PAVEMENT PERFORMANCE DATA ANALYSIS FORUM
Sponsored by the TRB Data Analysis Working Group
Jorge A. Prozzi, The University of Texas at Austin, Chairman
A. Robert Raab, TRB Senior Program Officer
January 21, 2012
Hampton Room, Omni Shoreham Hotel, Washington, D.C.

0900	Call to Order
0900-0930	Chairman's Welcome Staff Report
0930-1000	**DEFINING PAVEMENT CONDITION** Amy Simpson[1], Nastaran Saadatmand[2], and Jonathan Groeger[1] [1] AMEC E&I, Dallas Texas, USA [2] Federal Highway Administration, US Department of Transportation, Washington, DC, USA
1000-1015	Presenter's Questions and General Discussion
1015-1030	Morning Break
1030-1100	**POST-CONSTRUCTION MONITORING OF PAVEMENT PERFORMANCE ON A PERFORMANCE SPECIFIED MAINTENANCE CONTRACT** Gerhard van Blerk New Zealand Transport Agency, Tauranga, New Zealand
1100-1115	Presenter's Questions and General Discussion
1115-1145	**STATISTICAL MODELING OF RESILIENT BEHAVIOR OF UNBOUND GRANULAR MATERIAL** Elsabe van Aswegen Ndodana Consulting Engineers Pty Ltd, Pretoria, South Africa
1145-1200	Presenter's Questions and General Discussion
1200-1330	Mid-Day Break
1330-1400	**SELECTION OF PREOVERLAY REPAIR METHODS FOR ASPHALT OVERLAY ON ASPHALTIC AND COMPOSITE PAVEMENTS IN WISCONSIN** Haifang Wen Washington State University, Pullman, Washington, USA
1400-1415	Presenter's Questions and General Discussion
1415-1445	**INTERIM REPORT ON THE FORENSIC TESTING AND EVALUATION OF THE LONG TERM PAVEMENT PERFORMANCE (LTPP) SPECIFIC PAVEMENT STUDIES (SPS-9A) EXPERIMENT IN CONNECTICUT** Adam Zofka University of Connecticut, Storrs, Connecticut, USA
1445-1500	Presenter's Questions and General Discussion
1500-1530	**NEW DYNAMIC MODULUS PREDICTIVE MODELS FOR HOT MIX ASPHALT MIXTURE** Maryam S. Sakhaeifar[1] and Y. Richard Kim[2] [1] Auburn University, Auburn, Alabama, USA [2] North Carolina State University, Raleigh, North Carolina, USA
1530-1545	Presenter's Questions and General Discussion
1545-1600	Afternoon Break
1600-1630	**EVALUATION OF AUTOMATIC PAVEMENT DISTRESS EQUIPMENT** Pedro Serigos, Mike Murphy and Jorge A Prozzi The University of Texas at Austin, Austin, Texas, USA
1630-1645	Presenters' Questions and General Discussion
1645-1715	**MONITORING THE PERFORMANCE AND RUNOFF WATER QUALITY OF ASPHALT-RUBBER PERMEABLE FRICTION COURSES** Katie A. Larsen and Michael Barrett The University of Texas at Austin, Austin, Texas, 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
Washington, DC 20001
Telephone: 202-334-2569
Fax: 202-334-3471
Email: rraab@nas.edu

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

DEFINING PAVEMENT CONDITION

Amy Simpson[1], Nastaran Saadatmand[2], and Jonathan Groeger[1]
[1] AMEC E&I, Dallas, Texas
[2] Federal Highway Administration, US Department of Transportation, Washington, DC

ABSTRACT:

Asset management is one of the key components of highway engineering as our infrastructure continues to age. Each State has its own method for defining pavement condition within their borders with very few States electing to use the same measure. These varying methods make it difficult to evaluate pavement condition of the national highway system across the nation as a complete assessment of infrastructure health.

At present, the most widely used measure of pavement condition is the International Roughness Index (IRI). It is recognized that IRI measures only a single aspect of pavement condition. It has been widely recognized that some pavement distresses will contribute to the pavement roughness while others contribute little if any.

The Federal Highway Administration initiated a project to review methods for evaluating pavement condition. As part of this project, a pilot study was conducted along the Interstate 90 corridor through South Dakota, Minnesota, and Wisconsin. The study reviewed data from the Highway Performance Monitoring System (HPMS), the States' pavement management systems (PMS), and field data specifically collected for the project. These field data included cracking as defined for HPMS, roughness, rutting, and faulting. Additionally, the rolling wheel deflectometer (RWD) was used to collect data along the project. The field data were also reviewed to estimate the Pavement Condition Index (PCI) for 150 miles of the approximate 850-mile corridor.

