PAVEMENT PERFORMANCE DATA ANALYSIS FORUM
Sponsored by the TRB Data Analysis Working Group
Brian Ferne, Infrastructure and Environment Division, TRL Limited, UK
A. Robert Raab, TRB Senior Program Officer
January 10, 2015
Room 207B, Walter E. Washington Convention Center, 801 Mt. Vernon Place NW, Washington, D.C.

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.

0900	Call to Order
0900-0920	Chairman's Welcome and Staff Report
0920-0940	**TOP DOWN CRACKING IN THE LTPP DATABASE** Peter N. Schmalzer and Newton C. Jackson Senior Engineers, NCE Reno, Nevada, USA
0940-0950	Presenters' Questions and General Discussion
0950-1010	**IMPLEMENTING TECHNOLOGICAL ADVANCES IN PAVEMENT CONDITION SURVEYS WHILE RETAINING EXISTING PMS DATA: CONNECTICUT DOT CASE STUDY** Edgardo D. Block Transportation Supervising Engineer, Connecticut Department of Transportation Newington, Connecticut, USA
1010-1020	Presenter's Questions and General Discussion
1020-1040	**TANGIBLE PERFORMANCE MEASURES AND QUANTIFYING REMAINING LIFE OF A PAVEMENT** Bryan Pidwerbesky General Manager – Technical, Fulton Hogan Ltd Harewood, Christchurch, New Zealand
1040-1050	Presenter's Questions and General Discussion
1050-1105	Morning Break
1105-1125	**DAILY CHANGES IN ROUGHNESS ON LTPP SPS-2 TEST SECTIONS** Larry Scofield Director of Engineering and Research, International Grooving and Grinding Association Mesa, Arizona, USA
1125-1135	Presenter's Questions and General Discussion
1135-1155	**BIG DATA AND 3D INFORMATION, AND THEIR IMPACTS ON PAVEMENT ENGINEERING** Kelvin C.P. Wang Professor, School of Civil & Environmental Engineering, Oklahoma State University Stillwater, Oklahoma, USA
1155-1205	Presenter's Questions and General Discussion
1205-1225	**DATABASE APPLICATION OF NEW RIGID PAVEMENT TEST ITEM AT THE NATIONAL AIRPORT PAVEMENT TEST FACILITY** Qiang Wang[1] and David R. Brill[2] [1]SRA International, Linwood, New Jersey, USA [2]Federal Aviation Administration, Atlantic City, New Jersey, USA
1225-1235	Presenters' Questions and General Discussion
1235-1335	Mid-Day Break

1235-1335	Mid-Day Break
1335-1355	***2014 T&DI/ASCE-LTPP International Data Analysis Contest Winner's Presentation*** **ANALYSIS OF CRACKING IN JOINTED PLAIN CONCRETE PAVEMENTS** Changwei Xu Department of Engineering, University of Cambridge Cambridge, United Kingdom
1355-1405	General Discussion
1405-1425	***2014 T&DI/ASCE-LTPP International Data Analysis Contest Winner's Presentation*** **DETERMINING THE EFFECT OF CLIMATE ON CRACKING AND ROUGHNESS OF ASPHALT PAVEMENT USING INFOPAVE** Patricia Hogan, Nelson Shepard, and Holly Faubert University of Rhode Island Kingston, Rhode Island, USA
1425-1435	General Discussion
1435-1455	**ANALYSIS OF THE EFFECTS OF SUB-LAYERS AND ROADBED MATERIALS ON PAVEMENT CONDITIONS AND DISTRESSES** Michael D. Prohaska MSc. Graduate Student, Michigan State University East Lansing, Michigan, USA
1455-1505	Presenter's Questions and General Discussion
1505-1520	Afternoon Break
1520-1540	**QUALITY CONTROL DATA COLLECTION DURING CONSTRUCTION OF ASPHALT CONCRETE FOR VERY THIN SURFACING LAYER AND EVALUATION OF RESULTS** Athanassios Nikolaides Professor of Civil Engineering Department, Aristotle University of Thessaloniki Thessaloniki, Greece
1540-1550	Presenter's Questions and General Discussion
1550-1610	**REFERENCE DEVICE AND PROTOCOL FOR PAVEMENT DISTRESS INSPECTION SYSTEM VERIFICATION** Yaxiong (Robin) Huang[1] and Magdy Mikhail[2] [1]Pavement Equipment System Coordinator, [2]Pavements Branch Manager Texas Department of Transportation, Austin, Texas, USA
1610-1620	Presenters' Questions and General Discussion
1620-1640	**LONG-TERM FIELD PERFORMANCE OF WARM MIX ASPHALT PAVEMENTS** Haifang Wen Associate Professor, Washington State University Pullman, Washington, USA
1640-1650	Presenter's Questions and General Discussion
1650-1710	**AUTOMATED DETECTION OF SEALED CRACKS USING 2D AND 3D ROAD SURFACE DATA** John Laurent Vice President and Chief Technical Officer, Pavemetrics Systems Inc. Québec (Québec) Canada
1710-1720	Presenters' Questions and General Discussion
1720-1730	Evening Break
1730-1800	Steering Committee Meeting
1800	Adjourn

