

RESEARCH PROJECT SUMMARY

January 2015



NATIONAL ASPHALT
PAVEMENT ASSOCIATION

ASPHALT. AMERICA RIDES ON US.

Why Research?

Dear NAPA Member,

In little less than two years, NAPA, under the leadership of its members, has conceived, built, and launched a solid framework for conveying the asphalt advantage to our customers and the driving public. We have created credible, compelling programs based in sound science and engineering research, persuasive marketing and communications materials, and effective deployment strategies that holistically examine the pavement marketplace.

With an eye on enhancing areas of strength while improving product quality, the Pavement Economics Committee (PEC) leads the industry's research initiatives. Since its inception in 2012, 15 research and advocacy projects have been undertaken, spanning six areas of competition — pavement design, pavement type selection, legislative, quality and competitiveness, preservation, and sustainability. Through this research, the industry can continue to bring a superior product to market while addressing technical challenges and monitoring legislative advocacy needs.

The Go-To-Market (GTM) Task Group brings these research results to pavement designers and road owners in easy-to-understand, dynamic ways. Utilizing the latest market research to drive advertising, editorials, and dynamic content, these marketing

materials connect customers with the latest research projects and industry trends. Backed by the technical reports of the PEC, these materials convey the benefits of asphalt pavement using multiple media channels — online, print, social media, video — to get the message out.

Strategic action on the part of the industry's grassroots and grasstops resources helps inform our customers, lawmakers, and the driving public of the technical benefits of using asphalt in roadway construction. At the same time, the Deployment Task Group sells our product. By connecting with customers at tradeshow, through webinars and in-person meetings, we are able to highlight lessons learned, while underscoring the industry's collaborative approach in working with its customers.

All these efforts together — research, marketing, deployment — combine to create a better product for our customers and the driving public. For the public and for the industry, we will continue to lead with integrity, intelligence, and dependability.



John J. Keating
Chairman of the Marketing Council

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The National Center for Asphalt Technology

The asphalt industry's premiere research facility

The National Center for Asphalt Technology (NCAT) is a cooperative venture between NAPA and Auburn University. Founded in 1986, NCAT was created to ensure the asphalt paving industry is able to adapt to the needs of America's highway infrastructure. Working with stakeholders from highway agencies and the construction industry, NCAT evaluates new products, design technologies, and construction methods that lead to pavement improvements.



NCAT's main 40,000-square-foot facility is designed for complete testing of asphalt binders and mixtures with state-of-the-art equipment. Its training space with hands-on laboratories accommodates classes for up to 40 people. NCAT conducts training classes for more than 800 asphalt technicians per year and reaches thousands more industry professionals through workshops, webinars, and conference presentations.

NCAT's Pavement Test Track is located on a 309-acre site where research is

conducted on experimental asphalt pavements. This 1.7-mile oval track is comprised of 46 test sections sponsored on three-year cycles. The fifth cycle of accelerated performance testing has just been completed, and planning for the sixth test cycle is underway. The Pavement Test Track is a unique real-world laboratory allowing for cutting-edge pavement experimentation while avoiding risks of failures on actual roadways.

NCAT's focus is on practical research and the application of findings, which lead to specification improvements that agencies can put into contracts. Important priorities within this focus are developing practical guidelines for users of warm mix asphalt, the proper and expanded use of recycled materials, and improving understanding of how lab-measured mix properties relate to performance on the road. Its research center and test track make it one of the world's leading institutions for asphalt pavement research and an important source of information for those tasked with maintaining our nation's infrastructure.

Over the past 20 years, NCAT researchers have advanced aggregate testing and evaluation methods, developed mix design procedures



for stone matrix asphalt, evaluated modified asphalt mixtures, improved mix design and test procedures to minimize rutting, developed a perpetual pavement design method and developed the ignition method to measure asphalt content without solvents. The textbook “Hot Mix Asphalt Materials, Mixture Design and Construction,” now in its third edition, has helped to ensure engineers and technicians have the training needed to formulate and lay cost-effective asphalt pavements. The NCAT newsletter, Asphalt Technology News, is published twice a year and has a worldwide circulation of more than 7,000. It has been well received by practicing engineers both in the public and private sectors.

NCAT is guided by a Board of Directors and an Applications Steering Committee. The 14-member Board guides strategic plans and policies. It includes four members from the NAPA Research and Education Foundation, four from Auburn University, and five at-large members. In addition, there are two emeritus members and five ex-officio members representing the

industry. The Applications Steering Committee meets twice a year to review the scientific and technical quality of NCAT’s programs and reports their findings to the Board. This group consists of 12 regular members and eight ex-officio members.

NCAT’s dedicated staff of 35 full-time employees includes ten lead researchers. The center also employs about eight graduate students and five undergraduate co-op engineering students who are destined for careers throughout the pavement industry.

