



ASPHALT TECHNOLOGY NEWS

A Publication of the National Center for Asphalt Technology, Auburn University

Volume 7, Number 2

FALL 1995

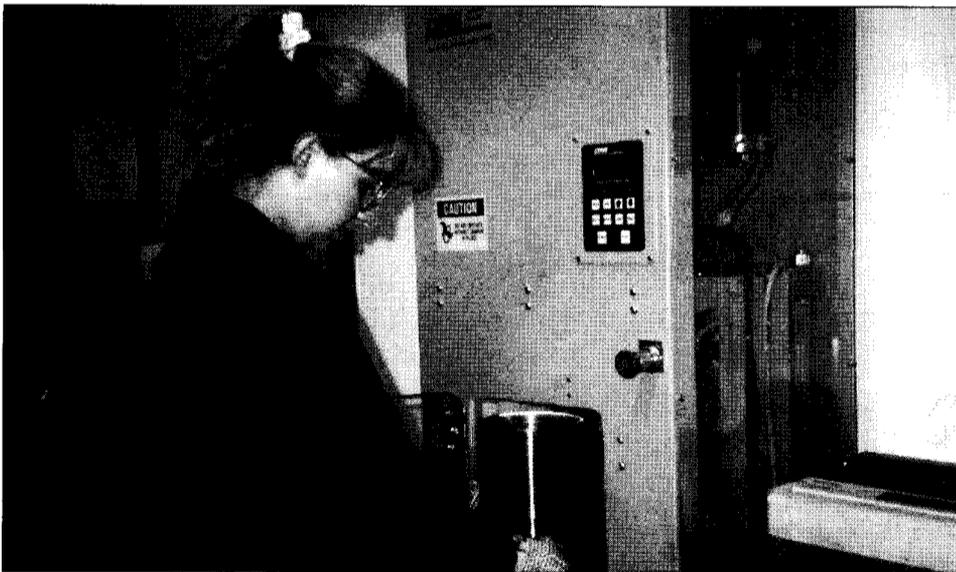
HMA RESEARCH UNDERWAY AT NCAT

The National Center for Asphalt Technology (NCAT) has undertaken a wide range of hot mix asphalt (HMA) related research projects. These projects have been funded by various agencies such as the National Cooperative Highway Research Program (NCHRP) of the Transportation Research Board, the Federal Highway Administration (FHWA), the Alabama Department of Transportation, the South Carolina Department of Transportation, and the National Asphalt Pavement Association Research and Education Foundation. Most of these research projects are of national interest and will help advance HMA technology. A discussion of some selected research projects and other NCAT activities follows.

Design and Evaluation of Stone Matrix Asphalt (SMA) Mixes. This NCHRP project was undertaken to develop a rational mix design and evaluation procedure for SMA. Phase I, which consisted of a recommended mix design procedure for SMA using Marshall equipment, has been completed. Phase II, which is under way, will recommend specific tests and criteria for the mortar fraction of the SMA mixture as well as for the total SMA mixture. On completion of this project, a revised Marshall mix design procedure and a Superpave mix design procedure will be recommended for SMA mixtures.

SMA Field Performance Review. This FHWA project has been designed to collect and document information on mate-

(Continued on page 2)



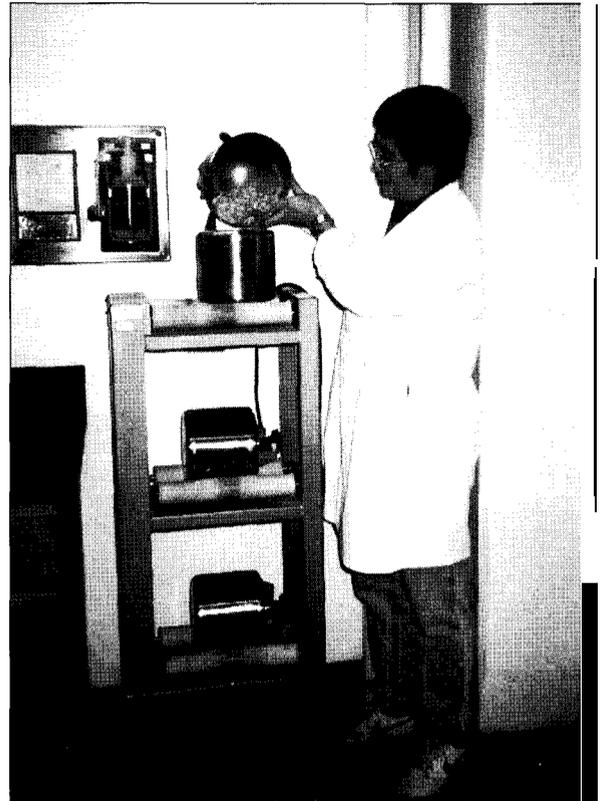
Superpave gyratory compactor being used in NCHRP Project 4-19 (Performance Related Aggregate Tests for HMA)

In This Issue

- HMA Research at NCAT
- Page 1
- Asphalt Forum
- Page 4
- Asphalt Forum Responses
- Page 5
- Putting Research into Practice
- Page 7
- Asphalt User Producer
- Page 9
- Indiana and HMA Quality
- Page 10
- Specification Corner
- Page 11
- Asphalt News
- Page 12
- NCAT Goes Online
- Page 13



Micro-Deval test method developed in France for aggregates is being evaluated as a potential replacement for Los Angeles abrasion test in NCHRP 4-19.



(HMA RESEARCH, Continued from page 1)

rials, mix design, construction, and performance of approximately 66 SMA projects placed in various states. The information being collected will be stored in a database so that engineers will have access to the data from previous projects.

Performance Related Aggregate Tests for HMA. This NCHRP project has been undertaken to evaluate the existing aggregate tests (such as Los Angeles abrasion, sulfate soundness, sand equivalent, and crushed particle count) for their relationship to HMA pavement performance. If the relationship is not satisfactory, new tests which are related to HMA performance will be developed and recommended. Aggregates which have a wide range of mineralogical composition, particle shape and surface texture, and field performance are being evaluated.



Crumb Rubber Modifier (CRM) Technology. NCAT is a major subcontractor to Oregon State University for this FHWA project which will develop guidelines for structural design, mix design, mix production, construction, and quality control of CRM modified HMA pavements, and establish the long-term pavement performance of CRM mixtures as well as the ability to recycle these mixtures.

Training Course for Asphalt Pavement Recycling. This FHWA project has been undertaken to develop course material (including student book, instructors manual, and visual aids) for a four-day training course on recycling asphalt pavements. The project also includes conducting two pilot courses and nine academic courses at different locations in the U.S.

Asphalt Content by Ignition Method. Although test procedures have been developed and submitted to AASHTO and ASTM for adoption, this research project is being continued to answer the following questions: (a) Should calibration be done with aggregate only or with mixture of known asphalt content? (b) What is the best method for evaluating reclaimed asphalt pavement (RAP) material? (c) Does the test affect the specific gravity and absorption of aggregate?

Review of HMA Mixtures. The objective of this study, sponsored by the South Carolina DOT, is to evaluate the existing standard specifications and construction practices and make recommendations as to what revisions should be made in light of recent HMA research to obtain long lasting HMA

(Continued on page 3)

**National Center for Asphalt Technology, 211 Ramsay Hall, Auburn University, Alabama 36849-5354
Phone: (334) 844-NCAT (6228) Fax: (334) 844-6248**

ASPHALT TECHNOLOGY NEWS (Library of Congress Catalog No. ISSN 1083-687X) is published by the National Center for Asphalt Technology (NCAT) of Auburn University. Its purpose is to facilitate the exchange and dissemination of information in hot mix asphalt technology, trends, developments and concerns. Opinions expressed in this publication by contributors and editors, the mention of brand names, the inclusion of research results, and the interpretation of those results do not imply endorsement or reflect the official positions or policies of NCAT or Auburn University.

E. Ray Brown, Director
Prithvi (Ken) Kandhal, Associate Director/Editor
James S. Killian III, Associate Editor, College of Engineering

(HMA RESEARCH, Continued from page 2)

pavements. A review of current technology with regard to polymer modified HMA, large stone mixes, stone matrix asphalt, and the use of slag aggregate in HMA, is also included in this study.

Study of Baghouse Fines. This project, sponsored by the South Carolina DOT, has been undertaken to identify the range in particle sizes of baghouse fines produced at typical HMA facilities, and to determine the effects of baghouse fines on the properties of HMA mixes, as well as the establishment of a valid criteria for their inclusion in HMA mixes. In the study, a minimum of 24 baghouse fines samples were taken over a minimum of five production days in each HMA facility. About 300 samples have been obtained from nine HMA facilities.

