THE UNIVERSITY OF TEXAS AT AUSTIN ✦ COCKRELL SCHOOL OF ENGINEERING

TEXAS PAVEMENT PRESERVATION CENTER

TxDOT

Newsletter

ISSUE 10 / SPRING 2008

Spring 2008 / Issue 10

Inside This Issue:

Proceedings from the TRB 87th Annual Meeting

Our Mission

The mission of TPPC, in joint collaboration with the Center for Transportation Research (CTR) of the University of Texas at Austin and the Texas Transportation Institute (TTI) of Texas A&M University, is to promote the use of pavement preservation strategies to provide the highest level of service to the traveling public at the lowest cost.

Executive Sponsor: The Texas Department of Transportation (TxDOT)

Contact Us

Director: Dr. Yetkin Yildirim, P.E.
E-mail: yetkin@mail.utexas.edu
Website: www.utexas.edu/research/tppc

Mailing Address:
Texas Pavement Preservation Center
Center for Transportation Research
The University of Texas at Austin
3208 Red River, CTR 318
Austin, TX 78705

Issue Highlights

TRB 87th Annual Meeting

The Transportation Research Board is a division of the National Research Council, which serves as an independent adviser to the federal government and others on scientific and technical questions of national importance. TRB's mission is to promote innovation and progress in transportation through research. The Transportation Research Board's 87th Annual Meeting attracted more than 10,000 transportation professionals from around the world to Washington, DC January 13-17, 2008. The TRB Annual Meeting program consisted of over 3,000 presentations in 600 sessions. Summaries of selected seminar papers related to pavement preservation are included in this issue.

TPPC Seal Coat Training Courses

As part of our continuing efforts to advance the field of pavement preservation, the Texas Pavement Preservation Center is proud to offer two new training courses on seal coats, also known as chip seals. Each course is designed to primarily target one group of maintenance professionals: "Seal Coat Inspection and Applications" is intended mainly for inspectors, while "Seal Coat Planning and Design" is tailored to the educational needs of maintenance engineers. The courses have 6 and 5 chapters, respectively, and cover topics from pavement preservation concepts to equipment inspection. All those attending one of the approximately 8 hour courses will have the opportunity to receive 0.8 Continuing Education Units (CEUs), provided they score above passing on the corresponding quizzes. The first three rounds of courses were held in Fort Worth on February 27 and 28, Austin on March 18 and 19, and Lubbock, TX April 15 and 16. For more information on continuing education courses or to request a course in your area, contact Dr. Yetkin Yildirim at yetkin@mail.utexas.edu.

Spray Applied Surface Seal Study: Fog and Rejuvenator Seals by Gayle N. King and Helen W. King

Although fog and rejuvenator seals have been traditionally used by agencies for a variety of purposes, such as preventing surface cracks, many agencies have begun to discontinue the use of these treatments due to safety concerns. Although they are the least expensive pavement preservation treatments, fog and rejuvenator seals are commonly believed to cause a reduction in skid resistance. The purpose of this study was to determine how effective these seals are, to what extent safety is affected by them, and if these safety hazards can be mitigated by taking certain precautions. To this end, the authors collected existing information on the subject and placed several test sections on roads with different climates, traffic levels, and surface characteristics. The authors then evaluated the field and lab test methods used and analyzed the data collected from the experimental road segments.

The authors crafted their study plan from the results of four state-of-the-knowledge workshops in 2001 and 2002. They found that emulsified sealers and rejuvenators work best as preventive maintenance treatments on pavements that have begun to age but are still in good condition. The use of these treatments is limited to asphalt pavement with sufficient permeability to allow emulsion infiltration. Until the seals have fully cured and friction returns to an acceptable level, traffic must be strictly controlled. The cure time for these sealers depends upon the emulsion, existing pavement, and climate. In King and King's 2007 trials, the amount of time before traffic could return to full speed varied between 15 minutes and 4 hours.

