommittee on Materials (SOM) had requested that the ETG review and comment on the recommendations to simplify the N_{design} table in the recently completed study under NCHRP 9-9, "Refinement of the Superpave Gyratory Compaction Procedure." Areas of investigation also included compaction of open graded friction courses and SMA with the gyratory compactor, investigation of lab compaction temperatures, investigation of separate compaction "N" values for base and surface mixes, and sensitivity of current values of N_{design}. Professor E. R. Brown, Director of the National Center for Asphalt Technology, reported the study findings to the ETG. Members also heard a presentation from Mike Anderson, Director of Research for the Asphalt Institute, on " N_{design} II," an FHWA sponsored effort to evaluate the relation of traffic densification to lab compaction. This effort was begun soon after conclusion of the SHRP efforts and was an attempt to augment the findings of the original SHRP N_{design} experiment. These studies are now complete and copies should be available early in 1999.

Following the presentations, the ETG held breakout group discussions on the issues presented. The ETG members approved the following revisions to the N_{design} table. These changes were subsequently approved by the Superpave Lead States and have now been forwarded to AAHTO for possible adoption by the SOM and eventual incorporation into the AASHTO Provisional Standards.

Superpave Gyratory Compaction Effort

chart1.jpg (20645 bytes)

Notes:

1. Traffic Level based on 20 year pavement design life.

2. For base/binder pavement layers, where surface of the layer is more than 100mm below the surface of the pavement; decrease the design compactive effort of the mixture for that layer by one level, but not less than N_{design} of 50 gyrations.

3. Age design mixtures at compaction temperature for 2 hours per PP2, Volumetric Mix Design. No aging on plant produced mix is specified.

4. For lab design, volumetric properties are measured directly on specimens compacted to N_{design} and not estimated based on $N_{maximum}$.

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Improved Superpave Standards: Summary of Proposed Changes to Superpave Mix Design

Robert McGennis, Technical Manager, Navajo Western Asphalt Co.
and Paul Mack, Deputy Chief Engineer, NYSDOT

National standards for the Superpave system are published and maintained by AASHTO through the Subcommittee on Materials (SOM). The Subcommittee, with membership from all 50 states, held its annual meeting last August in Duluth, Minnesota. At the August meeting, a five-state Task Force was established to consider, prepare and recommend changes to mix design standards for balloting by the entire Subcommittee. Several of the Task Force members are also members of either the AASHTO Lead State Team or the Mix Expert Task Group (ETG) and some are members of both.

In making its recommendations, the Task Force was charged with considering changes proposed from among several sources, including:

• NCHRP 9-9: *Refinement of Superpave Gyratory Compaction Procedure*

• *1*998 Lead State Guidance (June 1998)

• Input from the Superpave Mixture Expert Task Group

• Suggestions by member States

The Task Force completed its work in November and forwarded proposed revisions of four standards to the Subcommittee. Dr. Haleem Tahir at AASHTO headquarters has prepared the final ballot, which has been distributed to the entire Subcommittee on Materials for voting.

The standard revisions, based on a combination of research, expert opinion and practical experience, are intended to clarify and simplify the mix design process, and improve the resulting product. To improve standards, information has been gathered from letter ballots to the AASHTO Subcommittee on Materials for the following test methods:

AASHTO PP2 - *Standard Practice for Short and Long Term Aging of Hot Mix* Asphalt

AASHTO TP4 - *Standard Method for Preparing and Determining the Density of Hot Mix Asphalt Specimens by Means of SHRP Gyratory Compactor*

AASHTO MP2 - *Standard Specifications for Superpave Volumetric Mix Design*

AASHTO PP 28 - *Standard Practice for Designing Superpave Hot Mix Asphalt*

The most significant changes to these methods are summarized below.

Item 1 - New N_{design} Table

Research conducted at NCAT, the University of Texas at Austin, and Heritage Research showed that the current N_{design} values were reasonable but that the N_{design} table could be simplified. This was based on engineering property testing at the University of Texas and Heritage Research and on volumetric testing at NCAT. N_{design} values in the new table are based on 20-year design equivalent single axle loads (ESALs). For lesser design periods, design traffic should be inflated to obtain a 20-year-ESAL value to be useable in the table. Four design ESAL ranges are defined in the table although five design ESAL ranges are used for binder, aggregate and mix design.

chart2.jpg (25021 bytes)

Item 2 - More precise definition of layers

If less than 25 percent of layer is within 100 mm of surface, then the layer is considered below 100 mm for material selection and mix design purposes.

Item 3 - Change in short term aging temperatures

Mixture is to be aged at the mixture compaction temperature rather than being fixed at 135 °C. This reduces the practical number of mix design ovens from three to two.

