



ASPHALT TECHNOLOGY News

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NCAT DEVELOPS IGNITION METHOD FOR DETERMINING ASPHALT CONTENT

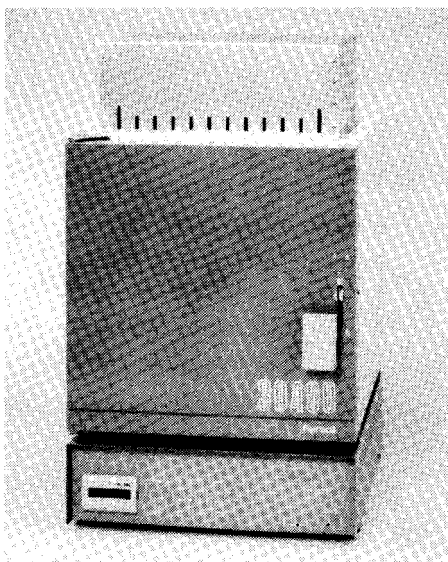
The National Center for Asphalt Technology (NCAT) has developed a test method to determine the asphalt content of hot mix asphalt (HMA) mixtures by ignition. At the present time, many agencies use chlorinated solvents (such as 1,1,1-trichloroethane) to dissolve and remove the asphalt cement from the aggregate. Such solvent extraction methods provide two important properties: asphalt content and aggregate gradation of HMA mixtures. However, the solvents used for extraction are expensive, difficult to dispose of, and unsafe. Growing health and environmental concerns associated with the

use of chlorinated solvents have been major factors in the search for alternate methods of determining asphalt content.

Newer types of solvents, generically called biodegradable solvents, have been evaluated and used by some agencies as a replacement for chlorinated solvents. Biodegradable solvents, however, require a modified extraction procedure which is time consuming. The proper disposal of biodegradable solvents containing the dissolved asphalt cement is also a problem in some states.

Nuclear asphalt content (NAC) gauges have been substituted for solvent extraction in some states. NAC gauges are capable of rapidly measuring the asphalt content of HMA mixtures with accuracy at least comparable to solvent extraction methods. Although NAC gauges have solved many of the problems associated with solvent extraction methods, these methods do not allow for determination of aggregate gradation. Furthermore, the solvent extraction test is still required for determining the asphalt content of reclaimed asphalt pavement (RAP) materials.

Because NAC gauges and biodegradable solvents have not successfully eliminated the use of chlorinated sol-



NCAT Asphalt Content Tester.

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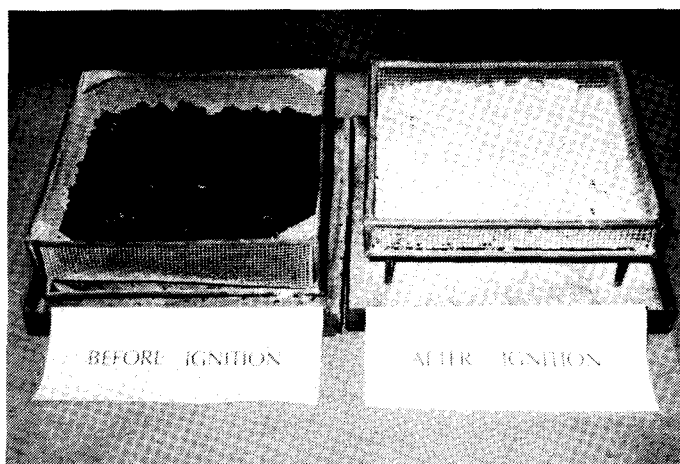
Research in Progress

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vents, other test methods have been sought to determine asphalt content. NCAT research on this problem—begun in 1990—has recently developed a test method for determining asphalt content by ignition.

In the ignition method, a sample of HMA mixture is subjected to very high temperatures in a furnace resulting in virtually complete combustion (or burning off) of the asphalt binder. The difference in weight of the HMA mixture before and after ignition indicates the asphalt content



HMA mix before and after ignition in the NCAT Asphalt Content Tester.



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E. Ray Brown, Director
Prithvi (Ken) Kandhal, Assistant Director/Editor

of the HMA mixture. The aggregate is then subjected to sieve analysis to determine its gradation.

During the past four years, NCAT has experimented with various equipment and procedures to minimize the aggregate mass loss (0.2-0.3 percent for some aggregates) and the testing time. The following variations were used: (a) different types of muffle furnaces, (b) different types of containers or racks to hold the HMA mixture sample, (c) a range of ignition temperatures, (d) different air-flow rates in the furnace, and (e) different HMA test sample sizes. Various types of aggregate and a range of asphalt contents were used in this NCAT research project.

Based on study results, a standard method can be recommended. This method uses a programmable furnace (14x14x14 inches inner chamber dimensions) capable of heating the HMA mixture to 538°C (1,000°F). The HMA test sample is divided into two portions and placed in two stainless steel No. 4 mesh trays. One tray is placed on the top shelf and the other on the bottom shelf of the pre-heated furnace. The HMA sample is allowed to burn for one hour at 538°C (1,000°F). At this time and temperature, the aggregate mass loss has been determined to be insignificant based on the test results for the three aggregate types evaluated (gravel, granite and limestone). A scale to weigh the HMA sample during the ignition test is placed underneath the furnace. NCAT has also used a data acquisition system using a personal computer to obtain a plot of test time in minutes versus weight loss (percent). The oven can also be shut off automatically once a constant weight is reached. It may also be possible to determine moisture content and polymer content in HMA mixtures from the plot of test time versus weight loss, because moisture and polymers are expected to evaporate or burn off at different temperatures.

IGNITION METHOD (Continued on page 11)



FHWA engineers visited NCAT in March, 1994.

REGIONAL ASPHALT USER-PRODUCER GROUPS

As a component of the implementation process for the Strategic Highway Research Program (SHRP), the concept of regional asphalt user-producer groups was developed. The initial objective of these groups was to provide regional cooperation in the implementation of the results of SHRP research. Since the formation of these groups, many have expanded their function to include all aspects of hot mix asphalt (HMA) design and construction. There are five groups: West Coast, Rocky Mountain, North Central, Southeast, and Northeast. Each user-producer group consists of users (DOTs, cities, counties) and producers (HMA contractors, asphalt cement suppliers, aggregate producers, etc.) of hot mix asphalt. Each group has a steering or management committee comprised of equal numbers of users and producers headed by two co-chairpersons, a representative of a user agency and a representative of a producer. Each group has had a general meeting each year, with subcommittee and task force meetings throughout the year. Many of the groups also send out a newsletter two or three times each year. On a national basis the chairpersons of each of the groups meet annually to coordinate the activities of the groups.