Sanding is another method used to mitigate the loss of friction or reduce the amount of time required before ceasing traffic control. As long as loose the sand is cleaned away before traffic is allowed to travel at full speed, sanding can be very effective at increasing early friction levels; sanding on the 2006 projects showed an immediate increase in friction values. The emulsion residue rheology should form the basis for sanding strategy design. Harder residue emulsions, for instance, allow almost immediate sand application following a fog seal. For softer residue emulsions, it is recommended that sanding be performed at least 20 to 40 minutes after fog seal application to avoid leaving oil-saturated sand on the surface.

Even when precautionary measures are taken, however, fog seals should never be used on a pavement that already exhibits poor surface texture or low friction numbers. Furthermore, roads with large cracks, rutting, shoving, or structural deficiencies are not good candidates for fog sealing.

Life-Cycle Cost Optimization of Highway Maintenance and Rehabilitation Strategies Based On an Integrated Maintenance Management System by Yuanjie Xiao, Fujian Ni, Jingli Du, and Qiao Dong

Many different systems and applications for pavement management exist, with designs ranging from basic to extremely complex. The commonly used methods all have flaws, however. Xiao, et al. have identified some of the most typical problems and propose a new maintenance management system to combat these problems. Most management systems support either network-level or project-level decisions, which inhibits the integration of maintenance planning with scheduling and budget allocation. Many maintenance systems focus primarily on pavement and bridge maintenance while ignoring the care required to maintain roadside appurtenances, such as guardrails, signs, and lighting facilities.

In order to overcome these common shortcomings, the authors developed a comprehensive framework for highway maintenance. The main focus of the study was to formulate a practical life-cycle cost analysis (LCCA) and optimize the maintenance, repair, and renovation (MR&R) activities at both the project and network level.

The pavement management system developed by the authors uses Markov-chain deterioration models to predict the performance of highway facilities. These models are effective because they can capture the time-dependent and uncertain nature of the deterioration process, maintenance operations, and initial pavement condition. The system includes a comprehensive cost elements analysis, which is designed to minimize the total life-cycle MR&R costs while optimizing highway performance. The system uses a genetic algorithm to deal with the scale of this problem. The authors tested the applicability of this system using real-world data from the Jiangsu Department of Transportation and found it to be an effective method for pavement maintenance management.

Safety Effect of Preventative Maintenance: Microsurfacing, a Case Study by Tara Erwin and Susan L. Tighe

First and foremost, pavement maintenance operations are meant to improve driver safety. However, many agencies simply assume that the application of a treatment will make roadways safer without any empirical evidence. Erwin and Tighe realized that the Region of York transportation department in Ontario was using microsurfacing treatments to improve pavement surface conditions without first understanding the effect these treatments have on safety. Therefore, the authors conducted a before-after study designed to show how microsurfacing affects safety conditions.

This study used data from the Region of York to compare the crash experiences on roadways before and after a microsurfacing treatment was placed. The authors assumed that if everything else remained the same, the crash experience before the treatment would be a good estimate of what would have happened without improvement. The study utilized a file that listed the microsurfacing treatments by number, year, location, and type, as well as a file that provided crash data from between 1999 and 2005 for the treatment sites listed in the first file.

The results of this study show that microsurfacing is generally effective at improving road safety, with crash

reduction factors as high as 54 percent. The study found them to be most beneficial at sites that are often wet or slick and/or have a high occurrence of severe crashes, intersection-related crashes, and/or rear end crashes. Further research exploring how pavement maintenance impacts safety conditions should be performed to enable agencies to make the best and safest management decisions possible.

Pavement Performance Evaluation and Prediction Based on Extension Theory by Qiang Li and Kelvin C.P. Wang

Li and Wang introduce a new pavement performance evaluation and prediction methodology based on extension theory, a knowledge system developed to solve contradictions and incompatibility problems that uses the concepts of matter-elements and extension sets. Because pavement performance criteria are frequently inter-related with unclear quantitative relationships, Extension Theory is potentially an excellent method for discovering the quantitative interactions between them. In this study, Li and Wang used the performance criteria found in the Mechanistic Empirical Pavement Design Guide (MEPDG) and information from the LTPP database to create comprehensive quantitative performance predication models based on Extension Theory.