Item 4 - More precise definition of short term aging

If only volumetric property testing is to be conducted, then loose mixture should be aged in a forced draft oven for two hours at the compaction temperature. If mechanical property testing is to be conducted, then loose mixture should be aged in a forced draft oven for 4 hours at the compaction temperature. This clarifies the intent of the short term aging procedure.

Use pans that are large enough so that the loose mixture can be spread between 25 and 50 mm thick. This simplifies the old requirement, which had been based on a spread ratio in kg/m^2.

Item 5 - Operation of gyratory compactor

Replicate specimens should be compacted to the design number of gyrations (N_{design}) rather than $N_{maximum}$. This corrects minor errors in volumetric properties at N_{design} that were previously based on calculated rather than measured values.

Item 6 - Verification of the mix properties at $N_{maximum}$

Replicate specimens at the design asphalt binder content should be compacted to $N_{maximum}$ to verify that the mix bulk specific gravity is less than 98% of G_{mm}. Since the mix designer is no longer compacting specimens to $N_{maximum}$, this will verify that requirement is met on the final mix.

Item 7 - Change in dust proportion requirement

The current acceptable range in dust proportion is from 0.6 to 1.2 (i.e. the ratio of percent passing the 75 mm sieve to percent effective asphalt content). This range will change to 0.6 to 1.6. In other words, more material finer than 75 mm will be allowed.

Item 8 - Change VFA requirements for 9.5, 25, and 37.5 mm mixtures

For some nominal maximum aggregate sizes, current requirements on voids filled with asphalt (VFA) result in an impractically low range of acceptable VFA. The range has been adjusted based on design ESALs and nominal aggregate size to address this issue.

Item 9 - Change %Gmm at $N_{initial}$

The current requirement on percent density at initial number of gyrations ($N_{initial}$) is fixed for all design ESALs. The requirement will be changed to be a function of design ESALs. The following changes will likely allow finer and higher percentages of sand for lower volume roadways.

< 0.3 million ESALs, maximum %Gmm at $N_{initial}$ = 91.5%

0.3 to 3 million ESALs, maximum %Gmm at $N_{initial}$ = 90.5%

>3 million ESALs, maximum %Gmm at $N_{initial}$ = 89.0%

Item 10 - Change in calculation of low pavement temperature from low air temperature

The current approach in the system conservatively assumes that low air temperature and low pavement temperature are equal. The computations from the new model, developed by the FHWA LTPP Division, indicate low pavement temperature to be warmer than low air temperature. Such a change may affect selection of binder for some areas by one or possibly two grades. For example, assuming higher pavement temperature can result in selection of a PG 70-22 binder where previously a PG 70-28 was required.

Disclaimer: These proposed changes are under consideration by the AASHTO Subcommittee and do not become official until approved by that body. In anticipation of this approval some states have already included some of these changes in specifications or special provisions for next season.

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ASTM Holds December Meeting

Anne Stonex, P.E. , Operations Manager

Northeastern Superpave Center, NECEPT

As customary, Committee D04 on Road and Paving Materials sponsored a symposium to kick off its activities for December Committee Week. The "Symposium on Hot-Mix Asphalt Construction: Certification and Accreditation Programs" was organized by Scott Shuler and James Moulthrop. Nine papers were presented in this session from 1:00 to 6:00 p.m on Tuesday, December 8.

The symposium was very well-rounded. It included discussions of a range of approaches from small, proficiency intensive to larger, more general types of certification and accreditation programs with limited proficiency requirements. The papers came from a wide variety of programs in locations throughout the U.S.: New England, Rocky Mountain region, Pennsylvania, Arkansas, Illinois and South Carolina. Papers were also presented by representatives of the AASHTO Materials Reference Laboratory (AMRL)/National Institute of Standards and the National Institute for Certification in Engineering Technologies (NICET). AMRL is a national leader in accreditation of testing laboratories. NICET certifies technicians throughout the United States in a number of engineering and construction related areas and levels of expertise. Representatives of a large nationally recognized contracting firm, APAC, Inc., presented the contractor's view of certification programs. A relatively large audience showed considerable interest throughout the paper sessions. Paper titles and authors are listed at the end of this article. Symposium papers will be collected and published by ASTM as customary in a Special Technical Publication (STP).

Activities related to Superpave implementation included consideration of various standards for Performance-Graded (PG) asphalt binder tests and equipment, for mixture tests and equipment, and for aggregates. Subcommittee D04.44 on Rheological Tests is continuing work to refine dynamic shear rheometer, bending beam rheometer and direct tension test methods and equipment for characterizing asphalt binders. Considerable effort is being applied to evaluating the appropriate diameter of DSR plates to improve repeatability of tests performed at intermediate temperatures. The tests for Superpave consensus properties of aggregates are under the jurisdiction of Subcommittee D04.51 on Aggregate Tests. D04.51 is currently working to refine and clarify the standard test method for Flat and Elongated Particles in Coarse Aggregate, ASTM D 4791-95, last revised in 1995.

