FAA Center Designs for the Future

Over a million Americans take to the skies every day, taking off and landing over 6,000 times at commercial airports. Thousands more flights take off from general aviation fields. Only a handful of the passengers give a thought to the pavement they land on.

The Federal Aviation Administration (FAA), however, has to pay attention to the pavement. Take off and landing are two of the most critical points in a flight. Providing a safe, smooth runway is essential. In fact, the FAA invests approximately $2,000,000,000 — that's right, two billion dollars — a year on pavements.

The National Airport Pavement Test Facility (NAPTF) at the FAA's William J. Hughes Technical Center at the Atlantic City International Airport is used to study how to design airfield pavements for the heavy loads applied by civilian aircraft, which are an order of magnitude greater than highway loadings. In addition to heavy loads, airfield pavements must be able to accommodate a variety of landing gear configurations.

Today's — and tomorrow's — heavy loads and complex landing gear configurations are far different from the loads and wheel spacings that were used to develop the commonly used pavement design procedures. In fact, most airport pavement design is based on highway pavement design technologies. The NAPTF is pursuing a comprehensive series of experiments to develop new pavement design procedures for airfield pavements. The FAA continues to take advantage of advances in highway design and Department of Defense research for military aviation, but is also working to solve its own unique problems.

The FAA developed a layered elastic pavement design procedure in the 1990's and continues to work on refinements to the software. In addition, the FAA is working on a new generation of pavement design using 3D finite element procedures to allow even greater complexity and accuracy in design.

Performing research to account for the effects of traffic loading can be a time consuming activity while waiting for thousands or millions of vehicles to pass over test sections. So, researchers frequently turn to testing under accelerated loading to compress the traffic into a shorter time frame.

In the United States, there are about 15 active accelerated pavement testing (APT) facilities. The types of facilities vary widely, including test roads and test tracks with actual vehicles as well as mechanical loading frames that simulate traffic.

Test tracks include the one at NCAT and the former facility at WesTrack. Test tracks subject pavements to controlled loads under real weather conditions.

Some APT facilities use actual, uncontrolled highway traffic. MnROAD in Minnesota and Virginia’s SmartRoad both can divert real traffic onto their test sections. MnROAD also has a low volume road loop that uses controlled traffic to load the test sections.

There are also a number of facilities in the US that use mechanical loading rather than actual vehicles. There are fixed facilities, where the pavement sections are constructed in a test pit inside a building, in Indiana, Kansas, Mississippi and New Hampshire. The fixed facilities generally offer close control of environmental conditions.

The FHWA’s ALF, Accelerated Loading Facility, is one well-known example of a moveable mechanical loading system. There are other devices of this general type in Illinois, Texas, Louisiana, California and Florida. These devices can be used inside a building, offering the same control over conditions as the fixed facilities, or can be transported to the field.

These facilities have been used to address a wide array of issues. More information is available from the Transportation Research Board's Committee on Full-Scale and Accelerated Pavement Testing at www.k-state.edu/pavements/trb/A2B09/index.htm, which includes links to all of these sites, as well as information on accelerated testing worldwide.
FAA  Continued from Page 3

One tool the FAA has to address pavement design issues is the full-scale loading facility at the NAPTF, which was commissioned in 1999. The FAA and Boeing Company jointly funded the facility. The Transportation Research Board Committee on General Issues in Asphalt Technology toured the facility in April.

This huge loading frame, shown in Figure 1 on page 3, allows a test vehicle to apply accelerated loading to test pavements. The automated test vehicle can apply up to 75,000 pounds per wheel on two landing gear trucks, which can be different. Each landing gear can have as many as six wheels per gear. The test vehicle can simulate aircraft weighing up to 1.3 million pounds!

The test vehicle runs at speeds up to 15 mph and can load in both directions. It can also simulate typical aircraft wander.

The pavement is 900 feet long and 60 feet wide, so multiple experimental sections can be in study at the same time. Both asphalt and concrete sections have been studied. Three different subgrades are used to allow investigation of the effects of subgrade strength on pavement performance. The subgrade CBPs range from 3 to 20%.

The test pavements are instrumented, and the data is collected automatically. Over 1000 sensors are used to measure temperature, moisture, humidity, resistance, deflection, strain, joint movement and pressure. FAA makes the data available to researchers worldwide through the database maintained on their website.