This study reviewed various pavement condition measures used by FHWA and the State agencies. Condition measures evaluated included IRI, PCI, HPMS, and those used by the States. The collected data were reviewed to identify similarities and differences between each data set. The data were also reviewed to compare how condition differs between opposing directions of travel and the results of these comparisons 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- Are the differences observed in the condition measures expected?

2- How are States tracking maintenance and rehabilitation activities and how are these incorporated in observations made from pavement management data?

3- What sorts of measures should be considered with respect to the RWD data collected?

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

POST-CONSTRUCTION MONITORING OF PAVEMENT PERFORMANCE ON A PERFORMANCE SPECIFIED MAINTENANCE CONTRACT

Gerhard van Blerk
New Zealand Transport Agency
Tauranga, New Zealand

ABSTRACT:

This presentation deals with insights into pavement performance that were gained during analysis of pavement rehabilitation on the performance specified maintenance contract (PSMC) on a road network in New Zealand. This network consists of 450 km of low volume roads in a high rainfall area. The PSMC001 contract started in 1999 and is now in its ninth year of operation. The contract offered unique opportunities for the client (represented by the New Zealand Transport Agency) and the contractor (Transfield Services New Zealand), to cooperate and innovate in the interest of best practice. The presentation will highlight the methods used to analyze rehabilitation performance using annual high speed survey data (rutting, roughness and skid resistance) as well as detailed project level post construction Falling Weight Deflectometer (FWD) data. Key objectives of the analysis are to determine the accuracy of post-construction evaluation and approval methodologies, as compared to actual observed medium term performance. The presentation will highlight key insights challenges in the interpretation and use of the in-service performance data.

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

1-- One of the aspects of the analysis of performance data was the evaluation of post-construction FWD data to assess compliance to contract performance measures. This created some problems related to the interpretation of FWD backcalculation data (different analysts would get different results). Our approach to contain this issue was to develop a set of guidelines for FWD backcalculation, based on research and best practice. Another approach may have been to simplify the process and base acceptance only on deflection bowl parameters. I would like to hear from attendees' that have worked with the analysis of FWD data related to acceptance criteria.

2- In the analysis of our set of long term performance data, we found it difficult to correlate FWD parameters, with functional parameters such as roughness and rutting. At this stage of our analysis, it is clear that some form of calibration of mechanistic design methodology and criteria is needed. We are uncertain how to proceed to perform such a calibration, given the available data scope (as presented). I would like to know if other attendees who were faced with a similar situation in which mechanistic design criteria needed to be calibrated within a project context (as opposed to a long term research situation). For example, is there a methodology for achieving such a calibration?

3- My presentation will show our devised graphical formats for summarizing performance of rehabilitation projects and sub-networks, and for tracking network deterioration over time. I would like to hear suggestions for improved data mining practices (e.g. are there performance aspects we may be missing in our data presentation formats?), given the available information on this ten year contract (as explained in the presentation).

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

STATISTICAL MODELING OF RESILIENT BEHAVIOR OF UNBOUND GRANULAR MATERIAL

Elsabe van Aswegen
Ndodana Consulting Engineers Pty Ltd
Pretoria, South Africa

ABSTRACT:

The resilient modulus (M_R) is commonly used to characterize the behavior of unbound granular material under repeatedly applied traffic loading. However, M_R is not constant and influenced by a number of parameters. Various models exist for the determination of the resilient behavior based on mainly the output of tri-axial laboratory testing. Tri-axial laboratory testing in South Africa is a specialized field, with only a handful of laboratories able to conduct the tests. An investigation where basic engineering properties, such as grading, laboratory compaction characteristics and optimum moisture content are incorporated into a resilient behavior model, to quantify the effect of basic material properties on the resilient response of unbound granular materials was conducted. Data from tri-axial laboratory tests on materials originating from the United States Long Term Pavement Performance (LTPP) test sections are combined with basic engineering parameters of typical unbound granular material through a statistical modeling process to develop a model for the prediction of the resilient behavior that can be used as a practical predictor of the expected behavior during Level 2 and/or Level 3 Mechanistic Empirical Pavement Design analysis. The work illustrates the process and the potential to develop a general resilient behavior model for unbound granular materials incorporating saturation effects.

