North Central Superpave Center News

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NCSC Vision and Mission:

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

Regional RAP Report Confirms National Findings

A study of reclaimed asphalt pavement (RAP) from the North Central region conducted by the NCSC largely confirmed that the findings of NCHRP 9-12, a national study on RAP, apply to Midwestern materials. NCHRP 9-12, *Incorporation of Reclaimed Asphalt Pavement in the Superpave System*, was also conducted by the NCSC, in partnership with the Asphalt Institute.

Based on the results of extensive testing of RAPs from Connecticut, Florida and Arizona, the NCSC and Asphalt Institute found that the interim guidance on use of RAP issued by the Materials Expert Task Group and FHWA were reasonable. That is, up to 15% RAP can be used without changing the virgin binder grade. For 16 to 25% RAP, the virgin binder grade should be dropped one increment on both the high and low temperature grades. For greater than 25% RAP, the RAP binder should be extracted and tested so that blending charts can be developed. The research also led to an improved extraction and recovery procedure and developed methods for developing blending charts. Based on this work, changes were made in the AASHTO provisional standards for mix design (MP2 and PP28) and the extraction/recovery procedure (TP2).

The recently completed regional study expanded on the NCHRP results by looking at three typical Midwestern RAPs and investigating higher RAP contents. The study compared mix-

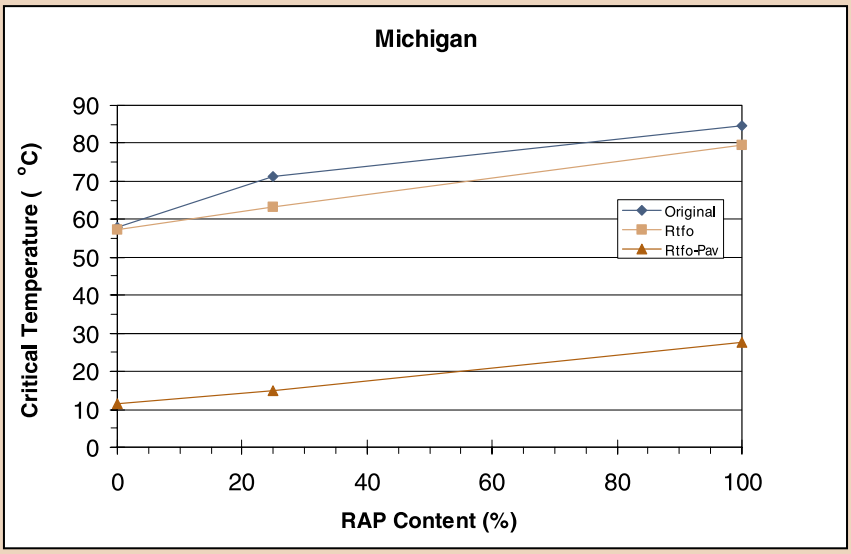

Figure 1. Binder blending chart for Michigan RAP shows linear blending equations are appropriate for predicting RTFO and PAV aged binder properties.

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Regional RAP

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tures produced in the laboratory with different proportions of RAP and virgin materials. Three RAP sources were investigated at RAP contents up to 50%. Indiana, Michigan and Missouri provided RAP and virgin materials for use in the study. For each RAP source, a laboratory mix was also compared to a plant-produced mix with the same RAP content. Binder and mixture tests were performed following protocols established in NCHRP 9-12.

The study demonstrated that acceptable Superpave mixtures can be designed with up to 50% RAP. The aggregate quality and gradation may limit the amount of RAP that can be used, as expected. For example, only 40% of the Michigan RAP could be used because of its relatively fine gradation.

Linear blending charts, as recommended in NCHRP 9-12, were found to be appropriate for estimating the effects of RAP binder on the blended binder properties, in most cases. Linear blending charts were not strictly correct when testing the binder from the plant mixes and from the RAPs as if they were original, unaged binders. These binders had in fact been aged to some extent during production and service. The errors, however, were typically small and conservative. Linear approximations were very accurate for the RTFO and RTFO-PAV aged materials from Michigan and Missouri, as illustrated in Figure 1.