The FAA and many co-sponsors are hosting a conference April 16-18, 2007, to discuss New Directions in Airport Technology. Airport pavement design, pavement management, full-scale testing, and construction materials and methods are some of the topics that will be addressed at the conference. In addition, tours of the William J. Hughes Technical Center and the NAPTF will be offered.

More information on the NAPTF and the conference are available on the web at www.airporttech.tc.faa.gov/.

New Project Dissects Historic Research Effort
Rebecca McDaniel, North Central Superpave Center

A new National Cooperative Highway Research Program (NCHRP) project to document the SHRP Asphalt Research Program has been awarded to a team led by the North Central Superpave Center. The 21-month project, NCHRP 9-42, will examine the organizational and technical issues encountered during the SHRP Asphalt Research Program and the implementation of its products.

The Strategic Highway Research Program (SHRP) was one of the most important episodes in transportation-related research in the twentieth century. SHRP was the largest, most highly focused research effort in the United States since the AASHO Road Test of the late 1950s. SHRP was an unprecedented, coordinated research effort aimed at developing high-payoff products in focused areas of national need.

The Asphalt Research Program under SHRP eventually led to the development of the Superpave system for the design of asphalt mixtures. Superpave has changed asphalt technology in the U.S. and has had an impact around the world.

The SHRP Asphalt Research Program was a success not only because of its technical developments but also as a result of its organization. The methods of funding, administration, organization and decision-making all contributed to success. This project will document the SHRP process to provide a pattern on which focused research efforts of the future can be planned.

Perhaps, SHRP’s greatest achievement is the implementation of the research results. From the outset, SHRP’s objective was to implement the technology that was developed. The focus of the entire research effort was on high-payoff, implementable research results. This important effort will also be studied during the project.

In addition to the successes of the SHRP Asphalt Research Program, however, there were some things that did not go as smoothly as they could have. The lessons learned and reflections on how things could have worked better will also be documented in the project. Interview subjects will be asked what they would do differently, if they had it to do over again. Information about the SHRP research and implementation phases will largely be gathered from dozens of interviews with researchers, managers, users and others involved in the program. AASHTO, DOTs, industry, the research teams, SHRP administration, the Lead State Team, Superpave Centers and other groups in the US and Canada will all be represented in the interviews. Published and unpublished documents will also be reviewed to develop an unbiased, comprehensive accounting of the program.

The final report on the project, with the working title Superpave: Anatomy of a Research Program, will help research managers, especially those involved in large-scale programs like SHRP II and Highways for Life. In addition, the report will identify areas of research that were not pursued, because of constraints like time, funding, technical obstacles and “politics.” These areas may be fruitful areas of future research.

The team consists of Rebecca McDaniel, NCSC; Ted Ferragut, TDC Partners; Gerry Huber, Heritage Research Group; Rita Leahy, Nichols Consulting Engineers; and James Moulthrop, Fugro-BRE.
AAPT Discusses Pluses and Minuses of PWL Specs

Rebecca McDaniel, North Central Superpave Center

Every year the Association of Asphalt Paving Technologists (AAPT) puts on one of the preeminent asphalt conferences in the world. This March, over 240 people attended the 81st meeting of the group in Savannah, Georgia.

In addition to a Government and Industry Forum, a workshop and several technical sessions, a symposium on a focused topic has become an annual event. The topic of the symposium this year was Asphal Concrete Quality Management with PWL. Speakers addressed a variety of perspectives on the subject of Percent within Limits specifications.

Chuck Hughes, consultant, opened the symposium with a Primer on Percent within Limits. Hughes explained that PWL specifications use the average of a number of test results along with the standard deviation, a measure of the spread or variability in those results, to estimate the properties of the population from which those samples were taken. The population is some predetermined quantity of material, such as a truckload or a lot. PWL specifications encourage contractors to control variability to produce a more consistent product. While interest in PWL has been growing lately, it is not a new concept; the Department of Defense has been using PWL since the late 1950’s. Hughes reported that now over half the state DOTs are using PWL, as well as FHWA and FAA.

A summary of FHWA initiatives regarding PWL was provided by Matt Corrigan. FHWA is committed to achieving quality construction. A statistically sound method of measuring and controlling quality is essential, and FHWA has supported development of sound QA techniques over the years. Although other statistical methods exist, PWL specifications are unique in that they provide a way for the risks of the agency and the contractor to be quantified and balanced. Corrigan summarized some of the issues that must be considered when using any quality measure or acceptance plan and suggested how these issues can be addressed.