TOP DOWN CRACKING IN THE LTPP DATABASE

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ABSTRACT:

Most modern flexible pavement design methodologies include or assume pavement damage models where fatigue cracking propagates from the bottom of the pavement upward. The LTPP experimental matrix was developed with this concept in mind. The problem is that many agencies are observing that most of their cracking is surface cracking. This provided complications for both pavement design and pavement management dealing with remaining life processes, as well as calibration of m-e design models used in pavement design.

Many states like Washington have observed top down cracking now for over 25 years so the phenomena is not new. The increased number of observations is probably due to the fact that more agencies are coring the cracks and discovering that they are top down cracks. Washington State is now reporting that most of their resurfacing program involves pavements with top down cracking. This also indicates that most of their pavements are long life pavements and are structurally sound but require periodic renewal of the surface every 10 to 20 years.

If surface cracking is that prevalent throughout the county one could ask why isn't identified in the LTPP database? The problem is that the LTPP protocol doesn't allow coring within the test sections so none of the cracks have been cored to see if they are top down or full depth cracks. The current FHWA-funded LTPP data analysis study has a goal of identifying which pavement test sections have top down cracking and which sections have full depth cracks. This could be very important information for those who are using the database to calibrate M-E fatigue damage models. It could also expand the potential use of the LTPP database to those researches studding top down cracking.

The next problem is how to identify top down cracking in test sections where coring is not allowed. This top down cracking study is attempting to clearly identify surface cracking using fwd derived pavement stiffness measures such as effective modulus, layer modulus, or some other measure like the area value, particularly if they are changing or not changing with time.

Hopefully, through analysis of trends in time in pavement stiffness (as expressed in individual layer moduli and the area parameter) versus distress propagation for all 1465 LTPP flexible pavements, a dataset will be developed that:

Indicates the prevalence of the top-down cracking in the LTPP database,

Allows other researchers to consider pavement models that take the phenomenon into account,

Warns researchers and agencies to avoid the use of LTPP sections with top down cracking when calibrating current mechanistic-empirical design methodologies using bottom up fatigue cracking damage models.

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

1. Have other agencies and researches observed top down cracking?

2. How do you determine if it is top down cracking without coring? We would like to see if anyone has tried other nondestructive approaches other than deflection based.

3. What are the consequences of not knowing if it's top down rather than full depth cracking?

PRESENTERS' STATEMENT: This work is still in progress, and has not been submitted for presentation or publication at another meeting.

IMPLEMENTING TECHNOLOGICAL ADVANCES IN PAVEMENT CONDITION SURVEYS WHILE RETAINING EXISTING PMS DATA: CONNECTICUT DOT CASE STUDY

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ABSTRACT:

Advances in sensing and data storage capability over the past few decades have made it possible for pavement managers to access unprecedented levels of quantifiable and objective pavement condition information which they can use in managing pavement networks. The speed of innovation has also meant that product (sensor) life cycles are shortened, presenting a challenge in maintaining consistency in the decision-making process and in capturing the value of data collected with earlier-generation sensing systems. The challenge is typically first encountered when deciding to switch from manual condition assessments to those using automated condition measurements – switching makes it difficult to translate the data collected with one system and replicate decision mechanisms in the management systems. In more general terms, the problem is one of migrating from one measurement technology to the next, and, given the rate of technological innovation it is likely to be a recurring issue for the foreseeable future. This presentation describes how a transportation agency approached this problem in the area of pavement cracking data, migrating from pavement cracking measures using one automated system to the next generation system, and proposes a pavement-condition-data framework that can accommodate changes in measurement technology, at least with respect to measures of pavement condition. Specifically, the Connecticut DOT upgraded the cracking-imaging system in one of its two data collection vehicles in 2010. Until the second vehicle is upgraded, network data are collected with two different cracking-detection systems – one with strobed visible illumination and the other with a laser-illuminated line-scan camera. This has required that the agency develop a methodology for combining the two data streams into one data set used in its Pavement Management System for the state-maintained highway network. The process has been aided by having the ability to conduct concurrent measurements of pavement segments with both systems, and several opportunities to compare data inherent in the yearly data collection process. The methodology used to combine both data sets provides a blueprint for developing a stable framework for pavement cracking data collection and can be expanded to other pavement features related to pavement topography.

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

1. Validity of method to combine data
2. Statistical sampling/experiment design comments
3. Comments on approach to defining pavement features and benchmarks (‘ground truth’)

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

TANGIBLE PERFORMANCE MEASURES AND QUANTIFYING REMAINING LIFE OF A PAVEMENT

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ABSTRACT:

Historically, New Zealand's state highways and local roads have been constructed primarily of unbound granular pavements surfaced with chip seals. Where vehicle loadings have increased, virgin aggregates modified with foamed bitumen or cement are being used in some heavier trafficked rural highway new construction to assure better performance. With the additional cost of the modified pavements, the NZ Transport Agency expects improved performance from these pavements in design-build projects. Contractual Key Performance Indicators (KPIs) for the improved performance include measures of skid resistance, rutting, roughness, etc. If the actual performance does not satisfy the KPI's, financial penalties may be applied to the design-build contractor. Thus, it is critical that the performance measures are tangible and the data analysis is robust. Work is currently underway to develop a robust methodology that can be used in a contractual setting. To be fair to both parties, the KPI measures are not applied to the entire project so the pavement is segmented; the purpose of segmentation is to identify uniform construction length that comply with performance specification and the lengths not complying plus categorizing the latter into uniformly performing categories. The work also includes a technical forecast for the performance of modified granular pavements against a rutting KPI, and a number of questions have arisen. Measured rut values and FWD measurements are being used to assess the most likely end-of life from a performance perspective; a significant aspect of this task is to formulate an appropriate terminal rut depth value. An international literature review has been inconclusive in finding an appropriate segmentation process and terminal rut depth for unbound and modified granular pavements.

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

1. What is an appropriate segmentation process for this analysis?

2. What is the appropriate terminal rut depth condition for sealed unbound/modified granular pavements? (Pavement designers generally assume 20-25 mm is the terminal rut depth for such pavements, whereas from a NZ state highway asset manager's perspective, maintenance intervention is typically done after 10-12 mm rut depth, though it is rarely triggered by rut depth.)

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

DAILY CHANGES IN ROUGHNESS ON LTPP SPS-2 TEST SECTIONS

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ABSTRACT:

The Long Term Pavement Performance (LTPP) program collected 140 sets of 5 repeat profile measurements on nine of the remaining 13 Special Pavement Studies (SPS-2) test sections to evaluate the change in daily roughness on the SPS-2 test sections which are plain jointed, dowelled pavements with 15 ft joint spacing. Profile measurements were obtained at three intervals during the day ranging in duration between 8 hrs and 14 hrs. The average daily change in roughness (MRI) was 12 in/mi with extremes to 38 in/mi. The design feature which had the greatest impact on daily roughness change was flexural strength. The higher flexural strength produced a 30% higher average daily change. The PATB base provided the best mitigation to daily roughness changes and it appears there may be some benefit to the widened shoulder concept for controlling daily roughness changes.