SYMPOSIUM PAPERS and AUTHORS

"Accreditation and Certification: A Contractor's Perspective" T.A. Lynn and R.C. West

"Basic Elements in the Design of a Certification Program for Hot Mix Asphalt Construction Personnel" A. Farouki, M. Clark, J. Antrim

"Lake Land College/Illinois Department of Transportation: Quality Control/Quality Assurance Training Program Development and Implementation" D.L.G. Hutti and L. Hymes

"South Carolina's Experience with Certification and Accreditation" S. Amirkhanian

"New England Transportation Technician Certification Program (NETTCP) A Regional Approach" L.C. Stevens, T. Peterson, C. Bowker

"Asphalt Technician Certification - The Rocky Mountain Way" M.M. Cassidy, S. Conner

"The AASHTO Accreditation Program - A Review of Its History, Experiences and Impact" R.A. Lutz, J. Houston, D. Savage, P. Spellerberg

"Experiences With Bituminous Technician Training and Certification in Pennsylvania" D. Christensen and A. Stonex

"A First Year Summary of the Arkansas Hot-Mix Asphalt Technician Certification Program" K.D. Hall and R. Pylant

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AAPT to Meet in Chicago

Rebecca S. McDaniel, Technical Director
North Central Superpave Center

Seventy-five years ago, a group of men from around the US and Canada met in Chicago and initiated the formation of an association dedicated to the technology of asphalt paving, now known as the Association of Asphalt Paving Technologists (AAPT). This year, the association will meet again in Chicago, March 8-10, to celebrate the 75th anniversary of its inception.

A Government Engineers' Forum is held the afternoon before the meeting. This year's topics include Performance and Superpave, RAP and Superpave, and Certification. The unique feature of the forum is that, although anyone may attend the session, only engineers working for governmental agencies are allowed to sit at the forum table and speak.

The workshop session will include discussion of the ignition method, wheel-tracking devices and Superpave construction issues and performance. The symposium this year will review the history of AAPT and advances in binders, additives, mixes and design, structural design, construction, quality and pavement management. Technical sessions, held Tuesday and Wednesday, will deal with Binder/Mastic Rheology, Mix Design and Performance, Low Temperature Performance Testing and In-Situ Pavement Properties.

For information on the Association or the Annual Meeting, contact the AAPT at phone 651/293-9188, fax 651/293-9193 or e-mail at Aaptbev@aol.com.

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Researchers, Practitioners Convene at TRB

Rebecca S. McDaniel, Technical Director, North Central Superpave Center

Once again, thousands of engineers and others from government, industry and academia met in Washington, D.C., at the Annual Meeting of the Transportation Research Board to discuss all aspects of transportation. The meeting was the venue for nearly 500 paper sessions, plus hundreds of committee, subcommittee and other group meetings.

Superpave was the focus of many of the sessions held during the Annual Meeting. Some of the topics discussed included: QC/QA specifications for Superpave, field experiences with PG binders, evaluation of Superpave mixtures and performance, aggregate properties and performance, testing modified binders, and much more.

A special conference on WesTrack was held on Sunday prior to the annual meeting. This conference discussed design and construction of the track, operation of the robotic vehicles, performance testing of the mixtures placed at WesTrack, performance modeling and the findings of the forensics team that analyzed the failures of various sections of the track. The findings of the forensics team are summarized in the article "*Team Summarizes Forensic Analysis of Early Rutting at WesTrack*" on page 6.

Copies of most of the preprint papers submitted for the meeting are available on CD-ROM from the Transportation Research Board Publications office for $50.00, plus sales tax in some states and shipping and handling for airmail orders outside North America. (Attendees at the Annual Meeting each received a copy of the CR-ROM.) To order, fax to TRB at 202/334-2519, phone 202/334-3213 or mail to TRB, Box 289, Washington, D.C., 20055. Payment by check, Mastercard, Visa or American Express must accompany the order.

Also, be sure to check the TRB website for more information. They can be reached at http://www.nas.edu.trb.index.html or most of the Superpave Center websites provide a link to TRB.

TRB will soon be seeking papers for the Year 2000 Annual Meeting, to be held January 9-13, 2000. Calls for papers are being prepared and will soon be available on the web. Papers will be due by August 1, 1999, to TRB for review. This is an excellent forum to share the work you may be doing with Superpave. Although technical research papers are common at TRB, practical papers are strongly encouraged.

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NCSC Vision and Mission:

To be an industry-recognized source of Superpave expertise and to lead further development and implementation of Superpave technology by providing services to its customers, through excellence in research, training, and communication.

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