The activities of these user-producer groups vary throughout the country. The groups have generally been very active in training personnel on the use of SHRP binder equipment. The Federal Highway Administration (FHWA) Office of Technology Applications bought five sets of SHRP binder equipment and loaned one set to each user-producer group. These sets were used to conduct initial training at the regional level. Any agency interested in hands-on training with this equipment, beyond what the National Asphalt Training Center at the Asphalt Institute provides, should contact its regional user-producer group.

In keeping with this concept of regional cooperation, the FHWA has decided to establish five SUPERPAVE™ centers at state universities through a partnership of the

respective state highway agency, a state college or university within the region, and the five regional user-producer groups. At each of these centers, the FHWA will install, provide operator instruction, and upgrade as required, the SHRP SUPERPAVE™ Level II/III equipment. This equipment will consist of the SUPERPAVE Shear Tester (SST), and the Indirect Tensile Tester (ITT). This equipment and the expertise at each of these centers will be used to develop Level II/III designs for SPS-9 projects for state highway agencies within each region. The FHWA has announced that the centers will be located in Texas, Pennsylvania, Indiana (Purdue University), Nevada (University of Nevada at Reno), and Alabama (National Center for Asphalt Technology at Auburn University).

The future of these user-producer groups holds great potential and is expected to vary from region to region. Plans or activities could include training personnel on quality control/quality assurance (QC/QA) procedures, coordinating the schedules for the implementation of the SHRP binder specifications, developing regional databases on new materials and processes used to construct HMA pavements such as crumb rubber, SMA, large stone mixes, etc., and generally improving communication within the industry with regard to HMA design and construction.

For more information about the user-producer group in your region, it is suggested that you contact the persons listed below:

West Coast User-Producer Group (the grandfather of the groups) made up of Arizona, California, Nevada, Oregon, and Washington. Contact: Bob Doty, Caltrans, (916) 227-7304; Rick Holmgreen, Shell Development Co., (713) 493-8257

Rocky Mountain User-Producer Group made up of Alberta, Colorado, Idaho, Montana, New Mexico, North Dakota and Wyoming. Contact: Tom Atkinson, Wyoming DOT, (307) 777-4476; Bob Rask, Asphalt Institute, (303) 798-2972

Northeast User-Producer Group made up of Connecticut, Delaware, Maine, Maryland, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. Contact: Wayne Brule, NY State DOT, (518) 457-3240; Frank Fee, Koch Materials Co., (609) 428-8808

North Central User-Producer Group made up of Illinois, Indiana, Iowa, Kentucky, Manitoba, Michigan, Minnesota, Missouri, Ohio, Oklahoma, Saskatchewan,

USER-PRODUCER GROUPS (Continued on page 11)

PROFESSOR TRAINING PROGRAM IN ASPHALT TECHNOLOGY

NCAT is offering its eighth annual two-week intensive course in asphalt technology during the summer of 1995 (June 12-23, 1995). The course prepares its participants to return to their institutions and begin offering a state-of-the-art course in asphalt technology. Financial assistance to defray the costs of housing, food, and transportation is possible. Please write or call NCAT for further information at 205-844-6228.

SHRP IMPLEMENTATION UPDATE

by
A Haleem Tahir - AASHTO

Two years ago the AASHTO member departments and the Federal Highway Administration (FHWA) not only accorded top priority to the implementation of SHRP SUPERPAVE™ products, they invested a significant level of resources to achieve this goal. In terms of accomplishments within the past two years, substantial progress has been made. This column highlights the ongoing activities and summarizes future plans.

Ongoing Activities

AASHTO released its publication on the provisional standards based on SHRP findings in January, 1994. These standards are within the jurisdiction of the AASHTO Subcommittee on Materials (SOM). Of the 23 standards included in the report, 11 pertain to asphalt products, and the remaining address concrete and aggregate products. Since the adoption and publication of the provisional standards, asphalt binders have received the most scrutiny by the industry as well as the state DOTs and the FHWA. The FHWA took three major steps to ensure that these tests receive a thorough and critical review. First, a technical working group (TWG), with membership from the industry, DOTs and the FHWA, was established and charged with the responsibility of making a critical review of the provisional standards. Second, with the ex-

ception of the direct tension test, FHWA conducted the ruggedness testing according to ASTM C1067 on the binder protocols. Third, the user-producer groups were encouraged to offer independent review and comments on the protocols. In addition to these initiatives, the AASHTO Materials Reference Laboratory (AMRL) took the lead in organizing a round robin testing program on the performance graded (PG) binder samples.

The information and feedback resulting from these initiatives has been most valuable. By and large, the TWG's feedback and the input received from the user-producer groups were found to be persuasive by the SOM, and it decided to publish addenda to the 1994 provisional standards which will include the review comments. The final report on the ruggedness testing has not been released. However, at the expense of oversimplifying, the draft report can be interpreted to yield two major conclusions. First, the tests subjected to the ruggedness program may not require a major change. Second, the aluminum and silicone rubber molds used for the bending beam test conducted according to AASHTO TP1 produced a slightly different dimensional configuration of the test specimens.

SHRP (Continued on page 9)

TABLE 1. PRECISION ESTIMATES FOR PG64-22 ASPHALT BINDER USING AASHTO MP1						
Performance Graded Binder Samples 155 & 156			Single Operator		Multilaboratory	
Test Result	Labs	Avg.	Coeff. Var. (%)	d2s% Limits	Coeff. Var. (%)	d2s% Limits
Tests on Original Binder						
Brookfield Viscosity at 135°C (Pa•S)	33	0.40	3.0	8.5	11.7	33.1
DSR Complex Shear Modulus G* (kPa)	32	1.30	4.9	13.9	15.1	42.8
DSR Phase Angle, δ (degrees)	30	86.2	0.3	0.8	0.4	1.2
DSR G*/sinδ (kPa)	32	1.32	4.8	13.5	15.7	44.4
Tests on TFO or RTFO Residue						
DSR Complex Shear Modulus, G* (kPa)	32	2.95	5.2	14.7	13.4	38.0
DSR Phase Angle, δ (degrees)	31	82.2	0.8	2.3	0.9	2.5
DSR G*/sinδ (kPa)	32	2.97	5.1	14.3	13.3	37.7
Tests on PAV Residue - PAV at 100°C						
DSR Complex Shear Modulus, G* (kPa)	26	3309	7.1	20.1	17.0	48.1
DSR Phase Angle, δ (degrees)	27	47.7	1.3	3.8	3.0	8.4
DSR G*/sinδ (kPa)	26	2437	6.8	19.2	16.3	46.3
BBR Creep Stiffness (MPa)	24	126	4.3	12.3	10.5	29.7
BBR Slope, m	27	0.347	1.6	4.5	4.1	11.5
DT Failure Stress (MPa)	10	1.83	13	36	42	119
DT Failure Strain (%)	10	1.28	22	61	35	98

PUTTING RESEARCH INTO PRACTICE

The following papers were presented at the annual meeting of the Association of Asphalt Paving Technologists (AAPT) in March, 1994, in St. Louis, Missouri. Observations and conclusions reported from these papers may be of value to field engineers. These comments are obtained mostly from research projects with a limited scope. Before application to practice, it is recommended that the entire paper be read to determine any limitations. Titles of the papers are given, with names of author(s) in parentheses, followed by NCAT's summary.