For the Indiana materials when tested as original, RTFO and RTFO-PAV aged, the binder from the plant-produced mix was significantly stiffer than expected. This behavior was also observed in testing the plant-produced mixture from Indiana in the Superpave shear tests. This was not observed with any of the other materials investigated in the regional study nor in NCHRP 9-12. One possible explanation for this behavior is that this particular plant caused increased aging during production. The Indiana materials were one year older than the materials from Michigan and Missouri and may have aged during storage, but this seems less likely than plant differences.

The results support the concept of a tiered approach to RAP usage. Adding 20 to 25% RAP raised the high temperature grade of the plant-produced mixture by one increment. Under the recommended tiers, this amount of RAP could be used by dropping the virgin binder grade by one increment to counteract the stiffening effect of the RAP binder. Low amounts of RAP (up to about 15%) could be used with no change in the virgin binder grade.

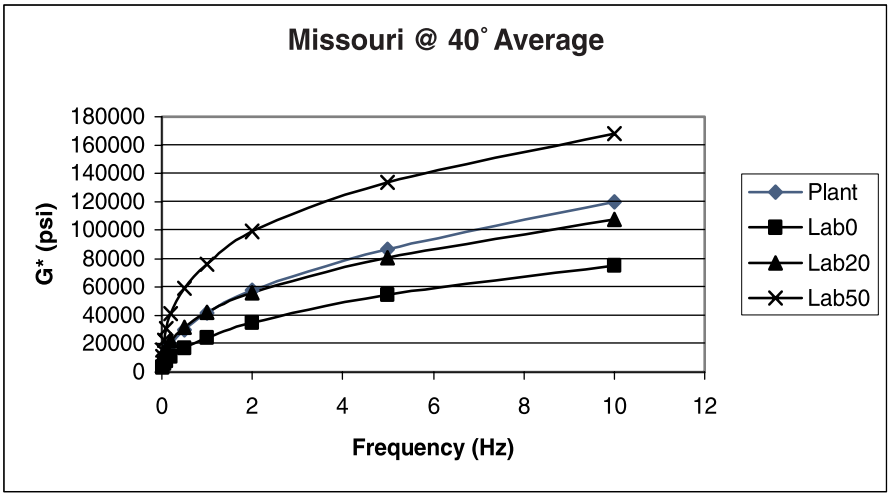

Figure 2. Mix shear testing showed that the stiffness of the mix increased as the RAP content increased and the plant mix compared well to the laboratory-produced mix at the same RAP content.

Shear testing of the mixtures generally showed that the higher the RAP content, the higher the mixture stiffness and the lower the shear strains, as illustrated in Figure 2. Higher RAP content mixtures could be expected to perform better in terms of rutting resistance due to this increased stiffness, provided the mixtures are properly designed and constructed. The RAP binder and aggregate properties need to be accounted for in the design.

The results of this regional study were generally consistent with the NCHRP 9-12 findings. This implies that the results and the recommendations of the national study can be implemented with confidence in the North Central region. Based on these results states should, at the very least, allow RAP at levels comparable to pre-Superpave levels and may consider increasing the allowable RAP contents. Other considerations, such as durability or acceptable friction for surface courses, will also come into play when determining allowable RAP contents.

Local agencies may find these results especially appealing since the addition of RAP can help to offset the perceived higher costs of Superpave mixtures while still providing good performance for low volume roads. Mixtures designed for low volume roads should be designed for durability, so all mixtures need to be designed for appropriate traffic levels. This may be especially true for mixtures with higher RAP contents since the stiffening effect of the RAP could negatively impact durability and fatigue behavior unless the virgin binder grade and total binder content are selected to account for this effect.

This study was funded by Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri and Wisconsin. After final editing, the full report will be posted on our website in May.

NCAUPG Meets in Detroit

The Michigan DOT hosted the annual meeting of the North Central Asphalt User-Producer Group at the beautiful Detroit Renaissance Center in January. Over 107 people attended the Technicians Workshop and 104 attended the user-producer group meeting. Seven vendors or organizations exhibited their wares at the meeting.

