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PAVEMENT SUPPORT PROGRAM 2013

July 2014

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Abstract

The primary objective of the Rutgers Pavement Support Program (PRP) is to utilize the extensive laboratory and field pavement testing equipment and staff expertise of the Pavement Support Program in all aspects of Pavement Engineering to assist the New Jersey Department of Transportation's Pavement and Drainage Management Systems Unit in developing pavement management system strategies, innovative materials, improved pavement design tools, and advanced laboratory and field data collection equipment aimed at enhancing network condition by optimizing available capital resources. The primary goals of the current program are to:

1. Enhance the Department's Pavement Management System,
2. Provide support for implementation of Mechanistic-Empirical Pavement Design/Darwin-ME,
3. Assist in the planning, design, construction and management of a NJDOT ride quality specification,
4. Use NDT/NDE tools to examine pavement structures, enhance pavement information for pavement design, management programs, and quality assurance,
5. Promote the use of intelligent compaction and infrared bar in construction, and
6. Promoting the development and implementation of tools to enhance the State's Environmental Stewardship in the Pavement area; specifically Quiet Pavements and use of Warm Mix Asphalt and Recycled Asphalt Pavement (RAP).

Key Words	Distribution Statement
Pavement Management System, MEPDG, Darwin-ME, NDE/NDT, Quiet Pavements, WMA, RAP	No Restrictions.

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EXECUTIVE SUMMARY

The mission of Rutgers University's Center for Advanced Infrastructure and Transportation (CAIT) Pavement Support Program (PSP) is to provide pavement engineering support to the New Jersey Department of Transportation (NJDOT)'s Pavement and Drainage Management Systems (P&DMS) Unit.

The activity was a partnership between federal and state transportation agencies and the academic institution of Rutgers University to provide technical and educational services to address transportation infrastructure in New Jersey. The Center supported the NJDOT by providing staff and resources to address pavement engineering, performance modeling, material characterization, operational issues, training, and other technical support as needed by the Pavement and Drainage Management Systems Unit.

The goal of the Pavement Support Program was to assist in developing the tools and apply the resources of the Center to optimize the funds available through the NJDOT's capital program to improve the condition of New Jersey highway pavements. The condition of New Jersey's pavements has declined steadily over the past decade as available resources have been committed to other needs. The significant backlog of pavement maintenance and rehabilitation has resulted in a significant increase in vehicle operating costs to NJ motorists.

A fresh approach to pavement management using the latest technology was needed to help restore New Jersey's highway infrastructure to a state of good repair with limited available resources. The Pavement Support Program served as an extension of the NJDOT's Pavement and Drainage Management Systems Unit and functioned as the primary research and technology arm to address the unit's needs. It was organized to rapidly respond to the Department's need for implementation of advanced pavement evaluation and asset management technologies.

The PSP worked to develop asset management tools, database architecture, material testing and evaluation, validation and implementation of new technologies, methodologies and materials. The services provided by the joint NJDOT/CAIT pavement engineering program included field and laboratory testing and evaluation, development of advanced pavement information systems, and specialized training/educational programs for NJDOT and its consulting pavement engineers.

INTRODUCTION

The primary objective of the Rutgers Pavement Support Program (PSP) is to use the extensive laboratory and field pavement testing equipment and staff expertise of the Pavement Support Program in all aspects of Pavement Engineering to assist the New Jersey Department of Transportation's Pavement and Drainage Management Systems Unit in developing pavement management system strategies, innovative materials, improved pavement design tools, and advanced laboratory and field data collection

equipment aimed at enhancing network condition by optimizing available capital resources.

The primary goals of the current program are to:

- Enhancing the NJDOT's Pavement Management System,
- Assisting in the implementation of the latest pavement design procedures (Darwin-ME).
- Assisting the NJDOT in developing and implementing tools to improve the ride quality on New Jersey's state-maintained road network.
- Promoting the development and implementation of tools to enhance the State's Environmental Stewardship in the Pavement area.
- Utilizing NDT tools to examine pavement structures, enhance pavement information for pavement design, management programs and quality assurance.
- Promoting the use of intelligent compaction and infrared bar technology.
- Providing on-call pavement and materials testing services when necessary.
- Educating and training agency and consultant pavement specialists.

Task Summary

Pavement Management Systems

Background

The Pavement Support Program agreed to continue to provide technical support to the NJDOT Pavement and Drainage Management Systems and Technology Unit by working with the unit staff in establishing and implementing a comprehensive pavement strategy toolbox that optimizes maintenance and capital investment by selecting the right fix at the right time on the right pavement.

The PSP agreed to assess Version 9 of dTIMS PMS, the latest version, and make recommendations for implementation and modifications, where necessary.

The PSP agreed to make recommendations to refine pavement preservation, rehabilitation and reconstruction treatment triggers, models, resets and costs.

The PSP agreed to develop a plan to monitor the section with pavement preservation treatment strategies to evaluate the treatment decision trees or treatment rules, condition resets, costs, performance, life extension and failure criteria based on the results of the NJDOT Research Project - Appropriate Implementation of pavement preservation treatments.

The PSP agreed to work with the unit staff and Deighton to update the dynamic NJDOT Deighton dTIMS user manual and training of NJDOT staff in using the dTIMS asset management software.