Evaluation of Polymer Modified Asphalt Binders. Ten different polymer modified asphalt binders are being evaluated with the Superpave binder tests in this project sponsored by the Alabama DOT. Based on the binder test data, the five most promising polymer modified asphalt binders will be selected for evaluation in HMA mixes. These mixes will be subjected to various performance related tests including wheel tracking tests, to identify polymers which enhance HMA properties.

HMA Densification and Performance Study. This project, sponsored by the NAPA Research and Education Foundation (NAPAREF), was initiated in 1992 to determine which laboratory compactor simulates physical properties (including density) of in situ HMA mix over a period of four years. Initially, a mechanically operated Marshall compactor, hand operated Marshall compactor, rotating base slanted foot Marshall compactor, California kneading compactor, Corps of Engineers gyratory compactor, and Texas gyratory compactor were used. The study has now been expanded to include the Superpave gyratory compactor. Six new HMA construction projects in New Mexico, Idaho, Wisconsin, South Carolina, and two sites in Alabama are being monitored for the changing in situ physical properties from the day of construction. All four primary climatic regions of the U.S. are represented in these projects. Five AAMAS sites (in Colorado, Wyoming, Michigan, Virginia, and Texas) were also included in this study because those sites were not monitored for an adequate period of time. This project will verify the number of gyrations of the Superpave gyratory compactor to suit the climatic and traffic conditions prevailing at each HMA project site.

Hot Mix Recycling with Superpave Technology. This project, sponsored by the NAPAREF, was undertaken with the following objectives in Phase I: (a) to develop a procedure for selecting the Superpave performance grade (PG) of virgin asphalt binder to be used in hot-mix recycling, and (b) to develop Superpave mix design procedures (primarily involving volumetrics) suited to the use of reclaimed asphalt

pavement (RAP) in HMA. Phase II will be undertaken to evaluate resistance to permanent deformation (rutting), fatigue, and low-temperature cracking of recycled HMA mixtures in comparison to virgin HMA mixtures. This will be done using Superpave shear test, indirect tensile test procedures, and the Georgia loaded wheel tester. Tests on the HMA mixtures are considered more appropriate than those on the binders because the efficacy of mixing of aged asphalt binder and virgin asphalt binder is difficult to determine. Various percentages of RAP will be evaluated. Virgin asphalt binder selection will be made based on the work conducted in Phase I.

Evaluation of Various Longitudinal Joint Construction Techniques. One of the first places that we observe problems in HMA is in longitudinal joints. During the construction of a project these joints are sometimes built having lower density than the surrounding area and as a result, these joints often crack and ravel leading to a loss in performance of the HMA pavement. This project, sponsored by the NAPAREF, was begun in 1992 to evaluate various techniques of constructing longitudinal joints to determine the best construction techniques. Several techniques were attempted in Wisconsin and Michigan in 1992. Based on these studies three additional states (Colorado, Pennsylvania, and New Jersey) expressed interest in participating in the research program. Colorado constructed its test sections in 1994, and Pennsylvania in 1995. New Jersey has scheduled construction in 1996. NCAT will continue to monitor the performance of these projects as long as needed for the identification of the best methods.

Regional Superpave Center. NCAT has been designated by the FHWA as the regional Superpave Center for Southeast. A Superpave shear tester (SST) and indirect tensile tester (ITT) equipment are expected to be received soon at the center. The regional Superpave Center has the following objectives: (a) perform shakedown, ruggedness, and precision and bias testing for SST and ITT equipment, (b) support SPS-9a and 9b efforts, and (c) provide training on Superpave binder and mixture testing.

HMA Textbook. NCAT published the first-ever textbook on HMA technology in 1991. This textbook, entitled "Hot Mix Asphalt Materials, Mixture Design and Construction" is being used by many universities for teaching courses in asphalt technology and/or pavement materials. The textbook is being revised to include new developments in HMA technology such as Superpave binder and mixture tests, stone matrix asphalt (SMA), and modifiers. The revised edition of the text book should be available in early 1996.

Superpave Mix Design Workshops. NCAT conducts two and a half day workshops on Superpave mix design sponsored by the specifying agencies and the industry. One workshop was held recently in October; two more workshops are scheduled for January and March. More sessions will be scheduled

(Continued on page 6)

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.

Utah (Wade Betenson, Utah DOT)

The Utah DOT (UDOT) is continuing to advertise HMA paving projects specifying performance grade (PG) asphalt binders. Four projects specifying PG binders were constructed in 1994 and two major projects were constructed in 1995. Our asphalt laboratory personnel are well trained in testing PG binders. We would recommend that the AASHTO specifications covering PG grades requiring polymers address potential settlement problems during shipping, handling, and storage. We have handled it by referring to AASHTO PP-5, Section 8.3.1-8.3.5. An aluminum tube is filled with the binder and crimped. It is then placed upright in an oven at 163°C for 48 hours. $G^*/\sin\delta$ is determined at the specified high temperature and compared with the value obtained on the material before placing in the oven. The difference can be no greater than 10 percent.

It will take some time to purchase all the Superpave gyratory compactors (SGC) needed to change over to the Superpave mix design procedures. During this time we will continue to specify the Marshall method while we run check designs with the SGC. We have developed restricted zone for our aggregate gradations. We have also developed a draft of QC/QA specification for our dense-graded HMA mixtures. It was developed by a quality initiative (QI) team comprising of contractors, consultants, FHWA, and UDOT personnel.

Florida (Gale Page, Florida DOT)

There are two issues which are not adequately covered in the current Superpave asphalt binder specification, which are critical to implementation of the specifications and would have a significant impact on how the binders are specified and supplied: (a) practice to "bump up" one or two grades on the high temperature end for interstate traffic (not standing loads), and (b) solubility/storage stability of modified asphalt binders. (It is preferable to have binders pretested for volatility/storage stability before shipping and use.) If highway agencies start adding new specification and/or tests to the current Superpave binder specification, we will end up with a multiplicity of Superpave specifications rather than some commonality.

Connecticut (Charles Dougan, Connecticut DOT)

We are currently planning to pave a five-mile section of roadway using Superpave volumetric mix design. Also incorporated into this project will be a test section utilizing 20-30 percent reclaimed asphalt pavement (RAP) material.

Ohio (Dave Powers, Ohio DOT)

We believe that the NCAT ignition method of determining asphalt content is a satisfactory means of dealing with the problem of extraction using chlorinated solvents. However, we have noted some material breakdown in the case of some limestone mixes. Have other states experienced a similar problem? We are also interested in other states' experiences with quality control of HMA mixes using one hour versus two hour aging or cure times.

Maryland (Larry Michael, Maryland DOT)

Our Western Regional Laboratory was host for a Superpave volumetric mix design workshop. This three-day workshop involved classroom and hands-on training for 24 technicians from Maryland, other state DOTs and Canada as well as producer representatives. Since the feedback was overwhelmingly favorable, a second workshop has been planned for December, 1995.

We have observed that different additive requirements are indicated when the HMA mixtures are tested for moisture susceptibility by the ASTM method (D4867) and the AASHTO method (T283). What is the experience of other states?

Louisiana (Chris Abadie, Louisiana Transportation Research Center)

Louisiana now requires the use of a material transfer device on most paving projects. According to reports from project engineers, it appears that this device has improved rideability and reduced segregation.

We allow up to 30 percent RAP in all polymer-modified HMA mixes except those used in the wearing course. Recovered asphalt binder viscosity values at 60°C of these polymer-modified mixes often exceed our current limit of 12,000 poises, which was based on the use of unmodified AC-30 asphalt cement. Do any states have higher viscosity limits for recycled mixtures?

Montana (Ken Neumiller, Montana DOT)

Our Bituminous Testing Section has noted high air voids in the Grade D mix. They are controlling voids with Marshall testing and with more emphasis on the in-place voids by taking cores.

South Carolina (Milt Fletcher, South Carolina DOT)

What are other DOT's approval procedures for truck bed release agents?

(Editor: This question was asked by the Texas DOT in
(Continued on page 8)

ASPHALT FORUM RESPONSES

The following responses have been received to questions raised in the spring, 1995, Asphalt Forum.

What are other states' approval procedures for overnight storage of hot mix asphalt (HMA) in silos? (Milt Fletcher, South Carolina DOT)

Wisconsin (Bob Schmiedlin, Wisconsin DOT)

The Wisconsin DOT's current specifications limit the storage of HMA mixes in approved silos not to exceed 16 hours. This is allowed provided the HMA mix at the time of loading meets all applicable requirements, the properties of the mixture are substantially unchanged by storage, and the temperature of the HMA mix when delivered to the paver is not lower than 225°F for a lower course mixture and 250°F for a surface course mixture, or as otherwise designated by the construction engineer. The department is currently in the process of rewriting the HMA specifications in cooperation with the Wisconsin Asphalt Paving Association. The revised specification may allow storage for up to 30 hours through the use of insulated silos and improved technologies.