Current project sponsors include the National Cooperative Highway Research Program, numerous individual state departments of transportation, the Federal Highway Administration, various corporations, and the NAPA Research and Education Foundation. NCAT’s annual budget is typically about \$5 million.

Newsletters, training information, technical reports, and research synopses can be accessed at ncat.us. Pavement Test Track research and performance data can be found at pavetrack.com.

Advancement of Innovative Asphalt Technology

PURPOSE: This cooperative agreement is for the advancement of new and innovative technologies to design, specify, construct, and preserve asphalt pavements.

Background/Need

A cooperative agreement, a form of a grant, is a partnership between FHWA and a contractor where costs are typically shared. In this case, FHWA provides 80% of the cost (up to \$2 million) and NAPA provides 20% (\$500,000). The agreement is for five fiscal years and began in October 2013.

FHWA and the asphalt pavement industry represented by NAPA have developed a positive system for advancing and implementing asphalt technologies and materials. This includes technology identification through research studies and demonstrations and international and domestic scanning tours. Crucial to the implementation are FHWA's Mobile Asphalt Laboratory, government and industry ETGs, TWGs,

and industry committees, such as NAPA committees and TRB. Standards and specifications are refined and implemented through AASHTO subcommittees and American Society of Testing and Materials (ASTM) committees.

Study or Project Focus

The objectives of this cooperative agreement are: to 1) Promote the deployment and adoption of state-of-the-art innovative materials,

design procedures, specifications, practices, and construction methods to improve asphalt pavement performance and extend the pavement life of our transportation facilities; and to 2) Replace or update multiple documents that have been



Committee for Asphalt Research and Technology, Engineering Advisory Committee

Funding Level: Up to \$2.5 million

Research Lead: NAPA

Project Dates: October 2013–September 2018

developed in the last decade or earlier to improve the performance of asphalt pavements to reflect today's technology. The audience for this effort is the asphalt material community consisting of state and local agencies, industry, manufacturers, suppliers, producers, field construction, and researchers/academia.

The cooperative agreement is led and managed by Dr. Audrey Copeland and assisted by NAPA staff. NAPA has established an innovation team of recognized experts in asphalt technologies including NCAT, Texas A&M Transportation Institute, Advanced Asphalt Technologies Inc., other industry consultants, and the State Asphalt Pavement Associations.

Outcome/Benefits

This cooperative agreement presents a unique opportunity for mutual FHWA-NAPA technology activities to be managed under one "umbrella" which will facilitate simultaneous activities and allow for longer term planning for

the most cost-effective and successful pavement technology program.

The deliverables of the cooperative agreement will include conferences and workshops, presentations at government and industry events, webinars, publications, surveys for benchmarking, and multimedia tools.

Progress Report

Several deliverables were completed in 2014 including:

- Approval of the work plans and the implementation and marketing plan
- Webinar on pavement economics and LCCA for asphalt pavements
- Webinar on improved sustainability and performance with high RAP and RAS
- 2013 construction season Recycled Materials and WMA Usage Survey and promotional materials
- 2014 Asphalt Pavement Sustainability Conference supported by FHWA

Annual Asphalt Pavement Industry Survey on Recycled Materials and Warm-Mix Asphalt Usage: 2009–2013 (IS-138)

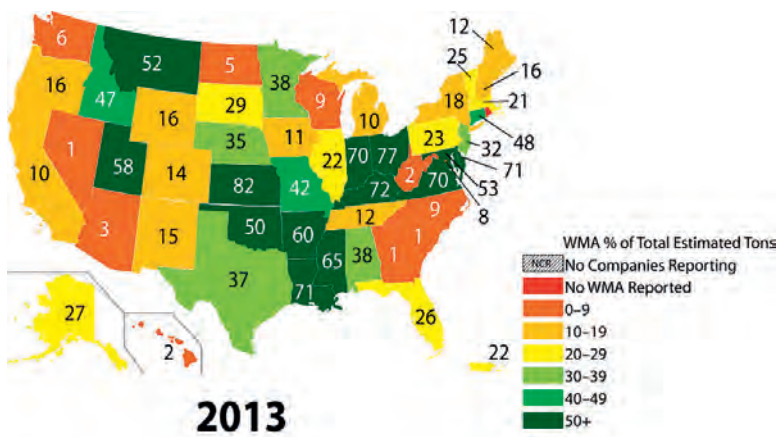
Background

The FHWA/NAPA survey was first conducted in 2010, focusing on the use of RAP, RAS, and WMA technologies in the 2009 and 2010 construction season. This initial survey served as a benchmark for the asphalt pavement industry’s use of these sustainable technologies and complimented state DOT surveys conducted by AASHTO/ FHWA. To continue the tracking of the

uptake of these technologies, FHWA successfully partnered with NAPA to conduct similar surveys for 2011, 2012, and 2013. Future versions of this survey are being conducted under the NAPA/FHWA Cooperative Agreement.