Gale Page, Florida DOT (FDOT), discussed his state’s implementation of PWL specifications. FDOT adopted a PWL specification in 2002 and reviewed that specification in 2004 to compare variability before and after implementing PWL. In 2002, FDOT also adopted a Contractor Quality Control plan, using contractor QC test results for acceptance. FDOT analyzed a large amount of data to develop the limits used in their PWL specification. The review showed that, in general, the specifications were reasonable and were working as desired. Small adjustments were made to some of the parameters to further improve the system.

Carl Monismith, professor at the University of California, Berkeley, offered a dissenting viewpoint. He pointed out that performance could be achieved without using PWL specifications. He outlined a procedure using accelerated testing and performance modeling to estimate the relative performance of the constructed mix. Target (design) values and reasonable variation are used to assess the mixture. The cost analysis includes only the agency costs. Monismith argued that this approach is preferable to PWL since it uses established performance models and mechanistic analysis to estimate pavement performance. If the produced mix does not meet the targets for specific distresses, the pavement performance will suffer and costs to the agency can be quantified.

Jim Schmidt, Koch Performance Roads, shared experiences using PWL on two warranty projects, a 20-year warranty in Virginia and 15-years in Wisconsin. Schmidt reported that the use of PWL specifications was successful and helped to control the variability of the material placed, which should help to meet the warranty requirements. He stressed the need for communication and training of the personnel involved. The limits also need to be reasonable; in one case the contractor struggled to meet density and smoothness requirements that were probably too tight for the situation.

Lastly, Adam Hand, Granite Construction, shared a contractor’s perspective on the advantages and disadvantages of PWL specifications. The widespread implementation of QC/QA specifications in the 1990’s required contractors to make significant investments in laboratories, training and personnel to take on the responsibility of controlling the quality of their materials. Hand commented that PWL is a reasonable way to measure quality. PWL also provides an opportunity for contractors to be compensated for producing quality material when incentives are included. The implementation of QC/QA specifications in general encouraged contractors to increase their technical competence, which is an overall benefit. Disadvantages, though, include a lack of understanding of the risks by both the contractors and the agencies; small changes in specification parameters can affect the risks. Inappropriate limits are also a problem; considerable care needs to be exercised when analyzing the data to set the limits. Hand outlined some additional disadvantages and inequities in typical PWL and QC/QA systems. He closed with some philosophical questions about the specifications in use, but also noted some positive steps being taken across the country to further improve the specifications.

Abstracts of the papers presented at this meeting, as well as electronic-only papers, will be added to the searchable database at the North Central Superpave Center, at http://rebar.ecn.purdue.edu/Superpave/search.asp. Additional information about AAPT, including membership application, is available at http://www.asphalttechnology.org.

Other sessions at the meeting covered a wide range of topics, including performance criteria for HMA; the Bailey method; warm mix asphalt; crumb rubber; binder performance; testing and quality control; several papers on Superpave performance testing; surface energy and more. A new addition this year was an International Forum where international participants had an opportunity to share their work and current activities. In another first this year, Dr. Rita Leahy was the first female president of this august group.

Next year’s meeting will be held March 12-14, 2007, in San Antonio, Texas.
NCAT Studies Calibration for M-E Pavement Design

Angela L. Priest (Edited by Don Watson and Rebecca McDaniel)

The structural design of hot mix asphalt (HMA) pavements over the past fifty years has shifted from empirical design equations to a more powerful and adaptive design scheme. Mechanistic-empirical (M-E) design has been developed to utilize the mechanical properties of the pavement structure along with information on traffic, climate and observed performance to more accurately model the pavement structure and predict its life.

The M-E design process integrates environmental conditions and the material properties of the HMA and underlying layers into the pavement structure. The structure is then modeled using a mechanical analysis program, and the pavement response is calculated given the axle load and tire configuration. The pavement response is correlated to performance, or cycles to failure, through empirically derived transfer functions for specific distress types.

The transfer function is the key to a successful M-E pavement design, and much effort has been devoted to developing useful transfer functions. Transfer functions are somewhat mix specific and dependent on the climate; therefore, local calibration or development is required to account for local materials and conditions. In addition, the level of distress that is considered “failure” must also be defined locally.