The technicians shared their experiences regarding quality control and mix design, binders, construction and laboratory operations. The technicians also continued to work on test standardization across the region. They broke into working groups and discussed issues related to testing binders, aggregates and mixtures. Mike Heitzman, Iowa DOT, and Rich Wolters, Minnesota Asphalt Pavement Association, will be working with smaller task groups beginning this Spring to develop recommendations for standardizing common test procedures.

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Relationship Between "Internal" Angle and Density

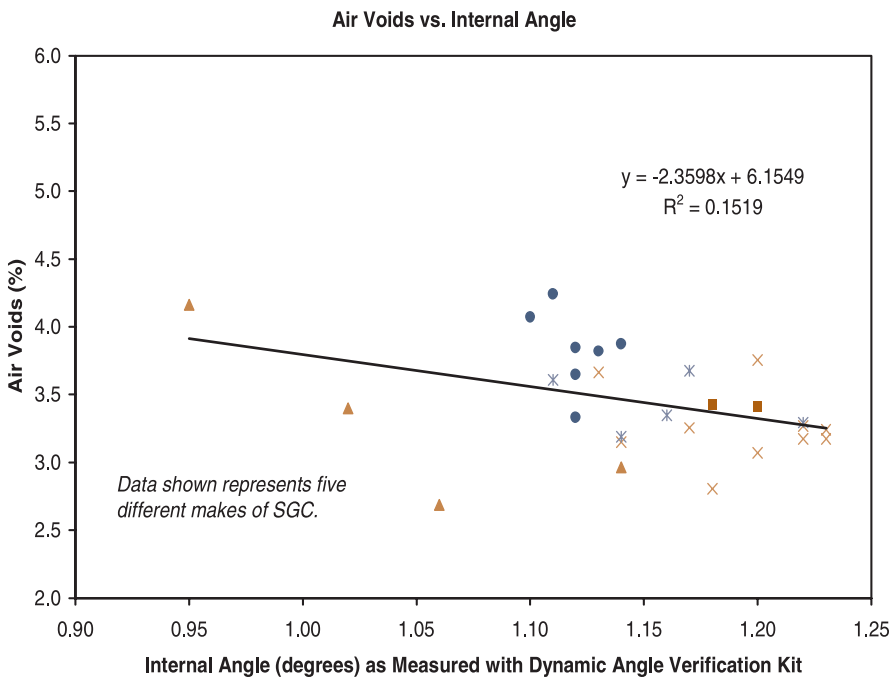
by Allen Cooley, Southeast Superpave Center

The Superpave gyratory compactor (SGC) was developed as a tool in the Superpave mix design system to better simulate the field compaction of hot mix asphalt (HMA). All SGCs are designed to meet specifications found in AASHTO T312; however, AASHTO T312 does not contain a precision statement. Therefore, it is not clear what should be the acceptable difference in measured sample density between various SGCs. Many agencies within the U.S. have reported significant differences in the bulk specific gravity of compacted HMA samples from different SGCs that have been properly calibrated.

One of the potential causes of these observed differences in density is the method of measuring the angle of gyration. The gyration angle for the majority of compactors can be measured in unloaded and loaded conditions. Research has shown that the gyration angle decreased during compaction, depending on the mix characteristics. The primary reason for the changing gyration angle is the flexing of the SGC frame. The Federal Highway Administration has taken a lead in identifying this problem and also providing a potential answer. FHWA developed a device to measure the "internal" angle within the SGC mold during compaction. This device has been called the angle verification kit (AVK) or the dynamic angle verification (DAV) kit. The internal angle device is placed in the SGC mold with a sample of HMA and dynamically records the gyration angle during compaction. An "internal" angle is then measured.

The verification of the gyration angle is crucial to the proper design of HMA mixes. The state of Alabama acknowledged this potential problem and initiated a research study with the National Center for Asphalt Technology (NCAT) to use the device within all state approved SGCs. Through the study, NCAT is to utilize the internal angle device on almost 140 SGCs. A significant amount of information about the internal angle will be learned from this study.