Study or Project Focus

The survey focuses on the quantities of RAP and RAS being used in asphalt mixtures, as well as the total



FHWA/NAPA

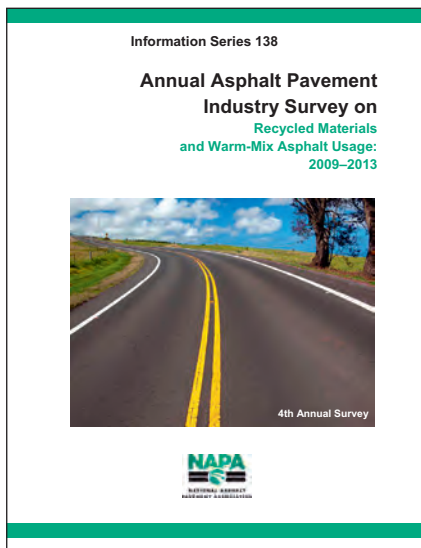
Funding Level: \$40,000
Research Lead: Kent Hansen, Audrey Copeland
Project Dates: Annual

PURPOSE: Quantify the use of recycled materials, including RAP and RAS, and warm-mix asphalt (WMA) production by the asphalt pavement industry to help support and promote sustainable practices such as incorporating recycled materials into pavements and WMA. Starting in 2012, the use of other recycled materials commonly used in asphalt mixes began to be tracked.

amount of WMA produced nationally. Estimates are also made for the total asphalt mixture market in each state or territory. Information on other recycled material, such as rubber and slag, was also collected for 2012 and 2013.

Outcome/Benefits

The survey results have shown significant growth in the use of RAP, RAS, and WMA technologies over the past few years. These results show that the asphalt industry remains the country's number one recycler, recycling asphalt pavements at an average rate of 99 percent. The amount of RAP used in asphalt mixtures has increased by 21 percent, from 56 million tons in 2009 to 67.8 million tons in 2013. Use of RAS increased 133 percent from 702,000 tons in 2009 to 1.64 million tons 2013. In 2013, WMA production was estimated at over 106 million tons, more than 30 percent of the total asphalt mixture market for 2013, and WMA use has increased more than 533 percent since 2009.



This data has been widely quoted in the trade press and was part of FHWA's Every Day Counts initiative.

Progress Report

The survey report is complete and available on the NAPA website www.asphaltpavement.org/recycling.

Silica/Asphalt Milling Machine Partnership

PURPOSE: Reduce potential dust and silica exposures during roadway milling operations.

Background/Need

Expanding on the success of prior government-labor-asphalt industry partnerships, the Silica/Asphalt Milling Machine Partnership was formed in 2003 to create a mechanism for addressing potential dust and silica exposure during roadway milling operations. Under the guidance of The National Institute for Occupational Safety and Health (NIOSH), dust and silica monitoring during roadway milling operations was used to develop and refine equipment control technologies that could substantially reduce potential worker silica exposure. Activities culminated during the Occupational Safety & Health Administration (OSHA) silica rulemaking process where partnership members were asked to testify in front of the Agency describing the group's success in identifying and developing effective equipment controls that reduce dust and potential silica below OSHA's proposed PEL.

Study or Project Focus

Develop effective milling machine equipment controls to reduce dust and potential silica exposures during roadway milling operations. A number of field trials were conducted from 2006–2014 to identify and fine-tune appropriate equipment control technologies.

Outcome/Benefits

Milling machine equipment manufacturers successfully engineered control mechanisms to reduce dust and potential silica exposure during milling operations. Each of the partnership manufacturers has submitted letters to OSHA indicating its control equipment will be standard on half-lane and larger milling machines starting in January 2017 and retrofit kits will be available for older machines.

Health & Safety Committee

Funding Level: \$100,000 direct costs

Project Dates: 2003–2015; limited ongoing activities



Progress Report

NIOSH has produced the document: "Best Practice Engineering Control Guidelines to Control Worker Exposure to Respirable Crystalline Silica during

Asphalt Pavement Milling," which is scheduled to be available on the NIOSH website during the first quarter of 2015.

Optimized Flexible Pavement Design and Material Selection

PURPOSE: Synthesize best practices regarding optimized flexible pavement design and materials utilization, develop supporting data and make recommendations that further refine current and new design practices for cost-effectiveness and performance.

Background

Current flexible pavement design methods may result in oversized asphalt pavement thicknesses and unnecessary higher initial costs. In the years since the AASHTO Road Test, pavement materials and construction technologies have advanced significantly. However, these advances have not been adequately incorporated into pavement design methods. Capitalizing on known and proven technological advances in will reduce the cost of the pavement structure while providing quality long-term performance.