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

1. What diurnal roughness changes have others experienced?

2. Has anyone determined the minimum change in IRI that is perceptible by the consumer?

3. What is the minimum time interval over which measurements should be obtained?

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

BIG DATA AND 3D INFORMATION, AND THEIR IMPACTS ON PAVEMENT ENGINEERING

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ABSTRACT:

For decades, pavement engineers dealt with design and management data in the size of megabytes. Pavement engineering has been going through major transformations in the past decade and such transformations are continuing at a rapid pace. Many people would agree that these transformations have direct and immediate impacts on how data sets are collected, managed, and applied in pavement design and management, and pavement materials research. Such data sets today are in many terabytes on annual basis, challenging the status quo of many agencies to make both technological and organizational changes. This presentation specifically addresses several key issues of large data sets including 3D data on highways, and their requirements on computing needs, data analysis, data quality, and engineering practices as follows:

1. 3D pavement surface at 1mm resolution for both management and design
2. WIM data and its application to the next-generation of pavement design, AASHTO Pavement ME Design
3. Data compression, storage and management
4. Integration of efforts from multiple divisions of a state DOT
5. Solutions based on the big data to current and future pavement engineering problems
6. Newer technologies that would further improve data quality, resolution and definition.

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

1. Is Big Data impacting your agency on both collection and storage, and how?

2. What are the new applications of big data for pavements at your agency?

3. Are the big data sets overkill? or are you facing any challenges that are not addressed in the presentation?

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

DATABASE APPLICATION OF NEW RIGID PAVEMENT TEST ITEM AT THE NATIONAL AIRPORT PAVEMENT TEST FACILITY

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ABSTRACT:
The Federal Aviation Administration conducts full-scale airport pavement testing at the National Airport Pavement Test Facility. All pertinent data and information collected at the NAPTF is arranged by construction cycles. A construction cycle includes test pavement construction, instrumentation installation, traffic tests to failure, post-traffic testing, and pavement removal. The recent completed construction cycle is Construction Cycle 6 (CC6) on rigid concrete pavement item. It was aimed at evaluating the effects of concrete strength and subbase materials. Two types of isolation joints were also tested for comparison.
Hundreds of sensors were distributed through the pavement sections to obtain the information of structural responses and material properties. During the aircraft loading traffic test, the NAPTF test vehicle simulates realistic aircraft wander by varying the lateral position of the carriages to simulate a normal distribution of aircraft traffic. All the sensor data were collected and stored in the CC6 database system. Based on the preliminary data processing, FAA released the construction cycle database on the web site for the public applications. The released information includes vehicle configuration, wheel wander pattern, pavement structure, material properties, sensor diagram, test area diagram, and collected sensor data.
This presentation introduces the CC6 database system and shows how to use the data for the further research and advanced analysis. An example demonstrates the application of the CC6 data on the concrete slab corner cracking. It presents that the displacement transducer and electric strain gage data well illustrate the slab cracking propagation in a hundred vehicle passes.

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

1. FAA performed a series of full scale pavement tests and collected a huge of test data at NAPTF for our research purposes. We hope public people can use the test data on other research issues. Therefore, we design a web page to post our data online. We would like to hear suggestions on the public application of our database.

2. We found some sensors imbedded to the concrete slab were damaged during trafficking test period. The sensors with high quality and long term function are desirable. We are interested in the durable test techniques of pavement under heavy load of aircraft scale.

3. To evaluate the crack initiation and propagation in the pavement, FAA applied several testing methods on NAPTF test sections. Using the displacement and strain sensors to monitor the cracking was introduced in this presentation. We welcome the new development of in situ method to monitor the micro-cracking in rigid pavement.

4. In the NAPTF databases, http://www.airporttech.tc.faa.gov/naptf/, test data are posted by the construction cycle number. CC6 data are the new update test on the rigid pavement. What do you think on the query of data format?

PRESENTERS' STATEMENT: This work is still in progress, and has not been submitted for presentation or publication at another meeting.

Winner's Presentation

The 2014 T&DI/ASCE-LTPP International Data Analysis Contest

sponsored by

The Long-Term Pavement Performance Program of the Federal Highway Administration
The Transportation & Development Institute of the American Society of Civil Engineers

ANALYSIS OF CRACKING IN JOINTED PLAIN CONCRETE PAVEMENTS

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ABSTRACT:

This paper investigates the trends of longitudinal and transverse cracking in jointed concrete pavements based on the LTPP SPS-2 data. The impacts of slab properties, base type, traffic volume, and environmental factors on the occurrence and extent of longitudinal and transverse cracking are identified from a simple analysis of the raw cracking data. SPS-2 sites in Arizona and Arkansas are chosen to investigate cracking mechanisms in detail. A new hypothesis for the prevalence of premature cracking on these sites is proposed and tested by numerical simulations.