1. FIELD VALUATION OF LABORATORY AGING PROCEDURES FOR ASPHALT AGGREGATE MIXTURES (Bell, Felling and Wieder)

Hot mix asphalt (HMA) mixtures undergo both short- and long-term aging processes. HMA mixes first age between the time of mixing and final placement on the roadway when the mixture is at elevated temperatures. This is referred to as short-term aging. Then the longer, never-ending process of oxidation or aging occurs while the HMA mixture is in service and exposed to the environment. This is referred to as long-term aging. One of the objectives of the Strategic Highway Research Program (SHRP) Project A-003A was to develop accelerated laboratory testing (ALT) procedures to simulate both short-term and long-term field aging. Such procedures can then be used in the laboratory for conditioning the laboratory mix samples before testing for rutting or fatigue cracking.

A short-term oven aging (STOA) procedure was developed by Oregon State University to simulate short-term aging. The procedure involves spreading the loose HMA mixture in a baking pan with a rate of about 4 lb/ft² and placing the baking pan in a forced draft oven maintained at 135°C (275°F) for four hours. The mixture requires stirring every hour with a spoon or spatula. Long-term aging was simulated by compacting the HMA mixture already exposed to STOA to about 8 percent air void content, and then subjecting the compacted specimens to long-term oven aging (LTOA) at 85°C (185°F) in a forced draft oven for cumulative periods of two, four and eight days. The effects of aging (both STOA and LTOA) were measured in terms of diametral resilient modulus of compacted HMA specimens. The resilient modulus of HMA generally increases on aging.

The primary consideration in selecting the field sites for validation of STOA and LTOA was the availability of original materials (asphalt cement and aggregates) which could be used in the laboratory. Field cores were obtained from various sites which ranged in age from 0 to 19 years.

The following conclusions have been drawn from this study:

- Four hours of oven aging of loose HMA mixture at 135°C (275°F) appears representative of the short-term aging which occurs in the field during mixing and placement. This is also sufficient for field aging of young projects less than two years old.
- Two days of long-term oven aging of compacted HMA specimens at 85°C (185°F) after short-term oven aging of loose HMA mixture, is representative of HMA pavement up to five years old, depending on the climate.
- Four days of oven aging at 85°C (185°F) appears to be representative of field aging of about 15 years in a wet-no-freeze zone and about seven years in a dry-freeze zone.

2. EFFECT OF CRUMB RUBBER MODIFIERS (CRM) ON PERFORMANCE RELATED PROPERTIES OF ASPHALT BINDERS (Bahia and Davies)

This study was undertaken to evaluate the effects of crumb rubber modifiers (CRMs) produced by different processes on basic rheological, failure, and aging properties of asphalt binders. The laboratory evaluation was done using the new performance related testing and aging procedures developed by SHRP.

The study used three common types of CRM produced from whole passenger tires. One type of CRM was produced by ambient shredding, a second by cryogenic grinding, and a third by a special extrusion process with the use of some additives. The three CRMs were similar in gradation and had a maximum particle size of approximately 1 mm (16 mesh). Of the four asphalt cements used, two were AC-10 grade asphalt cements, one was an AR-2000 grade asphalt cement, and one was a 200/300 penetration grade asphalt cement. Mixing of CRMs and asphalt cements was done at 160±5°C (320±8°F) for one hour using a high-speed laboratory mixer. The amount of CRM was kept at 15 percent by weight of the total mix for all rubber-asphalt combinations. The rota-

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tional viscometer was used to measure response at pumping, storage, and construction temperatures. The dynamic shear rheometer (DSR) was used to measure response at maximum and intermediate pavement temperatures. The bending beam rheometer (BBR) and the direct tension tester (DTT) were used to measure the response at lowest pavement temperatures. The aging characteristics of the asphalt-rubber binders were evaluated by the thin film oven test (TFOT) and pressure aging vessel (PAV) aging procedures.

The following conclusions were drawn from this laboratory evaluation of asphalt-rubber binders:

- SHRP testing procedures can be used to characterize asphalt-rubber binders, with minor modifications, without major problems. However, due to the increased stickiness and granulated nature of the binders, caution should be used in preparing the test specimens.
- CRMs result in increased viscosity at pumping and mixing temperatures. This effect is not favorable since it makes pumping of binders, mixing, and compaction of HMA produced with these modified binders more difficult.
- CRMs increase the values of $G^*/\sin\delta$ (rutting factor) at high pavement temperatures and, therefore, are favorable with respect to increasing the contribution of binders to rutting resistance.
- The effect of CRMs on the fatigue factor ($G^*\sin\delta$) was marginal. That is, CRMs are not likely to significantly affect the fatigue resistance of the HMA.
- The effect of CRMs at the lowest pavement temperature (which causes low-temperature cracking) was also marginal based on the BBR and DTT results.



John Clements (middle), FHWA's Associate Administrator for Research and Development, toured the NCAT Laboratories with Mack Roberts (left), Director of Alabama DOT, and Bob Johnson (right) NCAT Laboratory.

- At high temperatures, the effects of CRMs are highly asphalt cement- and rubber-specific.
- At intermediate pavement temperatures, the source of asphalt cement was found to be more important than the rubber type.
- Relative changes in properties measured before and after the PAV aging indicate that the introduction of CRMs may result in reduction in hardening due to oxidative aging.
- Additional research is needed to reveal the nature of interaction between asphalt cements and CRMs. It is clear from this study and many previous studies that the research community does not fully understand the mechanism by which the interaction between these two materials takes place.

3. EVALUATION OF RUTTING POTENTIAL OF OREGON SURFACE MIXES (Sosnovske, Leahy and Hicks)

The objective of this study was to evaluate the rutting resistance of selected HMA mixtures used in Oregon using the French LCPC rutting tester and SHRP shear tester (SST). The following four HMA mixtures were evaluated:

Class A - A large stone mix (1½ inches or 38 mm maximum) which is increasing in use primarily for base course.