Study or Project Focus

Synthesize current best practices regarding optimized flexible pavement design and pavement materials utilization and develop new supporting data/best practices that further refine current practices focused on the design of cost-effective, well-performing pavements.

Outcome/Benefits

The final report will illustrate the potential for long-lasting asphalt pavements to be designed in a more economical fashion through 1) the use of proper MEPDG calibration and implementation, 2) appropriate pavement performance reliability and criteria for evaluating pavement designs, 3) the use of limiting strain criteria (with appropriate strain levels), and 4) optimized materials utilization.

Progress Report

The following reports are complete:

A report and research synopsis for “Flexible Pavement Design: State of the Practice” (NCAT Report 14-04 and NCAT Research Synopsis 14-04) provide an overview of current flexible pavement design practices in the United States.

The report “Recalibration Procedures for the Structural Asphalt Layer

Joint Pavement Type Selection/ Pavement Design Task Group

Funding Level: \$190,000

Research Lead: NCAT

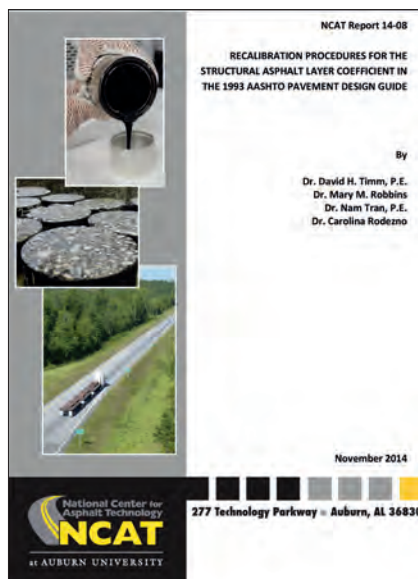
Project Dates: August 2013–April 2015 (20 months)

Coefficient in the 1993 AASHTO Pavement Design Guide” (NCAT Report 14-08) outlines methods for localizing and calibrating the structural number for pavement designs using deflection data, historical performance data, or matching mechanistic-empirical design thicknesses.

Both reports are available through the NCAT website, www.ncat.us

Deployment

The authors have spoken at SAPA conferences on the project and research papers have been submitted to journals.



Simplified Pavement Design Tool — PaveXpress

PURPOSE: Develop a web-enabled computer application and a corresponding mobile application capable of providing structural designs for concrete and asphalt roadways and parking facilities.

Background

To better educate and assist pavement decision makers, a simplified pavement design tool is desired. The expectations are that the simplified pavement design tool, PaveXpress, will be easy to use and understand while providing technically sound pavement structural designs and analyses that illustrate the benefits of using asphalt pavement structures.

Study or Project Focus

The primary software functionality will involve roadway structural pavement design (asphalt and concrete), pavement structural analysis (asphalt), and an interactive help tool covering program operation and pavement engineering references. In Phase II, beginning at the end of 2014, the tool will continue to be refined and a thin asphalt overlay module will be added, as well as,

support for mechanistic design concepts based on PerRoad.

Outcome/Benefits

PaveXpress provides a user-friendly, visually appealing, pavement design tool accessible to users on a variety of devices that provides pavement decision makers technically sound pavement designs, demonstrates the benefits of using asphalt pavement structures, and provides a free alternative to other pavement design software.

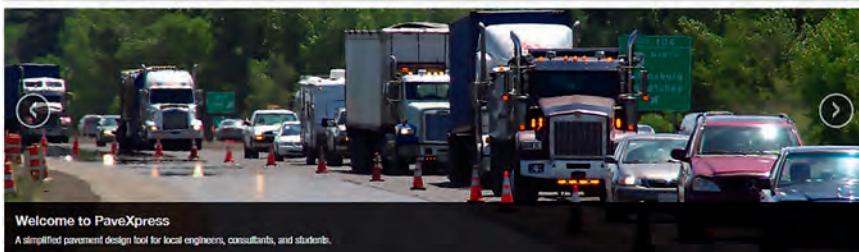
The Roadway Pavement Design module compares pavement designs for up to three alternatives: Long-Life Asphalt Pavements per elastic layer theory/fatigue & rutting criteria, Asphalt Pavements per AASHTO 93 methodology, and Concrete Pavements per AASHTO 93 methodology and the 1998 AASHTO Supplement.

Pavement Design Task Group

Funding Level: \$65,000 for 2013, \$100,000 for 2014/
\$15,000 for Phase II

Research Lead: Pavia Systems

Project Dates: October 2013–July 2015



Introduction

Welcome to PaveXpress, a stopping tool to help you create simplified pavement designs while taking into account key engineering inputs.