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

1-Which basic engineering parameters do you consider to be the most important? (I.e. parameters that are derived from basic laboratory testing such as sieve analysis, Atterberg Limits, etc.)

2-Do you think statistical process to evaluate the data is correct?

3-Are the results obtained by the model too basic for Level 2 and/or Level 3 analysis?

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

SELECTION OF PREOVERLAY REPAIR METHODS FOR ASPHALT OVERLAY ON ASPHALTIC AND COMPOSITE PAVEMENTS IN WISCONSIN

Haifang Wen
Washington State University, Pullman, Washington

ABSTRACT:

Asphaltic concrete overlay is a commonly used rehabilitation technology for existing distressed asphaltic pavements or concrete pavements. The condition and distresses of the existing pavements show large variability when they are selected for asphaltic overlay. Current practice regarding the selection of preoverlay repair is based on the experience of designers and field engineers. As a result, the performance and quality of asphalt overlays vary significantly. Therefore, there is a need to develop a guideline to select the most cost-effective preoverlay repair methods. In this study, a database that includes 338 historic asphaltic overlay projects is developed. The traffic information, preoverlay repair methods, pavement structure, preoverlay and overlay performance, and functional class of the highway are collected for analysis. The pavement performance data was extracted from Pavement Information Files (PIF). Other information was collected mainly from the as-built plan.

The service lives of the asphalt overlays, based on each repair method, were predicted by analysis of the development of the historic Pavement Distress Index (PDI) data. The agency and user costs over the service lives were analyzed. The results of the study indicate that: (1) the preoverlay repair method that results in a longer service life is not necessarily the most cost-effective choice; (2) surface patching quantity has little effect on the cost analysis results for asphaltic concrete (AC) pavement, but the quantity of the base patching has a significant effect on the cost analysis results for composite (COMP) pavement (concrete pavement that has been overlaid at least once); (3) the effectiveness of the preoverlay repair methods depends on the type and severity of the existing pavement distresses.

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

1- How to model the development of the pavement performance data, such as the Pavement Distress Index (PDI), with respect to the pavement age, therefore the pavement performance and service lives could be predicted properly?

2- How to deal with the effect of the maintenance on the development of the PDI data properly?

3- It is possible that doweled concrete base patching was preferred for severely distressed composite pavement and AC base patching was preferred for relatively slightly distressed composite pavement in practice. In this case, can we still compare the effectiveness of these two methods, and how?

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

INTERIM REPORT ON THE FORENSIC TESTING AND EVALUATION OF THE LONG TERM PAVEMENT PERFORMANCE (LTPP) SPECIFIC PAVEMENT STUDIES (SPS-9A) EXPERIMENT IN CONNECTICUT

Adam Zofka
University of Connecticut, Storrs, Connecticut

ABSTRACT:

A comprehensive forensic study is being conducted by the Connecticut Department of Transportation (ConnDOT) in partnership with the University of Connecticut to better understand the differences in performance from six test sections installed in 1997 as part of the FHWA-LTPP Specific Pavement Studies Experiment (SPS-9A): " Validation of SHRP Asphalt Specifications and Mix Design and Innovations in Asphalt Pavements – Superpave Validation" and monitored until rehabilitation and experimental close-out in 2009.

The six test sections on CT Route 2 were comprised of three control sections as part of the required LTPP program and three supplemental sections utilizing twenty percent recycled asphalt pavement (RAP). This experiment represented Connecticut's first large-scale Superpave project as well as the first HMA project in the state where Quality Control was the Contractor's responsibility. These test sections are unique in that an abundance of high quality data are available including: LTPP scheduled testing, comprehensive materials and traffic loading data, availability of original asphalt binder samples from the Materials Reference Library (MRL) and close-out falling weight deflection (FWD) and materials samples. Approximately 200 cores were strategically extracted during the 2009 close-out. In addition, ConnDOT Photolog, pavement images and other pavement-related data were collected on an annual basis.

This presentation will provide information on the design of the forensic testing plan; methods developed to track cores, field data and test results; and summary and results from testing to date. The ongoing research effort includes the close-out testing recommended by the FHWA-LTPP Regional contractor as well as advanced forensic testing methods such as fracture energy testing, aging investigation using the FT-IR and interlayer shear bond testing. Discussion will include the challenges of conducting forensic testing on limited amounts of core samples and interpretation of results. In addition discussion will include how material and performance data collected in this project will serve as preliminary data for work focused on verification and validation of the M-E PDG models for pavements in Connecticut.

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

1- How to check and ensure the quality of performance data? How to manage the performance data (what tools)? Is our database properly set up and sufficiently comprehensive?