Indiana (Rebecca McDaniel, Indiana DOT)

The Indiana DOT has a provision in its specifications that allow extended storage (up to 72 hours) of HMA mixtures in storage silos, provided asphalt binder hardening due to storage does not exceed 10 percent of the original value of penetration prior to mixing. An Indiana test method has been developed for quantifying the storage hardening at 24, 48, and 72 hours. Copies of the pertinent specifications and test method are available on request.

New Jersey (Eileen Connolly, New Jersey DOT)

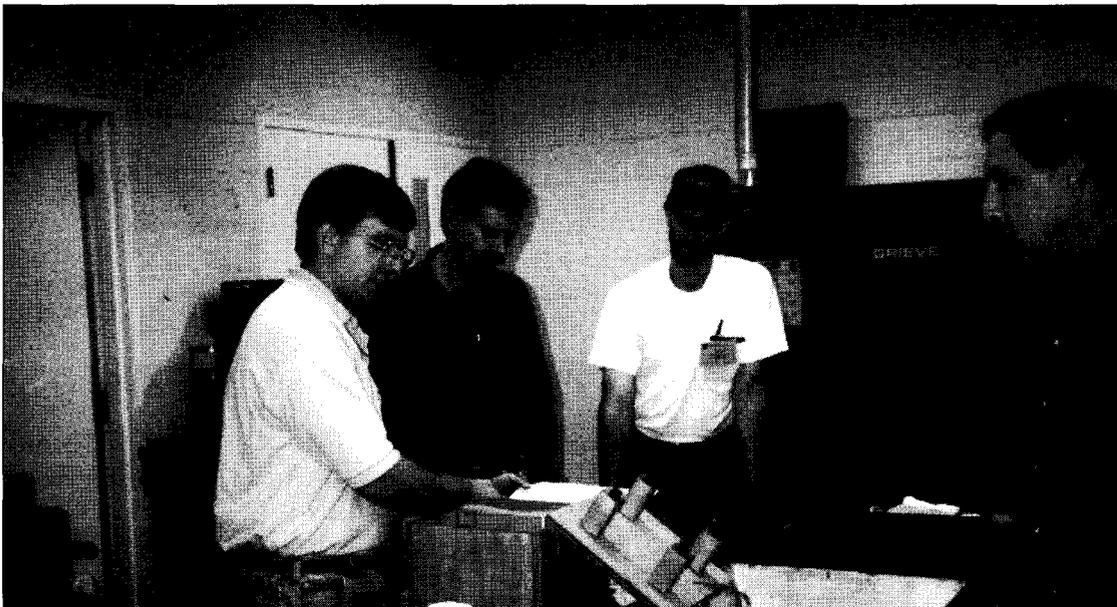
New Jersey DOT's requirements for overnight storage of HMA mixes in silos include limitations on temperature of the HMA, the decrease in penetration of the recovered asphalt cement binder, and the variation in gradation. A copy of our specifications and New Jersey DOT research report titled "Storage of Hot Bituminous Concrete Mixes" dated October 1973, is available on request.

It is our understanding that the SHRP binder tests and specifications were developed for virgin asphalt cements, and we believe that extending these to modified asphalt binders may not necessarily be appropriate and valid. Because the new SHRP specifications may force us to use modified asphalt binders, we would like to know the opinion of other states and user agencies. (Francis Manning, Rhode Island DOT)

Indiana (Rebecca McDaniel, Indiana DOT)

If the Superpave binder tests measure fundamental engineering properties needed of asphalt binder, and if the modified asphalt binders do not contain particulates or other structures that would interfere with the testing, then the same test methods should be appropriate for both modified and unmodified binders. There will certainly be some modified asphalt binders that cannot be tested reliably using the standard binder tests and Superpave mixture analysis tests will be required to measure any mixture improve

(Continued on page 6)



Hands-on training for Superpave mix design workshop participants.

(HMA RESEARCH, Continued from page 3)
 ulated based on the future demand.

Asphalt Technology Course (ATC). This two-week course in asphalt technology is held by NCAT in February every year. ATC is intended for personnel of specifying agencies (such as FHWA, state DOTs, FAA, Army, Navy, Air Force, and local governments) and the industry. The course involves both classroom and laboratory work related to HMA technology. Superpave binder tests and mixture design are also included. The ATC covers materials, mix design, mix production, construction, and maintenance/rehabilitation of HMA pavements.

Professor Training Course (PTC). This course in asphalt technology is held in June every year for faculty who teach or intend to teach pavement materials technology. NCAT conducted its first PTC in 1988. Since then it has been conducted almost yearly, and will be continued in the future. This two-week course, along with the HMA textbook developed by NCAT, has encouraged and facilitated the inclusion of asphalt technology in the curriculum of many universities in the U.S.

Information Services. The purpose of information services is to act as a clearinghouse for state-of-the-art information on HMA technology, and to bridge the gap between theory and field practice. NCAT has a Transportation Research Information Service (TRIS) terminal to retrieve research literature pertaining to HMA technology by using key words. A supplemental literature database has also been established. The NCAT library contains books and journals dating from 1905 to the present. This NCAT newsletter, *Asphalt Technology News*, is published twice a year and has a worldwide circulation of about 6,500. NCAT also publishes research reports on completed projects which are available at nominal cost. Since 1988, NCAT has published over 30 research reports.

JOIN US!

*We at NCAT hope you enjoy this issue of **Asphalt Technology News**. It is provided free of charge. If you wish to be added to our mailing list, please send your business card or your name and mailing address to:*

Prithvi (Ken) Kandhal
 Associate Director, NCAT
 211 Ramsay Hall
 Auburn University, AL 36849-5354

SUPERPAVE BINDER TESTING WORKSHOP

Superpave binder testing workshop will be held at NCAT on February 19-23, 1996. This five-day workshop consists of intensive lectures and hands-on training on testing asphalt binders using the Superpave technology. If you want to participate, please contact NCAT at (334)844-NCAT for details or visit our web site at <http://www.eng.auburn.edu/center/ncat>.

(RESPONSES, Continued from page 5)
 nents due to the modifiers. The issue of modifiers is being considered by a binder expert task group. We will certainly follow its efforts and stay tuned to developments that may require revision of the specifications. In the interim, INDOT is actually looking forward to the widespread use of the Superpave specifications, since it gets us out of the business of specifying when a modifier should be used and which one should be used on a given project. We will no longer have to do new product evaluations and field trials with new modifiers — if they meet the specifications, they can be used.

Georgia (Ron Collins, Georgia DOT)

The Georgia DOT (GDOT) has developed a polymer modified asphalt cement specification for evaluation and acceptance of polymer modified asphalt cements used in open-graded and stone matrix asphalt (SMA) mixes currently placed in Georgia. These modified binders have properties similar to a Superpave performance grade 76-22, but there are several materials, modified and unmodified, that can meet the Superpave performance grade specification for 76-22 that do not pass GDOT's polymer modified asphalt specification. Superpave binder specifications will not necessarily force suppliers into using a polymer modified system to meet the higher performance grades due to availability of other materials in the market such as air blown asphalts. However, past experience has shown these alternatives may not provide a desired product. Therefore, it is apparent that further research needs to be conducted with polymer modified asphalts using Superpave test procedures in order to determine acceptable performance standards. At the same time, those tests will need to rule out undesirable components or states will be forced to add "qualifiers" to their specifications to keep these materials from being incorporated into the work.

(Editor: We believe that NCHRP Project 9-10 "Superpave Protocols for Modified Asphalt Binders" which is expected to begin in January, 1996, will address Mr. Manning's concerns. One of the primary objectives of this project is to recommend modifications to the Superpave asphalt binder tests for modified asphalt binders.)

PUTTING RESEARCH INTO PRACTICE

The following papers report observations and conclusions which may be of value to engineers in the field. These comments are obtained mostly from research projects with a limited scope; therefore, before application to practice, it is recommended that the entire paper or report be read to determine any limitations.