Some preliminary results from NCAT's study are shown in the Figure. Results within the figure represent five different SGC models. Based on the figure, it appears that there is a relationship between internal angle and the resulting density of HMA samples. Excluding the one SGC type (triangles within Figure), the relationship for the remaining four SGCs is relatively strong. This suggests that the measurement of the internal angle is a step in the right direction in achieving similar compaction within different SGCs. However, there also appear to be some other factors that influence density, because the relationship is not perfect. Factors such as wear on the SGC, uniformity of mold diameter, smoothness of mold, etc. also likely affect the resulting SGC density. All of these factors need to be evaluated further and quantified.



All in all, the measurement of gyratory angle internally appears to be a move for the better. However, there are still some issues that need to be evaluated further.

NCAUPG Meets

Continued from Page 2

The full meeting of the user-producer group provided updates on the status of Superpave implementation from the national perspective by John D'Angelo; the recent activities at the NCSC by Becky McDaniel; and the current topics before the TRB Mixture/Aggregate Expert Task Group by Jim Musselman, the chair of the ETG. Tom Harman, FHWA, and Tom Brovold, TestQuip, Inc., discussed the history and current status of gyratory compactor validation. Laurin Lineman, Eastern Federal Lands, discussed the calibration of profilers. A panel discussion of SMA experiences rounded out the first session. John Volker, Wisconsin DOT; Mike Mallos, Thompson-McCully; and Erv Dukatz, Mathy Construction shared their experiences with SMAs.

Mike Heitzman and Rich Wolters summarized their recommendations and plans for test standardization during the second session of the annual meeting. A report on the NCAT test track was provided by Buzz Powell, the manager of the track. John Hinrichsen, Iowa DOT, reported on the activities of the Technician Certification Coordination Council (TCCC) and Multi-Regional Training and Certification Group (M-TRAC). Mike Frankhouse, Michigan DOT, discussed longitudinal joint construction, including the use of joint tape.

The next meeting of the NCAUPG will be held at the Milwaukee Hilton City Center, January 28-30, 2003, in Milwaukee, Wisconsin.

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The National and Regional Superpave Newsletters are published three times a year and are coordinated by the North Central Superpave Center. The NCSC is one of five Superpave Regional Centers established to assist with implementation of the Superpave performance-based system for designing asphalt pavements. The NCSC is a joint effort of Purdue University, the Indiana Department of Transportation, and the Federal Highway Administration and is administered by the Joint Transportation Research Program at Purdue University.

Calendar of Events

2002

July 15-17 **Petersen Asphalt Research Conference**
Laramie, Wyoming
Contact: www.westernresearch.org

Aug 27-28 and 28-29 **Binder ETG and Mix ETG**
Minneapolis, MN

Sept 23-24 **3rd International Symposium on Binder Rheology and Pavement Performance**
San Antonio Marriott Riverwalk, San Antonio, TX
Contact: Abatech, Inc., Phone (267) 880-1295

Oct 11-15 **AASHTO Annual Meeting**
Anchorage, Alaska
Website: http://www.aashto.org/mtng_events/a_me.html

Oct 21-25 **Pavement Evaluation**
The Hotel Roanoke & Conference Center, Roanoke, VA
Contact: www.conted.vt.edu/pavement.htm

2003

Jan 12-16 **Transportation Research Board 82nd Annual Meeting**
Washington, DC
Contact: TRB (202) 334-2934 Website: http://trb.org/

Jan 11-17 **NAPA's 48th Annual Convention**
San Diego Marriott Hotel San Diego, California
E-mail: cprouty@hotmix.org

Jan 28-30 **NCAUPG 2003 Annual Meeting**
Hilton City Center, Milwaukee, Wisconsin
Contact: NCSC, 765/463-2317 ext 224, http://bridge.ecn.purdue.edu/~spave

Mar 10-12 **Meeting of the Association of Asphalt Paving Technologists**
Marriott Griffin Gate Resort Hotel, Lexington, KY
Contact: AAPT, (651) 293-9188 Website: http://www.asphalttechnology.org/

Mar 17-19 **Asphalt Pavement Conference**
Nashville, Tennessee
Website: http://www.asphaltalliance.org/registration/superpave2003.htm

Mar 18-20 **World of Asphalt™ Show**
Nashville, Tennessee
Website: www.worldofasphalt.com

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