North Central Superpave Center News

Volume 5, Number 1
Spring 2006

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NCSC Vision and Mission

To be a recognized source of hot mix asphalt expertise and to provide services to advance and transfer HMA technology through training, research, technology transfer and technical support.

North Central Superpave Center

NCSC Looks Ahead to Busy Summer

As the construction season heats up across the North Central region, the activities at the North Central Superpave Center are also shifting into high gear.

While it seems like we are always busy – just like everyone else these days – the type of work we are doing changes according to the season. Just like many of you, more of our work will focus on outdoor activities. Some of the things in store this summer include the following.

We are continuing to evaluate the field performance of a porous asphalt trial section. We will visit the site at least twice before Fall to collect pass-by noise levels. Within a day of noise testing, we will also perform texture measurements using the Circular Texture Meter (CTM), described on page 8, and measure friction using a companion device called a Dynamic Friction Tester (DFT). These same tests will be performed on an adjacent SMA section and a conventional (Superpave) HMA section for comparison purposes.

We are also working on other projects related to friction and are using the same devices in those studies. This summer we will be polishing and testing the texture and friction levels on nearly 40 slabs of hot mix produced using varying aggregate blends and gradations as part of a study on optimizing aggregates for friction. This study, sponsored by the Iowa and Indiana Departments of Transportation, is examining the relative contributions of microtexture and macrotexture to overall pavement friction.

The NCSC is also continuing to work on several projects related to asphalt pavement recycling. In cooperation with Heritage Research Group and the FHWA, the NCSC will be testing six plant-produced mixtures with varying percentages of RAP and two different virgin binder grades. We will be looking at the low temperature performance of the mixtures and will assess the amount of blending that occurs between the RAP and virgin binders using a new technique developed by Advanced Asphalt Technologies. We will report on the results of that testing in the next newsletter.

A new study getting underway this summer will tie together our work on RAP and friction. We will be exploring ways to allow the use of RAP in surface mixes while ensuring adequate friction. Since the composition of the aggregates in RAP is often unknown, many states are reluctant to allow the use of RAP in surfaces. The DFT and CTM will be used in this study as well.

Another field test site we will be working on this summer is continued monitoring of a Long Term Pavement Performance (LTPP) test site in Indiana. The site includes six test sections with different binder grades; one of the sections includes 15% RAP and was included in the regional RAP study completed in 2002. This long term performance evaluation will help to verify the results of the regional pooled fund study.

These are a few of the highlights of what we will be working on this summer. Another major effort includes working with a subcommittee of our Steering Committee to refocus our efforts on meeting the needs of the region – you'll be hearing more about that in the near future as well. Here's to a productive summer for all of us!

North Central Region Looks at Test Variations:

Update on Regional Round Robin Analysis

Ayesha Shah, NCSC Research Engineer

In January 2004, Erv Dukatz challenged the North Central Asphalt User Producer Group (NCAUPG) to start addressing non-uniformity in test procedures as a first step towards test standardization. Since different labs in the region may follow different test procedures, either due to multiple options allowed by AASHTO specifications or due to local specifications followed, it was necessary to first determine if these variations led to differences in test results. The North Central Superpave Center (NCSC) coordinated the effort on behalf of the NCAUPG.

Five state labs and the NCSC volunteered to participate in this effort. The state labs were Iowa DOT (Ames), Wisconsin DOT (Madison), Nebraska DOR (Lincoln), Indiana DOT (Crawfordsville) and Kansas DOT (Wichita).

Materials Used and Properties Tested

The raw materials (aggregate and binder) from nine mix designs were sent to each of the six participating labs. The nine mixes tested in this study represented a wide range of binder grades, design traffic volumes and other properties, as shown in Table 1. No recycled asphalt pavement (RAP) was used in any of the mixes to remove one source of variability.