The analysis shows that longitudinal and transverse cracking are more sensitive to slab thickness and base type than other construction variables. Surface cracking is worse in dry climatic zones than wet. Most transverse cracks initiate from the slab edge close to the shoulder and two forms of longitudinal cracks can initiate from transverse edges of slabs: a single long crack or multiple short cracks along the whole section. In addition to inadequate compaction of the base layers during construction and rehabilitation, the major contribution to premature longitudinal cracking appears to be voiding beneath the outer edge of the pavement. This is caused by localised plastic deformation of 'depressurized' soil, which occurs principally due to slab curl.

Winner's Presentation

The 2014 T&DI/ASCE-LTPP International Data Analysis Contest

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The Transportation & Development Institute of the American Society of Civil Engineers

DETERMINING THE EFFECT OF CLIMATE ON CRACKING AND ROUGHNESS OF ASPHALT PAVEMENT USING INFOPAVE

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ABSTRACT:

This research paper examines Long-Term Pavement Performance (LTPP) data in four climate regions of the continental United States to determine the effect of climate on cracking and roughness of asphalt pavements. The four climate regions, characterized by temperature and precipitation, are Wet-Freeze, Wet-Non-Freeze, Dry-Freeze, and Dry-Non-Freeze, as defined by InfoPave. The following sections were chosen to represent each climatic region respectively: Centre County, Pennsylvania; Etowah County, Alabama; Twin Falls County, Idaho; and San Joaquin County, California. The examined data show the fatigue cracking, transverse cracking, and the International Roughness Index (IRI) recorded throughout the study period. This report also provides recommendations for Rhode Island's pavement. Pavement performance data for Rhode Island, obtained from the Rhode Island Department of Transportation (RIDOT), are examined for consistency with LTPP data trends. This study concludes how asphalt pavement cracking and roughness are affected by climate and how Rhode Island's pavement compares to the LTPP data representing its climate region.

ANALYSIS OF THE EFFECTS OF SUB-LAYERS AND ROADBED MATERIALS ON PAVEMENT CONDITIONS AND DISTRESSES

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ABSTRACT:

The accurate modeling of pavement performance is dependent on a thorough understanding of the mechanisms of pavement conditions and distresses and the impacts of each aspect of pavement design and pavement treatments on their magnitudes and rates of change. This project utilizes the Long-term Pavement Performance (LTPP) database to verify section design and identify pavement sections having sufficient time series pavement conditions and distresses data to model their rates of change. Comparative analysis on the effects of base, subbase, and subgrade soil types on these rates of change will be conducted. First, the LTPP data will be sectioned by state, climatic conditions, and traffic level and then the sensitivity of the pavement conditions and distresses and their rates of change to each sub-layer type. The key in this study is to determine the most adequate analysis methods by which potential correlations between the dependent (pavement conditions and distresses) and independent variables (material, pavement section, and treatment types) can be identified. Results of preliminary analyses of these potential correlations will be presented and discussed during the DAWG session in Washington DC. The presentation will concentrate heavily on treated pavement sections.

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

1. Sensitivity of each sub-layer type varies widely between published works, is there a consensus on which publication best fits each climate zone?

2. Does anyone know of publications which indicate the effects of sub-layer suffusion in the advancement of pavement distresses and conditions?

3. For assessing if sub-layer types play a significant role in pavement condition and distress development a minimum of three data points were required to model pavement behavior; would increasing the minimum number of points required for assessment be an improvement despite a significant decrease in the number of acceptable data sets?

4. Rut modeling was accomplished assuming a power behavior for both pre and post-treatment. What would be a more accurate method of modeling post-treatment rut return when pre-treatment rut was experiencing no significant increase?