1. COMPARISON OF THE SUPERPAVE GYRATORY COMPACTOR TO THE MARSHALL FOR FIELD QUALITY CONTROL (by D'Angelo, Paugh, Harman, and Bukowski in Proceedings of the Association of Asphalt Paving Technologists, March, 1995)

The Federal Highway Administration Office of Technology Applications (FHWA-OTA) has been evaluating the Superpave gyratory compactor (SGC) and the Superpave mix design system for use in hot mix asphalt (HMA) production quality control. The OTA mobile testing laboratories have been used on several HMA paving projects where paired HMA production samples were compacted both in the SGC and the automatic Marshall compactor for comparison of volumetric properties such as voids in the total mix (VTM) and voids in the mineral aggregate (VMA). Test data obtained on five different HMA mixtures produced at five different HMA plants were analyzed to compare the performance of the SGC as a quality control tool when compared to the Marshall. Three of the mixes were used in surface courses. The remaining two were used in binder courses. NCAT's six-inch Marshall procedure was used for the binder mixes.

The design number of gyrations for the SGC was based on the traffic level and average design high air temperature as recommended in the Superpave procedures. The following conclusions have been drawn from this study:

- The Superpave gyratory compactor (SGC) was able to identify HMA production variability (such as asphalt content) similar to the Marshall compactor when only the VTM was considered. This would indicate the SGC and the Marshall are interchangeable for quality control (QC) type testing for VTM. It was observed that the SGC generally gave lower VTM values (about 2 percent) compared to the Marshall compactor.

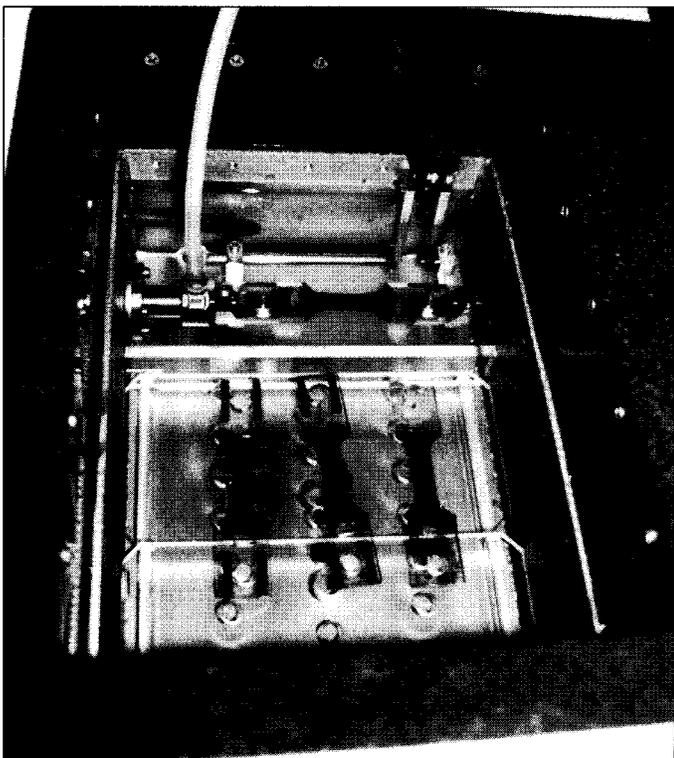
- The aggregate structure of the SGC specimens was significantly different from the aggregate structure of the Marshall compacted specimens. The difference was clearly demonstrated when the VMA results were compared. The two compactors reacted differently in terms of VMA to the changes in mix composition during production. Therefore, the SGC and the Marshall are not interchangeable for QC testing of VMA. Generally, the SGC gave lower VMA values compared to Marshall compactor.

- The data from this project indicates that HMA mixes designed with the SGC cannot be tested and controlled in the field using the Marshall.

2. COMPARISON OF SEVERAL MOISTURE SUSCEPTIBILITY TESTS TO PAVEMENTS OF KNOWN FIELD PERFORMANCE (by Aschenbrener, McGennis, and Terrel in Proceedings of the Association of Asphalt Paving Technologists, March, 1995)

This study was undertaken in Colorado to perform a post-mortem investigation of 20 HMA pavements of known performance with respect to moisture induced damage (strip-

(Continued on page 14)



This redesigned direct tension test (DTT) device has now been developed by the FHWA for testing Superpave asphalt binders. The new, compact system uses a fluid (ethanol) bath for temperature control (like the bending beam rheometer) and an extensometer instead of a laser to measure strain.

(FORUM, Continued from page 4)

the spring, 1994, issue of **Asphalt Technology News**. Please see the fall, 1994, issue for responses from Florida, Indiana, and Ohio.)

Oklahoma (Lawrence Senkowski, Oklahoma DOT)

Crumb rubber modifier (CRM) was used in a full depth HMA pavement on US 62 in Oklahoma this year. The Rouse process CRM was transported in bulk trucks to the HMA plant site where it was transferred to a silo equipped with a blower. The CRM was blown into the drum mixer along with the asphalt cement binder. The blower kept the rubber particles fluffy as they mixed with the asphalt binder and aggregate at 315°F. The CRM modified HMA mix had 30 percent higher cost than the standard mix. Major and intermediate bleeding was observed throughout both outside lanes when the project was inspected five months after construction.

A stone matrix asphalt (SMA) was constructed on Interstate 35 in June, 1995. The SMA mixture was produced using Type I-C polymer modified asphalt cement.

Kentucky (Dwight Walker, Kentucky Department of Highways)

We will design and lay our first Superpave mixture this year in Frankfort with the cooperation of the Asphalt Institute. The HMA mix will be verified at the plant with a Superpave gyratory compactor. A PG 70-22 asphalt binder will be used. Next year, we plan to merge the Superpave specification with our quality management procedures with a goal of designing and laying a high-performance HMA pavement.

Indiana (Rebecca McDaniel, Indiana DOT)

The Indiana DOT will construct a HMA project in 1996 under the FHWA Innovative Contracting Procedures project. The project will involve use of the lane rental concept for selecting the successful low bidder plus a five-year warranty on the performance of the HMA pavement (overlay over cracked and sealed concrete pavement). The performance measures to be quantified under the warranty provisions include longitudinal cracking, rutting, surface friction, and ride quality. A research project will monitor the contracting and construction procedures, and long term pavement performance.

Nebraska (Laird Weishahn, Nebraska Department of Roads)

Nebraska's new HMA mixes have combined gradations which are 100 percent passing the 3/4 inch (19 mm) sieve and are on the fine side of the maximum density line (MDL). We have noted that the new mixes perform satisfactorily under moving vehicles but tend to rut under stop and go traffic. The addition of crushed material helps, but would a mix on the coarse side of the MDL help this situation?

Rhode Island (Francis Manning, Rhode Island DOT)

Aggregate gradation does change at different points in

HMA production and placement. Other than the fineness modulus (FM), are there other ways to quantify the degradation?

Wisconsin (Bob Schmiedlin, Wisconsin DOT)

Wisconsin DOT is constructing three HMA paving warranty projects in 1995. These projects are warranted by the main contractor for five years. There are three or four additional HMA warranty projects being planned for 1996.

Australia (John Bethune, Australian Asphalt Pavement Association)

There is a considerable interest in the NCAT ignition method of determining asphalt content without use of solvents.

The three state road authorities who use scrap or crumb rubber have recently issued "Scrap Rubber Bitumen Guide" which is a practical guide to assist in selection, design, and field operations for both scrap rubber sprayed sealing and scrap rubber HMA.

The association has issued Advisory Note 9 - Asphalt Rutting and Stripping.

A SHORT COURSE IN ASPHALT TECHNOLOGY

This training course has been developed by NCAT for practicing engineers who are involved with hot mix asphalt (HMA). The purpose of this two-week intensive course, which will be held January 29 - February 9, 1996, is to provide a general understanding of all phases of HMA technology. Upon completion, the participant will be able to make knowledgeable decisions related to HMA pavements and communicate effectively with asphalt specialists when the need arises. NCAT will accept applications from practicing engineers from both private and public sectors in the United States and abroad. This includes personnel from the FHWA, state DOTs, FAA, Corps of Engineers, Air Force, Navy, county engineers, city engineers, consulting engineers, and contractors.

Please call (334)844-NCAT or visit our web site at

<http://www.eng.auburn.edu/center/ncat>

for brochure or information.

ASPHALT USER PRODUCER GROUPS UPDATE

The National Asphalt User Producer Group met in June 1995 at Denver, Colorado where the regional asphalt user producer groups gave an update on their respective activities.

Southeast Asphalt User Producer Group

This group has a target implementation date of January 1, 1997, for the Superpave binder specification (PG grading system). A survey of PG binder grades that states plan to use and anticipated binder grade availability is being completed. The group has three active subcommittees on Superpave binder, Superpave mixtures, and crumb rubber modifier. In the binder area, various task forces are looking at the dynamic shear rheometer, pressure aging vessel, bending beam rheometer and rolling thin film oven tests, and certification issues.