NCAT Test Track Study

As states move to adopt the new Mechanistic Empirical Pavement Design Guide (MEPDG), developed as part of the National Cooperative Highway Research Program (NCHRP) project 1-37a, states or regions will have to calibrate the M-E models to local conditions. The recently completed NCAT Test Track Structural Study looked at calibrating the fatigue models for different pavement structures using accelerated loading.

Laboratory-developed performance equations do not accurately predict the fatigue life of asphalt pavements in the field. Due to the differences between the laboratory and the field, fatigue life relationships must be calibrated or shifted to observed field performance. This is the empirical part of M-E design.

Given the above concerns, eight test sections of the National Center for Asphalt Technology (NCAT) Test Track were devoted to a structural experiment to investigate the many integral parts of M-E design. The sections, sponsored by the Alabama DOT (ALDOT), Indiana DOT (INDOT) and FHWA, included three different HMA thicknesses and two different binder types (PG 67-22 and an SBS modified PG 76-22). All eight sections had an underlying 6 in. crushed granite granular base over fill material constructed over the existing embankment. Figure 1 shows the cross sections of the structural study sections, N1-N8.

Instrumentation, including strain gauges, earth pressure cells and thermistors, was installed in the pavement structure to directly measure the pavement response and condition.

The sections were designed to show a variety of distresses over the life of the experiment. It was intended that at least the 5 and 7 in. sections would exhibit fairly extensive structural distress in order to correlate performance to field-measured pavement responses. The thin sections (N1 and N2) were designed for about 1.1 million ESALs, the medium sections (N5-N8) for 2.9 million ESALs and the thick sections (N3 and N4) for 7.8 million ESALs.

The test sections were trafficked with a fleet of heavily loaded triple-trailers (gross vehicle weight 152 kips) and one legally loaded box trailer. Since real drivers were used, the wheel wander and traffic conditions at the Track were similar to open-access highways.

Fatigue Cracking Theory

The textbook definition of fatigue theory states that fatigue cracking initiates at the bottom of the flexible layer due to repeated and excessive loading, and it is associated with the tensile strains at the bottom of the HMA layer. The M-E structural design process limits the tensile strain in the HMA layer in order to control or design against fatigue cracking.

Fatigue cracking is also referred to as alligator cracking due to its distinctive pattern; the cracking often looks like the back of an alligator (Figure 2).

Prior to the development of the new MEPDG, researchers working on various M-E design procedures had recommended fatigue shift factors ranging from slightly over 1 to over 400. As an improvement over earlier efforts, the MEPDG calibrated the fatigue transfer function using data from the Long Term Pavement Performance (LTPP) database from different pavement sections all over the U.S. A total of 82 LTPP sections were included in the analysis.

The current state-of-the-practice fatigue transfer function equations, including the Asphalt Institute MS-1, Shell Oil Design Guide and the MEPDG, take the form:
where,

\[ N_f = k_1 \left( \frac{1}{\varepsilon_t} \right)^{k_2} \left( \frac{1}{E} \right)^{k_3} \]

- \( N_f \) = Number of load cycles until fatigue failure
- \( \varepsilon_t \) = Applied horizontal tensile strain
- \( E \) = HMA mixture stiffness
- \( k_1, k_2, k_3 \) = Regression constants

In the development of the MEPDG, all three regression constants were tweaked to better match LTPP performance data. In a similar manner, all three regression constants were calibrated to fit the data collected at the NCAT Test Track for the models presented here.

Test Track Findings

In both the HMA stiffness data and the pavement strain data, seasonal trends and damage were observed over time. The induced strain is a function of the stiffness of the mix, which in turn is a function of temperature. As a result, the strain response is strongly correlated with the temperature of the HMA layer.

Unlike the stiffness data, however, the strain data is also a function of the thickness of the HMA layer. The thickness effect is the central concept behind M-E design, which is to determine the needed layer thicknesses to control the critical responses, such as horizontal strain at the bottom of the HMA layer, given the traffic and seasonal data.

Using the data from the instrumentation at the Test Track, transfer functions in the form above were developed for thin and thick pavement structures. In other words, the regression coefficients, \( k_1, k_2, \) and \( k_3 \), were determined for the conditions and performance at the track.