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

QUALITY CONTROL DATA COLLECTION DURING CONSTRUCTION OF ASPHALT CONCRETE FOR VERY THIN SURFACING LAYER AND EVALUATION OF RESULTS

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ABSTRACT :

Asphalt Concrete for Very Thin Surfacing Layer (AC-VTSL) started to be used in Greece in the year 2005, after successful trial section laid in 2000 and monitored for five years. In 2006 the first major project was implemented where AC-VTSL was laid at a thickness of 23 to 28 mm over an area of approximately 2 million square meters of dual carriage motorway (approximate length 94 km). During the execution of asphalt works extensive quality control testing was carried out on polymer modified bitumen, properties of AC-VTSL, surface texture depth, tack coating, layer thickness, surface evenness, and constructional details (environmental temperatures, bituminous mix temperatures during laying, number of finishers used, etc). The paper presents construction details and evaluation of quality control results obtained assisted by statistical analysis. The final aim of this paper is to establish safe variation coefficients from targeted values after examining the performance of the very thin surface layer after a period of 10 years in use. This will be valuable information for National relevant specifications. The examination of the performance of the very thin surface layer is scheduled to take place in 2016.

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

1. Asphalt concrete for very thin surfacing layer (AC-VTL) (25 mm to 30 mm) is a relatively new surfacing material , has anyone measured it's long term performance.

2. Performance is related to quality control testing during execution of asphalt works; is testing of bituminous binder sampling from storage tank, determination of binder content and aggregate gradation of the mix, surface texture depth and layer thickness obtained, and amount of tack coating applied sufficient for quality control testing?

3. Should constructional conditions, such as environmental temperature (or pavement surface temperature), speed of wind, bituminous mix temperature in the spreader box, number of finishers used when two lane carriageway is to be paved, be decisive parameters for long term satisfactory performance? What the limit values will be for AC very thin surfacing layer?

4. What is the effect of executing AC-VTSL asphalt works during the night due to traffic or other restrictions?

5. Is frequency of: a) sampling of the mix and bituminous binder, b) range of variation from target mix, and c) accepted variation of bituminous binder properties, set for conventional asphalt concrete mix, sufficient for AC-VTSL quality control for long term performance?

6. Is the number of test results falling outside specified limit values per type of test, as required by some national specifications for mix compliance, sufficient for quality control measurements? Should standard deviation limit values be implemented instead, related to the number of tests carried out?

7. How initial texture depth achieved with the use of AC-VTSL is related to long term surface skid resistance?

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

REFERENCE DEVICE AND PROTOCOL FOR PAVEMENT DISTRESS INSPECTION SYSTEM VERIFICATION

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ABSTRACT:

A concept of on-demand and on-site verification or certification for pavement surface distress inspection equipment has been developed and is being tested by the Texas Department of Transportation.

The concept consists of three major parts. First, a high resolution/accuracy reference device for walking ground truth survey. Second, a set of protocols regulates how many road sections, how many types of distresses, and how many actual distresses are required to establish the ground truth. Third, a method used to compare the ground truth and equipment-collected data to conclude the verification.

TxDOT team has built the device and had preliminary tests on selected pavement. Further investigations will focus on software improvements for better ground truth data abstraction and to examine the performance of a 3D full lane width inspection system verified/certified for different types of pavement.

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

1- Is it necessary to develop a standard verification method/standard for pavement distress inspection system verification?

2- With an established facility with pre-manufactured distressed pavement sections, or a portable system with standard operating protocol; which is the better approach for verification of pavement distress inspection systems?

3- Do you think “the need based verification” is practical and applicable? If a vendor is contracted to do flexible pavement inspection, is it necessary to verify its performance on both concrete and flexible pavements?

PRESENTERS' STATEMENT: This work is still in progress, and has not been submitted for presentation or publication at another meeting.

LONG-TERM FIELD PERFORMANCE OF WARM MIX ASPHALT PAVEMENTS

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ABSTRACT:

Warm mix asphalt (WMA) has been dramatically used due to its environmental friendliness; however, the long-term field performance of WMA pavement is rarely studied but it is of paramount importance for its wide application. This study investigates 24 field projects selected in the United States that have hot mix asphalt (HMA) as the control mix and WMA pavements, subjected to different climate conditions, service years, traffic volumes and pavement structures. The field distress survey was conducted in accordance with the Long-Term Pavement Performance distress identification manual. A dual cracking comparison criteria is proposed: one is based on the percentage of difference of the weighted averages of the cracking lengths for the HMA and WMA pavement; and the other is based on the absolute difference of the average crack length coming from the threshold value that is able to distinguish between good and fair pavement in Mechanistic Empirical Pavement Design Guide. Based on the cracking comparison criteria, it is found that the WMA pavement exhibit better or comparable transverse cracking performance than the HMA pavement, but the WMA pavement show worse or comparable top-down longitudinal cracking performance than the HMA pavement.