The Deighton dTIMS PMS agreed to enhance capabilities to use GIS tools to illustrate the condition and other data contained in the PMS database. The PSP will work with the unit staff and Deighton in establishing, document, and implementing of ArcGIS tools to enhance the use of Deighton dTIMS PMS.

The PSP agreed to develop a NJDOT dTIMS software construction program report.

The PSP agreed to develop a plan to integrate the output from the Pathways Pavement Profiler's subsystems (automated distress subsystem, rut depth measurement system, GPS, and profile) into the NJDOT PMS database.

The PSP agreed to work with NJDOT PMS staff to develop a QC program for assessment of field condition data.

The PSP will assess the correlation of the pavement texture laser data with the ASTM E274 lock wheel trailer skid numbers and assess the correlation with the pavement noise study

Work Performed

In the first quarter, the PSP used the dTIMS procedures manual to duplicate the economic and performance analysis for the modified performance models, triggers, and resets to validate the manual description. The PSP used the CAIT procedure for the dTIMS construction report to validate the manual description and to compare the procedure with that of the NJDOT construction program methodology. The PSP worked with the unit staff and Deighton to continue the refinement of the NJDOT Deighton dTIMS user manual.

In the second quarter, the PSP completed the comparison of the CAIT procedure for the dTIMS construction report to the procedure used by the NJDOT construction program methodology. The majority of the projects were selected for each procedure. The main difference was the year selected for the work to be performed. This difference is due to the economic analysis used by dTIMS to make the preferred selection in a given year. During this period, the NJDOT hosted the Deighton Regional User Group meeting. The PSP discussed the use of the Deighton Core/GPR graphical database with Deighton staff. The PSP assisted NJDOT PMS staff in responding to a FHWA process review of the PMS system. The FHWA met with the NJDOT to discuss the final process. The PSP assisted the NJDOT with any further refinements cited in the process review. The PSP worked with the PMS unit staff and Deighton to continue the refinement of the NJDOT Deighton dTIMS user manual.

In the third quarter, the PSP reviewed the new dTIMS version 9 software Interface, Workspace, Ribbons, mapping and GIS Interface, Regression, and GPR/Core Accelerators with Deigton Vice President Rob Desanti. The PSP and NJDOT staff met Rob Desanti to explore the use of the Deighton GPR/Core Accelerator software to migrate the GPR, CORE, and Asbuilt data from HPMA to a Deighton-CAIT software application. Deighton followed up by arranging a software demonstration of the software.

In the fourth quarter, the PSP met with CAIT and Deighton staff to develop the plan for migration of the HPMA GPR, and asbuilt data to a new application. This work will be performed under the PSP 2014 program. The PSP developed new Pavement Treatment Costs for use in dTIMS analysis. The performance and economic analysis will compare the new performance models, triggers, and treatment costs to those used previously using the 2013 PMS data. The PSP will continue to work with the PMS unit staff and Deighton to continue the refinement of the NJDOT Deighton dTIMS user manual.

Mechanistic-Empirical Pavement Design Guide (MEPDG)/Darwin-ME

Background

The Pavement Support Program agreed to provide technical support to the NJDOT Pavement and Drainage Management Systems and Technology Unit to Support NJDOT's efforts to implement the latest pavement design procedures (Darwin-ME) in NJ.

The PSP agreed to work with the unit to develop model calibration and training, continue the establishment of pavement calibration sites for Darwin-ME model refinements, collect traffic data and perform material characterization (e.g., HMA binder and mixture, granular and subgrade materials) at the selected locations and run MEPDG analysis and compare analysis results to measured data.

The PSP agreed to evaluate NJDOT's trial runs of Darwin-ME and compare the AASHTO/DARWIN trial runs with Darwin-ME results on five projects.

i. Compare NJDOT's AASHTO/DARWIN 3.1 trial runs with Darwin-ME results on existing pavement design projects
ii. Identify key differences between the two systems.
iii. Identify issues with traffic, and material input data in developing pavement design solutions

The PSP agreed to concentrate on the continual calibration of the flexible rehabilitation distress models, as well as composite pavement (i.e. asphalt overlay on PCC) pavements. The continual calibration will utilize material collection and performance testing, while continuing to measure the pavement distress level over time. The composite pavement program will look at both field measurements of the current pavement structure, as well as collecting materials for performance testing. PSP will

reach out to the Texas Transportation Institute (TTI), who is the current contractor of NCHRP Project 1-41, Models for Predicting Reflective Cracking of Hot-Mix Asphalt Overlays, to determine what the key parameters will be for proper calibration of the upcoming Mechanistic Empirical Pavement Design Guide reflective cracking models. It is proposed that a minimum of five (5) test sections will be utilized for the calibration of the Darwin-ME reflective cracking models.

The PSP agreed to develop a NJ-LTPP program to assess the pavements designed with the new M-E Pavement Design Guide (MEPDG) to determine the “as constructed” level 1 inputs for the MEPDG and enhance the predicted pavement performance models for IRI, top down and bottom up cracking and rutting.

The PSP agreed to work with NJDOT Traffic staff to develop traffic inputs for Darwin-ME.

The PSP agreed to work with the NJDOT to develop specifications for longitudinal joint evaluation through literature search, survey of other states, and laboratory and field trials of various products and procedures.

