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 12, 2013 Hampton Room, Omni Shoreham Hotel, Washington, D.C.	
0900	Call to Order
0900-0930	Chairman's Welcome Staff Report
0930-1000	**ASSET MANAGEMENT FOR LOW-VOLUME ROADS: HOW TO MAKE DATA COLLECTION AFFORDABLE AND SUSTAINABLE AT THE LOCAL LEVEL (AND IN LOW INCOME DEVELOPING COUNTRIES)** Asif Faiz and Chris Bennett The World Bank, Washington, DC, USA
1000-1015	Presenter's Questions and General Discussion
1015-1030	Morning Break
1030-1100	**ASSESSING BELLS3 EQUATION IN PREDICTING ASPHALT LAYER TEMPERATURE PROFILE BASED ON THE LATEST LTPP FWD TEMPERATURE DATA** Dong Wang and Huang-Hsiung Sean Lin FHWA Turner-Fairbank Highway Research Center, McLean, VA, USA
1100-1115	Presenter's Questions and General Discussion
1115-1145	**SMOOTHNESS SPECIFICATION FOR FREEWAY AND URBAN HIGHWAY PAVEMENTS IN TAIWAN** Lin Lin National Taiwan University, Taipei, Taiwan (R.O.C.)
1145-1200	Presenter's Questions and General Discussion
1200-1330	Mid-Day Break
1330-1400	**TEN YEAR CASE STUDY OF PERFORMANCE EVALUATION OF ASPHALT PAVEMENT WITH FLY ASH STABILIZED FULL DEPTH RECLAIMED BASE** Ahmed Faheem[1] and Haifang Wen[2] [1]Bloom Companies, LLC, Milwaukee, WS, USA [2]Washington State Univ, Pullman, WA, USA
1400-1415	Presenter's Questions and General Discussion
1415-1445	**EVALUATION OF TEXAS PAY ADJUSTMENT SYSTEM FOR HMA AND RIDE SPECIFICATIONS OF CONCRETE AND ASPHALT PAVEMENTS** Prasad Buddhavarapu, Andre De Fortier Smit, and Jorge A Prozzi The University of Texas at Austin, Austin, TX, USA
1445-1500	Presenter's Questions and General Discussion
1500-1530	ASCE-LTPP International Contest Winner, Challenge Category **CLASSIFICATION OF FEATURES OF PAVEMENT PROFILES USING EMPIRICAL MODE DECOMPOSITION** Daniel P. Franta Minnesota Department of Transportation, Maplewood, MN, USA
1530-1545	Presenter's Questions and General Discussion
1545-1600	Afternoon Break
1600-1630	**MULTIPLE RUT EVALUATION METHODS AVAILABLE FROM HIGH RESOLUTION TRANSVERSE PROFILES** Hitesh Shah and D.J. Swan Fugro Roadware, Mississauga, Ontario, Canada
1630-1645	Presenters' Questions and General Discussion
1645-1715	**THE CONTRIBUTION OF MICRO- AND MACRO-TEXTURE TO THE SKID RESISTANCE OF PAVEMENTS** Pedro A. Serigos, André de Fortier Smit, and Jorge A. Prozzi The University of Texas at Austin, Austin, TX, USA
1715-1730	Presenters' Questions and General Discussion
1730-1800	Steering Committee Meeting
1800	Adjourn

A NOTE ABOUT THE DAWG

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:

A. Robert Raab, PhD, PE, F.ASCE
Transportation Research Board
500 Fifth Street NW
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Telephone: 202-334-2569
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TRB's DATA ANALYSIS WORKING GROUP ("the DAWG")
PRESENTATION ABSTRACT FORM

TITLE OF PRESENTATION:

ABSTRACT:

Guidelines:

- *Any person who wishes to brief the DAWG on the status of his/her unfinished and unpublished work is invited to submit an abstract.*
- *Each abstract must contain a small set of questions on issues being considered by the submitter in the further development of his/her project.*
- *Each briefing will be followed by a period devoted to consideration of the presenter's questions and requests for advice.*
- *Briefings should focus on techniques for extracting, processing, and analyzing pavement performance data, as well as preliminary results of applications of these techniques.*

Note: Please delete the guidelines and use this space for your abstract.