The thin sections, N1 and N2, failed in a very similar manner and within two months of each other. Section N1 failed prior to section N2, which was expected because the strain values of N1 were statistically higher, and N2 was slightly stiffer than N1. Both of these effects are quantified in the transfer function equation.

The fatigue transfer function for the thick sections is based on assumptions regarding the current state of distress of the test sections at the time the report was written. In calibration of the thick model, hourly temperature and traffic data were used, and a current damage ratio was assigned to each test section. Section N6 had the highest amounts of cracking and was the only section with areas of interconnected cracks; therefore, it was assigned a damage of 0.7. Sections with less severe or no cracking were assigned proportionately lower damage ratios. The thick sections (N3 – N7) will be loaded more during the third cycle of the Test Track, allowing future refinement of the transfer functions.

An attempt was made in this study to evaluate one pavement section with a rich bottom layer. A binder content higher than optimum at the bottom of the paved section is reported to increase the fatigue life of the pavement. In this structural study, the single rich bottom section did not perform as expected. As a result, further investigation into the rich bottom concept should be pursued at NCAT and elsewhere, both in the laboratory and the field, before it is widely accepted as a viable pavement design option.

Conclusions

The fatigue transfer functions presented here were developed to aid ALDOT and other states in adopting M-E design procedures. The models are applicable to public highway analysis and design for conditions similar to those of the NCAT Test Track. The test sections were designed using ALDOT materials and specifications; therefore, they are directly applicable to the State of Alabama and other states with similar mixture designs and climatic conditions. Further, two separate models were presented for thick and thin HMA pavements, avoiding any necessary shift factors. The rich bottom model was developed using only one test section, so further investigation is warranted, especially since the section did not perform as expected.

More detailed information on this study is available on the web at http://bridge.ecn.purdue.edu/~spave/Newsletters/Newsletters.htm.
Circular Texture Meter Proves Useful for Measuring Pavement Surface Texture  
Douglas I. Hanson and Brian D. Prowell

Pavement friction during wet conditions continues to be a major safety concern for pavement design and maintenance. The friction of a pavement surface is a function of the surface textures that include microtexture, consisting of wavelengths of 1 µm to 0.5 mm, and macrotexture, with wavelengths of 0.5 mm to 50 mm, according to the World Road Association (PIARC). Microtexture provides a gritty surface to penetrate thin water films and produce good frictional resistance between the tire and the pavement. Macrotexture provides drainage channels for water expulsion between the tire and the pavement, thus allowing better tire contact with the pavement to improve frictional resistance and prevent hydroplaning. Currently there is no system capable of measuring microtexture profiles at highway speeds. Therefore, microtexture is evaluated by using pavement friction at low speeds as a surrogate.

Pavement macrotexture, or more specifically variation in macrotexture, has been used to identify pavement segregation. Segregation refers to separation of the coarse and fine fractions of aggregate in a paving mixture. Coarse areas tend to have lower asphalt content, lower density and higher permeability. These areas tend to fail prematurely. Areas with high levels of segregation may increase the life cycle cost to the agency by as much as 50 percent, as reported by Mary Stroup-Gardiner and Ray Brown.

Previous work has indicated that the Circular Texture (CT) Meter can be used to determine the texture of a pavement surface. The National Center for Asphalt Technology (NCAT) Pavement Test Track was used to compare the CT Meter to the classic measure of pavement macrotexture, which is a volumetric method typically referred to as the “sand patch” method. The repeatability of the CT Meter was compared to the sand patch procedure, and the reproducibility of the CT Meter was determined by comparing results from three CT Meters when used to test the same locations.

Two nominal maximum aggregate sizes (NMAS) are present on the track surface, 9.5 mm and 12.5 mm. Gradations include fine and coarse dense graded mixtures (Superpave and Hveem), stone mastic asphalt (SMA) and open graded friction courses (OGFC). Novachip was also installed on one section to correct friction problems. Eight major aggregate types were used on the track including granites, limestone, various gravels, slag and combinations thereof, including reclaimed asphalt pavement.

The CT Meter test procedure is presented in ASTM E2157. The CT Meter, shown in Figure 1, uses a laser to measure the profile of a circle 284 mm (11.2 in) in diameter and 892 mm (35 in) in circumference. The profile is divided into eight segments of 111.5 mm (4.4 in). The average mean profile depth (MPD) is determined for each of the segments of the circle. The reported MPD is the average of all eight segment depths.