The PSP agreed to perform an evaluation of urethane grouts and installation procedures and tools for undersealing of composite or concrete pavements.

The PRP agreed to the development of a Construction Quality Assessment (Report Card-good paving practices) [from plant to end of construction]. [milling, tack/polymer joint adhesive, compaction, MTV, paver operation]

The PRP agreed to evaluate PMS pavement condition data collection to support Darwin-ME calibration.

The PSP agreed to assist the Department and the State GIS office in implementing the Rutgers Soil Engineering GIS layer and database to complement the Soil Boring Management System, familiarize the NJDOT staff with the Rutgers Soil Engineering GIS layer for subgrade soil type locations (Rutgers Soils Maps), material characterization, and properties for use in Darwin-ME and develop a web-based software tool to make the Rutgers Soil Engineering information available to NJDOT and consultant pavement engineers.

The PRP agreed to work with the unit staff to integrate a GIS mapping of the Project Tracking System for experimental material application and preventive maintenance/pavement preservation treatments, locations, properties, and performance. This database and GIS tool will provide the means to track innovative treatment locations (constructed by Maintenance Operations personnel or contracts), and assess performance, and costs

The PRP agreed to update the NJDOT Darwin ME user manual material inputs, use of advanced computational modeling techniques to improve the understanding of

pavement failure mechanisms and Explore interface debonding (delamination), and backcalculation of the equivalent modulus of each pavement layer based on a dynamic finite element model that simulates FWD test and utilize NDT tool (PSPA) and enhanced backcalculation techniques to improve the Darwin-ME rehabilitation pavement analysis and designs.

Work Performed

In the first quarter, the PSP finalized the Material Inputs request that PSP provided to the lab. This is generally reformatting the E* master curve data, as well as reformatting the G* and Phase Angle requirements. Some information was not possible, such as Thermal Cracking inputs for SMA, but is not a big issue as Thermal Cracking is not a problem with SMA mixtures, and has not been an issue in NJ.

In the second and third quarters, the PSP completed and distributed the DARWIN-ME Pavement Analysis and Design Manual for NJDOT Book 3 – Material Inputs to the NJDOT. The PSP also upgraded to Darwin ME Pavement Analysis, version 2.0. The PSP staff reviewed the update manual to determine if any changes needed to be made to the NJDOT DARWIN-ME Pavement Analysis and Design Manuals.

In the fourth quarter, the PSP reviewed the FHWA webinars on Calibration of the Pavement ME (Darwin ME) models in anticipation of trial implementation of the software by NJDOT. The PSP prepared the paperwork for the Pavement ME renewal for 2014-2015.

Ride Quality of New and Rehabilitated Pavements

Background

The PRP agreed to assist the Department in improving the repeatability and accuracy of quality assurance of pavement smoothness measurements by performing an annual certification of NJDOT's walking, portable and high-speed pavement profilers using the pavement profiler certification test site and training NJDOT staff and industry staffs on the use of available pavement profiler tools. The PRP staff will locate a new pavement profiler certification site to replace the NJ Turnpike test site and develop the profiler testing sections. Once the site is determined and prepared, the PRP will provide annual ride quality certification services of NJDOT's walking, portable and high-speed pavement profilers.

The PRP agreed to work with the NJDOT Pavement and Drainage Management Systems and Technology Unit to:

a. Coordinate the new pavement profiler certification site to replace the NJ Turnpike test site and develop the profiler testing sections.
b. Provide annual ride quality certification services of NJDOT's walking, portable and high-speed pavement profilers
c. Assess the Department's new Pavement and Bridge Deck ride quality specification in improving the overall State-wide pavement smoothness level.

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Work Performed

In the first quarter, the PSP worked with NJDOT Field Survey to layout the ride quality test site on the Route 295 SB Rest Area. The PSP painted the wheel paths for the smooth and moderate smooth wheel paths. The PSP team collected pavement profile data on the four wheel paths and analyzed the data with Proval.

The PSP provided the procedure used for field pavement profile data collection and Proval analysis to two national experts for review and recommendations. At the request of the NJDOT, the PSP reviewed the proposed ride quality specification for Local Aid projects. A revised ride quality procedure and new pay adjustment algorithm was prepared and presented to NJDOT.

In the second quarter, the PSP provided the procedure used for field pavement profile data collection and Proval analysis to Steve Karamihas, Rohan Perera, and George Chang for their review. PSP waited for their verification or modifications. Their recommendations were incorporated into future Pavement Profile Certification Procedures and the NJDOT Pavement Profiler Certification Procedures will be finalized and presented to NJDOT.

The PSP assisted the NJDOT PMS group to collect profile data on the four wheel paths on the Pavement Profiler Certification Test Site. The profile data was analyzed by the PSP and summarized. The data and analysis was sent to Rohan Perera (FHWA contractor) for his review. Rohan Perera reviewed the profile data collected with the Rutgers SurPro, and NJDOT Dynatest, ICC and Pathway Profilers. His recommendations would be used to modify the analysis where possible.