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

1-

2-

3-

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

Name
Mailing Address

Telephone
Fax
E-Mail

Completed forms should be sent to:
A. Robert Raab
Senior Program Officer, TRB
Email: rraab@nas.edu

ASSET MANAGEMENT FOR LOW-VOLUME ROADS: HOW TO MAKE DATA COLLECTION AFFORDABLE AND SUSTAINABLE AT THE LOCAL LEVEL (AND IN LOW INCOME DEVELOPING COUNTRIES)

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ABSTRACT:

Excessive data collection is probably one of the key factors why Asset Management Systems for Low Volume Roads (LVRs) become unsustainable and eventually dysfunctional, especially in local jurisdictions. This is also the case in low-income developing countries. Data collection is expensive. Each data item collected requires time, effort, and money to collect, store, retrieve, and use. The first rule of data collection is that data should never be collected because "it would be nice to have the data," or because "it might be useful someday". The commonly used data collection systems are seen as too data intensive, too technically sophisticated, and too costly to sustain at the local level.

The design of any data collection system for LVR asset management should begin by answering the following questions:

- What decisions are required to manage the LVR assets at the local level?
- What data are needed to support these decisions?
- Can we afford to collect these data initially?
- Can we afford to keep the data current over a long time period?

And there are three guiding principles that should always be considered when deciding which data to collect:

- Collect only the data you need;
- Collect data to the lowest level of detail sufficient to make appropriate decisions; and,
- Collect data only when they are needed.

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

1- How much automation is needed in data collection for managing LVR assets, especially at the level of local jurisdictions (e.g. rural counties) and low-income developing countries ?

2. To what extent are manual methods of data collection sufficient for condition surveys needed for planning and programming LVR rehabilitation and maintenance activities , in particular unpaved rural roads? Are automated surface roughness measurements appropriate for such roads?

3-What would be the minimum equipment requirements for data collection and management for LVR assets—e.g. GPS tools/cameras, automatic distance/altitude measuring equipment ,computers and data storage devices etc.

4- Is there a need among the LVR community to develop a standardized data collection, recording and analysis system (open source) for managing LVR assets, based on the three guiding principles noted in the abstract.

PRESENTERS' STATEMENT: This work is still in progress, and has not been submitted for presentation or publication at another meeting. The objective of this work is to explore practical ways for collecting and managing data for managing LVR assets.

ASSESSING BELLS3 EQUATION IN PREDICTING ASPHALT LAYER TEMPERATURE PROFILE BASED ON THE LATEST LTPP FWD TEMPERATURE DATA

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ABSTRACT:

BELLS3 equation was devised to rapidly estimate transient temperature profile within an asphalt layer based on infrared surface temperatures during FWD testing. BELLS3 equation is a statistical model that was developed based on LTPP FWD temperature data collected between March 1994 and October 1996.

The primary advantage of BELLS3 equation lies in its simplicity. However, comparisons between BELLS3-predicted and measured pavement subsurface temperatures based on the latest LTPP FWD temperature data show that BELLS3 does not perform equally well with respect to the time of interest, e.g., the absolute error between predicted pavement subsurface temperature and measured one is as small as 0.1°C at a certain time, and as large as 13.3°C at a different time. This motivates us to conduct the proposed study.

The primary purpose of this study is to assess BELLS3 equation in estimating asphalt layer temperatures based on measured surface temperatures by using the latest LTPP database. In particular, we are interested in drawing such a conclusion as "BELLS3 equation offers relatively better results for asphalt layer temperature prediction for the time period between time A and time B in the LTPP West region." This kind of statement is not only useful to inform BELLS3-users when BELLS3 equation performs relatively better, but also desired for the following scenario:

> Supposing pavement subsurface temperatures were not measured during FWD testing, and some analytical or numerical approach will be employed to predict pavement temperature profiles based on measured surface temperatures at the time of FWD data collection, BELLS3 equation will provide a practical way to estimate initial asphalt layer temperature profile for the time lying in the interval [A,B] because initial pavement temperature profile is indispensable to temperature prediction.