The three 9.5-mm NMAS mixes had very similar gradations, but had different binder grades and were designed for different design traffic volumes. Two of the three 12.5-mm NMAS mixes, NE1 and WI1, also had similar gradations, but were also designed for different traffic conditions. In addition, IA2 and WI2 had similar gradations and NMAS, but different binder grades and design traffic volumes. The aggregates used in these mixes included limestone, dolomite, quartzite, natural sand and slag.

The aggregate and mixture properties investigated in this initial study were the bulk specific gravities of the stone (G_{sb}) and the mix (G_{mb}), fine aggregate angularity (FAA), maximum theoretical specific gravity of the mix (G_{mm}) and percent air voids at N_{des} (V_a). Test results were forwarded to the NCSC for analysis.

Variations in Test Procedures/Equipment

Most of the labs followed the relevant AASHTO specifications, except KSDOT and IDOT labs. These two labs followed local test specifications, which were very similar to the corresponding AASHTO methods. For the determination of G_{mm} according to the AASHTO T209 method, only the KSDOT and NDOR labs used the "weigh in water" method.

All the labs followed Method A for the G_{mb} tests. The bulk specific gravities of the fine and coarse aggregate (AASHTO T84 and T85) were measured on blended aggregate by the IDOT, NDOR and WisDOT labs, and on individual aggregate by the NCSC, INDOT and KSDOT labs. The INDOT lab did not conduct fine aggregate angularity tests on any of the aggregate. The NCSC and IDOT labs tested individual aggregates used in each mix; and the KSDOT, NDOR and WisDOT labs tested blended aggregates.

Four of the six participating labs, IDOT, NDOR, WisDOT and NCSC, used Troxler 4140 compactors, while the remaining two labs used two different models of Pine Gyratory Compactors. Three of the six labs, NCSC, WisDOT and INDOT, compacted the mixes to N_{des}; whereas the remaining three labs compacted samples to N_{max} and reported back-calculated N_{des} values.

Another great variation in testing was observed in the mixing, compaction and curing temperatures. The largest mixing temperature variation was observed for the modified binder (PG76-22) used in mix KS1, where the mixing temperatures ranged from 300°F to 342°F between the different labs. The largest range of in compaction temperature was 270°F to 300°F, which was observed for mix NE1 with PG70-28.

Mixes were typically cured two hours at compaction temperature prior to compaction. INDOT mixed, cured and compacted all mixes at 300°F; IDOT cured all mixes at 275°F for two hours. Other labs used varying compaction temperatures that were as high as 320°F for mix KS1.

Analysis and Findings

Two-factor statistical analyses were conducted to determine if either "lab" or "mix" played a significant role in the test result for each property/parameter tested. An alpha value (α) of 0.05 was used as the criterion to reject the null hypothesis. The α-value is the risk of rejecting the null hypothesis, when it is in fact true. The null hypothesis was that the test results from the various labs were equal, or statistically the same.

If a factor was found to be significant, the Bonferroni multiple comparison of means test was used to determine which labs or mixes were similar or dissimilar. This method divides the factors (lab and mix) into groups that are *not* significantly different. If the groups overlap, it is difficult to clearly differentiate between the groups.

Figure 1 shows the G_{mm} values obtained by the participating labs for the nine mixes studied and the corresponding mix design values. Except for mixes IN1 and IN2, the G_{mm} results from the labs show a low degree of scatter around the mix design value. (Only two of the six participating labs conducted replicate tests.) Two-factor ANOVA tests indicated that the variable "mix" was significant, but not the variable "lab." This implies that the mixes are different, but not the labs. Variations in lab practices in the determination of G_{mm} did not

Continued on Page 11

Mix ID	NMAS	Grade	N_{des}	ESALs (x 10^6)
IN1	9.5 mm	PG 64-22	50	< 0.3
IN2	9.5 mm	PG 76-22	100	10 - 30
IA1	12.5 mm	PG 64-28	96	10
IA2	19.0 mm	PG 76-28	109	12.9
KS1	19.0 mm	PG 76-28	100	21.3
KS2	9.5 mm	PG 70-28	125	40
NE1	12.5 mm	PG 70-28	96	10
WI1	12.5 mm	PG 58-28	75	2
WI2	19.0 mm	PG 58-28	100	3 - 10