Class B - The workhorse HMA mix (¾ inch or 19 mm maximum) used on high volume roads.

Class C - A commercial mix (½ inch or 13 mm maximum) commonly used by cities and in private work.

Class F - An open-graded mix (¾ inch or 19 mm maximum) containing 15 to 20 percent air voids, commonly used as a thick (2 to 4 inches) wearing surface on B mixes.

All HMA mixtures were made using a performance based grade PBA-5 which had original viscosity equivalent to an AC-20 grade. Two aggregates, river gravel and crushed quarry stone, were used. The HMA mixtures were compacted after short-term aging by means of rolling wheel compaction in accordance with SHRP method M-002. From the rolling wheel compacted slabs, both prismatic and cylindrical specimens were extracted for testing with the LCPC wheel tracking device and SST. Beam specimens for LCPC device measured 19¼ x 6¼ x 4 inches (743 x 168 x 100 mm). Cores for the SST measured 6 inches (150 mm) in diameter and 2 inches (50 mm) in height.

The LCPC wheel track tester has been widely used in France to evaluate rut resistance of HMA mixtures. Pneu-

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matic tires with loads up to 1,200 lbs. and tire pressures of 100 psi, operate at a frequency of 1 Hz on HMA slab samples. Specimens are tested at 104 or 140°F (40 or 60°C). All specimens were subjected to 50,000 wheel passes, unless the deformation (rut depth) exceeded 0.5 inch, at which point the test was terminated. Rut depths are measured at various cumulative numbers of wheel passes.

The SHRP shear tester (SST) was used to determine the permanent shear strain of the cylinder specimens following the procedures for the constant height repeated simple shear test (CHRSST) described in SHRP protocol M-003. All tests were performed at 104 or 140°F (40 or 60°C).

The following conclusions were drawn from this study:

- The LCPC wheel tracking device was able to rank mixture types in the laboratory in terms of rut depth and rutting potential. It was also able to distinguish differences in performance between aggregate types. The workhorse B mix and commercial C mix performed the best. The large stone A mix also performed well. However, the open-graded F mix did not perform well despite its success in the field. Additional tests will be run with higher confining pressures. The crushed quarry rock aggregate resulted in less rut depth at 50,000 repetitions compared to river gravel aggregate. However, all mixes met the rut criteria currently used by LCPC in France.
- The CHRSST was also able to rank the mixtures in terms of rut depth and rutting potential. Generally, the rankings are similar to the LCPC wheel tracking device. Both mix types and aggregate types affected the performance of the HMA mixtures. The dense-graded mixes outperformed the open-graded mix at 104°F (40°C). Generally, the rut potential of crushed quarry rock was less than that of river gravel.
- The results of CHRSST indicate that this test is acceptable for dense mixes but does not capture the field performance of open-graded mixtures for the conditions evaluated.

4. DEFINING SPECIFICATION LIMITS WITH RESPECT TO TESTING VARIABILITY (Stroup-Gardiner, Newcomb and Savage)

A very large historical data base for HMA test methods has been developed over the past three decades by the AASHTO Materials Reference Laboratory (AMRL). AMRL conducts a series of proficiency programs that distribute pairs of samples to participating laboratories

once a year. Since 1985 the AMRL Bituminous Mixture program has distributed proficiency samples for determining asphalt content and recovered binder properties. The AMRL Bituminous Concrete program, begun in 1974, has distributed proficiency samples for determining the theoretical maximum specific gravity of loose HMA mixtures and the bulk specific gravity and void content of compacted HMA samples.

All samples have historically used a wide range of asphalt cement grades with a crushed limestone aggregate from Maryland. However, AMRL used a West Coast partially crushed, highly absorptive river gravel instead of the typical limestone in 1992. This provided an opportunity to compare the historical trends in testing variability associated with the limestone aggregate to the testing variability associated with a change in aggregate type.

All test data accumulated by AMRL over the years was analyzed statistically and the following general conclusions have been drawn:

- Theoretical maximum specific gravity: for limestone mixtures the average within- and between-laboratory standard deviations were 0.007 (range of 0.006 to 0.008) and 0.013 (range of 0.012 to 0.013), respectively. However, the use of absorptive river gravel aggregate significantly increased both the within- and between-laboratory standard deviations to 0.010 and 0.020, respectively (average maximum specific gravity of 2.425).
- Bulk specific gravity of compacted HMA specimens: the use of river gravel in lieu of limestone significantly increased the within-laboratory standard deviation from 0.007 to 0.010. However, the between-laboratory variability did not change significantly.
- Asphalt content: The between-laboratory standard deviation was approximately 0.17 from 1980 to 1985, 0.20 from 1983 through 1989, and 0.26 in 1990 and 1991. The general trend of increasing between-laboratory variability with an increasing number of participating laboratories indicates that the test method could be more specific so that there is less room for different interpretations of testing procedures. The extraction test method as currently written, allows for a choice among five extraction methods (centrifuge, three types of reflux, and vacuum), three solvents, variable sample size (dependent upon type of extraction), quantity of solvent, and the length of time the extraction is allowed to run (until effluent is "straw colored").
- Reasonable specification ranges need to be set to account for changes in the test method variability induced by changes in aggregate properties.

ASPHALT FORUM

NCAT invites your comments and questions. Questions and responses are published in each issue of Asphalt Technology News. Some are edited for reasons of consistency and space.

Georgia (Ron Collins, Georgia DOT)

Georgia DOT has placed an HMA test section on a state route in Effingham County, which used 5 percent asphalt roofing shingles by weight of the mix. The shingles were a by-product of the production process and were formerly disposed of as waste material in landfill. The use of roofing shingles has conserved natural resources by reducing the amounts of virgin asphalt cement and fine aggregate required in the HMA mixture. The shingles were incorporated in the HMA mix through the HMA facility's recycle feed system. The mix appears to be economical, and no problems were encountered during production and placement of the test section.

We would like to hear from other states as to how they run extraction test on HMA mixes containing SBR or crumb rubber modifiers. How effective is the nuclear asphalt gauge in determining the asphalt content of these modified HMA mixes?

We are also interested in any research or formal cost comparisons done by states which have developed incentive/disincentive specifications for HMA. We would like to know if any studies reveal whether the quality and performance of HMA pavements have improved sufficiently to justify the use of special bonuses or incentives.

Texas (Maghsoud Tahmoressi, Texas DOT)

Does any state have specifications for density at the longitudinal joint of HMA pavements? If so, are the specifications effective?