Sand Patch Method

The Sand Patch test procedure is described in ASTM E965. It uses a volumetric approach for measuring pavement macrotexture. A known volume of glass beads is spread evenly over the pavement surface to form a circle, thus filling the surface voids as shown in Figure 2. (Originally, Ottawa sand was used in this method, hence the common name “Sand Patch.”) The diameter of the circle is measured on four axes and the values averaged. This value is used to calculate the mean texture depth (MTD).
Relationship between Test Results

CT Meter and Sand Patch tests were performed at five random locations within 45 of the 46 test sections at the NCAT Test Track. (Section W10 was not tested because of its short length.) The pavement was approximately 28 months old at the time the measurements were taken.

The CT Meter readings were taken prior to the Sand Patch tests so that residual glass beads would not affect the readings.

A comparison of the CT Meter and Sand Patch results is shown in Figure 3. Each point represents the average of five tests by each method. Four sections were considered to be outliers: W3, W4, W5, and W7. Sections W3, W4 and W5 were open graded friction courses (OGFC) and section W7 was a Novachip section. These types of mixes are so porous that they allow the glass beads used in the Sand Patch test to flow into the voids interconnected with the surface texture, producing an erroneously high result. The correlation coefficient ($R^2 = 0.95$), excluding these outliers, indicates a strong relationship between the MPD measured by the CT Meter and the MTD determined from the Sand Patch test.

An equation was developed to correlate the MPD to the fineness modulus (FM) of the mix. The FM is the sum of the cumulative percentages retained on the 0.15, 0.30, 0.60, 1.18, 2.36, 4.75, 9.5, 19.0, 37.5, 75 and 150 mm sieves, divided by 100.

Variability of CT Meter Results

A mini round robin was conducted at the NCAT Test Track to evaluate the variability of the CT Meter. Three organizations provided CT Meters and participated in the study, the Arizona Department of Transportation, Koch Materials Company and NCAT. Three sections were selected for testing: N2, N12 and S4. N2 is a 9.5 mm NMAS fine graded Superpave mixture produced with a blend of granite and limestone. N12 is a 12.5 mm NMAS SMA produced with granite aggregate. S4 is a 12.5 mm NMAS OGFC produced with limestone aggregate. Both N2 and S4 were reconstructed in 2003.

Ten random locations were determined for each section. All readings were taken at the same transverse location in the lane to minimize material variability. The testing order for the three machines was randomly selected for each section. The random testing order determined for each section was then used for all ten sites in that section. Triplicate readings were taken at each site.

ASTM E691 software was used to determine the precision of the CT Meter from the round robin results. Precision of the test method has two components, repeatability and reproducibility. Repeatability ($Sr$) is the single-operator standard deviation of the test results. Reproducibility ($SR$) is the multi-operator standard deviation of the test results.

The repeatability and reproducibility were calculated based on a single run, the average of two runs and the average of three runs. As expected, the repeatability and reproducibility improved by averaging multiple runs. Since the test is so fast, this does not pose a problem during field tests. Based on test results, it appears that there is a significant improvement in repeatability and reproducibility when two CT Meter runs are averaged, but little improvement resulting from averaging three runs. It is recommended that two CT Meter readings be averaged for a given site in future testing.

ASTM E965 reports the coefficient of variation for the Sand Patch Test can be as low as 1 and 2% for repeatability and reproducibility, respectively. The coefficient of variation for the CT Meter was determined to be 3.2 and 5.9% for repeatability and reproducibility, respectively. This indicates that the CT Meter can be more variable than the minimum reported precision for the Sand Patch test. Averaging two measurements to produce a single test result would improve the precision of the CT Meter. The coefficient of variation for the average of two test results would be estimated to be 2.3 and 4.2% for repeatability and reproducibility, respectively. One reason that the precision of the CT Meter may not be quite as good as the sand patch test is that the area the CT Meter tests is smaller than that tested in the Sand Patch test.

Conclusions

♦ The CT Meter produces comparable results to the ASTM E965 Sand Patch Test.
♦ An equation was developed to relate fineness modulus to macrotexture. This equation was validated with independent data collected by Virginia Transportation Research Council.
♦ Testing conducted as part of a mini round robin indicated that two readings should be averaged to represent a single CT Meter measurement.
♦ The within-lab coefficient of variation for the CT Meter is estimated to be 2.3%. The between lab coefficient of variation for the CT Meter is estimated to be 4.2%. Both estimates are based on the average of two tests being reported as a single measurement. This indicates that the CT Meter is more variable than the sand patch test. However, less technician skill is required to operate the CT Meter. Further, the authors question the validity of the precision of the Sand Patch test over the wide range of materials tested in this study.