Resources

PaveXpress includes access to resources such as design guides from state DOTs and industry associations so you can build formal designs from its simple recommendations.

[View Resources](#)

Get Started

Click on the button below to launch the PaveXpress Scoping Tool and start creating your own designs, with options for both flexible and rigid pavement construction.

[Launch](#)

Progress Report

PaveXpress has been completed and is available at www.pavexpressdesign.com.

Determining Service Life Based on Comparable International Roughness Index Values

Background

Technical advancements have improved the performance of asphalt pavements and, as a result, have increased the lifespan of asphalt pavement. However, these technology advances have not been adequately incorporated into the analysis and prediction of pavement service life which is an input into

pavement type selection tools, such as LCCA. A method is needed to accurately determine performance life and eliminate errors introduced from inappropriately applied maintenance cycles.

Study or Project Focus

Phase I focuses on pavement ride quality (smoothness), how it changes over time, and how it can be used in



Pavement Type Selection Task Group

Funding Level: \$65,000

Research Lead: NCAT

Project Dates: October 2013–March 2015

PURPOSE: Analyze and determine how pavement ride quality (i.e., smoothness) can be used to determine service lives in a life-cycle cost analysis (LCCA) and quantify the cost of different pavement options in order to validate LCCA input assumptions such as the period of performance for initial construction and maintenance.

best practices to determine service/performance lives for various cycles (i.e., initial construction, maintenance, rehabilitation, etc.) in an LCCA. Phase II focuses on determining the cost of constructing and maintaining asphalt and concrete pavements over their design lives to validate the assumptions made in LCCA and the application of the results from Phase I.

Outcome/Benefits/ Deliverables

This project will assess the state of practice for determining pavement service life and provide recommendations for determining service life, which is used in life cycle cost analyses, based on maintaining ride quality. Ride quality is a function

of pavement smoothness and building and maintaining smooth pavements improves performance and fuel economy for vehicles.

Progress Report

A synthesis report and literature review have been completed and will be published on the NCAT website. A survey and summary report of agency practices on determining service life and a report of best practices and establishing service life cycles for maintenance and rehabilitation will be completed in 2015. The research team has learned that historical cost information is not readily available; other options for Phase II are currently being explored.

Phase I: Unintended Consequences of Reflective Pavements

PURPOSE: This study reviewed the gaps with initial modeling assumptions relying on pavement albedo and surface temperature as an input and determinant in building cooling loads and mitigating the urban heat island effects.

Background

Addressing the urban heat island effect (UHI) is a growing concern for many municipalities. As a result, mitigation strategies, such as increasing pavement albedo in efforts to reduce surface temperature and offsets carbon dioxide emission are being adopted. Meanwhile, current research is beginning to identify unintended consequence of large scale reflective surface deployment.

Study or Project Focus

This study reviewed the overlooked research gaps on modeling/mitigating UHI purely relying on pavement albedo, including: 1) unintended effects on human health and comfort and 2) implications for building HVAC (heating, ventilation, and air conditioning) load, particularly in climatic regions with heavy winter-time heating demand (e.g., New York City).

Outcome/Benefits

The results of the study were reported in “Unintended Consequences: A Research Synthesis Examining the Use of Reflective Pavements to Mitigate the Urban Heat Island Effect,” which surveyed a wide range of recently published research. Specific areas of concern identified include increased energy demands for buildings subjected to solar reflections, increased light pollution, increased wintertime snow and ice buildup, and even human health concerns.

Progress Report

The final report was first published in October 2013. In response to the report’s findings, the Global Cool Cities Alliance (GCCA) issued a fact check and letter to ASU. The project team examined each issue noted and found that the majority of the issues raised by the GCCA were free of factual errors, and merely different points of view. ASU published its response to

PEC Environmental Sustainability Task Group

Funding Level: \$20,000

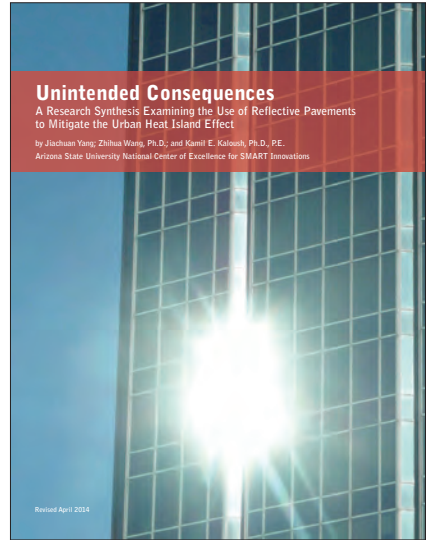
Research Lead: Arizona State University

Project Dates: March 2013–December 2013

GCCA and a revised version of the report. Both the response and the revised report are available on the ASU website.