Maine (Warren Foster, Maine DOT)

Maine is paving a one-mile long experimental HMA test section in which crumb rubber modifier (CRM) will be mixed with the aggregate. In 1991, a one-mile test section was paved with CRM using the wet process. To date there are about 8 percent fewer reflective cracks in the CRM section compared to the control section.

Tennessee (Bobby Rorie, Tennessee DOT)

The Tennessee DOT recently participated in a round-robin on asphalt cements conducted by the AASHTO Materials Reference Laboratory (AMRL). We have not yet received the results. (Editor: AMRL's round-robin results are given in this issue in the column "SHRP Implementation Update.")

Classification of in-state asphalt cement sources according to SHRPPG grading system was initiated in early

spring. During this time repeated breakdowns have occurred with the compressor on the Bending Beam Rheometer. We have extensively used the Brookfield viscometer in the evaluation of temperature-viscosity relationships of modified asphalt cements.

A laboratory study in the design of stone matrix asphalt (SMA) mixes is currently under way. We have observed that the 75-blow Marshall method of compaction apparently has a tendency to degrade the mix due to the aggregate-on-aggregate contact.

Kentucky (Larry Epley, Kentucky Department of Highways)

We are gaining experience with SHRP binder equipment by running comparative tests. We have also begun making comparisons between Marshall specimens and samples compacted by the gyratory compactor.

West Virginia (Gary Robson, West Virginia DOT)

When taking hot bin samples at HMA batch plants, what sample sizes do other states require from the coarse aggregate bins?

Michigan (Doug Coleman, Michigan DOT)

We would like to know which states use the effective specific gravity of the aggregate to determine the voids in the mineral aggregate (VMA). If so, how do they account for absorption of the asphalt binder? What percentage absorption value is assumed, if any?

Indiana (Rebecca McDaniel, Indiana DOT)

Indiana DOT will evaluate HMA mixture containing roofing shingles (manufacturing waste) later this year.

New Brunswick, Canada (Terry Hughes, New Brunswick DOT)

We use extracted asphalt content in the field to calculate VMA. Should this asphalt content be corrected for the dust passing through the extraction filter? If not, the result is an inflated VMA value.

Does the dust passing through the filter during the extraction act as an asphalt cement extender? How will this dust affect the HMA mix properties?

Rhode Island (Francis Manning, Rhode Island DOT)

We observed some five to six years ago that the open-graded friction course (OGFC) that was in place for sometime was prone to ravelling in those areas that were

restriped with thermoplastic material. Recently, the same was reported to occur in Connecticut and Maryland. Do other states have similar problems? If so, what is the explanation for this phenomenon?

Ohio (**Dave Powers**, Ohio DOT)

Are there any interesting alternatives to 1,1,1-trichloroethane being pursued for reflux extractions other than trichloroethane?

(Editor: Please read NCAT's method of determining asphalt content by ignition on page 1)

Arizona (**Dan Simpson**, Arizona DOT)

Arizona DOT will construct two interstate projects with SMA and SHRP LEVEL III(modified) test sections. Three additives (rubber, polymer and cellulose fiber) will be used in the SMA mixture.

ASPHALT FORUM RESPONSES

NOTE: The following responses address the question (asked in the spring issue) from Tahmoressi of Texas DOT: "Does any DOT have specifications or approval process for hot mix truck release agents?"

Florida (**Gale Page**, Florida DOT)

At the present time, we do not perform any tests on release agents. Our specifications state that: "The inside surface of the truck bodies after cleaning shall be thinly coated with soapy water or an approved emulsion containing not over five percent oil. The coating shall be applied prior to the first loading each day and repeated as necessary throughout the day's operations. After the truck bodies are coated and before any mixture is placed therein, they shall be raised to drain out all excess liquids."

Indiana (**Rebecca McDaniel**, Indiana DOT)

Indiana DOT maintains an approved list of truck release agents that pass our Indiana Test Method No. IND

576-84. This method looks at hardening or softening of the asphalt cement or changes in the adhesive properties of the HMA mix caused by the release agent.

Ohio (**Dave Powers**, Ohio DOT)

We have a simple procedure that has proved adequate over the years. This involves (a) simulating the truck bed by placing the HMA mix on a steel plate coated with the release agent and raising one side of the steel plate, and (b) testing the release agent to determine if it dissolves the asphalt cement binder.

(Editor: Copies of the test procedures used by Indiana DOT and Ohio DOT are available from NCAT.)

SHRP (Continued from page 4)

However, the reporters are doing more analysis to see if the dimensional differences in the specimens using two different types of molds have a significant effect on the test values. The final report will give the last word on this issue.

In regard to the round robin testing, the AMRL has released a report, "Performance Graded Binder Samples 155 & 156" in August. The results are of significant interest to users, producers and researchers. The report presents and analyzes data submitted by over 30 laboratories. A tabulated summary on the precision estimates for single operator and multilaboratory testing based on ASTM E691, is shown in Table 1 (page 4).

Near Future Plans

Goals for the near future are as follows:

- SOM will continue to improve and fine tune already published standards on the basis of ongoing scrutiny and reviews.
- AMRL plans to initiate another round robin on the performance graded binders in March, 1995.
- SOM will ballot SUPERPAVE™ Mix Design protocols in October 1994.
- The FHWA is planning to develop guide material and construction specifications for SUPERPAVE™ products.
- The equipment manufacturing industry is being encouraged to develop a scaled down version of SUPERPAVE™ shear tester (SST) for field use.
- At least six states are planning to use SUPERPAVE Level 1 design for at least one pilot project in 1995.

SPECIFICATION CORNER

Ohio—For medium traffic dense-graded surface mixes, Ohio DOT is experimenting with gradation control of the fine aggregate portion, lower percent passing No. 4 sieve, and 3.5 percent air voids for increased asphalt content.

The large stone base course mixes which have been used for two years will be modified to avoid overly sand-
ed mixes, reduce segregation, and possibly increase the asphalt content slightly.

An intersection and high-stress area design policy for maintenance has been revised to provide more thorough rehabilitation, and will include a variety of options of modified asphalt cements and HMA mixes for district selection.

Georgia—Georgia DOT has begun placement of HMA mixtures on a 65,000-ton stone matrix asphalt (SMA) project near Savannah, Georgia, using SHRP Binder Specifications. Based on geographical area and traffic loading conditions, the asphalt cement grade being used is SHRPPG 76-22. An open-graded friction course (OGFC), which will be placed later, is planned using SHRPPG 70-22 grade. This will be one of the first tests for implementing SHRP Binder Specifications on a major interstate project with an innovative mixture such as SMA. The project will be reviewed periodically for performance in comparison with an adjacent project which also used SMA mixtures and conventional polymer-modified asphalt cement specifications.

