PAVEMENT PERFORMANCE DATA ANALYSIS FORUM
Sponsored by the TRB Data Analysis Working Group
Alex T. Visser, University of Pretoria, Chairman
A. Robert Raab, Transportation Research Board, Staff
June 22, 2007
Pella Room, Divani Caravel Hotel, Athens, Greece

1300-1310 Chairman’s Welcome
Staff Report

1310-1330 MOISTURE CONTENT AND DENSITY OF SOIL LAYERS FROM TIME DOMAIN REFLECTOMETRY USING MICROMECHANICS AND SYSTEMS IDENTIFICATION
Robert L. Lytton
Texas A&M University, College Station, Texas, USA

1330-1340 Presenter’s Questions and General Discussion

1340-1350 INFLUENCE OF ROUGHNESS ON STRUCTURAL INTEGRITY OF PAVEMENTS USING THE BOUNDARY ELEMENT METHOD
Luis Picado-Santos
University of Coimbra, Coimbra, Portugal

1350-1360 Presenter’s Questions and General Discussion

1400-1410 LTPP: UNDERSTANDING THE ACCURACY, REPEATABILITY, AND REPRODUCIBILITY OF LONGITUDINAL PROFILING EQUIPMENT
Larry J. Wiser
Federal Highway Administration, McLean, Virginia, USA

1410-1420 Presenter’s Questions and General Discussion

1420-1440 BITUMEN STABILISED MATERIALS: MODELLING PERFORMANCE
Kim Jenkins
Stellenbosch University, Matieland, South Africa

1440-1450 Presenter’s Questions and General Discussion

1450-1500 TECHNIQUES FOR IMPROVING THE PREDICTION OF PAVEMENT LIFE USING FALLING WEIGHT DEFLECTOMETER MEASUREMENTS
Graham Salt
Tonkin & Taylor Ltd., Dunedin, New Zealand

1450-1500 Presenter’s Questions and General Discussion

1500-1520 NEW APPROACHES TO DESIGNING ASPHALT OVERLAYS FOR JOINTED CONCRETE PAVEMENTS
Tom Scullion
Texas Transportation Institute, College Station, Texas, USA

1520-1530 Presenter’s Questions and General Discussion

1530-1550 Concluding Remarks
ABSTRACT:

The Long Term Pavement Performance (LTPP) Seasonal Monitoring Program (SMP) initiated the measurement of in-situ moisture content of unbound base course and subgrade materials using Time Domain Reflectometry (TDR) probes developed by the Federal Highway Administration (FHWA). The determination of moisture content depended upon a set of empirical correlations between the measured dielectric constants of the soil and the moisture content of the soil. These empirical relations differed from type of soil to another and were found to have significant errors when compared to subsequently measured values of soil moisture content. The empirical method used did not account for the effect of the air on the dielectric value of the soil mixture nor did it account for the change of density of the soil as the moisture content changed with the times and seasons. The method of determining the soil dielectric property was the “apparent length method”.

In order to minimize the error and improve the accuracy of the interpretation of the TDR data for calculating the volumetric moisture content, a new method which consists of three steps is developed and is the subject of this presentation. The approach employs the transmission line equation for the propagation of a voltage wave through a complex dielectric medium to calculate the dielectric constant, conductivity, and reflectivity of the soil mixture. A self-consistent micromechanics scheme for three component mixtures was used to determine the volumetric moisture content, percent air and dry density and to calibrate these to the measured in-situ data at the time of the installation of the instrument. A Systems Identification (SID) method was used iteratively to solve for the soil dielectric parameters, moisture content, and dry densities for all subsequent TDR measurements. The validation of the new approach, when applied to all types of soils ranging from granular to fine-grained, indicated that the calculated errors were less than 5% and constitute an improvement on the former method which is both more precise and more accurate. The new method has been automated and the complete FHWA data base of over 250,000 dielectric measurements has been re-computed by the new method.

Because the dielectric value of ice is substantially different from that of water, it is expected that this measurement method should be applicable to detecting the presence of freezing and thawing zones in the soil but this would require a four component self-consistent micromechanics method to be developed for the purpose of analysis.

PRESENTER'S QUESTIONS: I would like to receive comments, suggestions, and feedback from the meeting's attendees on the following matters:

1. Does anyone have installations of TDR equipment in which the “apparent length method” has been used together with the regression method of predicting the sol moisture content has been used satisfactorily?

2. Has anyone used TDR equipment for detecting when freezing and thawing in subgrade soils or base courses is occurring? Is TDR a useful method for setting weight limits during the periods of Spring thaw?

3. The Enhanced Integrated Climatic Model that is used in the Mechanistic-Empirical Pavement Design Guide makes use of a suction-water content relation for each soil and base course layer. Would it be useful if the TDR equipment were further calibrated to produce suction measurements?