Deployment

The report has been critical for advocating against pavement albedo mandates in green construction rating systems at the local, state, and national levels. A deployment webinar covered talking points, letter templates, and strategies on how to inform green rating code decision makers of the unintended consequences to requiring pavement albedo. In addition, Dr. Kamil Kaloush highlighted findings from this study in a presentation at the 2014 Asphalt Sustainability Conference.



Phase II: Effect of Pavement Types on Building Energy Efficiency

PURPOSE: The main project outcome is to understand the effect of different pavement types on building energy efficiency, radiative forcing, and human thermal comfort by creating a numerical model of the thermal interactions between buildings and their environment.

Background/Need

State legislation, as well as federal legislation and green building codes, are increasingly penalizing dark-colored pavements in efforts to mitigate the urban heat island effect (UHI). Unfortunately, the laws have moved faster than the science; as demonstrated in the PEC Project “Phase I: Unintended Consequences of Reflective Pavements.” Current modeling efforts can demonstrate energy savings from reflective materials; however, these models oversimplify thermal interactions by neglecting the physical interactions between buildings and the surrounding urban environment.

Study or Project Focus

This study will build a numerical model that includes building-environment thermal interactions.

The model will be validated from field experiments and used to identify

the effect of different pavement characteristics (including, but not limited to, thermal conductivity, heat capacity, pavement porosity, albedo, and thermal inertia) on noted unintended consequences such as energy consumption, radiative forcing, and human thermal comfort.



PEC Environmental Sustainability Task Group

Funding Level: \$75,100

Research Lead: Zhihua Wang, ASU

Project Dates: July 2014-June 2015

Outcome/Benefits

The model will be made available for use by other researchers. Results from the study will be presented at a conference and published in an academic journal.

Progress Report

The project team has developed an urban canopy model that enables modeling of building environment interactions with climatic conditions

for Phoenix, Ariz. Field measurements were used to validate the model for a variety of urban land cover types. Using the developed model, the project team will test the model for simulating thermal transport (heat fluxes) and impact of albedo inside urban canyons to investigate the significance of thermal interactions between canyon facets. In addition, they will also model energy transfer through the building envelope (roof and wall) via heat conduction.

Develop an Industry Average Environmental Product Declaration

PURPOSE: Create an industry average Environmental Product Declaration for asphalt mixtures.

Background

Environmental Product Declarations (EPDs) are being incorporated into green rating systems, such as LEED and International Green Construction Code (IgCC), replacing material credits for best practices such as recycling and materials reuse. An EPD is a certified document that reports fair, verified, and comparable information on the potential environmental impacts of a product. Information used in an EPD is based on life-cycle assessment (LCA) methodology following certain product-specific requirements and boundaries called product category rules (PCRs).

Study or Project Focus

An LCA study will be conducted and product category rules developed for asphalt mixtures. In addition, a software tool will be created to aid asphalt mix producers in declaring the environmental



impacts of their asphalt mixes through a certified NAPA Environmental Product Declaration.

Outcome/Benefits/ Deliverables

The real-time EPD software program created will allow asphalt mix producers to develop NAPA-certified EPDs for their various mixes in a fast, simple, and affordable manner. EPDs certified under the NAPA EPD program will aid producers in demonstrating their commitment to sustainability,

PEC Environmental Sustainability Task Group

Funding Level: \$100,000

Research Lead: Amlan Mukherjee

Project Dates: August 2014–August 2015

showcase their environmental improvements over time in a common in a credible reporting format, and enable them to meet the new material requirements in green rating systems. Material suppliers with EPDs will gain a competitive advantage over those without EPDs.

Progress Report

A PCR Development Working Group of various stakeholders was developed and has begun drafting the PCR for asphalt mixes. In support of the PCR being developed, an LCA is being conducted to identify the availability of primary data and validate the feasibility of the PCRs.

Environmental Life Cycle Assessment (LCA) Use-Phase Emissions Due to Pavement Roughness

Background

Life-cycle assessments (LCA) are used to quantify the environmental impacts associated with a product spanning all phases of its life. While most pavement LCA tools are “cradle to grave,” focusing on the material extraction, manufacturing, and construction phases, research has shown that this accounts for only 10%–12% of the total greenhouse-gas (GHG) emissions associated with a pavement life cycle. A very large portion of the emissions come from the pavement use phase.

Study or Project Focus

Previous studies have shown that pavement roughness directly impact rolling resistance, which in turn impacts vehicle fuel efficiency. This study developed an analysis method to mine IRI data from the FHWA Long-Term Pavement Performance (LTPP) database, in order to identify



significant statistical trends in IRI degradation over time. These trends are directly applied to estimating pavement use-phase GHG emissions.