One state from each of the four LTPP geographic regions has been selected, and total 1,975 temperature differences between BELLS3-predicted and measured pavement subsurface temperatures were generated. Initial analysis of these temperature difference data suggested that, in general, BELLS3 performed best from 10 am to 11 am, followed by 12 am to 1 pm and 1pm to 2 pm with average errors being -1.7°C, -1.7°C, -1.9°C; and standard deviations 1.9°C, 2.3°C, 2.9°C, respectively, where error = predicted temperature –measured temperature.

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

1- How many states from each of the four LTPP geographic regions are needed in this study? And what's the sample size in order to draw the sample conclusion above, e.g., 2,000 or 5,000?
2- What should be the suitable length of time frame included in the sample conclusion above, e.g., 1 hour (9 am to 10 am) or 2 hours (9 am to 11 am)?
3- Is this work meaningful to the pavement community? If yes, what would you expect from this study?

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

SMOOTHNESS SPECIFICATION FOR FREEWAY AND URBAN HIGHWAY PAVEMENTS IN TAIWAN

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ABSTRACT:

Pavement roughness has a great impact on road users. The main objective of the work is to examine whether the present Taiwanese smoothness specification thresholds are appropriate or not. Public Construction Commission suggests that the IRI threshold be 1.75m/km for freeway and 3.50m/km for non-freeway pavements when using inertial profilers as acceptance equipment and IRI as acceptance index. However, these recommendations were not based on objective criteria, and are not currently used in practice. The current state-of-the-practice in Taiwan is to use the acceptance specification corresponding to the 3m-straightledge equipment. The threshold is 2.40 mm for freeways and 2.60 mm for non-freeways. In this research, specifications for freeways were analyzed using the roughness value for newly maintained pavements and compared to international specifications. For non-freeways (urban highways), PSD analysis was conducted in addition to the above criteria.

Two existing freeways were considered: National Freeways No. 1 and No. 3. Both existing and newly maintained sections were analyzed. For urban highways, only newly maintained sections from Taipei City highway and New Taipei City highway were considered.

In analyzing freeway data, the M-E PDG software was used to simulate the variation of service life by entering different initial IRI values (1.60, 1.45, 1.30, 1.15, 1.00, 0.85, 0.70 and 0.55 m/km). These are entered as IRI_0. The M-E PDG results showed that the pavement service life remains almost constant when IRI_0 is below 1.30 m/km. Using the concept of partitioned pricing, the IRI limits for the incentive zone, full payment zone and disincentive zone were selected as 1.30 m/km, 1.46 m/km and 1.75 m/km for freeways. If using 3m-straightedge standard deviation as acceptance index, limits for the incentive zone, full payment zone and disincentive zone were 1.36 mm, 1.51 mm and 1.78 mm.

For urban highway data, the reference spatial frequency was set as 0.1 cycle/m in the PSD method. The PSD value was correlated to IRI using regression. Based on ISO 8608 and literatures, Road Class C IRI criteria were used as thresholds. The IRI limits for the incentive zone, full payment zone and disincentive zone were selected as 2.94 m/km, 3.50 m/km and 4.40 m/km. If using 3m-straightedge standard deviation as acceptance index, it is recommended to use the current specification of 2.60 mm.

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

1. The new thresholds are still high compared to the specifications used by US SHAs; any feedback on implications of these thresholds?

2. Is IRI the right index for urban environment and are the proposed IRI thresholds for urban highways reasonable? The existence of roughness features (e.g., drains, sudden grade changes, crowns, etc.), lower operating speed, and stop and go traffic make it hard to interpret the IRI summary index in terms of user perception in urban environment. What are the implications from the above? Any feedback on this would be appreciated.