2- How to decide the priority of experimental/forensic testing in case of limited amount of core samples?

3- What are the best approaches to analyze performance data and relate it to multi-variable laboratory data?

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

NEW DYNAMIC MODULUS PREDICTIVE MODELS FOR HOT MIX ASPHALT MIXTURE

Maryam S. Sakhaeifar[1] and Y. Richard Kim[2]
[1] Auburn University, Auburn, Alabama
[2] North Carolina State University, Raleigh, North Carolina

ABSTRACT:

The rheological properties of bituminous materials provide a fundamental understanding of the behavior of these materials. These properties play important roles in the selection of paving materials, and in the analysis and design of asphalt pavements. This study presents a fundamental modeling framework for prediction of dynamic modulus (|*E**|) of hot mix asphalt (HMA) mixtures based on viscoelastic principles and the time-temperature superposition concept. In order to overcome the limitations of an empirical approach, a series of models are developed in this study for the phenomenological characterization of asphalt mixtures with a wide range of material properties under potentially needed test conditions. These models are composed of various formulations for the dynamic modulus mastercurve and are calibrated for all the desired temperatures as well as the individual temperatures that are recommended in the American Association of State Highway and Transportation Officials (AASHTO) TP62-03 test protocol. In these models, the complex modulus mastercurve is described by a sigmoidal function that has been calibrated and parameterized after identification of the dominant variables and appropriate censorship of the test data. Thus, the models developed in the study represent a complex case of characterizing viscoelastic materials by making the best use of available modeling techniques. The new dynamic modulus models were developed and tested for accuracy and rationality, and are found to estimate the dynamic modulus of HMA mixtures with a very high level of accuracy and rationality over the full range of potential conditions. The databases used for this purpose were assembled from existing national efforts and from North Carolina State University and consist of measured modulus values from both modified and unmodified mixtures from numerous geographical locations across the United States. The set of closed-form models developed in this research study has practical implications beyond the current study. The most direct use of these models is the prediction of the dynamic modulus values for the *Mechanistic-Empirical Pavement Design Guide* (*MEPDG*) or other structural/performance analyses of asphalt concrete pavements. These models are shown to estimate more accurate and less biased dynamic modulus values than those predicted by the model used in the current MEPDG. Therefore, these models are strongly recommended for the practical implementation of pavement performance analysis.

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

1- What are the additional works to extend the applicability of the modeling framework to wider material properties?

2- How accurate do the |E*| predictions need to be?

3- Can predicted modulus values be effectively used in pavement design and analysis procedures?

PRESENTERS' STATEMENT: This work is still in progress. This presentation is a summary of two papers that have been submitted to two different journals, but has not been published yet.

EVALUATION OF AUTOMATIC PAVEMENT DISTRESS EQUIPMENT

Pedro Serigos, Mike Murphy and Jorge A Prozzi
The University of Texas, Austin Texas

ABSTRACT:

The Texas Department of Transportation (TxDOT) has developed a state-of-the-art 3-D system for rut measurements. The development of a system to more accurately measure and quantify roadway cracking is also currently underway. These systems will allow the assessment of road performance at both the network- and project-levels and potentially eliminate the need for manual visual assessments to rate pavement distress. Furthermore, the improved accuracy of these systems, which can measure distress while traveling at highway speeds, will eliminate any subjective elements in visual rating and can lead to more consistent and reliable data.

The improved accuracy of the systems under development will significantly impact the TxDOT Pavement Management Information System (PMIS). PMIS is used to monitor statewide pavement condition and to evaluate the effectiveness of pavement maintenance and rehabilitation treatments. PMIS is also used to report progress towards the annual statewide pavement condition goal (90 percent of lane miles in "good" or better condition). Based on preliminary reports from other State agencies, adoption of the new system may indicate an "apparent" increase in overall pavement rutting. Consequently, current algorithms and utility functions used in PMIS will require revision to reflect the improved accuracy of these new systems.

To ensure the rational adoption of the new systems, TxDOT have initiated this project to allow an independent assessment of the accuracy and repeatability of the new automated distress data measurements. The TxDOT system will be compared to other similar systems from a variety of different vendors to identify the best system for automated distress that can be implemented by TxDOT. The project will have two 2 phases. Phase 1 will evaluate the rut measurements; and Phase 2 will evaluate automated distress data measurements including longitudinal, transverse, and alligator cracking, failures, spalled cracks and punchouts.