PRESENTER'S STATEMENT: This work is still in progress, and has not been submitted for presentation or publication at another meeting.
INFLUENCE OF ROUGHNESS ON STRUCTURAL INTEGRITY OF PAVEMENTS USING THE BOUNDARY ELEMENT METHOD

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ABSTRACT: 

Road pavement roughness is characterized by a difference between the longitudinal profile determined by the design and the real profile. The quality of a road pavement from the user's point of view is mainly related to this parameter. High roughness levels induce dynamic loads, which accelerate the degradation of the structural quality of pavements.

This deterioration mechanism occurs on pavement surface, therefore a numerical method that only requires discretization of the surface rather than the volume – BEM (Boundary Element Method) – will be used to model its influence on the degradation of the structural quality of pavements. The pavement structural model will be three-dimensional (3D) and will be considered the influence of the load dynamic character.

PRESENTER’S QUESTIONS: I would like to receive comments, suggestions, and feedback from the meeting's attendees on the following matters:

1. Which roughness classes should be selected for analysis?
2. As selection of the element type for BEM net is a very important step, which type should be used?
3. Which variables/parameters should be considered in the analysis?
4. How should be considered the dynamic character of the load?

PRESENTER’S STATEMENT: This work is still in progress, and has not been submitted for presentation or publication at another meeting.
LTPP: UNDERSTANDING THE ACCURACY, REPEATABILITY, AND REPRODUCIBILITY OF LONGITUDINAL PROFILING EQUIPMENT

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ABSTRACT:

The Long-Term Pavement Performance (LTPP) program was designed as a 20-year study of pavement performance. A major data collection effort at LTPP test sections is the collection of longitudinal profile data using inertial profilers. In the LTPP program, profile data are collected by four Regional Support Contractors (RSCs), and processed to compute roughness indices, such as the international roughness index (IRI), root mean square vertical acceleration (RMSVA), slope variance, and the Mays index. The data is then stored as the computed roughness parameters and profile data in the LTPP database and made available to the research community.

As an element of quality assurance a comparison test between the four ICC profilers used by the LTPP RSCs was performed in May 2007. The K. J. Law T-6600 profiler that is operated by the North Central RSC also took part in the comparison test. The purpose of the profiler comparison test was to: (1) evaluate the static accuracy of the height sensors in the profilers, (2) evaluate the results from the bounce test, (3) evaluate the accuracy of the distance measuring instrument, (4) compare International Roughness Index (IRI) values obtained by the LTPP profilers with those from the Dipstick®, (5) compare the IRI values between the four profilers, and (6) compare the profiles obtained by the profilers.

A report summarizing the activities that were conducted during the comparison test and the results of the comparison between the LTPP profilers will be made available by the Federal Highway Administration (FHWA) through the LTPP Customer Support Service Center (E-mail: ltppinfo@fhwa.dot.gov).

PRESENTER’S QUESTIONS: I would like to receive comments, suggestions, and feedback from the meeting’s attendees on the following matters:

1. What other methods could be used to perform comparison tests of high-speed inertial profilers to ensure accurate, repeatable, and reproducible data?

2. Reference elevation data for the profiler comparison studies has been collected using the Dipstick®, an Australian Road Research Board (ARRB) walking profiler, and rod-and-level measurements. Are there alternative reference devices available that should be investigated at future longitudinal profiler comparisons?

3. Is there a need for calibration facilities to assure the adequacy of profile data for the intended purposes? What considerations should be given to the laying out and construction of a calibration/verification facility?

PRESENTER’S STATEMENT: This work is still in progress, and has not been submitted for presentation or publication at another meeting.
ABSTRACT:

A project is currently underway in South Africa to investigate and develop test protocols that are pertinent for mix design testing and classification for recycled materials i.e. bitumen stabilized materials. The project is particularly geared for Southern African materials which are predominantly graded crushed stone and some weathered gravels, but also includes blends of RAP and granular materials that have been stabilized with foamed bitumen and emulsified bitumen, making it pertinent to many other countries.

The objectives of the research include the identification and validation of relevant standard-laboratory mix design and compliance tests as well as advanced research-laboratory tests. In particular, improved curing protocols and new compaction protocols, new “simple” triaxial tests and new durability tests (moisture sensitivity of the materials and binder durability tests) are being developed.

This project is about 30% complete and already some trends are being identified with regard to the performance of the bitumen stabilized recycled materials. These preliminary findings will be reported on.

PRESENTER’S QUESTIONS: I would like to receive comments, suggestions, and feedback from the meeting’s attendees on the following matters:

1. Which material properties for bitumen stabilized materials (foamed bitumen and emulsified bitumen) are considered to be critical for defining the performance of these materials?

2. Which tests are the most appropriate to determine the engineering properties bitumen stabilized materials using recycled aggregates, that can be linked to performance?