Northeast Asphalt User Producer Group

A survey of the users and producers has been completed to assess (a) the asphalt binder PG grades expected to be specified by the users, and (b) the PG grades which can potentially be supplied by the producers. The binder equipment on loan from FHWA has completed the round of all northeastern states.

New York has placed approximately 85,000 tons of HMA on five projects using PG 58-34 asphalt binder. The projects are located in the cold region of the state where thermal cracking is a problem. Another small experimental test section was constructed on Interstate 87 near Plateville, using Superpave PG 76-40 binder and Superpave volumetric mix design.

Maryland has placed about 1,000 tons of HMA at an intersection using three different asphalt binders: PG 70-22, PG 76-22, and PG 82-22 and Superpave volumetric mix design in order to evaluate the rut resistance of the HMA mixtures.

North Central Asphalt User Producer Group

A draft implementation plan for Superpave binder specification (target date of January 1, 1997) and a draft implementation plan for Superpave Level 1 volumetric mix design, are being reviewed. A draft of the asphalt supplier certification plan developed by Amoco and the Indiana Department of Transportation is under consideration of the group.

Various states are using the Superpave gyratory compactor and the Marshall compactor in parallel for comparative purposes. The states and Canadian provinces in the region are at various stages of adoption of the Superpave volumetric mix design. Extensive training programs and technician certification programs have been instituted by many highway agencies. Reciprocal agreements that would allow a technician who is certified in one state or province to be automatically certified in another state or province, provided certain minimum standards are met, are also un-

der consideration by the group.

The Michigan DOT has decided to adopt Superpave PG grading system for asphalt binders in 1996 -- one year ahead of the nation's goal. DOT engineers found that some of their conventional viscosity or penetration - graded asphalt binders also conformed to the required PG grades. For example, a 85-100 penetration grade asphalt binder would normally meet the Superpave PG 58-28 binder specification. They decided to go with the single PG grading system rather than having a dual system which would involve too much testing.

Rocky Mountain Asphalt User Producer Group

This group has three subcommittees: binders, mixtures, and specification. The binder subcommittee is considering a Superpave binder acceptance certification plan which would require the producer to execute the quality control program. The user then checks and accepts the producer's certification. The mixture subcommittee is reviewing (a) aggregate angularity tests specified in Superpave, and (b) the short-term aging of HMA by placing in an oven for two hours rather than four hours as specified.

The Colorado DOT is building one HMA project where a PG 52-40 grade asphalt binder and the standard AC-10 asphalt cement will be used for comparative purposes. In addition, two other projects will use a PG 58-28 asphalt binder. Each Colorado DOT region has received a Superpave gyratory compactor, which is being used to gather mix design data.

The Utah DOT is continuing to advertize HMA paving projects specifying PG graded asphalt binders such as PG 58-24, PG 64-28, PG 64-34, PG 70-28, PG 70-34, and PG 70-40. The binder specifications include a settlement specification based on AASHTO PP-5 (section 8.3.1 to 8.3.5) to ensure a homogeneous polymer-modified asphalt binder. The binder specification does not allow on-site blending of polymers with asphalt cements. Since all projects advertised in 1996 will be specifying PG binders, it is expected that more quality control of the binder will be exercised by the producers. The Utah DOT is fully equipped for specification compliance testing of PG binders. Some major HMA projects completed in the 1995 construction season have used PG 70-28 and PG 70-34 grade binders.

Alberta, Canada, completed its first SPS-9 experimental section in July, 1995, which involved two Superpave mixes and the department's conventional high stability mix. The asphalt grades used were a PG 52-34 (200-300 penetration), a PG 46-34 (300-400 penetration), and the conventional 150-200 penetration (PG 58-28). The mix was designed corresponding to traffic levels between 3 million and 10 million ESALs.

West Coast Asphalt User Producer Group

This group would like to implement PG grading sys-

(Continued on page 11)

INDIANA PURSUES HOT MIX ASPHALT PAVEMENT QUALITY

by

Rebecca S. McDaniel
Indiana Department of Transportation

In the mid-1980's, Indiana was experiencing serious problems with many of its asphalt pavements. Rutting was a significant problem and several premature rutting failures had occurred. Other problems cropped upon isolated projects around the state: bleeding, delaminations, segregation, etc.

When the Indiana Department of Transportation (INDOT) recognized the magnitude of these problems, an aggressive course of action was undertaken to turn the situation around. INDOT began to pursue several approaches to design, specify, and construct quality hot mix asphalt (HMA) pavements. The approaches included changes in specifications, improvements in mix design procedures, and applied research addressed at specific problems. Thanks to these efforts, the department and the HMA industry in Indiana have improved the situation immensely. However, INDOT is constantly striving towards further improvements. INDOT and industry are working together to proactively address refinements to continue the course of improvement that was initiated in reaction to the problems of the last decade. This article will briefly outline some of the current on-going efforts underway in the department.

Specifications

INDOT began implementing mix design and density related Quality Assurance (QA) specifications in 1986 on a few projects. The number of QA projects grew rapidly each year and is now routine. Under the QA specifications, the contractor is responsible for designing the HMA mixtures to be used on the project using a Marshall mix design procedure. During construction, voids, VMA, asphalt content, gradation, and density are monitored. A certified technician must beat each plant during mix production. These technicians must have completed an intensive training course in HMA construction and testing administered by the state. Contractors, though initially uncertain about the new specifications, have embraced the new procedures and many now have a greater understanding of the materials with which they are working.

INDOT has expanded the QA concept into other materials and is now moving into contractor Quality Control (QC) for HMA mixtures. On six projects this year and 17 scheduled for 1996, the contractors developed their own quality control plans outlining how they would manage all aspects of HMA production, transport, placement, and rolling. Minimum standards for testing and calibration of equipment have been established by the department. Acceptance of the QC plan by the district does not currently change how the department inspects and tests the materials; the QC process is, however, leading to possible use of contractors' acceptance test results for payment, greatly reducing the amount of testing performed by the department. INDOT will likely let one such trial project in 1996.

INDOT has also worked closely with industry to develop an asphalt pavement warranty project for construction in 1996. This project will include the concept of lane rental (or A + B contracting) when selecting the successful low bidder, as well as a five year warranty on the pavement performance. The warranty will be based on measurements of ride quality, surface friction, longitudinal cracking, and rutting. This project will be the subject of follow-up research to evaluate the effectiveness of the process.

Laboratory Quality Standards

The INDOT Materials and Tests Division laboratories became AASHTO Materials Reference Laboratory (AMRL) certified in 1994. Quality laboratory work is essential to the integrity of the asphalt program evolving in the state. The department is carrying this commitment to quality onward to other laboratories involved in HMA paving. Contractor's laboratories, for example, must be AMRL inspected. INDOT has initiated its own biannual *Inter-Laboratory Quality Control Project Sample Exchange Program for Facility Performance Appraisal* to evaluate the reproducibility and repeatability of test results in the six district laboratories compared to the central laboratory.

Superpave

Indiana is adopting the new SHRP Superpave technology. While we recognize that refinements and simplifications may be necessary, we feel the Superpave binder specifications and mix design procedures represent a real step forward. INDOT experimentally used the asphalt binder specifications and Superpave mix design procedures on five projects in 1995; 13 are currently scheduled for 1996. INDOT will adopt the performance grade (PG) binder specifications exclusively in 1997, along with the rest of the North Central region.

Reflecting its commitment to Superpave, Indiana was selected to host the North Central Superpave Center. This center will focus on facilitating adoption of the Superpave specifications and procedures in the region by providing training, technical assistance, mix designs, and research addressing regional concerns. A steering committee consisting of representatives of each of 12 states and two Canadian provincial DOT's and industry has been formed to guide the work of the Center towards meeting regional needs.

Research

INDOT continues to have a strong research program. Asphalt-related research has long been a hallmark of the program. Some of the ongoing projects were reported in the *Research in Progress* section of this newsletter. A few notable projects will be described further here.

(Continued on page 13)

SPECIFICATION CORNER

Louisiana - Polymer modified asphalt binders are now required in all HMA wearing courses and all high traffic HMA binder courses. PAC-40 grade is specified for high traffic roads with the following specifications: (a) penetration at 25°C = 50-75, (b) viscosity at 60°C = 4,000 poises minimum, (c) elastic recovery = 60 percent minimum, (d) forced ductility ratio = 0.3 minimum, and (e) must meet the specified separation test. PAC-30 grade is specified for all other wearing courses with the following specifications: (a) penetration at 25°C = 50 minimum, (b) viscosity at 60°C = 3,000 poises minimum, (c) forced ductility at 30 cm = 0.5 lbs. minimum. Linked SBS polymers have generally met PAC-40 grade specifications whereas many latexes have met PAC-30 grade specifications.