A full report on this study is available from NCAT at www.eng.auburn.edu/center/ncat.
Highway Issues Resonate Half a World Away

It seems like human nature to get totally focused on our own issues. We get wrapped up in our own projects. We concentrate on our own state's specifications. Sometimes we venture to a regional meeting to share with neighboring states. We may even go to a national conference from time to time, but for most of us, local issues—especially local problems—demand the majority of our attention.

The world can seem like a much smaller place when we learn that other people are facing the same challenges that we face. A recent conference in New Zealand is a case in point. The conference, sponsored by the New Zealand Institute of Highway Technology, addressed recycled pavements and porous asphalts—two very hot topics in North America as well.

Just like us, folks half a world away are also trying to stretch their funding for roadway maintenance and construction. They are concerned about the environment and sustainable site design. The availability of resources, especially near urban areas, is a growing problem. Reducing traffic noise is a principal aim of the environmental strategy developed by Transit New Zealand, the governmental body responsible for the state highways, so interest in low-noise pavements is growing there, as it is here in North America.

These concerns led to their interest in exploring pavement recycling to take advantage of existing resources, ensure performance and offer economical options for roadwork. Stormwater management, noise issues and safety prompted interest in porous asphalt.

At the conference, speakers from Canada, the USA, Australia and New Zealand shared their experiences with recycling and porous asphalt. Speakers represented industry, academia and government. The two-day conference also provided ample opportunity for participants to share their experiences informally over tea and meals.

Stephen Damp, Senior Vice President of the Miller Group in Canada gave the keynote speech on Why Road Owners are Increasing their Use of Recycled Pavements. He indicated that the benefits of reduced costs, good performance and environmental advantages have caused rapid growth in pavement recycling across North America. Damp also spoke on how to construct high quality recycled pavements for various applications.

Rebecca McDaniel, Technical Director of the North Central Superpave Center in Indiana, offered some case studies of recycled pavements in the US and summarized design of RAP mixtures. She summarized a laboratory study of RAP mixes in the Midwest, supplemented with a field evaluation of performance. She also discussed RAP mixture design considerations.

Local New Zealand speakers shared their experiences with foamed bitumen, in situ stabilization, and trial projects with RAP and crumb rubber. Another local study reported on controlling leachates from waste materials used as aggregate replacements, including toxicity measurements on the effluent. The environmental impacts of pavement stabilization and saw cutting were also discussed.

The keynote speech on porous pavements, given by Rebecca McDaniel, summarized the applications and benefits of porous pavements for noise control, safety and stormwater management. She also outlined the special design considerations that are needed to ensure the durability and long term functionality of porous pavements and porous surfaces.

Damp discussed the use of porous pavements in eastern Canada. The climatic conditions in Canada present some difficult challenges for porous pavements. While there have been some performance issues, like raveling, there will still be limited use in British Columbia and Ontario.

Local speakers reported on some early noise measurements performed on in-service surfaces to reduce tire-pavement noise. Open graded porous asphalt (OGPA) and twin layer OGPAes have been used experimentally in New Zealand for about five years. Based on good performance to date, Transit New Zealand is incorporating OGPAes in their specifications to increase their use for noise control. Transit New Zealand also presented a paper on cutting transverse grooves in dense asphaltic concrete surfaces to improve frictional properties of the surface. By using random spacing of the grooves, the tire whine can be reduced to acceptable levels. A local industry representative presented an ultra thin asphalt surface that can improve texture and skid resistance.

New Zealand is about the size of Colorado, with a population of just over 4 million. It has nearly 11,000 km of state highways, including about 170 km of expressways, and 82,000 km of local roads. Many of their pavements are very thin, by North American standards. In fact, much of the network outside the urban centers is built up of chip seals over stabilized bases. The texture of the chip seals is quite aggressive to provide good friction, but that texture also causes them to be quite noisy.

There are many differences between New Zealand and the US, but there are also many areas of common concern. Many of the same issues echo around the world. Their research and field experiences in these areas can expand and supplement our work. It is a small world after all!