Table 1. Details of Mixes Tested

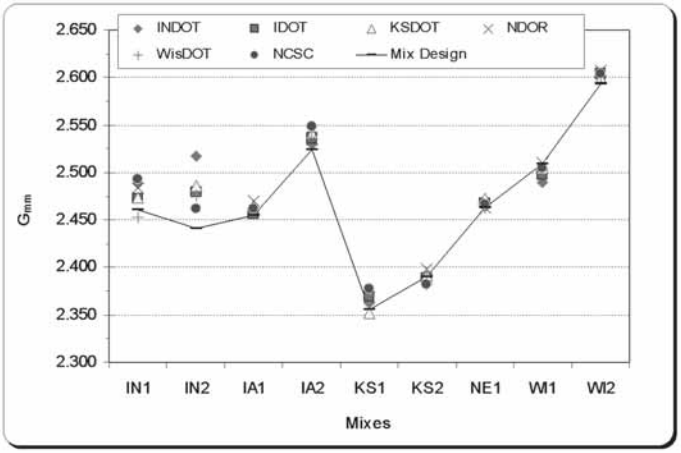

Figure 1: G_{mm} of mixes and mix design values

influence the resulting G_{mm} values. On the other hand, differences between mixes were expected due to the wide range of mixing and curing temperatures, aggregate sources and types, gradations, etc.

The bulk specific gravities of compacted HMA samples at N_{des} and the mix design values are shown in Figure 2. Unlike the G_{mm} data, these data show a higher degree of scatter. Two-factor ANOVA on the combined G_{mb} dataset (measured and back-calculated) indicated that both factors were significant. In general, the IDOT and KSDOT labs yielded higher G_{mb} at N_{des} (back-calculated) than NDOR and WisDOT labs (measured values).

Bonferroni comparison tests indicated that, in general, the Kansas mixes and WI1 appear to be unique mixes, while the IA2 and WI2 mixes with similar gradations and NMAS, but different binder grades and compaction temperatures, yielded similar G_{mb} values. Bonferroni tests on the labs showed significant overlapping between labs. This was expected due to the many variables involved in the sample preparation process.

Since it is suspected that compaction level is probably the most significant factor influencing the result, the dataset was divided into two groups: measured versus back-calculated G_{mb} values. Analysis of the measured G_{mb} dataset alone (separately) did not show "lab" as a significant variable. In other words, it appears that variations in lab practices did not influence of the G_{mb} of the samples prepared by the NCSC, WisDOT and INDOT labs—they all gave similar results.

Analysis of the back-calculated G_{mb} dataset seemed to indicate that the NDOR lab data was significantly different from the data produced by the IDOT and KSDOT labs. However, due to a lack of replicate samples from the NDOR lab, it is impossible to conclude that this is indeed a "true" difference resulting from differences in lab practices.

Since percent air voids is estimated from G_{mm} and G_{mb} values, it may be expected that the V_a data would represent the combined variability observed in these two properties. As in the case of the G_{mb} analysis, this data was also analyzed in two parts; "measured" and "back-calculated." The back-calculated percent air voids of samples from the NDOR lab were found to be statistically different from the KSDOT and IDOT sample set, which reflects the findings from the G_{mb} data analysis. Analysis of data from the "measured" samples indicated that the labs were different, but did not yield any clear distinctions as to which labs were similar or dissimilar; the groupings were mix dependent.

Statistical analysis of the fine aggregate angularity data did not indicate any significant differences between the labs. This indicates that testing the blended aggregate or individual aggregates used did not alter the FAA result, within the limited scope of this study. Statistically significant differences between mixes were found, as expected, but no multiple comparison tests could be conducted due to the lack of replicate data from most of the labs.

Two-factor ANOVA tests on the G_{sb} data indicated that both "lab" and "mix" were significant factors, that is, both contributed to the variability observed in the data. No further statistical tests were run due to the lack of replicate tests.