Once the authors completed designing the procedures of the evaluation process, they conducted case studies to develop performance prediction models. The pavements were then compared and analyzed, revealing that the models developed by Li and Wang were effective at predicting the quantitative deteriorations of the overall pavement performances.

Understanding the Effects of Aggregate and Emulsion Application Rates on the Performance of Asphalt Surface Treatments by Ju Sang Lee, Ph.D. and Y. Richard Kim, Ph.D., P.E.

Asphalt surface treatments (ASTs) are commonly used by many state Departments of Transportation (DOT) for pavement preservation. The amounts of emulsion and aggregate used in these treatments often are not regulated by protocol but are chosen based on experience. The guidelines that exist for aggregate and emulsion application rates (AARs and EARs) are just general descriptions of the typical rates found in ASTM and used by some state DOTs. This study seeks to develop a method for determining the optimum AAR and EAR for each individual preservation project.

The typical AST performance failures due to improper application rate design are bleeding and aggregate loss, which are generally caused by too little or too much aggregate or emulsion. In this study, the third-scale Model Mobile Loading Simulator, MMLS3, a unidirectional vehicle load simulator that uses a continuous loop for trafficking, was used along with the digital image processing (DIP) technique. This combination allowed for the development of a new comprehensive AST performance test procedure that can make evaluations using realistic loading conditions. The new test was used in this research to assess the performance of ASTs utilizing different AAR and EAR combinations on samples with two differently graded aggregate types.

According to this study, the newly developed test method is very effective at evaluating AST performance. The factor most affecting AST performance was found to be aggregate gradation. Furthermore, the study developed a method for determining the optimum AAR and EAR for individual projects. The results were found to be accurate by a blind test performed by two independent organizations. Finally, the study discovered a dependent relationship between the reference voids in AST, the voids in the loose aggregate, and the aggregate gradation type.

Development of a Sampling Protocol for Condition Assessment by Ricardo A. Medina, Ali Haghani, and Nicholas Harris

The objective of this study is to improve the Peer Review Measurement Program established by the Maryland State Highway Administration (SHA) by developing a sampling protocol. The program is intended to assess the condition of the highways and roadsides maintained by SHA and evaluate the level of service (LOS) provided to the customers using these facilities. LOS is calculated using the percentage of assets that meet or exceed either predefined or desired maintenance conditions; LOS is the basic measurement of the condition of each asset in the road system.

The four categories of assets examined in this study are shoulder, drainage, traffic & safety, and roadside. Presently, the data used to find the LOS for each individual county and the state as a whole come from field surveys. In the current system, samples for the surveys are taken randomly, meaning that certain mitigating circumstances, such as roadway functional classification and average annual daily traffic (AADT), are ignored. These samples may not be of sufficient size and diversity to represent the whole of the agency's assets. To remedy this problem, Medina et al. sought to develop a sampling protocol for condition assessment based on the level of confidence and precision desired. To this end, the authors studied the effect of sample size on the accuracy of LOS estimates.

The study concluded that, for a given level of confidence and precision desired, the size and distribution of the samples required for the annual peer review of each maintenance shop are functions of four parameters: the number of centerline miles in each shop, the stratification assets in the region, the distribution of the assets throughout the system, and the estimates of the population variants in each stratum. The system outlined in this study can provide sound information to agencies, allowing them to more effectively prioritize locations in need of maintenance and make better choices regarding the allocation of funds, personnel, and equipment.

Bituminous Surface Treatment Protocol for the Washington State Department of Transportation by

Jianhua Li, Stephen T. Muench, Joe P. Mahoney, and Linda M. Pierce

In an effort to reduce the costs of pavement preservation activities, the Washington State Department of Transportation (WSDOT) is considering using a bituminous surface treatment (BST), also known as a chip seal or seal coat, as an alternative to hot mix asphalt (HMA) overlays. In an average cost comparison from 1995 to 2007, the typical WSDOT BST surfacing treatment was about one-tenth the initial price of the typical WSDOT HMA overlay. The purpose of this study is to find the best strategy to increase the amount of BST used instead of HMA, create a life-cycle cost comparison between the two treatments, and identify the difference in lifelong condition between roads with a BST and those with an HMA overlay.