3. Is M-E PDG applicable for countries other than the US, like Taiwan?

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

TEN YEAR CASE STUDY OF PERFORMANCE EVALUATION OF ASPHALT PAVEMENT WITH FLY ASH STABILIZED FULL DEPTH RECLAIMED BASE

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ABSTRACT:

This study addresses the long term performance of environmental benign technology for highway construction. Ten year performance of cold in place recycling of a test section in Wisconsin was evaluated. This section was reconstructed with full depth reclamation in 2001 where the existing asphalt layer is pulverized along with the base layer to form a new base layer. To increase the support of the newly formed base Class C fly ash was added to benefit from its self cementing properties. The analysis of the pavement was conducted through visual distress survey of pavement condition and application of non destructive testing using the falling weight deflectometer to quantify surface characteristics and mechanical stability over a period of ten years. The results show improvement of the structure stability of the pavement sections over the first three years of the service. However, it was also found that starting the sixth year after the construction, the modulus of base began to decline, when compared to the third year results. It is believed that freeze-thaw effects may have reduced the strength of the stabilized base course. A visual distress survey found that top-down cracking from the asphalt surface began to occur three years after the construction as the predominant distress, followed by thermal cracking and rutting. The excessive rutting that occurred in the last three years of service is believed to be a side effect of excessive surface cracking causing magnification of the freeze thaw effect of the base layer. The stiff base could be a reason for the top-down cracking and that friction between the HMA layer and base contributed to the thermal cracking. The M-E Program showed that increasing the surface layer thickness could eliminate the early surface cracking observed. This study shows, although base stabilization is important, appropriate pavement design to accommodate the increase in base stiffness is also as important.

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

1. What are the design considerations for flexible pavements with stiff bases?
2. What are the approaches to identify the causes for premature cracking in presence of stiff bases?
3. Based on coring data, the premature longitudinal cracking was shown to be top down cracking. Do you have similar pavement monitoring data? How do those pavements perform?

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

EVALUATION OF TEXAS PAY ADJUSTMENT SYSTEM FOR HMA AND RIDE SPECIFICATIONS OF CONCRETE AND ASPHALT PAVEMENTS

Prasad Buddhavarapu, Andre De Fortier Smit, and Jorge A Prozzi
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ABSTRACT:

Texas Department of Transportation (TxDOT) currently uses a pay adjustment factor (PAF) system for production and placement of Hot Mix Asphalt (HMA) and ride quality of HMA and concrete pavements that has been in existence for almost a decade. A reward/penalty of a contractor according to the current PAF system is based on the offset to the average contractor's performance, which was calculated based on the historical data reflecting contractor's capabilities. However, the average performance of contractors has arguably been raised in the past few years due to the improved quality control with the advent of modern equipment in pavement construction. Consequently, current PAFs may be skewed resulting in PAFs that are mostly greater than 1.0, that is, resulting in bonus payments for the vast majority of projects.

TxDOT is sponsoring a research project in an effort towards validating the existing pay adjustment system and to adjust it, if necessary, based on performance considerations. The study team developed a comprehensive database by integrating construction quality and pavement management databases. The database summarizes information from about 1,500 surface projects across Texas and assisted the researchers in thoroughly understanding Texas pavement construction contractors' behavior and examining the relationship between measurable construction quality control parameters and corresponding pavement performance. A detail critique on the existing statistical-based pay adjustment system including both merits and demerits will be presented. In addition, the on-going research on developing causal relationships between construction quality control parameters and pavement performance with a special emphasis on statistical modeling techniques will be discussed. The study team is currently exploring various performance criteria (dependent variable in the performance models) such as deterioration rate based on surface roughness, accumulated cracking and rutting at the end of a three-year period starting from the construction date, and others. Project-level variation of construction quality and its influence on future performance is also being examined.