The PSP assisted the NJDOT PMS group collect profile data in the portion on the Pavement Profiler Certification Test Site set up to assess the effects of pavement stop bars and rumble strips on IRI levels using their ICC and Dynatest 146 pavement profilers. The PSP laid out the pavement stop bars and rumble strips and worked with NJDOT Maintenance Operations and contractor staff to install the thermoplactic pavement stop bars and rumble strips. The PSP collected the profile data after the construction was complete. The PSP assisted the NJDOT PMS group to collect the post-construction profiler data on the portion on the Pavement Profiler Certification Test Site set up to assess the effects of pavement stop bars and rumble strips on IRI levels. The PSP analyzed the pre-construction and post-construction profile data. The analysis was provided to the NJDOT.

The PSP assisted NJDOT Region South and Region North in calibrating their SurPro DMI and collecting profile data with their SurPro. Region North was unable to complete the profiler data collection. The profile data and pavement profiler certification analyses and IRI assessment were sent to NJDOT Region South for their records. Region Central and Trenton have not collected profile data with their SurPro profilers on the new test site.

At the request of the NJDOT, the PSP reviewed the proposed ride quality specification for Local Aid projects. The PSP continues to help with the refinement of the ride quality specification for Local Aid projects. The PSP and NJDOT staff met with staff from AID and NJDOT Bureau of Materials to discuss the ride quality specification for Local Aid projects.

The PSP continued to help the NJDOT with the refinement of the ride quality specification for Interstate and State highways

In the third quarter, the PSP presented the new approach to PA for ride quality at the League of Municipalities, the NJDOT SAT refresher course, and the Mid-Atlantic Quality Assurance Workshop.

In the fourth quarter 4, at the request of the NJDOT, the PSP assisted the NJDOT in reviewing the proposed ride quality specification for Local Aid projects. The PSP reviewed the final report and specification from Advanced Infrastructure Design on the ride quality specification for Local Aid projects.

The PSP presented the new approach to PA for ride quality at the New Jersey Asphalt Paving Conference.

The PSP staff performed maintenance (repainted wheel path lines) on the Pavement Profiler Certification Test Site on Rt. 295. Rutgers Surpro data was collected for accuracy validation of the NJDOT portable and high speed profilers.

Evaluate the Pathways Profiler Subsystems Purchased by NJDOT

Background

The New Jersey Department of Transportation recently purchased a new Pathways profiler and will need assistance from the Pavement Resource Program to establish and set up the profiler for efficient and adequate use.

The PRP agreed to refine the current distress analysis and incorporate the automated distress data into the dTIMS PMS database

The PRP agreed to synchronize the Global Positioning System elements to the road linear referencing system

The PRP agreed to determine the accuracy of the profiler's rut capabilities and incorporate the rut data into the PMS database.

The PRP agreed to evaluate if the profiler's texture measurement capabilities can replace or supplement the skid resistance data from the ASTM E-274 trailer currently employed by the NJDOT and if the profiler's texture laser system can be used to predict

or capture tire-pavement noise trends and/or changes with different pavement surface types

Work Performed

In the first quarter, the Profiler Certification on the Route 295 test site had been surveyed, the wheelpath lines have been applied, and the profile data was collected with the Rutgers SurPro. The field testing procedure and ProVal data analysis procedure was sent to Steve Karamihas, Rohan Perera, and George Chang for their review.

In the second quarter, the PSP continued to evaluate the PMS data collected with the Pathway profiler. The data reference locations were checked against the GPS location data and modified as needed. This enabled the GPS location data to be used control the PMS data collection in the future.

The PSP began a complete video review of the manual pavement distress data collected by the NJDOT staff using the new Pathway rater keyboard. The areas in question are identified and will be modified as needed based on review by the NJDOT PMS staff. The PSP, NJDOT and Pathway staff will meet to discuss the manual distress data collection and develop an analysis protocol for the automated distress analysis and development of the NDI, LDI, and SDI pavement Index, rutting assessment, and texture analysis

In the third and fourth quarters, the PSP continued a complete video review of the manual pavement distress data collected by the NJDOT staff using the new Pathway rater keyboard. The areas in question will be modified as needed based on review by the NJDOT PMS staff. The PSP, NJDOT and Pathway staff met to discuss the manual distress data collection and develop an analysis protocol for the automated distress analysis and development of the NDI, LDI, and SDI pavement Index, rutting assessment, and texture analysis.

The PSP completed the video review of the manual pavement distress data collected by the NJDOT staff using the new Pathway rater keyboard. The areas in question were modified as needed based on review by the NJDOT PMS staff. The Pathway staff reviewed the manual distress data and the automated distress data collection to develop an analysis protocol for the automated distress analysis and development of the NDI, LDI, and SDI pavement Index, rutting assessment, and texture analysis.

The PSP reviewed the texture data (Mean Pavement Depth –MPD) collected by the profiler texture laser to develop a relationship between the MPD and the pavement skid SN40R data. There is no direct relationship between the MPD data and the SN40R data. The PSP performed a literature search to determine how other agencies use the MPD data. Based on papers by Florida DOT, the PSP identified locations with varying levels of MPD that covered the range found in the Network data collection and worked with NJDOT staff (Nick Gephart) to collect SN40R (Ribbed tire), SN40S (Smooth tire) and MPD data to attempt to develop a better relationship to predict the SN40R from the MPD or texture data. This attempt was not successful.

The PSP revised their approach by identifying locations with low SN40R values. Additional testing will be performed on these locations to determine if a relationship can be developed from the SN40R, SN40S and MPD or texture data.