Georgia DOT has also developed a modified OGFC which (a) uses a coarser aggregate gradation to improve permeability, (b) uses a polymer-modified asphalt binder to improve overall performance and extend service life, and (c) incorporates mineral fiber to reduce previous problems related to binder drain-down. The final pavement surface is very smooth and provides substantially improved visibility during rain for both day and night driving conditions.

Australia—Road and airfield agencies are starting to include performance related asphalt properties in asphalt specifications. In some cases, these will run in parallel with existing specification requirements in order to gain data and confidence on the new performance related test procedures.

Texas—Quality control/quality assurance (QC/QA) specifications were used in 42 HMA projects this year. Full implementation will take place in 1995. The use of fly ash was disallowed in SMA mixtures due to severe drain-down problems. A limit has also been placed on the material passing 20 micron for SMA mixtures.

Maine—The first attempt at QC/QA is under way. One project will be tested under both QC/QA and standard specifications. At this time, penalties or bonuses will be calculated but not applied.

Arizona—Arizona DOT has incorporated an 85 percent minimum two-face crushed requirement for coarse aggregate and a 45 percent minimum uncompacted void content for fine aggregate to be used in HMA mixtures for interstate projects.

Kentucky—It is planned (a) to discontinue the moisture-susceptibility test, (b) to increase the minimum VMA requirements, and (c) to increase the emphasis on compaction of HMA mixtures.

Statistically based QC/QA specifications are being developed. Four trial projects are under contract.

West Virginia—A new end-result HMA specification has been implemented this year on all National Highway System projects throughout the state. The contractors' daily QC tests are used to monitor HMA design properties. Acceptance is based on density, thickness, and smoothness. Full implementation is expected next year.

Mississippi—Mississippi DOT has had no significant changes to HMA specification since November 1987 until 1994. Due to rutting problems attributed to heavy truck traffic and stripping of underlying HMA courses, the department recognized the need for a higher type HMA mix for heavy duty pavements. This was accomplished by requiring much more plus No. 4 material with gradation falling below the maximum density line on the FHWA 0.45 power gradation chart. The amount of natural sand was also reduced to a maximum of ten percent. To elimi-

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SPECIFICATIONS (Continued on page 11)

SPECIFICATIONS (Continued from page 10)

nate stripping, the department now requires one percent hydrated lime (by weight of aggregate) in all dense-graded HMA courses.

New Jersey—Specifications for an upcoming SMA project are being revised to preclude the flushing and rutting problems experienced on the first SMA project. The revisions include modification of gradation, asphalt content, and additives.

Michigan—QC/QA specifications for HMA have been revised (a) by changing the incentive and disincentive tolerance criteria, (b) introducing minimum VMA requirements for the produced mixture, and (c) allowing retroactive job-mix formula (JMF) changes.

New **Brunswick, Canada**—The New Brunswick DOT has started to use SS-1 emulsified asphalt as a tack coat on all arterial and collector highways. The tack coat is used under the first lift of the HMA only, and not between the lifts unless left over the winter. Two HMA projects are expected to be bid next year with end-result specifications.

Rhode Island—Specifications are being developed for crumb rubber modified HMA mixtures in case ISTEA Section 1038 is implemented.

Indiana—Beginning October 1, 1994, the Indiana DOT is requiring (by special provision) all HMA contractors to submit a letter of certification stating their intended use of RAP and/or blast furnace slag aggregate. This is being done to enable Indiana DOT to track the use of these materials as a substitute for crumb rubber modifiers (CRM) to help comply with ISTEA Section 1038, pending any changes to that legislation.

NCAT'S SHORT COURSE IN ASPHALT TECHNOLOGY

NCAT is offering a two-week course to provide a general understanding of all phases of HMA technology: asphalt cement, aggregate, hot mix asphalt, construction, and SHRP research. The course will be taught February 6-17, 1995, at Auburn University, Alabama. NCAT is accepting applications from practicing engineers from both private and public sectors in the U.S. and abroad. It is recommended that the participants have an undergraduate degree or at least ten years experience in HMA technology. Please write or call NCAT for further information on this two-week course. Call NCAT at 205-844-6228.

USER-PRODUCER GROUPS (Continued from page 3)

South Dakota and Wisconsin. Contact: Don Lucas, Indiana DOT, (317) 232-5529; Dave Holt, Minnesota Asphalt Pavement Assn. (612) 636-4666

Southeast User-Producer Group made up of Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Texas, Virginia and West Virginia. Contact: Larry Lockett, Alabama DOT, (205) 242-6539; Doug Hanson, NCAT, (205) 844-6240

Federal Highway Administration (FHWA) Office of Technology Applications. Contact: Ted Ferragut, (202) 366-1130 for general inquiries about all user-producer groups.

An **Airfield User-Producer Group** was also formed in June 1993 by representatives of the Federal Aviation Administration (FAA), the U.S. Army Corps of Engineers, the U.S. Air Force, the U.S. Navy, the Department of Defense (DOD), HMA contractors, and the National Asphalt Pavement Association (NAPA). The group is interested in developing a common set of criteria for HMA pavement construction for airfields. Contact: Ray Brown of NCAT at (205) 844-6228; Dale Decker of NAPA at (301) 731-4748; or Ray Rollings of the Waterways Experiment Station at (601) 634-3892 about this group.



IGNITION METHOD (Continued from page 2)

Barnstead/Thermolyne Corp., based in Dubuque, Iowa, is fabricating 12 units of the "NCAT Asphalt Content Tester" based on this research. A filter will be installed inside the furnace to catch the smoke particulate. NCAT intends to send these units to various HMA laboratories that have expressed an interest in participating in a round-robin study. These prototype units are estimated to cost about \$10,000 each. However, the cost of the equipment is expected to be significantly below \$10,000 in the future, once full production of the equipment begins.

More work by NCAT and participating laboratories is expected to improve the testing equipment and procedures, further reduce test time and optimize accuracy of the test procedure.

ASPHALT NEWS HIGHLIGHTS

The following items of interest are gathered from HMA talks, articles and reports.

The FHWA is planning to conduct detailed environmental studies on four HMA paving projects involving the use of crumb rubber modifier (CRM). In 1995, the FHWA will also undertake accelerated pavement testing of CRM pavements versus conventional HMA pavements using an accelerated loading facility (ALF) or a test track. This testing program is expected to indicate the relative long-term performance of CRM pavements.