3. Is fatigue considered to be an important mechanism of failure of foamed bitumen or emulsion stabilized materials?

PRESENTER’S STATEMENT: This work is still in progress, and has not been submitted for presentation or publication at another meeting.
TECHNIQUES FOR IMPROVING THE PREDICTION OF PAVEMENT LIFE USING FALLING WEIGHT DEFLECTOMETER MEASUREMENTS

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ABSTRACT:

Five different methods (ranging from empirical to advanced mechanistic-empirical) for predicting pavement life from FWD measurements have been trialed, with case history data to investigate the accuracy of the alternatives. Informative examples are provided of “Predicted Life” vs “Actual Life” Rutting progression models show poor correlations while a new method based on roughness progression appears markedly better, and we intend studying this further.

PRESENTER'S QUESTIONS: I would like to receive comments, suggestions, and feedback from the meeting's attendees on the following matters:

1. We have developed a simple performance measure for pavement structural uniformity that shows promise for predicting roughness progression. Are there other quantifiable uniformity measures in use elsewhere that can be determined non-destructively on newly constructed pavements and then used for deterioration modelling?

2. Have other roughness progression models, based solely on non-destructive methods (eg FWD) shown useful correlation when Actual vs Predicted Life from case histories been examined? Our interest is in-service pavements rather than Accelerated Pavement Testing.

3. Other pointers for roughness progression modeling using FWD are requested.

PRESENTER'S STATEMENT: This work is still in progress, and has not been submitted for presentation or publication at another meeting.
NEW APPROACHES TO DESIGNING ASPHALT OVERLAYS FOR JOINTED CONCRETE PAVEMENTS

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ABSTRACT:

Designing long lasting asphalt overlays for Jointed Concrete Pavements continues to be one of the most challenging tasks for pavement engineers. Work is underway in Texas to evaluate the use of two new technologies to assist in this task. These are the Rolling Dynamic Deflectometer (RDD) for field testing and the TTI overlay tester (OT) for mix design.

The RDD is a project level continuous deflection device which is capable of measuring the load transfer efficiency of every joint in the section. The current system has 3 rolling geophones which collect continuous deflections data at a speed of 1.5 mph. Criteria have been developed to use this information to calculate joint load transfer efficiency. Joints with poor LTE can not be effectively overlaid. The RDD permits the designer to quantify the extent and severity of problem joints in the existing pavement. By treating the problem joints the designer can focus on designing an overlay which will resist reflection cracking based primarily on the thermal movements of the buried slabs.

The TTI overlay tester is being evaluated by TxDOT as a mix design tool to supplement the current wheel track rutting tests. This test simulated the performance of asphalt layers in resisting cracking caused by thermally induced movements of buried concrete slabs. The new mix design criteria include the balance design concept where the proposed mix must pass both rutting and reflection cracking criteria. A new generation of overlay tester have recently been developed and implemented in Texas DOT laboratories. The use of the device and the balanced mix design concept has recently been incorporated into Texas specifications.

This presentation will provide a status report on both the RDD and the overlay tester. It will present raw data from actual projects and show how criteria were developed to identify problematic joints. Development of the overlay tester criteria will be discussed and a case study will be provided to show the integration of both technologies.

PRESENTER'S QUESTIONS: I would like to receive comments, suggestions, and feedback from the meeting's attendees on the following matters:

1. What is the status of development of rolling deflectometers in Europe and elsewhere? Are any of these devices used at the project level?

2. What are the latest recommendations from Europe on designing overlay for JCP, where can this information be obtained

3. What studies are currently underway

PRESENTER'S STATEMENT: This work is still in progress, and has not been submitted for presentation or publication at another meeting.
DEVELOPMENT OF EFFECTIVE PAVEMENT TEMPERATURE FOR SUPERPAVE ASPHALT MIX TESTING

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ABSTRACT:

The objective of this study is to develop a new approach for calculating the Effective Pavement Temperature (EPT) for testing asphalt mixtures as part of prediction of in situ performance. Specifically, the objective of this research study is to explore the possibility of developing a more accurate and simplified procedure for calculating Effective Pavement Temperature for asphalt mixture performance prediction for any location in the U.S.

An enhanced approach is being developed for calculating Effective Pavement Temperature for rutting (EPT-r). A Mechanistic-Empirical approach similar to the approach used for the development of enhanced high temperature PG binder selection procedure is utilized in this study to develop EPT-r for asphalt mixtures.

A Mechanistic-Empirical approach was also developed to determine EPT for fatigue cracking (EPT-f). The critical location for fatigue cracking is at the bottom of the AC layer, therefore unlike critical rut depth, this depth is not fixed and change with AC thickness. NCHRP 1-37a model for fatigue cracking was utilized to determine fatigue damage. This model has two main parameters: Stiffness of the AC (at the bottom of the layer) and the tensile strain at this location.