Outcome/Benefits/ Deliverables

The study showed that asphalt pavements tend to have a lower initial IRI and are overall smoother than concrete pavements; however, they tend to grow rougher at a faster rate than concrete pavements. A critical insight from the study is that context-specific approaches must be used to identify the best pavement type and maintenance schedules. IRI Explorer,

PEC Environmental Sustainability Task Group

Funding Level: \$70,000

Research Lead: Michigan Technological University

Project Dates: June 2013–December 2014

PURPOSE: Identify how pavement roughness directly impacts use-phase greenhouse-gas emissions for asphalt and concrete pavements.

www.iriexplorer.com, an easy-to-use interface for analyzing IRI data in the FHWA LTPP database and modeling use-phase GHG emissions, was developed to aid decision-makers in conducting context-specific comparisons of their own, including support for additional data not included in the LTPP.

Progress Report

Two conference papers resulted from this study and were presented at the 2014 International Symposium on Pavement LCA in Davis, Calif., and at the 2015 TRB Annual Meeting. In addition, IRI Explorer now includes a login feature allowing individual users and state DOTs to add their own data.

Deployment

Project findings were presented by Dr. Amlan Mukherjee at the 2014 Asphalt Sustainability Conference and FHWA Sustainable Pavement Technical Working Group. Currently, the project team is developing training materials to aid the IRI Explorer deployment efforts. This will include a teacher's manual including a PowerPoint presentation and script, case studies, and quizzes, as well as a user's manual.

Modeling of Pavement Characteristics on Vehicle Rolling Resistance: An Analysis

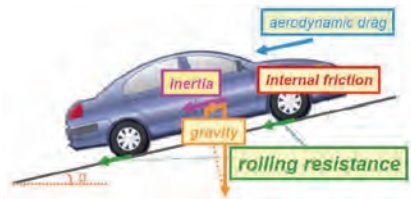
PURPOSE: Conduct an investigation concerning pavement properties that affect rolling resistance and vehicular fuel economy.

Background/Need

Concern over transportation-related greenhouse gas emissions has encouraged research to identify the impact of pavement characteristics on a vehicle's rolling resistance and fuel consumption. The Concrete Sustainability Hub (CSHub) at Massachusetts Institute of Technology (MIT) has released a modeling effort that identifies a substantial impact from pavement viscoelasticity or deflection on rolling resistance and vehicle fuel consumption, indicating that driving on asphalt roads is akin to continuously driving uphill. However, the assumptions and limitations of this model need to be understood.

Study or Project Focus

This analysis includes a review of existing literature on the effect of viscoelasticity of asphalt pavement on vehicle fuel consumption and will take an in-depth look at the methodology



Various forces must be overcome for a vehicle to sustain movement. (ISO 28580:2009)

behind the pavement-vehicle interaction (PVI) model developed by CSHub.

Outcome/Benefits

The survey of recent literature illustrates that smooth roads decrease vehicle fuel consumption while no real consensus has been determined as to the effect of pavement stiffness. Identified concerns with the CSHub PVI deflection model include: little transparency in data used for model validation and calibration, ignores conventional flexible pavement design philosophies and understood physical

PEC Environmental Sustainability Task Group

Funding Level: \$25,000

Research Lead: Richard Willis, NCAT

Project Dates: September 2013–September 2014

properties of asphalt pavements, and how the tire load is modelled.

Progress Report

“Effects of Pavement Properties on Vehicular Rolling Resistance: A Literature Review” (NCAT Report 14-07) was published in July 2014 and is available via the NCAT website. The critique of the CSHub modelling effort is under internal review and a synthesis document is being prepared that outlines the deficiencies of the research assumptions and model.

Deployment

Results from the study were presented by Dr. Richard Willis at NAPA's Asphalt Sustainability Conference and in a webinar, “Where the Rubber Hits the Road: Pavement Vehicle Interaction Re-examined”. Key findings from the model review were published as “Special Report 208: Modelling Pavement's Effect on Fuel Economy: A Brief Review of Concerns Identified in the CSHub 2012 Simulation Model.”

Development of Thin Asphalt Overlay Mixes with High Recycle Content

PURPOSE: Develop high binder replacement (HBR) surface mixes that have equivalent or better performance to standard mixes used in several states by conducting performance testing and analysis on laboratory prepared asphalt mixture specimens for the purpose of gathering data.

Background/Need

Thin-lift overlays, or Thinlays, with a high level of binder replacement using reclaimed asphalt pavement (RAP) or reclaimed asphalt shingles (RAS) can be utilized as an economical and environmentally sound pavement preservation treatment. Increasing the level of binder replacement in any asphalt mix design improves the cost effectiveness by putting waste material to practical use and reducing the need for virgin materials.