Promote the Development and Implementation of Tools to Enhance the State's Environmental Stewardship in the Pavement Area

Background

Quiet Pavements

The PRP agreed to work with the NJDOT task force in developing criteria on the use of quiet pavements in NJ. The PRP will conduct a Noise study on new pavements and rehabilitated pavements utilizing road side and at-the-source noise measurement of various pavement surfaces to determine relationships under different climatic (wind), speed, traffic levels, and geometric conditions. The PRP will continue to collect QPPP data on the "quiet pavement surfaces" for the 2nd of the required 7 year data collection program The data will be collected seasonally (4 times per year) on a minimum of 10 pavement sections to assess seasonal variations in pavement-tire noise generation. The data collected will eventually be transferred into a GIS based database to determine pavement noise "hot spots" in the state of New Jersey. The PRP will evaluate and implement the results of NCHRP study on quiet pavements.

Recycled Asphalt Pavement (RAP)

The PRP agreed to continue to perform testing of NJDOT's High RAP asphalt mixture specification. The PRP will assist the asphalt industry of New Jersey in looking at an alternate method of using recycled asphalt materials such as rejuvenators, Warm Mix Asphalt, and recycled asphalt shingles (RAS).

Warm Mix Asphalt (WMA)

The PRP agreed to promote and evaluate the use of Warm Mix Asphalt in reducing air pollution, while maintaining pavement performance.

Mix Design

The PRP agreed to develop a fine-graded, thin-lift mixture using crumb rubber modified asphalt binder for use as a preventative maintenance treatment. The PRP will develop an open-graded drainage mixture for use in areas where there exists a high potential for roadway flooding. The open-graded drainage mixture would be able to be used with either polymer-modified or crumb rubber modified binders.

Work Performed

In the first quarter, the PSP is continued the mixture design work for the asphalt rubber gap-graded (ARGG) mixture for possible use as a pavement preservation/rehabilitation treatment. Asphalt rubber binder, currently being used by Stavola for work on the Garden State Parkway will be used for the mixture design and performance work.

The noise testing program continued this quarter. The pavement noise group also compiled research and developed a report that summarizes the pavement noise properties of NJ pavement preservation treatments. These include OGFC, micro-surfacing, Nova-chip, and asphalt rubber chip seals. The noise study of pavement preservation surfaces will hope to compliment the current research being conducted for the Pavement Management group.

In the second quarter, the PSP organized a noise testing evaluation of different micro-surfacing treatments in Pennsylvania. A section organized by PennDOT and managed by ARA was placed for evaluation in Spring 2013. NJDOT is considering alternate micro-surfacing technologies and the noise impact is being considered. It was estimated testing should be completed by the end of 2013

In the third quarter, the PSP helped suppliers work on HRAP mixes. Tilcon was already awarded one project and PSP has been working with them since December. American Asphalt, Trap Rock Industries, and Weldon are all working on their own respective designs. Most are moving towards using the NuStar asphalt binder, as opposed to looking at rejuvenators, etc. The PSP moved forward on the gap-graded asphalt rubber mixture design.

In the fourth quarter, the PSP was busy working with asphalt suppliers who were designing HRAP mixtures. This includes not only RAP characterization, but also performance testing of preliminary mixtures not officially submitted to the NJDOT.

RAP solvent extraction and recovery, along with PG grading and asphalt content determination, were conducted for the following asphalt suppliers:

1. Stone (Braen) Industries
2. Tilcon
3. Weldon
4. RE Pierson
5. Trap Rock Industries

Tilcon Mt. Hope facility has provided 5 different designs for performance testing and is still trying to finalize a mixture for approval.

The PSP conducted laboratory testing on a gap-graded asphalt rubber mixtures produced in PA using the mixture design recommendations from All States. This is a fine, 9.5 mm NMAS mixture using an asphalt rubber binder with 18% crumb rubber. A PennDOT 12.5 mm NMAS SMA mixture was also produced on the project and is being used as a “control” mixture for comparison. The performance of the asphalt rubber gap graded mixture will be used to help set tentative performance for future performance-based mixture design, as well as provide a general idea as to where the asphalt rubber gap graded mixtures compare to conventional SMA mixtures.

The PSP began some preliminary work with evaluating different materials regarding their Heat Capacity and influence on the Heat Island effect. The Heat Island effect occurs when large areas of paved surfaces retain heat due to continual high temperature cycles. The retention of heat has been linked to environmental impact

issues as elevated temperatures remain at the Earth's surface. Naturally, surfaces such as grass, vegetation, trees, etc. do not retain the heat like parking lots, roadways, airfields.

Non-Destructive Evaluation/Testing for Condition Assessment and QA/QC

Background

The Pavement Resource Program agreed to continue to provide technical support to the NJDOT Pavement and Drainage Management Systems Unit to:

- Work on the characterization of Rubblized Portland Cement Concrete Pavement (RPCCP)
- Provide field validation of Darwin-ME models using NDE Technologies; and
- Quality Assessment of Compaction of HMA Pavement Layers and Density or Air Voids of Longitudinal Joints.

Work Performed

During the first quarter, the PSP began contacting NJDOT engineers to begin work on the characterization of rubblized PCCP. The job on Route 80 was scheduled for later in the calendar year.