In addition, a comprehensive laboratory experiments are conducted on the extracted field cores, including dynamic modulus, creep compliance, indirect tensile (IDT) fracture test at intermediate and low temperature, as well as on the recovered asphalt binder, such as binder tests including PGs, multiple stress creep recovery, monotonic tests at intermediate and low temperature, which are to identify the significant material properties that best matches the field performance. It is found that the fracture work density obtained from IDT test is significant material property to characterize the transverse cracking, that is, the higher work density of mix, the less transverse cracking. The vertical failure deformation obtained from IDT test at intermediate temperature is found to be a good indicator for top-down longitudinal cracking.

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

1. The cracking comparison criteria to compare two pavements in terms of transverse cracking and top-down longitudinal cracking.

2. The methodology to determine the significant material property that best characterizes the field performance of asphalt pavement.

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

AUTOMATED DETECTION OF SEALED CRACKS USING 2D AND 3D ROAD SURFACE DATA

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ABSTRACT:

The use of high resolution transverse 3D laser profilers for the automatic measurement of cracks is now more and more a reality in the US as most recent DOT equipment purchases and data collection contracts require 3D sensors for the evaluation of surface distress. The use of 3D laser profilers allows to directly measure surface defects such as cracks, ruts, pot holes and macro-texture. These sensors also produce 2D intensity (images) that are used to detect lane markings but that can also be used to detect sealed cracks. However attempts at the use of only intensity (2D) data for sealed cracks detection has proven unreliable because sealed cracks can sometimes be darker or brighter than the surrounding pavement. To get around this problem texture evaluated from the 3D data

This presentation will focus on the difficulties in the automation of sealed cracks and will show promising results from automated algorithms that use intensity, shape and 3D texture data to improve the detection rates and reduce false positives. Examples on both asphalt and concrete data will also be presented. Examples of partially sealed cracks and degraded sealed cracks will also be presented.

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

1. We would like to know if the audience thinks if our combined approach (2D – color and shape and 3D texture) will work with all or most cases of sealed cracks in the field. Width and length constraints need to be applied are they reasonable? If not any suggestions?

2. We have not attempted to classify (transverse, longitudinal, alligator) the sealed cracks or evaluate there severity (width) are there any particuler needs regarding the classification of sealed cracks?

3. Some sealed cracks show areas with missing sealant and/or cracking along the edges of the seals. We would like to know if there is a need to evaluate the quality of such seals?

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

Alternate #1

FWD BACK-CALCULATION OF PCC SLAB PAVEMENTS: WHICH K-VALUE IS THE RIGHT ONE ?

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ABSTRACT:

Determination of PCC E-modulus and k-value from FWD testing on concrete slab pavements has traditionally followed the procedure:

1. Back-calculate E-modulus of PCC slab and foundation layer(s) using layered elastic analysis.
2. If a multilayer back-calculation has been performed, determine the surface modulus E_{fm} of the foundation (layers beneath the PCC slab). If the analysis is a two-layer model, then $E_{fm} = E_m$, the subgrade modulus.
3. The Modulus of Subgrade Reaction – the k-value – can then be determined in a number of ways:
    a. From the definition equation, based on the deflection of and pressure on a 30-inch diameter plate,
    b. From an equation suggested by Ullidtz, including E_{fm} and the equivalent thickness of the PCC slab
    c. From an equation that can be derived from the FAA LedFAA and FAARFIELD programs, expressing k as a power function of E_{fm}.

Using these methods on real data produces differing k-values, and a correction procedure must be applied in order to make the measured center deflections match the Westergaard calculated values. A TRB2014 paper by Crovetti highlighted the so-called (Deflection Basin) AREA method, which directly determined both PCC E-modulus and foundation k-value from FWD measurements.

The current presentation will present the metric constants for 300-mm and 450-mm FWD testing that have been developed from ISLAB2000 calculations. These constants are then applied in the analysis of real FWD data, showing that the uniformity of PCC E-moduli and k-values is better than the traditional linear elastic back-calculation approach.