This study was just a first step to examine the effects of variations in test procedures across the region. It points out the need to perform detailed, focused studies on specific test methods in the future. For example, we may need to prepare mix samples in one lab for G_{mm} testing in many labs across the region. Having more labs performing multiple tests would strengthen the statistics.

The NCSC will work with the NCAUPG to determine the course of action on the next steps to take on the path to regional test standardization.

The full report on this study will be available on our website at http://bridge.ecn.purdue.edu/~spave.

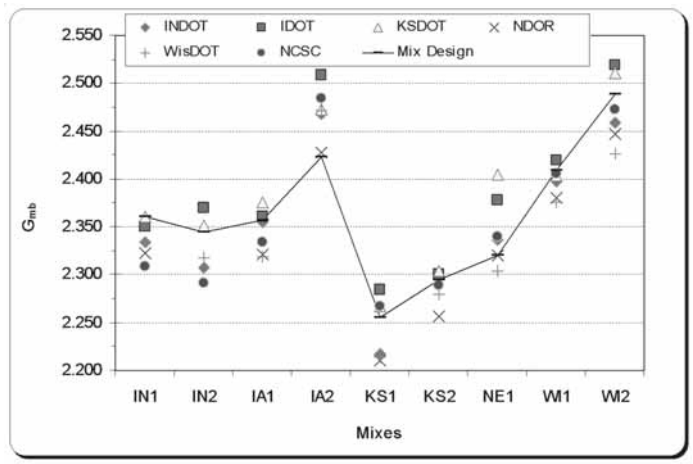

Figure 2: G_{mb} of mixes and mix design values

Electronic Version of the Newsletter Now Available

The North Central Superpave Center is now offering an electronic version of this newsletter. If you would like to receive the newsletter electronically, please go to the NCSC Newsletter electronic subscription page at the following website:

https://engineering.purdue.edu/ECN/mailman/listinfo/ncsc-newsletter-list

Please indicate if you wish to receive the electronic version only or if you would also like to receive a hard copy in the mail.

If you have any questions, please call the NCSC office at (765) 463-2317, extension 224, or e-mail warble@purdue.edu.

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The National Superpave Newsletters are coordinated by the North Central Superpave Center. The NCSC was originally established as one of five regional Superpave Centers to assist states with implementation of the Superpave system and now focuses on all hot mix asphalt issues. The Center is currently conducting research on tire pavement noise control, frictional characteristics of surfaces, recycling, regional test standardization and more. The NCSC is a joint effort of Purdue University, the Indiana Department of Transportation and the Federal Highway Administration. It is administered by the Joint Transportation Research Program (JTRP) at Purdue University.

Calendar of Events

2006

June 19-23 **Petersen Asphalt Research Conference and Pavement Performance Prediction Symposium**
Laramie, WY
Website: http://www.petersenasphaltconference.org/

August 12-17 **10th International Conference on Asphalt Pavements (ISAP)**
Hilton Quebec
Quebec, Canada
Website: http://www.icap2006.fsg.ulaval.ca

September 13-15 **International Conference on Perpetual Pavement**
Hilton Columbus at Easton Hotel
Columbus, OH
Website: http://webce.ent.ohiou.edu/orite/icpp/icpp.html

October 25-31 **AASHTO Annual Meeting**
Portland, Oregon
Website: www.transportation.org/aashto/calendar.nsf

2007

January 10-11 **NCAUPG Hot Mix Asphalt Technical Conference**
Hilton Minneapolis/St. Paul Airport
Mall of America
Contact: NCSC (765) 463-2317 ext 224

January 21-25 **Transportation Research Board 86th Annual Meeting**
Washington, DC
Contact: TRB (202) 334-2934 Fax: (202) 334-2003
Website: http://trb.org/news

March 12-14 **Association of Asphalt Paving Technologists 82nd Annual Meeting**
San Antonio, TX
Website: www.asphalttechnology.org

March 19-22 **World of Asphalt 2007**
Atlanta, GA
Website: www.worldofasphalt.com

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