Indiana - A specification change will be proposed in late 1995 to allow the use of roofing shingle manufacturing waste at the contractors' option. The maximum amount of shingles allowed will be 5 percent by weight of HMA mixture. Shingles will be allowed in any application where RAP is currently allowed, essentially in any mix except mainline surface courses.

Kentucky - The Department of Highways is in the process of developing and implementing a QC/QA specification for control and acceptance of HMA. Approximately 40 trial jobs will be done this year under a preliminary specification. The experience and data gained from these jobs will be used to further refine the QC/QA specification.

The department recently received the second-generation edition of the loaded-wheel tester. In the coming months, Kentucky personnel plan to participate in a "round-robin" evaluation of the loaded wheel tester with several other states. After completing this evaluation and analyzing several Kentucky mixtures with the device, consideration will be given to incorporating the loaded-wheel tester as a specification for potential rut depth determination.

South Carolina - Contractors will be required to perform their own 50-blow Marshall HMA designs beginning with the January, 1996, letting.

Maryland - A fine aggregate has been used effectively with stone matrix asphalt (SMA) in truck beds as a release agent. The fine aggregate is No. 10 screening with 1 percent asphalt content.

Florida - HMA mix design criteria has been changed from minimum effective asphalt content to (a) minimum VFA (voids filled with asphalt) and dust to effective asphalt binder ratio of 0.6 to 1.2. This change should allow coarser HMA mixtures without sacrificing durability. The change is also compatible with the Superpave mix criteria.

Ohio - The following changes have been made to HMA specifications: (a) AASHTO T283 (Resistance of Compacted

Bituminous Mixture to Moisture Induced Damage) will be required for HMA mixtures containing gravel and natural sand to address performance problems due to quality of aggregates used (such as adherent fines), (b) the asphalt content for 50-blow Marshall design HMA mixes (used on secondary roads) will be selected at 3.5 percent air voids, (c) gradation specification has been changed to minimize allowable total sand content, and (d) a three-wheeled roller is required as breakdown roller for better joint compaction. The department has planned partial implementation of NCAT ignition oven for asphalt content determination in 1996.

Australia - It has been agreed by the industry and state authorities that a national heavy duty HMA specification should be produced. Work has just commenced.

(ASPHALT USER, Continued from page 9)

tern in 1997, which is consistent with many other user producer groups' target dates. The group's binder committee will try to focus its effort on validation of the Superpave PG binder specifications especially the contribution of asphalt binder to permanent deformation and fatigue cracking of HMA mixtures. The task force on cold temperature test has recommended that the bending beam rheometer be included in the performance based asphalt (PBA) specification developed by the group.

The group's mixture committee was assigned the following tasks: (a) interact with the FHWA and other user producer groups regarding Superpave mix technology, (b) develop an evaluation process for Superpave technology in conjunction with the binder committee, and (c) encourage trial use of Superpave mix design technology to develop validation data.

Donation of Books to NCAT Library

Mike Geller has donated a large number of books and journals related to asphalt technology (such as TRB, ASTM and AAPT) to the NCAT Library located at Auburn University. Geller is a compaction consultant in New Jersey and is widely known and respected by the asphalt paving community for his expertise. We are grateful to him for his kind gesture. These books and journals will be very useful to NCAT researchers and students in the future.

ASPHALT NEWS

The Danish Road Institute has completed a research project which was undertaken with the objective of improving the rutting resistance, impermeability, and longevity of stone matrix asphalt (SMA). The research results show that performance attributes can be improved by increasing the contents of coarse aggregate, asphalt cement, and limestone filler. Further improvements were obtainable by using SBS modified asphalt cements.

* * *

A Detroit-based company has developed a process to extract carbon black and oil from rubber scrap tires. The patented process reclaims about eight pounds of carbon black and one pound of oil per tire. The extracted carbon black and oil are refined to produce an asphalt modifier called ATR-33. The North Carolina DOT is considering experimental use of this modifier which has been claimed to improve HMA's resistance to aging and rutting.

* * *

Oregon State University (with NCAT as one of its sub-contractors) is developing guidelines to implement the use of crumb rubber modifier (CRM) in HMA pavements. The guidance will be documented in a three-volume final report covering pavement structural design, mixture design, and construction. This research project was initiated by the FHWA with the participation of 32 state highway agencies.

* * *

Three Wisconsin contractors have constructed HMA pavements unchecked by state DOT engineers this year. However, the contractors had to guarantee their paving work for five years and back it with a \$300,000 bond. The Federal Highway Administration (FHWA) is treating the effort as an experimental program before funding its 80 percent share of two of the jobs because under FHWA regulations warranties are limited to one year only.

* * *

The HMA industry is now beginning to focus its attention on the Superpave software and performance prediction models that are used to analyze the performance of HMA mixtures. The FHWA is establishing a "models and software" expert task group composed of representatives from state highway agencies, industry, and academia.

* * *

A joint Nordic research project has found that the noise from traffic can be reduced by 3-5dB(A) if a porous HMA pavement is used in lieu of conventional dense-graded HMA. The porous HMA consists of a maximum aggregate size of 10-12 mm (about $\frac{1}{2}$ inch) and an air voids content of 22-23 percent. This reduction in noise is approximately equivalent to cutting the traffic volume by one half

or doubling the noise protection distance. In reality, noise barriers have to be used in order to achieve a corresponding or higher noise reduction.

* * *

The Australian Road Research Board has developed a new Walking Profilometer. The surface profile is automatically recorded when an operator pushes this compact, high-tech device over a paved surface. As soon as the survey is completed, the surface profile is graphically displayed on the onboard laptop computer. The surface profile is measured at 250 mm intervals with an accuracy of up to 0.2 mm height per meter of travel at operating speeds of 1 km/hour.

* * *

An international experiment to compare and harmonize pavement surface texture and frictional (skid) resistance measurements has been completed in Belgium and Spain. Systems and methods (such as locked wheel, side force, fixed slip, and British pendulum) vary widely from country to country making it almost impossible to compare pavement frictional resistance data. Sixteen countries participated in this experiment by bringing their testing equipment to 54 sites in Belgium and Spain. The test data was analyzed to develop relationships for converting results produced by the different devices to a common scale, the International Friction Index (IFI), and thus provide a basis for international standardization.

* * *

The National Cooperative Highway Research Program (NCHRP) has invited research proposals for NCHRP Project 9-9, "Refinement of Superpave Gyrotory Compaction Procedure." The objectives of this project are (a) to recommend revisions to the Superpave gyrotory compaction procedure (AASHTO TP4), and (b) to recommend Superpave gyrotory compaction procedures for stone matrix asphalt (SMA), open-graded, gap-graded, and large stone mixtures. The project is expected to begin in January, 1996, and is scheduled to be completed in 26 months.

* * *

Research proposals have also been invited by the NCHRP for NCHRP Project 9-10, "Superpave Protocols for Modified Asphalt Binders". The objectives of this project are (a) to recommend modifications to the Superpave asphalt binder tests for modified asphalt binders, and (b) to identify problems with the Superpave mixture performance tests in relation to mixtures made using modified asphalt binders. This project is also expected to begin in January, 1996, and is scheduled to be completed in 30 months.



(*INDIANA HMA, Continued from page 10*)

INDOT and the Federal Highway Administration are finalizing the administrative details for the National Pooled Fund study on Validation of SHRP Asphalt and Asphalt Mixture Specifications Using Accelerated Testing. This study will make use of the Accelerated Pavement Testing (APT) facility to provide partial validation of the Superpave specifications. The APT can compress the effects of 35 million ESALs into a few days of operation. Over 25 states have pledged in excess of \$500,000 to this study. Testing is expected to begin in 1996.