Li et al.'s paper reports on the first stage of a two-part study that examines the best times and locations for BST application using modeling software to predict long-term cost and condition. The follow-up study will explore the feasibility of increasing BST use and how to implement a strategy to do so if the results are positive.

For the first part of the study, the authors used the Highway Development and Management System (HDM-4), a powerful pavement management software tool. With this system, WSDOT was able to find a maximum AADT and traffic loading allowed on a BST surfaced road and the best strategy for integrating BST surfaces with existing HMA overlaid pavements. Results showed that the HDM-4 modeling system is capable of providing valuable information on both pavement condition and life-cycle costs. The research found that the life-cycle cost of BST is not lower than that of HMA; it is merely shifted from the agency to the user. Whether or not this shift is feasible will be the focus of the authors' next study.

Rolling Wheel Deflectometer-Based Pavement Management System Success: Champaign County, IL by William R. Vavrik, Ph.D., P.E.; Douglas A. Steele, P.E.; and Jeff Blue

In Champaign County, IL, engineering judgment has traditionally been the main tool used by the county highway department for planning, programming, and implementing road improvement activities. Because of recent budget issues due to a need for spending on roads not owned or maintained by the County, the department is interested in making more informed and efficient pavement management decisions.

The Champaign County highway department contracted an independent company to design an effective pavement management system (PMS) that would help reach the agency's objectives. The new PMS is intended to provide the County Engineer with better decision-making tools that will clarify the potential outcomes of certain investment decisions. It should accurately describe what is needed to either maintain or improve the county's highways and incorporate a pavement preservation program into the system. The PMS is also meant to be a science-based tool that can impartially allocate scarce funds among the competing sectors. Finally, the agency will become a leader in the use of PMS technology by being the first transportation department to utilize the Rolling Wheel Deflectometer for evaluating pavement structural conditions throughout the network and use those measurements in project and treatment selection.

The authors conclude that the use of the RWD to assess the structural condition of a road can eliminate the application of pavement preservation treatments to roads that are structurally inadequate. The new PMS has improved decision-making by using quantifiable data, standard evaluations, models, and economic analyses to weigh the alternatives rather than relying on the opinions of engineers alone.

User Cost Models for Improved Pavement Selection by O. Salem, Ph.D., P.E., CPC; Dr. Ashraif Genaidy; Abhijeet S. Deshpande; and Tony G. Geara

A growing concern in the transportation community is the exclusion of user cost comparisons in most current pavement selection methods. Recently, decision makers have begun to realize that user costs during the life of a pavement may be far more significant than the initial construction and miscellaneous costs for which the agency is responsible. User costs are those incurred through accidents, traffic and business disruptions, increased travel time, pollution, increased fuel consumption, or vehicle repairs

User costs do not just affect customer satisfaction but can have a very real impact on the local and national economies. Many increases in user costs are directly related to the type of pavement selected by a transportation agency. Therefore, agencies must be aware of all the potential user costs associated with each alternative pavement design and construction strategy.

This research study was undertaken in order to improve the Ohio Department of Transportation's (ODOT) pavement selection process by adding user cost analyses. Two alternative methods were developed from the results of a rigorous study of current user cost analysis practices from US and Canadian state departments of transportation. This study consisted of a review of ODOT's own practices, the creation of a comprehensive questionnaire survey of other state and provincial DOTs, an examination of user cost models, and an objective evaluation of the effectiveness of the developed methodology.

One of the approaches examined in this study is to incorporate user costs into life cycle cost analyses. This approach is the one currently used by all of the surveyed DOTs that considered user costs when selecting a pavement. The second approach involves comparing user costs of alternatives with equivalent life cycle costs. The authors recommend using RealCost software, developed by FHWA, to quantify user costs when taking this alternative approach.