In regards to QA/QC using NDT/NDE Technologies GPR to predict air void content and compaction level, the NDT team refined the analysis of the GPR data collected on seven sites. Of the seven, good quality data was collected at five sites. Based on the received information for the recovered cores for each of the lots, and the measured dielectrics, %air void vs. dielectric constant was plotted for each material type. The initial dielectric value vs. %air voids plots exhibited high dispersion of the results. However, when the results were limited to the data points where the GPR wavelength was less than the overlay thickness (or the wave reflection was fully developed within the travel time window), the correlation significantly improved. The correlation fitted well an anticipated hyperbolic/exponentially decaying relationship between the two, and R^2 increased to 0.66. This was a clear indication that moving from a previously used 1 GHz air-coupled antenna to a 2 GHz antenna would enable data collection that would provide significantly higher quality dielectric value vs. %air voids relationships for thin overlays. In addition to the core locations, GPR data was collected at 2 foot intervals along the entire lot. This data has been under analysis and is approximately 30% complete. The team acquired a GSSI 2 GHz air-coupled (horn) antenna through a lease program. After testing the antenna the team will schedule our van for potential projects with NJDOT.

Asphalt modulus data for QA/QC and field validation of Darwin-ME models - The asphalt modulus data collected using ultrasonic surface wave (USW) method on one site were analyzed and the data presented in terms of contour plots. In addition, the moduli obtained on an approximately 600 feet long section along three survey lines were analyzed to assess the modulus variability across the paved area. The average values of moduli in the middle section of the lane were only slightly higher, about five percent, than along the line close to the joint. The data obtained from USW are modulus

data in a 20-35 kHz range. When the correction to a 30-50 Hz frequency range is made (FWD range), a modulus of 400-450 ksi is obtained, which is an anticipated range of the asphalt modulus

In the second quarter, the PSP collected Modulus data on a rubblized section of I-80. A 200 ft section was tested using PSPA (portable Seismic Property Analyzer) for Soils along three survey lines for a total of 60 measurements. QA/QC of thin overlay bonding - Impact echo survey was conducted on a 200 by 10 feet area of NJ Rt. 322 East bound near the mile marker 26. Based on 123 impact echo tests, roughly 30 percent of the area is estimated to be either debonded or have partial/weak bonding. The results were validated with seven cores. From seven cores one core was intact, however with a visible thin crack between layers 5 and 6 (thin overlay). Three core debonded between layers 5 and 6, while two cores were fully debonded between layers 4 and 5. One core partially debonded between layers 4 and 5

In the third quarter, the PSP collected modulus data using portable seismic property analyzer (PSPA) for soils on November 8th on.a rubblized PCCP section of route I-80 (Westbound, near MP44). Around sixty measurements were made. Since the section was not fully compacted, the dispersion of the results was significantly higher than during the previous measurements and the average modulus was lower. In regards to using GPR to predict air void content and compaction level – The team prepared the GSSI 2 GHz air-coupled (horn) antenna setup through multiple runs on Rutgers parking areas. The research team was in contact with NJDOT staff finding acceptable jobs to collect GPR air-void data on. SMA pavements were avoided due to a poor relationship found in last year's program and a more common HMA mix was used (such as 25M64 and 12.5M64) to strengthen the relationship found with a 1GHz antenna. Rutgers staff collected data on two separate jobs (Rt 35 sandy reconstruction, Rt 42 in Gloucester twp) over the course of a few weeks totaling 50 unique core locations. Currently the GPR data is being processed so that a stronger correlation can be made using this year's data collected with the new 2GHz antenna from GSSI.

In the fourth quarter, the PSP collected more data on rubblized PCCP of route I-80 in the second half of May, 2104. The data collection included modulus measurements using Portable Seismic Property Analyzer (PSPA) for soils and GPR measurements to assess the variability of the thickness of rubblized PCCP. The data analysis was conducted in June of 2014.The PSP also prepared the GSSI 2 GHz air-coupled (horn) antenna setup through multiple runs on Rutgers parking areas. The research team has been in contact with NJDOT staff finding acceptable jobs to collect GPR air-void data on. SMA pavements were avoided due to a poor relationship found in last year's program and a more common HMA mix was used (such as 25M64 and 12.5M64) to strengthen the relationship found with a 1GHz antenna.