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

1- Has anyone in the audience been involved in the development of Pay-Adjustment Factors or a Bonus/Penalty System based on actual field data?
2- Keeping in mind that we are trying to use field data (QC/QA and field performance), do you have any advice or recommendations in terms of performance criteria. We are facing many challenges such as missing data, accuracy (or inaccuracy) or data within the pavement management system, etc. Data variability is a significant problem: shall project level variability be incorporated into the pay adjustment system?
3- Could you provide us with any criticisms or feedback in terms of the statistical modeling techniques proposed?

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

ASCE-LTPP International Contest Winner, Challenge Category

CLASSIFICATION OF FEATURES OF PAVEMENT PROFILES USING EMPIRICAL MODE DECOMPOSITION

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ABSTRACT:

The LTPP database contains surface profile data for numerous pavements that is used mainly for computing IRI. In order to obtain more information from these surface profiles, a Hilbert-Huang Transform (HHT) based surface profile algorithm was developed to analyze LTPP field road profile data to extract smoothed, consistent profiles from noise-filled data sets using empirical mode decomposition (EMD). The application of this algorithm to concrete surface profiles resulted in the successful separation of the intrinsic mode functions contained within the section data for several LTPP pavement sections in Wisconsin, Arizona, and Utah LTPP. Arizona LTPP slab profiles were shown to contain consistent "curl" deflections for the same slab over a 20 month time-span and during both winter and early fall seasons. The consistent slab shape is likely due to built-in curl. Built-in curl is permanent concrete slab deformation at early pavement age.

By categorizing and separating intrinsic mode functions contained with LTPP section profile data, the results can be used to analyze specific portions of LTPP surface profile data in order to improve concrete pavement models in the future. Currently, no comprehensive procedure exists to model or estimate the long-term, effective built-in curling. The developed surface profile algorithm is proven universal and can be applied to any LTPP section profiles for analysis.

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

1. Is it clear that there is a difference between a Hilbert-Huang Transform and a Fourier Transform?

2. What is it about this presentation or paper that stands out the most? Or is the most applicable/useful to the LTPP group?

3. Being a universal tool, are there other applications this transform can be used for?

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

MULTIPLE RUT EVALUATION METHODS AVAILABLE FROM HIGH RESOLUTION TRANSVERSE PROFILES

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ABSTRACT:

Well over a million miles of rutting information is collected annually across the United States and the world. With the current state of the practice equipment being used, a complete transverse profile with over 1,000 points is being measured. A range of algorithms are then developed to try to mimic manual data collection procedures. However, there are many ways to view and evaluate these transverse profiles to determine a rut depth.

To ensure accuracy and multiyear repeatability in rut data, along with flexibility to cater to different client requests, the rut processing is separated into three steps:

- Filtering the Transverse Profile: Smoothing of the data to obtain the optimal profile to be considered in the rut depth analysis.
- Rut Calculation: Measurement of the deepest rut depth possible (using wire or straight edge methods) at each point along the profile.
- Rut Selection: Selection of the representative value for the left and right rut.

With advent of systems like LRMS/LCMS which capture the transverse profile at high resolution there can be a discrepancy between the mental image of where ruts are expected and the representation of ruts as the deepest point on the road profile with respect to a wire or straight edge. In particular if the road profile is having a dominant single concave shape, both left and right rut will be located very close to the center of the profile. However, individuals performing manual measurements on the same site may have inherent tendency to select the deepest rut in the wheelpath portions of the lane.

With the detailed profiles and the availability of computers, it is possible to consider many possible options when determining rut depth such as different length straight edges, considering points outside the current lane, considering rut depth locations outside of the wheelpath, and considering rut locations based on adjacent profiles. However, with the availability of all of these options it becomes unclear what the best methodology should be to determine which of these rut depth value should be reported.

Traditionally for a given section of the road, each profile is treated independently during rut selection and the selection is based solely on the maximum rut depth. This criterion makes the selection step sensitive to various factors like sensor noise, driver wander, debris, and presence of drop-off/curb artifacts in the profile. This in turns can lead to the rut position having significant variation between consecutive profiles.