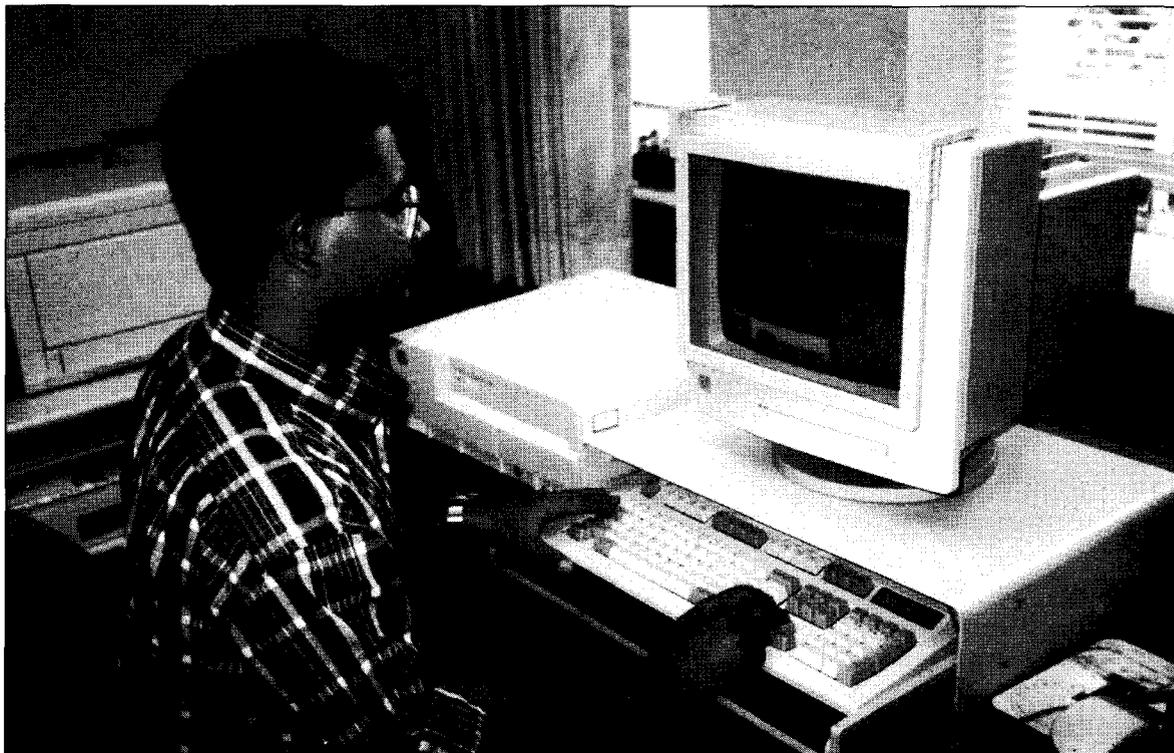
Purdue University has been developing test methods to quantify segregation to help INDOT and industry identify segregation problems during construction while they can still be corrected. The research has identified potential field test methods which are now being refined. An excellent and well-received videotape describing the sources of segregation and possible controls was produced under this project; copies are available from the Joint Highway Research Program at Purdue University.

Through all these efforts and more, the Indiana DOT and HMA industry continue to work together to improve the quality of HMA pavements in the state.

(**EDITOR:** Ms. McDaniel asks that we report this as her swan song. She has left INDOT and is now working for the North Central Region as technical director of the North Central Superpave Center.)



NCAT's home page on the world wide web (Internet) is updated on a periodic basis.



NCAT is now on the Internet! Our World Wide Web site is located at <http://www.eng.auburn.edu/center/ncat>. Our site can be accessed through Prodigy, CompuServe, America Online, other private carriers, and Internet Servers.

NCAT is taking advantage of the communications infrastructure that exists in Auburn University to provide this service to HMA user agencies, producers, consultants, and academia.

You will find the following information on our home page which will be updated as needed:

- NCAT's mission and organization
- Upcoming training courses and workshops, including information on how to register

Superpave binder and mix workshops
Asphalt technology course
Professor training course

- HMA research completed by NCAT
- HMA research in progress at NCAT
- List of NCAT publications, including information on how to order
- NCAT information services
- NCAT laboratory facilities

Please visit our web site for more information.

(RESEARCH, Continued from page 7)

ping). Four tests were used to analyze the HMA mixtures: AASHTO T283 (modified Lottman test), ASTM D3625 (boiling water test), the Environmental Conditioning System (ECS) developed in the Strategic Highway Research Program, and the Hamburg wheel-tracking device. The primary objective of this study was to identify the test method which would have best predicted the performance of these HMA pavements.

These sites represent a wide variety of material types and performance characteristics. The performance of seven sites was categorized as "good," that of five sites as "requiring high maintenance," that of four sites as "requiring complete rehabilitation," and that of four sites as "disintegrators." All of the sites were treated with anti-stripping agents, either liquid or hydrated lime. The following conclusions have been drawn from this study:

- AASHTO T283 (modified Lottman test) is fairly successful in identifying HMA mixes that are good performers and poor performers. This test did not identify mixes that were marginally susceptible to stripping. However, a slight modification (requiring 90 percent saturation obtained by a 30-minute vacuum saturation) of this test method was able to accurately predict the performance of marginal mixes as well.

- ASTM D3625 (boiling water test) failed almost all HMA mixes, regardless of field performance. It is a severe test when using a criteria of 95 percent retained coating. It is not an ideal test because the results are subjective and do not consider the void structure, permeability, or gradation of the HMA.

PROFESSOR TRAINING COURSE IN ASPHALT TECHNOLOGY

NCAT has written and published an up-to-date college textbook on asphalt technology. NCAT has also developed a training program for college and university civil engineering faculty that will allow them to offer state-of-the-art undergraduate and elective courses in asphalt technology. This two-week intensive course will be conducted at NCAT June 17-28, 1996. The course has been updated to include Superpave binder and mix technology, and stone matrix asphalt (SMA). Some financial assistance in attending this course is possible. Please call (334)844-NCAT or visit our web site at <http://www.eng.auburn.edu/center/neat> for brochure or information.

- The resilient modulus ratio from the Environmental Conditioning System (ECS) after either three cycles or four cycles and 0.70 criteria did not do an adequate job of identifying mixtures susceptible to moisture damage. The predictive ability of the ECS can be enhanced by future research because it comprises versatile testing equipment.

- Although 11 of the 12 unacceptable sites were predicted to be unacceptable by the Hamburg wheel-tracking device, four of the seven acceptable sites were also predicted to be unacceptable. It was necessary to reduce the severity of the specification and test temperature used by the City of Hamburg in Germany to improve the predictive ability.

- It appears ASTM D 3625 favors liquid anti-stripping additives whereas AASHTO T283 favors hydrated lime. Examination of field performance showed that neither additive was a panacea for good stripping performance.

3. HISTORICAL DEVELOPMENT OF ASPHALT CONTENT DETERMINATION BY THE IGNITION TEST METHOD (by Brown, Murphy, Yu and Mager in the Proceedings of the Association of Asphalt Paving Technologists, March, 1995)

This paper documents the historical development of this test to determine asphalt content of HMA mixtures by ignition. Work on this test was begun at NCAT in 1990. Since then, different aggregate types, HMA mix types, equipment configurations, sample containers, test temperatures, and testing time have been tried to optimize the test method. The ignition method, centrifuge solvent extraction method, and nuclear asphalt content gauge were also evaluated on five construction projects in Alabama. Based on the comparative asphalt content data obtained in these five projects and included in the paper, the ignition test appears very encouraging. A round robin study involving 12 laboratories across the U.S. was successfully conducted in 1995. The testing equipment is commercially available. The test procedure has been submitted to AASHTO and ASTM for adoption as a standard.

(Editor: Please see the "implementation notes" accompanying this issue for more details of the NCAT asphalt content tester.)

4. EXPERIMENTAL USE OF GLASPHALT (by Gargiulo and John, Pennsylvania Department of Transportation, Research Project 91-074 Final Report, August, 1995)

This study was undertaken by the Pennsylvania DOT to evaluate the use of waste glass in HMA (glasphalt) wearing courses in terms of performance, durability, safety, cost, and availability of supply. Three site locations were chosen to evaluate glasphalt. The first site constructed in 1990 consisted of three sections: (a) control, (b) glasphalt containing 5 percent glass without an antistripping agent, and (c) glasphalt containing 10 percent glass and no anti stripping agent. The

third site constructed in 1993 consisted of two sections both containing 10 percent glass.

The HMA mixtures were designed using Marshall procedures. The AASHTO T283 test was used to measure the resistance of compacted HMA mixtures (used in the second site) to moisture induced damage. The ASTM D3625 test, which uses boiling water to determine mix resistance to stripping, was used to evaluate mixes from all three sites. All three sites were evaluated visually on a periodical basis to determine the HMA pavement performance and durability. Surface macrotexture depth measurements were made using the sand patch procedure (Pennsylvania Test Method No. 751) to quantify the surface ravelling associated with the use of glass in HMA wearing courses.

The following conclusions have been drawn based on the laboratory and field evaluation of glasphalt in the wearing courses.

- The glasphalt exhibits significant stripping at the asphalt binder/glass interface both in samples from the field and in laboratory prepared samples. Hydrated lime increased the cost of glasphalt without providing significant improvement in glasphalt pavement performance.