The k-values from the various traditional methods are compared against the values from the AREA method. This analysis is used for presenting conclusions on how to determine k-values in the design of new PCC slab pavements.

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

4- Can AREA back-calculated PCC E-moduli and k-values be considered more “correct” than values determined from layered elastic analysis?

5- Is 30-in k-values more relevant than 18-in or 12-in values, considering the fact that deflections under a slab cover much greater areas?

6- Experience with back-calculation of PCC E-moduli and k-values from measurements under upward/downward curling conditions?

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

Alternate #2

NON-LOCK SKID MEASUREMENT

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ABSTRACT:

Non-Lock Friction Test
Traditionally, highway agencies have measured the frictional condition of the pavement utilizing equipment and methods described in ASTM E-274[1]. This process involves locking a trailer wheel and dragging it across the pavement for a little under 60 feet (nearly 18 meters) with a film of water sprayed on the pavement in front of the test tire. The test is performed at 40 mph (~60 kph).

While this process is fairly robust, it has several weaknesses:
1. It requires a large amount of water for relatively few tests. This limits network testing to 0.2 mile (322m) sample spacing.
2. The sequence of test functions limits the minimum spacing between tests to 0.05 miles (80m)..
3. The results can be quite speed dependent

We have developed a test that utilizes the same basic mechanical system, but performs the measurement just prior to the lock-up of the test wheel. The reported value is an average over less than 6 feet (1.8 meters). The entire test can be performed at much closer spacing (0.01miles, 16m) than the locked wheel test. This process should improve our ability to measure our network condition through higher resolution data that is less test speed dependent.

The development work is in the early stages and preliminary data will be presented.

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

1- Does the lack of speed dependence make sense?

2- Why are the preliminary results lower than the E-274 test?

3- How would you set the variables and why?

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

[1] ASTM E274 - 11
Standard Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire

Alternate #3

NETWORK LEVEL MULTI INPUT DETERIORATION PREDICTION MODEL (MID-PM) FOR FLEXIBLE PAVEMENT

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ABSTRACT:

A vital component of any effective and successful pavement management system is the ability to classify the sections as “good”, “moderate” and “poor” and then forecast the remaining pavement life in order to create a timely and accurate treatment intervention programme and thus reducing maintenance cost. Pavement sections classification and prediction models are normally based on an Index parameter known as Pavement Condition Index (PCI). The PCI is measured by evaluating the extent and severity of various surface distresses like cracks, rut depths, potholes, patch, texture etc. The reduction of PCI is thus an indication of pavement deterioration or improvement of PCI is an indication of any rehabilitation works is undertaken. The reviewed literature showed that pavement performance prediction models are either single or dual distresses based or only related to the reduction of PCI with age of pavement.

This paper presents the development of a network level deterministic deterioration models for flexible pavement on two classes of roads, arterial and collector, located in four climatic zones. The proposed models utilize all of the influencing parameters that affect pavement performance. The utilized parameters are a) distress (area and length of cracks), b) pavement age, c) traffic loading, d) maintenance effects, d) climatic effects and e) construction and material properties. The model performance is compared against the prediction model derived by the linear deterioration model in the Micro-PAVER system, which is based purely on the age of pavement.

The historical data of condition assessment in the Long-term Pavement Performance Database (LTPP) are employed to develop a deterioration trend in pavement condition index (PCI). For each climatic zones, deterioration models are developed and then cross validated with a separate data set for different functional class of road considering different constructions and materials used within the flexible pavement. The validation outcomes showed that the accuracy of empirical models for arterial roads is better than for collector roads in all climatic zones. These models have a significant potential to estimate the future performance of flexible pavements, resulting in timely and cost-effective maintenance and rehabilitation decisions.

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

1. This deterioration model is for network level pavement management system. Authors like to get your view on the overall approach especially in line with MAP 21 for pavement performance measure rules.

2. One of the limitations of the model is to mathematically incorporate the benefit of preventive maintenance like crack sealing, patching etc. on PCI? Is there any model available to address these in the deterioration prediction model and in subsequent PCI calculation?

3. Authors are aware that the acceptable level of PCI is dependent on the road type and level of service/threshold needed by the authority. Is there any database available in LTTP sites for the minimum acceptable level of pavement condition index?

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