PRESENTER'S QUESTIONS: I would like to receive comments, suggestions, and feedback from the meeting's attendees on the following matters:

1. Is Mean Annual Air and Pavement Temperature (MAAT, MAPT) a good parameter for estimating pavement performance?

2. What is the best method to estimate the pavement temperature with depth?

PRESENTER'S STATEMENT: This work is still in progress, and has not been submitted for presentation or publication at another meeting.
DEVELOPMENT AND EVALUATION OF 100% COVERAGE DEVICES FOR QUALITY CONTROL MEASUREMENTS OF NEW FLEXIBLE PAVEMENTS

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ABSTRACT:

In the USA quality assurance testing of newly constructed pavements layers is the responsibility of the Department of Transportation. For many decades this has involved point specific measurements with either nuclear density gauges or compositional testing of field cores. Problems with unsatisfactory quality and poor pavement performance continue to exist. Recently the Texas DOT funded research work at the Texas Transportation Institute to develop and evaluate new technologies which can be used to provide a more comprehensive evaluation of new pavement layers. The focus of this study was on devices which provide 100% coverage of the new layer.

Two devices a paver mounted infra-red temperature bar and a roller mounted vibration monitoring system have been recently developed and tested in a number of field trails. The infra-red bar is targeted at detecting thermal “truck-end” segregation in new asphalt overlays which continues to be a problem. Quality control measurements on new asphalt layers have become more problematic as in many instances these overlays are now placed at night. Instrumented vibratory rollers have been in use in Europe under for over 25 years but they have not been used in the USA. The approach of the TTI researchers was to develop an instrumentation package which could be retrofitted on any roller.

In this presentation the status of these devices will be described as well as the results from the field trials. Examples of the typical data collected on actual projects will be presented, together with efforts to evaluate the significance of these measurements on the in-situ engineering properties. For the temperature results this included density measurements on cores taken in areas compacted at different temperatures. In the case of the instrumented rollers validation testing with other devices including portable FWD, dynamic cone penetrometer, nuclear density gauges was performed to verify the source of the changes in roller amplitude. Changes in roller amplitude were found to correlate well with deep support within the soil layer and not well with the upper layer strength.

PRESENTER’S QUESTIONS: I would like to receive comments, suggestions, and feedback from the meeting’s attendees on the following matters:

1. What techniques are used to ensure quality of construction?
2. Has the use of warranties solved most of the quality problems?
3. What is the level of implementation of intelligent compaction technology? The results at TTI indicate that these can be caused by weak areas 1 to 2 meters below the surface, how can contractors be held responsible for these deep variations in pavement support. How significant are these to eventual pavement performance.

PRESENTER’S STATEMENT: This work is still in progress, and has not been submitted for presentation or publication at another meeting.
TRB’s Data Analysis Working Group, “the DAWG”, is an international forum for the discussion of methods of analysis of pavement performance data. Presentations at DAWG-sponsored forums address the technical interests of professionals engaged in highway research and engineering design, maintenance, and rehabilitation who are engaged in collecting, processing, and analyzing such data and developing insights into the behavior of pavements. Presentations offered by forum attendees (by prior arrangement) focus on work-in-progress concerning the development of techniques for extracting and analyzing data, and early results of recent applications of these techniques. Topics such as model building, sensitivity analysis, and development of transfer functions linking structural response to distress are especially popular and welcome.

A DAWG-sponsored forum has a minimum of formality to encourage open discussion among attendees and minimize the time between the presenters’ preparation and dissemination of analytical results. The agenda is prepared in advance, based on responses to a call for abstracts. Abstracts are reviewed solely for conformity with DAWG guidelines, and as many as time permits are placed on the agenda. Presentations are not subjected to prior technical review. Copies of presentation materials are not distributed. Presentations are not published. Comments by forum attendees are not recorded.

DAWG-sponsored forums are held twice each year: immediately preceding the TRB Annual Meeting in Washington DC in January, and approximately at the midyear at another location. The midyear meeting is usually held in conjunction with a major highway pavement conference where it is expected that many attendees will also be interested in participating in a DAWG forum. If requested by the organizers, the DAWG will arrange and conduct a formal paper session conforming to all the policies and procedures of the conference.

As a TRB committee, the DAWG has appointed members who serve as a steering committee to guide the planning of future meetings. However, DAWG forums are open to everyone interested in the subjects to be discussed, and all attendees enjoy equal status. There is no registration requirement or fee required to attend meetings, but advance notice of the intent to attend a particular forum is recommended and appreciated.

Inquiries are welcome from those interested in adding their names to the DAWG’s mailing list, and those wishing to submit abstracts of presentations for consideration for presentation at a particular forum. Inquiries and abstracts should be directed to:

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