With the large variation in analysis options and the ability to apply a rut position path along the direction of travel many different rut depth values can be determine from the same transverse profile. It is important for agencies to understand this variation and to consider requiring more advanced position smoothing techniques in order to provide consistent results regardless of the equipment or analysis software being used.

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

1. Is it more important to be repeatable year after year or to be strictly accurate at any given location along the road (i.e. a single transverse profile)?
2. How are agencies performing manual field measurements to compare automated measurements for accuracy?
3. It is more important to measure rutting in the wheelpath or deformation anywhere in the lane?
4. Based on the diversity of real-world cross-sections, which locations should cross-slope be measured from to match your expectations?

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

THE CONTRIBUTION OF MICRO- AND MACRO-TEXTURE TO THE SKID RESISTANCE OF PAVEMENTS

Pedro A. Serigos, André de Fortier Smit, and Jorge A. Prozzi
The University of Texas at Austin
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ABSTRACT:

There is currently a high demand for safer roads and a need for more effective methods for monitoring pavement safety parameters at a network level. Skid resistance is an important characteristic of the pavement surface to minimize the number of road accidents. The mechanisms involved in the activation of the frictional force required for a safe braking of the vehicle depend on both the macro-texture (wavelengths between 50mm to 0.5mm) and the micro-texture (wavelengths less than 0.5mm) of the pavement surface. The state-of-the-practice methodologies commonly used for measuring pavement texture account only for macro-texture, which alone might not be sufficient to effectively characterize skid resistance. This study was initiated with the objective of exploring different ways to characterize both the micro- and the macro-texture of pavement surfaces aiming to explain the pavement friction coefficient by means of its texture components and to assess the separate contribution of each to skid resistance.

The experiment will be designed to cover a range of friction coefficient values as wide as possible including different cases for each possible combination of fine and coarse macro-texture and smooth and sharp micro-texture. The surfaces to be analyzed in the study will include actual pavement surfaces as well as other surfaces presenting particular characteristics. A series of tests will be performed on each surface to characterize its texture and to measure its friction coefficient. The friction coefficient will be measured for both the dry and wet condition of the surface at lower speeds using a British Pendulum Tester (BPT), and at higher speeds using a Dynamic Friction Tester (DFT).

The texture will be characterized by analyzing 3D scans (i.e. the x-y-z coordinates) of the surface. The 3D scans will be obtained by using two different pieces of equipment: the AMES Laser Texture Scanner (LTS), capable of capturing wavelengths greater than 0.03mm and up to 100mm, and the Texas Department of Transportation (TxDOT) 3D Texture Scanner (TTS), which captures wavelengths greater than 0.2mm and up to 200mm. The LTS uses a laser sensor to measure the distance to each coordinate of the surface whereas the TTS uses a 3D camera and a laser to scan lines of the surface profile. In addition, a Circular Texture Meter (CTM) will be used to characterize macro-texture. Different parameters will be computed from the scanned surfaces in both the spatial and in the frequency domain. These parameters will be used to develop different regression models to explain the surface friction coefficient for each condition.

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

1. A pavement surface with coarse macro-texture and sharp micro-texture is expected to present high skid resistance whereas the opposite is expected in the case of a pavement with fine macro-texture and smooth micro-texture. If instead there were two pavement surfaces, one with coarse macro and smooth micro and another with fine macro and sharp micro, which pavement would you expect to present higher skid resistance under dry and under wet conditions? What would you expect for the case of slow and high speed?

2. The range of wavelengths defined for micro and macro-texture in this study have been used in several previous studies and it is commonly referenced in the literature. However, do you believe that the grouping of the wavelengths of the surface under these categories is the best approach for describing the effect of texture on skid resistance?

3. Do you know of other methods or equipment that scan 3D surfaces at the micro-level in the field? What parameters do you use or do you know of to characterize micro-texture?

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