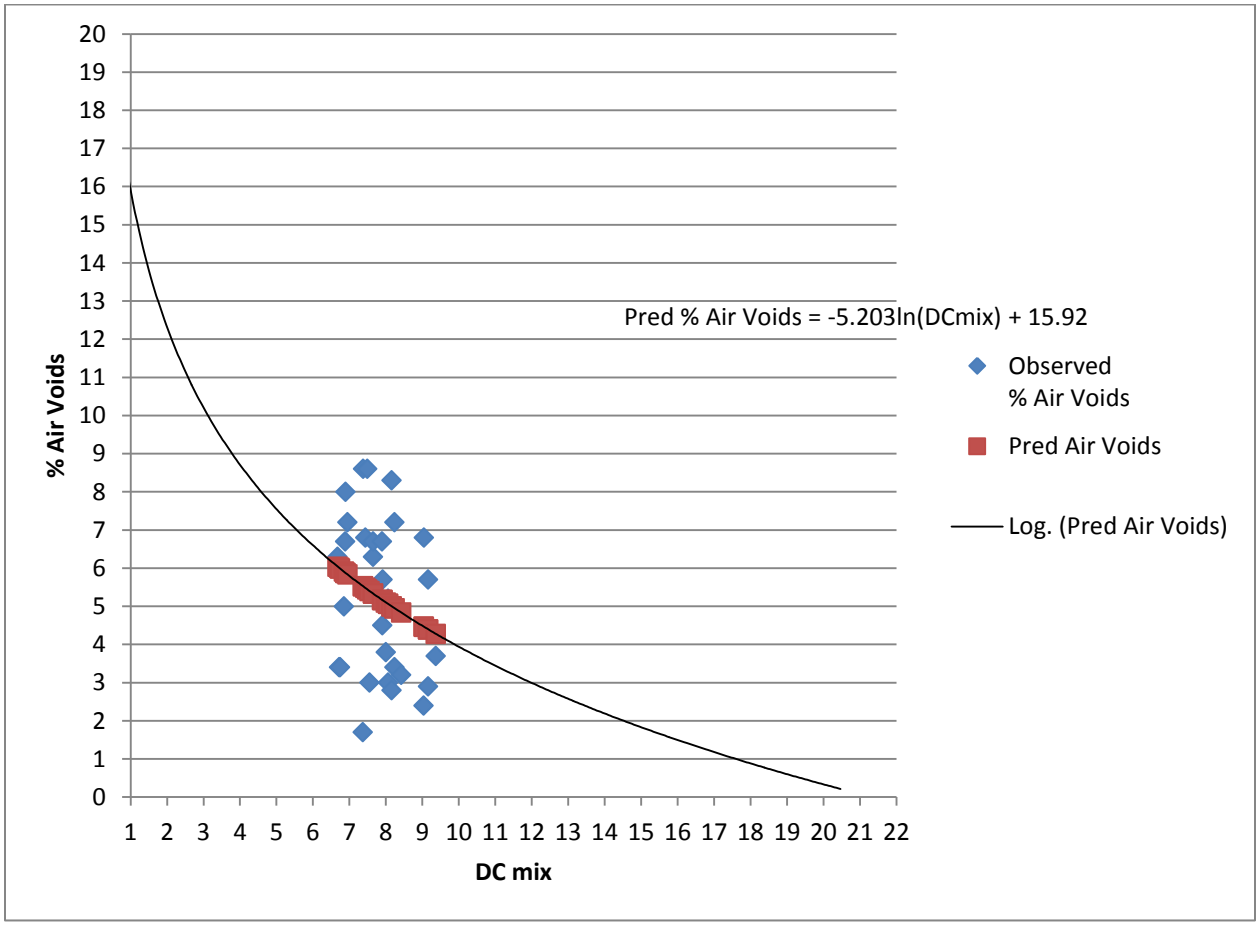
The PSP collected data on several jobs see below.

Project	Lot #	Course	Date	Resident Engineer	Route
Sandy Rest. MP 0-4	3	Base	12.04.2013	Don Olla	Rt 35
Sandy Rest. MP 0-4	4	Base	12.04.2013	Don Olla	Rt 35
Sandy Rest. MP 0-4	5	Base	12.04.2013	Don Olla	Rt 35
Sandy Rest. MP 0-4	1	Intermediate	12.20.2013	Don Olla	Rt 35
Sandy Rest. MP 0-4	2	Intermediate	12.20.2013	Don Olla	Rt 35
Sandy Rest. MP 0-4	3	Intermediate	12.20.2013	Don Olla	Rt 35
Sandy Rest. MP 0-4	4	Intermediate	12.20.2013	Don Olla	Rt 35
MRRC S Contract S106	5	Surface	1.13.2014	Dave Divalerio	Rt 42
MRRC S Contract S106	6	Surface	1.13.2014	Dave Divalerio	Rt 42
MRRC S Contract S106	7	Surface	1.13.2014	Dave Divalerio	Rt 42
MRRC S Contract S107	9	Surface	1.13.2015	Dave Divalerio	Rt 43
MRRC S Contract S108	10	Surface	1.13.2016	Dave Divalerio	Rt 44

NJDOT Materials supplied the core Air Void data. The 2GHz antenna GPR data was processed to develop relationships that could be used to predict the % Air Voids of the mix from the material dielectric constant. The relationship did not improve as expected.

λ = ns	DCmix	Observed % Air Voids	Predicted % Air Voids	Diff
0.84	6.68	6.3	6.04	-0.26
1.29	6.72	3.4	6.01	2.61
0.84	6.75	3.4	5.99	2.59
1.15	6.85	5	5.91	0.91
1.29	6.89	6.7	5.88	-0.82
1.125	6.9	8	5.87	-2.13
0.75	6.95	7.2	5.83	-1.37
1.08	7.37	1.7	5.53	3.83
1.08	7.38	8.6	5.52	-3.08
1.20	7.44	6.8	5.48	-1.32
1.08	7.49	8.6	5.44	-3.16
1.06	7.55	3	5.40	2.40
0.73	7.65	6.3	5.33	-0.97
1.06	7.65	6.7	5.33	-1.37
0.867	7.9	6.7	5.17	-1.53
1.1	7.91	4.5	5.16	0.66
1.1	7.91	5.7	5.16	-0.54
1.1	8	3.8	5.10	1.30
1.15	8.06	5.2	5.06	-0.14
1.15	8.06	3	5.06	2.06
0.96	8.16	8.3	5.00	-3.30
0.96	8.16	2.8	5.00	2.20