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The Transportation Research Board Committee A2D05 on General Asphalt Problems has appointed a task group to evaluate the existing HMA rut tester devices such as Georgia Loaded Wheel Tester and Hamburg Wheel Tracking Device.

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SHRP PG 64-22 and PG 70-22 grades are approximately equivalent to AC-20 and AC-40 viscosity graded asphalt cements, respectively. Generally, PG grades based on local environmental conditions are slightly skewed towards soft side of the viscosity grades in use.

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The National Institute of Standards and Technology (NIST) has developed an easy-to-use and relatively inexpensive calibration system for Marshall test compaction devices. The system, consisting of a mechanical device and portable data acquisition equipment, measures the compactive effort delivered by mechanical Marshall hammers. A preliminary laboratory evaluation study has indicated a significant reduction in the variability of Marshall test results when the device is calibrated. A complete description of the system and the laboratory evaluation program is documented in Publication No. FHWA-RD-94-002, "A System for Calibration of the Marshall Compaction Hammer," published in 1994.

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The Transportation Research Board is undertaking NCHRP (National Cooperative Highway Research Program) Project 4-21, "Appropriate Use of Waste and Recycled Material in Highway Construction." This \$500,000, three-year research project is expected to begin in January, 1995. The project will evaluate the applicability of existing test methods and acceptance procedures

and, where needed, develop new test methods and acceptance procedures for proper evaluation and use of waste and recycled materials (WRM) in a cost effective manner in highway construction. Physical properties, short-term behavior during construction, long-term chemical stability, potential environmental problems, recyclability, and eventual disposal problems will be evaluated.

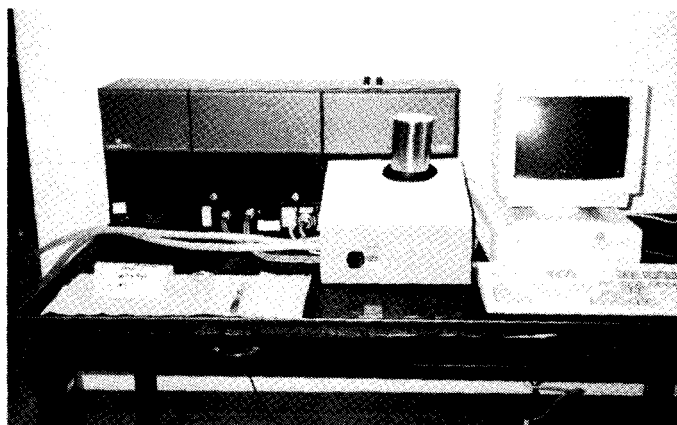
★ ★ ★

Virginia disposed of nearly one-tenth of its stockpile of 25 million waste tires by shredding 2.2 million for use as highway embankment fill near Williamsburg. This has been claimed to be the most ambitious use of the approach to date in the U.S. According to Virginia DOT, the 100,000 cubic yard plus embankment project evenly mixed shredded tires and sandy soil.

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ACKNOWLEDGEMENT

An article entitled "SHRP Asphalt Binder Tests and Specifications" appeared in the Spring 1994 issue of *Asphalt Technology News*. The article was based on material (including figures) developed by the Federal Highway Administration Office of Technology Applications.



NCAT recently purchased this laser-based particle size analyzer, which can determine the gradation of baghouse fines particles down to 0.4 micron size.

RESEARCH IN PROGRESS

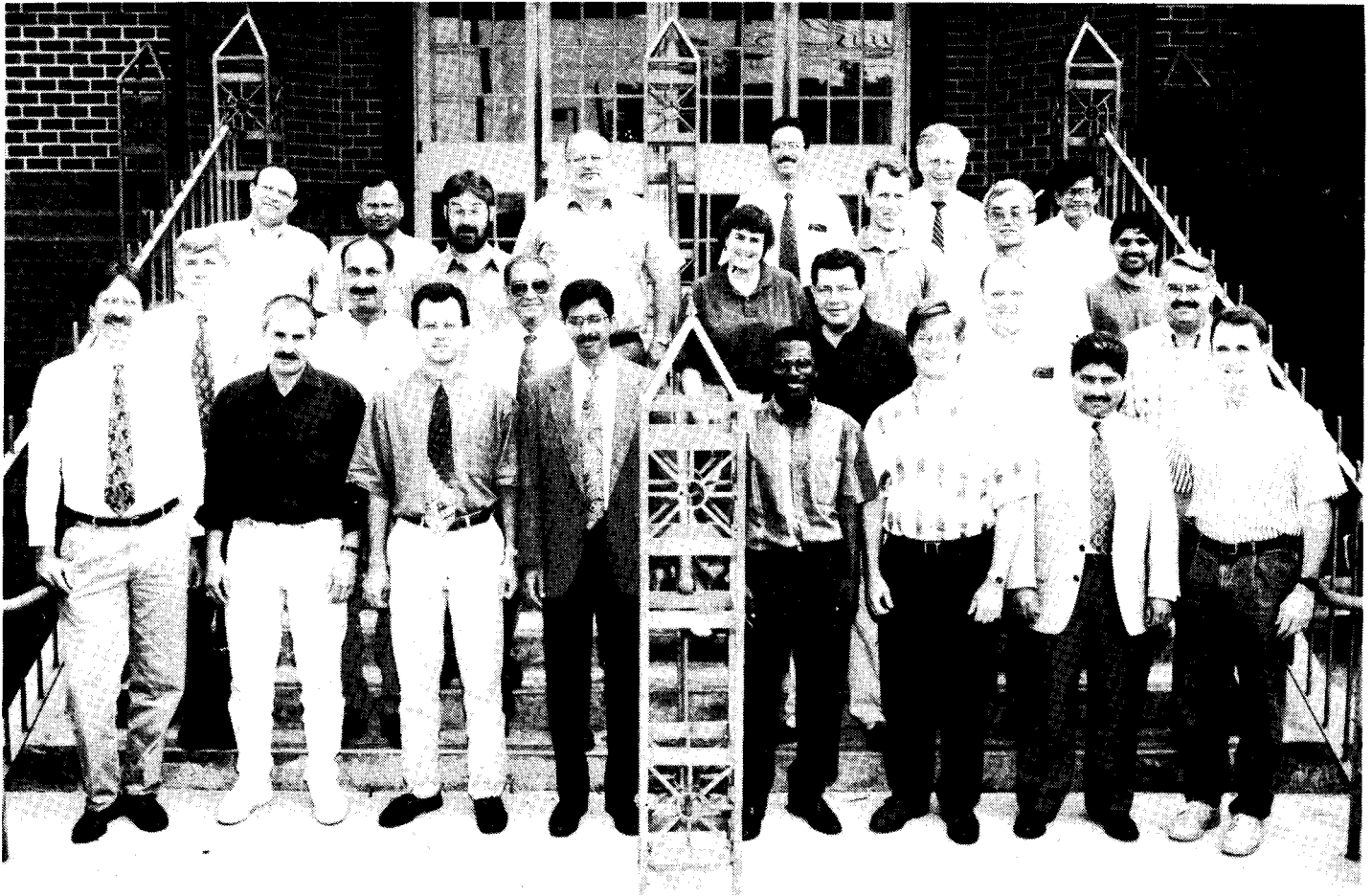
The following research projects pertaining to hot mix asphalt (HMA) pavements are currently in progress.