In Phase 1, a factorial experiment is proposed to test different pavements including those with hot-mix, cement concrete and surface treatments representing the population of pavement textures apparent on the Texas road network. The accuracy and repeatability of rut measurements using a 6ft straight edge will be compared to that of TxDOT system as well as other five vendor systems. The research will also evaluate the impact to PMIS scores and recommend any necessary changes to the utility factors due to the new rut depth measurements.

In Phase 2 a survey will be done to determine the current state of practice for automated distress measurements by different highway agencies in the US and abroad. The system developed by TxDOT will be compared to other viable systems towards recommendations for implementation of the best system to improve the accuracy and repeatability of condition data measurements. Likewise, the impact to PMIS scores will be investigated and recommendations made regarding changes to utility factors, if necessary, to reflect the condition measurements with the new system.

During this presentation, we will cover some of the preliminary results of Phase 1 for your consideration and comments and we will also present the work plan for Phase 2 for your feedback and recommendations.

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

1- Although the measurement of surface rut depth seems straightforward, we encountered numerous occasion where agreeing what rut was, was challenging. For example: rutting in the middle of the lane, rutting in the highway centerline, effect of macrotexture, wide cracks, how wide is a rut, effect of patches, effect of partial seal: how are all these accounted for by other agencies?

2- What are the protocols used by other agencies to measure cracking and what is the ground truth against whish measurements are compared? Do agencies use LTPP protocols or agency's own definitions? What about outside US?

3- Most automatic distress equipment has the ability to produce a "crack map". Is there any protocol to develop an accurate crack map manually? Is there any commercially available software that can process digital pictures to obtain a crack map?

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

MONITORING THE PERFORMANCE AND RUNOFF WATER QUALITY OF ASPHALT-RUBBER PERMEABLE FRICTION COURSES

Katie A. Larsen and Michael Barrett
The University of Texas at Austin, Austin, Texas

ABSTRACT:

Two asphalt pavement applications that separately offer benefits may, when combined into one application, result in a side effect that could potentially adversely impact the environment. Specifically, there is increasing use of tire-rubber in hot-mix asphalt and increasing use of permeable friction course (PFC) or open-graded friction courses (OGFC) as pavement surface layers. The addition of tire-rubber to PFC mixtures seems like a win-win because the properties of the asphalt mixture are improved and the disposal of tires into landfills minimized. However, one concern about the use of tire-rubber in pavements is the potential for it to act as an additional source of pollutants. Since tire rubber contains zinc compounds and some laboratory tests have shown tires to leach zinc, the inclusion of tire-rubber may result in higher zinc concentrations in stormwater from pavements with substantial tire-rubber content. The objective of this study is to analyze the performance of PFC surfaces and to monitor water quality data from Austin (Texas) and California highway sites to determine whether asphalt-rubber PFC layers act as a source of zinc in runoff and to evaluate the significance of those observed zinc levels in comparison to PFC applications without tire rubber and to environmental surface water quality criteria. Water quality measurements taken on a section of highway in Austin indicating elevated levels of zinc in runoff from PFC with crumb rubber compared to PFC without crumb rubber reveal a potential mechanism for the PFC, despite its stormwater filtration benefits, to be a source of zinc, a stormwater pollutant. Additional observations in California also reveal a pattern of rubberized hot mix asphalt surface layers having significantly-higher zinc levels compared to pavements without rubber materials. Some of the measured zinc concentrations exceed state and EPA surface water quality criteria. The study will continue to monitor water quality with time and evaluate the performance.

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

1. In addition to monitoring runoff, we are also monitoring permeability, noise, texture and friction of permeable friction course surface layers. Is anyone in the audience conducting (or aware of) similar projects? We are willing to share experiences.

2. Some laboratory tests show that zinc is not necessarily leached from pavement layers containing zinc; however, field tests of stormwater from pavements with asphalt-rubber show elevated levels of zinc. What could explain differences between lab and field results? Tire-rubber is implicated in the observed higher concentrations of zinc; however, leaching of neat or modified binders may also be a potential source. What are plausible mechanisms that would explain elevated zinc concentrations in pavements with asphalt-rubber? Could there be mechanisms where the chemical content of the binder influences zinc concentrations?

3. This study focuses on how well the pavement performs in the field in the quality of stormwater runoff. Overall, PFC has been shown to improve stormwater quality (with the exception described in this study). How do stormwater quality considerations enter into mix design and pavement material selection decisions? If not or minimally considered, what would be the best ways to facilitate consideration of pavement mixture impact on stormwater quality?

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