1.27	8.24	7.2	4.95	-2.25
1.27	8.24	3.4	4.95	1.55
1.24	8.42	3.2	4.83	1.63
1.24	9.04	2.4	4.47	2.07
1.24	9.05	6.8	4.46	-2.34
1.13	9.16	5.7	4.40	-1.30
1.13	9.16	2.9	4.39	1.49
0.984	9.37	3.7	4.28	0.58



The field 2GHz antenna GPR data was reviewed and the 1GHz and 2GHz GPR antennas are being run through a calibration exercise to determine if there is an equipment issue

Constructability

Background

The Pavement Resource Program agreed to coordinate a demonstration of Intelligent Compaction equipment on New Jersey pavements under a variety of variables.

Infrared Bar Technology – The PRP staff will coordinate a demonstration of the Infrared Bar technology on New Jersey pavements under a variety of variables.

Work Performed

In the first quarter, the PSP initiated the demonstration program by agreeing to terms with an Infrared Bar company (MOBA) and an intelligent compaction equipment supplier (JESCO) to supply their technologies for the demonstration. The team worked with the NJDOT diligently to find a location for the demonstration. The contractor could not provide a date with adequate time to provide for a successful demonstration. The

NJDOT and PSP agreed to pursue this again in the Fall by putting it into the bid specifications for a Fall Operations contract. PSP is currently drafting both an IR Bar and Intelligent Compaction specification for use in the Winter bid lettings

In second, third, and fourth quarters, the PSP drafted different specification drafts and had various meetings with the NJDOT to review. The PSP provided final drafts to the NJDOT for their use in an upcoming bid letting.

On Call Testing and Materials Testing Services

Background

The Rutgers Asphalt Pavement Laboratory is a valuable and useful asphalt research laboratory that could assist the NJDOT with some of their technical needs. The PRP agreed to provide timely testing as needed by the NJDOT.

The Pavement Resource Program has developed a number of performance-related specifications for pavement construction materials and houses a number of high speed, non-destructive evaluation tools that can be used to assess the in-situ properties of pavements and bridge decks. In the past, both the NJDOT Bureau of Materials and Pavement and the Drainage Systems and Technology Unit have used the laboratory and field evaluation capabilities of CAIT to provide quality analysis techniques in support of the NJDOT activities.

The PRP staff agreed to respond to 90% of requests within one day and develop an appropriate work plan. Based on requests from NJDOT, PRP staff will provide support for PMS analysis, pavement materials testing, MEPDG and profiler inquires, and NDE field testing. Infrastructure Condition Monitoring Program (ICMP) will respond to NDE field evaluation upon NJDOT request within 3 days.

Work Performed

In the first quarter, the PSP verified a number of asphalt mixtures for the NJDOT. They included:

- High Performance Thin Overlay (HPTO): South State, A.E. Stone, Stone Industries
- Bottom Rich Intermediate Course (BRIC): South State, A.E. Stone, Stavola

A large amount of effort was placed on a forensic testing program for field cores extracted from Rt 322. A final report was provided to NJDOT and it appeared that continued laboratory and NDE testing would be required to help supplement NJDOT during their evaluation.

In the second quarter, the PSP assisted the Bureau of Maritime Resources in developing a concept for utilizing modified dredge material as a base material for low volume roads using the procedures for FDR with cement.

The PSP was heavily involved in litigation cases with the asphalt industry on behalf of the NJDOT. Dr. Thomas Bennert provided an expert witness report regarding the air void range associated with the Binder Rich Intermediate Course (BRIC) mix. The asphalt lab at Rutgers was extremely busy with forensic testing involving the blistering of an HPTO mix on Rt 322. As a follow-up to the Rt 322 issues, the asphalt lab also conducted over 100 Shear Bond Strength tests on cores extracted from the Rt. 322 pavement. Along with the litigation work, the lab was also involved with approving HPTO, BRIC and BDWSC mixes for a number of asphalt suppliers. The lab is also completing a study on the influence of wet sawing or chiseling to break the bond of field cores prior to air void acceptance testing.

In the third quarter, the PSP performed a variety of tests on behalf of the NJDOT including the verification of a new HPTO mix from Tilcon Mt. Hope. The PSP also completed bond strength testing for Rt. 322 blistering issues.

In the fourth quarter, the PSP conducted on-call laboratory testing for the following performance-based asphalt mixtures:

- Stavola – HPTO (multiple designs)
- Stavola – BDWSC
- AE Stone – BDWSC
- National Paving – BDWSC

The PSP worked on a perpetual pavement design for Rt 440. Currently a PCC pavement, the NJDOT would like to reduce the recommended pavement thickness around overpasses by possibly using a BRBC mixture. The analysis conducted is consisting of DARWIN-ME and linear-elastic analysis to predict tensile strains at the bottom of the pavement.

CONCLUSION

The Pavement Resource Program at the Center for Advanced Infrastructure and Transportation at Rutgers University was pleased to participate as an extension and partner with the New Jersey Department of Transportation to perform a variety of tasks put before them.