- All glasphalt sites in this study exhibited ravelling of the glass aggregate from the HMA pavement surface. Spring inspections revealed significant amounts of surface glass deposited along curb and shoulder areas. This could be hazardous in residential areas. Sand patch tests indicated a glasphalt pavement surface texture depth more than three times as open as the control section.

- Glasphalt mixtures included in this study showed reduced pavement strength when compared to control mixtures.

- Based on the results of this study, glasphalt is not recommended for use in HMA surface courses. Other uses of waste glass in the unbound state such as a partial replacement in the subbase, material for pipe backfill, and material for embankment, appear to be the preferred method of using waste glass in highway applications.

5. PERFORMANCE EVALUATION OF FIBER REINFORCED ASPHALT CONCRETE (by Jenq, FHWA Report No. FHWA/OH-94-018, March, 1994)

Laboratory tests and field condition surveys were conducted in Ohio to assess the performance of HMA pavements reinforced with synthetic fibers (primarily polyester fibers and polypropylene fibers). Uniaxial creep test, fatigue test, resilient modulus test, indirect tensile strength test, Marshall stability test, and loaded wheel tracking test were performed in the laboratory to evaluate the effectiveness of these fibers in resisting cracking and rutting. The following general conclusions have been drawn:

- Although the indirect tensile strength showed some improvement when fibers were used, no improvement was noted

in the resistance to fatigue cracking based on laboratory fatigue tests. Field data also suggested that fibers are most effective in resisting cracking during the first one or two years of service.

- Based on the results of laboratory tests (such as creep test and loaded wheel test) and the field data it appears that fiber reinforcement is not very effective in reducing rutting potential in HMA pavements.

- Overall performance of HMA mixtures reinforced by polyester fibers and polypropylene fibers was judged to be almost the same.

- Additional cost estimated for adding 7.5 pounds of polyester fibers per ton of HMA and 6 pounds of polypropylene fibers per ton of HMA is approximately \$7.50 to \$15 per ton of HMA. Preliminary results from this study suggest that fiber reinforcement is not the most cost effective method of minimizing cracking and rutting of HMA pavements.

SUPERPAVE MIX DESIGN WORKSHOPS

Many state highway agencies (SHAs) are planning to implement Superpave mix design procedures in lieu of Marshall or Hveem methods in the near future. Most SHAs and many HMA contractors have procured the Superpave gyratory compactor which is used for the mix design. There is a need to train personnel of SHAs and HMA contractors in the Superpave mix design technology.

Superpave mix design workshops will be held at NCAT on January 17-19 and March 20-22, 1996. These workshops consist of two and a half days of intensive lectures, demonstration, and hands-on training on Superpave mix design procedures. Upon completion the participants will be able to conduct the Superpave mix designs in their laboratories.

Please call (334)844-NCAT for brochure or information, or visit our web site at:
<http://www.eng.auburn.edu/center/ncat>

ATTENDEES AND INSTRUCTORS OF NCAT'S SUPERPAVE MIX DESIGN WORKSHOP



Left to Right: (Row 1) George Carr, Hector Louzao, David Murnan, Joseph Ulrich; (Row 2) Russell Reynolds, Jeff Mather, Kent Hansen; (Row 3) Richard Jansen, Tom Bass, Jeff Coe; (Row 4) Sam Johnson, Michael Knight, Gerard Hickey; (Row 5) John Haddock, Doug Hanson, Ken Kandhal.



**NATIONAL CENTER FOR
ASPHALT TECHNOLOGY**
211 Ramsay Hall
Auburn University, AL 36849-5354

Non-Profit Organization
U.S. Postage
PAID
PERMIT NO. 9
Auburn University, AL 36849

NCAT Asphalt Content Tester for HMA

Background

At the present time, many agencies use chlorinated solvents (such as 1,1,1-trichloroethane) to extract asphalt cement from HMA. However, the solvents used for extraction are expensive, difficult to dispose of, and considered unsafe by engineers and scientists concerned with human health and the environment.

New types of solvents, generically called biodegradable solvents, have been used by some agencies as a replacement for chlorinated solvents. However the extraction procedure 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. Although NAC gauges have solved many of the problems associated with solvent extraction methods, they do not allow for determination of aggregate grading.

Because NAC gauges and biodegradable solvents have not successfully eliminated the use of chlorinated solvents, other test methods have been sought to determine asphalt content.

Approach

The National Center for Asphalt Technology (NCAT) has developed a test method to determine the asphalt content of HMA mixtures by ignition. In the NCAT ignition method, a sample of HMA mixture (about 1,200 grams) is subjected to an elevated temperature of 538°C (1000°F) in a furnace to ignite and burn the asphalt cement from the aggregate. NCAT's work has resulted in the development of test procedures and equipment that automatically measure the asphalt content in 30-40 minutes. The grading of the aggregate can then be determined using standard sieve analysis. Larger HMA samples (2,400 grams) can also be tested.

Test Procedure

The HMA test sample is divided into two portions and placed in two stainless steel No. 8 mesh trays which are stacked on top of each other in the NCAT asphalt content tester. The unit has a built-in scale with a digital readout underneath the furnace to weigh the HMA sample continuously during ignition. After the asphalt binder is completely burned and the sample achieves a constant weight, the buzzer in the tester goes off. A built-in printer prints out the asphalt content on completion of the test. Therefore, unlike solvent extraction tests, the ignition test does not need to be attended by the technician at all times. A built-in filter eliminates smoke in the exhaust.

Most aggregates experience minor mass loss (usually 0.2 - 0.3 percent) when subjected to 538°C (1000°F) temperature. Therefore, to optimize accuracy, a calibration factor has to be established for the aggregate used in the HMA mixture. This factor is input into the NCAT asphalt content tester, which automatically adjusts the asphalt content.

Accuracy and Precision of Test Procedure

After equipment for the procedure was developed by an instrumentation company, 12 units of the NCAT asphalt content tester were purchased for round robin testing to determine the accuracy and precision of the ignition test method. These units were provided along with laboratory prepared HMA samples to laboratories throughout the U.S. Four replicates of four HMA mixtures containing different aggregate types and asphalt contents were provided for testing. The participating laboratories did not have knowledge of the asphalt content or aggregate gradation contained in the four HMA mixtures. Testing was completed by the 12 laboratories in early 1995 and the results provided to NCAT for statistical analysis.

Table 1. NCAT Asphalt Content Test Data

Test	HMA MIX TYPE*			
	Gravel	Granite	Limestone	Traprock
Asphalt Content: Actual	6.00	6.00	5.00	5.50
Asphalt Content: Measured	5.98	5.99	4.97	5.53
% Passing No. 4: Actual	71.6	66.8	61.4	57.0
% Passing No. 4: Measured	71.5	66.6	61.4	56.6
% Passing No. 200: Actual	6.0	7.7	6.7	5.3
% Passing No. 200: Measured	5.6	7.7	7.2	5.1

* Each number shown is the average of 48 test results (12 laboratories x 4 replicates). Asphalt content is by weight of the total mix.

Table 2. Precision Statement

Test Property	Standard Deviation, Percent		Acceptable Range of Two Test Results, Percent	
	Within Lab	Between Labs	Within Lab	Between Labs
Asphalt Content (NCAT Tester)	0.04	0.06	0.11	0.17
Asphalt Content Solvent Extraction	0.21	0.22	0.59	0.62

Two important items of information are obtained from round robin studies: (a) how close the test results are to the true properties (accuracy), and (b) what the variability is of the test results within a laboratory and between different laboratories (precision). Tables 1 and 2 provide the information on accuracy and precision, respectively. It is evident that the NCAT asphalt content tester can accurately measure the asphalt content of HMA mixtures, and the precision (as measured by standard deviation) of this method is better than that of solvent extraction methods, with standard deviation reduced by approximately 75 percent. As can also be seen in Table 1, the tester also provides an aggregate that can be accurately tested for aggregate grading.

Application

Chlorinated solvents are being eliminated by the agencies due to growing health and environmental concerns;

and because nuclear asphalt content gauges do not allow for determination of aggregate gradation, the NCAT ignition test is being received very favorably by DOTs and the HMA industry. This method has been proposed by the Alabama DOT as an AASHTO standard test method. Some states like Virginia have adopted the ignition test as a standard. Numerous HMA contractors have purchased the NCAT asphalt content tester.

A copy of the test procedure can be obtained from the National Center for Asphalt Technology.

Reference

Brown, E. R., N. E. Murphy, and S. Mager. Historical Development of Asphalt Content Determination by the Ignition Method. Proceedings, Association of Asphalt Paving Technologists, Vol. 64, 1995.