STATE	PROJECT	RESEARCHER(S)	COST	COMPLETION DATE	OBJECTIVES
Arkansas	Blending Aggregate for Skid Resistance	Wheat, Arkansas Highway & Transportation Department	47,000	1995	Evaluate the frictional resistance of blended versus non-blended aggregates in HMA.
Florida	Development and Evaluation of a Testing Device for Accelerated Age Hardening of Bituminous Binders	Ruth and Bloomquist, University of Florida	207,300	December '94	Title self-explanatory
	Development of Relationships Between SHRP Asphalt Test Parameters and Structural Mixtures for Mechanistic Analysis	Tia and Ruth, University of Florida	305,000	November '96	Title self-explanatory
	Mix Design and Aggregate Evaluaion for Stone Matrix Asphalt Mixtures	West, Florida DOT and Ruth, University of Florida	185,000	December '94	Title self-explanatory
Illinois	Evaluation of Reclaimed Rubber Mixes in Bituminous Pavements	Trepanier, Illinois DOT	50,000	December '94	Title self-explanatory
	Evaluation of Stone Matrix Asphalt (In-Situ)	Rademaker, Illinois DOT	50,000	June '95	Title self-explanatory
Indiana	Concrete Pavement Crack and Seat Performance and Overlay Design	White, Purdue University and Coree, Indiana DOT	75,000	December '94	Develop design procedures for HMA overlays over crack and seat.
	Sources, Measurements and Effects of Asphalt Mixture Segregation	White, Purdue University	116,000	January '95	Develop test to quantify HMA segregation.

STATE	PROJECT	RESEARCHER(S)	COST	COMPLETION DATE	OBJECTIVES
Indiana	Conditions for Stripping Using Accelerated Testing	White, Purdue University	110,000	January '96	Title self-explanatory
	Using Pyrolyzed Carbon Black from Waste Tires in Asphalt Pavements	Lovell, Purdue University	150,000	March '97	Laboratory study of effect of pyrolyzed carbon black on HMA mixes.
	Ability of Asphalt Additives, Modifiers and Fillers to Resist Rutting	White, Purdue University	165,000	May '96	Laboratory and accelerated pavement testing of HMA mixes containing additives, modifiers and fillers.
Mississippi	Recyclability of Rubber Modified HMA	Denson, Mississippi DOT	74,700	July, '99	Title self-explanatory
	Evaluation of Structural Factors in the Design of HMA Overlays on CRC Pavements	Crawley and Seshadri, Mississippi DOT	74,400	October, '97	Develop overlay thickness methodology for HMA overlays on CRC pavements.
	Use of Stockpiled Aggregates Pretreated with Lime Slurry in HMA	Denson, Mississippi DOT	64,000	February, '96	Title self-explanatory
	Polymer Modified HMA Field Trial	Gatlin, Mississippi DOT	97,600	July, '99	Evaluate engineering properties and performance of eight different polymer modified HMA mixes.
New Jersey	Rut Resistant Asphalt Pavement	Vitillo, New Jersey DOT	431,900	1995	Evaluate asphalt additives and revise SMA gradation.
North Carolina	Testing, Analysis and Validation of SHRP Binder Specifications for North Carolina Asphalt Cements	Tayebali, North Carolina State University	50,500	June, '95	Title self-explanatory
Ohio	Effectiveness of Breaking & Sealing Reinforced PCC Pavements Before Overlay	University of Cincinnati	170,100	May '95	Title self-explanatory

STATE	PROJECT	RESEARCHER(S)	COST	COMPLETION DATE	OBJECTIVES
Ohio	Simulation of Hourly Temperature Gradients in Asphalt Concrete Pavement Structures	University of Toledo	82,600	June '95	Title self-explanatory
Oklahoma	Chemical Characterization of Asphalt Binders	Hagen, Oklahoma DOT	750,000	September '94	Title self-explanatory
	Evaluation of Asphalt Binders	Ooten, Oklahoma DOT	189,000	January '97	Title self-explanatory
Ontario, Canada	Evaluation of a Material Transfer Vehicle (MTV) in Ontario	Aurilio and Virani,MTO	15,000	March '95	Evaluate MTV for eliminating segregation of stony mixes
South Carolina	Study to Improve Asphalt Mixtures	Hanson, NCAT	113,900	June '95	Evaluate SCDOT's HMA specifications and recommend revisions including new technologies.
	Baghouse Fines in Asphalt Mixes	Hanson, NCAT	177,600	July '96	Determine properties of fines produced in HMA plants and evaluate their effects on HMA mixes.
	Evaluation of Quality Assurance Procedures for Bituminous Paving Mixtures	Burati, Clemson University	47,100	October '94	Title self-explanatory
Texas	Evaluation of Environmental Conditioning System (ECS)	Nazarian, University of Texas	124,000	1996	Evaluate ECS developed by SHRP to predict HMA stripping.
	Superpave Implementation Center	Texas DOT Personnel	400,000 (per year)	1998	Title self-explanatory
Wisconsin	Joint Study of Nuclear Versus Core Density for Asphaltic Pavements	Gaudette, Wisconsin DOT and Waelti, Wisconsin Asphalt Paving Association	42,100	January '95	Title self-explanatory

NCAT's 1994 Professor Training Course Attendees and Instructors



Left to right: (Row 1) Jim Crovetti, Riad Alakkad, Michael Petrou, Ram Pendyala, Sam Owusu-Ababio, Reed Freeman, Gazan Bozai, John Furman; (Row 2) Ray Brown, Soheil Nazarian, Ken Kandhal, Abraham Navarro, Robert Ash burn, Greg Schiess; (Row 3) A wad Hanna, Waheed Uddin, Richard Norris, Julie Kliewer, Steve Healow, H. Y. Yeh, Raj Arudi; (Row 4) Jimmy Hahs, Maher Alghazzawi, Doug Hanson, C. T. Luke.

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