Study or Project Focus

The results of the testing and analysis will help provide guidelines to other states for developing crack-resistant HBR surface mixes. Mixtures received from four participating states will go through rigorous testing processes. The cracking modes of interest are thermal and fatigue cracking.



Outcome/Benefits/Deliverables

A report will be produced comparing the control and high binder replacement (HBR) mixes from each state, including documentation of the testing results, performance comparisons and discussion of critical factors that may improve performance of future HBR mixtures.

Progress Report

Testing is complete for all states (Oregon, North Carolina, Ohio, and Maryland). The final report for Oregon is complete. The final reports for the remaining states are anticipated to be ready by late January 2015. Laboratory test data thus far show that using softer binder results in equal or better performance compared to standard mixes used in these states.

Pavement Preservation

Funding Level: \$70,000

Research Lead: NCAT

Project Dates: July 2013–January 2015

Comprehensive Synthesis on High Binder Replacement Effects and Practices

PURPOSE: Develop a synthesis of current and past research on asphalt mixes with 20 percent or greater binder replacement using reclaimed asphalt pavement (RAP) and/or reclaimed asphalt shingles (RAS), and develop articles and presentations from the research to facilitate knowledge transfer.

Background/Need

While the asphalt pavement industry has been using RAP and RAS for many years, opportunities remain to use these materials in combination and at greater levels with the potential for significant economic and environmental impacts. When RAP and RAS are used at higher percentages there is a chance the asphalt binder replacement (ABR) will vary considerably due to fractionation or combining the materials. With a number of states moving to specifying the amount of RAP and RAS that may be used in a mix by ABR it is important to synthesis existing research regarding ABR.



resources, reduction in energy consumption, and reduction in emissions.

Outcome/Benefits/Deliverables

This synthesis will document laboratory and field performance testing of high-ABR mixes to develop several types of materials for various audiences (contractors, public, owner, consultants, legislators, etc.), advancing knowledge on the benefits of using of RAP and/or RAS, and encouraging best practices for its use that ensure product quality.

Progress Report

The final report will be available in February. Articles/white papers and PowerPoint presentations are being developed. A webinar, "Improved Sustainability and Performance with High RAP and RAS Usage," based on this synthesis was presented on September 25, 2014 under the FHWA Cooperative Agreement.

Study or Project Focus

The project will focus on the benefits of using RAP and/or RAS based on ABR in asphalt pavement construction operations, including the economics of using the recycled/reclaimed materials, as well as the conservation of natural

PEC Best Quality and Competitiveness Task Group

Funding Level: \$30,000

Research Lead: Dr. David Newcomb (PI), Dr. Jon Epps, and Dr. Fujie Zhou, Independent Contractors

Project Dates: August 2013–February 2015

Effect of Speed of Construction on Total Costs for Maintenance, Rehabilitation and Reconstruction of Existing Pavements

Background/Need

One of the most recognized benefits of asphalt pavements is speed of construction. However, this benefit is seldom recognized in the pavement type selection process. Quantifying the

full costs associated with construction is needed for speed of construction to be used in user cost estimates in both pavement type selection and life cycle cost analysis (LCCA).



PEC Best Quality and Competiveness Task Group

Funding Level: \$50,000

Research Lead: Texas A&M Transportation Institute

Project Dates: January 2014–January 2015

PURPOSE: Determine the effect of speed of construction on the total costs — construction, user delay, and accidents — associated with maintenance, rehabilitation, and reconstruction of existing asphalt and concrete pavements.

Study or Project Focus

Determine the cost of construction, user delays, and accidents for typical maintenance, rehabilitation and reconstruction for asphalt and concrete pavements that may be used in LCCA and the pavement type selection process. The project will use case studies to document these benefits along with two hypothetical head-to-head comparisons.

Outcome/Benefits/Deliverables

Report quantifying benefits of speed of construction and their implications in pavement type selection and LCCA. Case histories will be included in report. Additionally, an urban widening project and a rural overlay case will be devised with asphalt and concrete options that rely on traffic data taken from actual projects to compare construction speeds and user costs and impacts.

Progress Report

A literature review is complete. The final report is in progress and it is anticipated it will be completed by January 31, 2015.

Other Relevant Information

TTI has extra funds available that will be used to develop more complete tools that can be used to evaluate different alternatives for project delivery, traffic control, etc., that will help evaluate the benefits of speed of construction.

Targeted Education, Promotion, and Training Program

PURPOSE: Develop training curriculum to help educate city and county public works officials, consulting engineers, and engineering firms on proper engineering methods required to design and deliver a high-quality asphalt pavement.

Background/Need

Insufficient knowledge of asphalt pavements and its benefits can lead to limited confidence in designing asphalt pavements and applying emerging technology.

Pavement type selection decision-makers and consultants need to be educated on our product. An adaptable training program that can be used by SAPAs or others to train and educate persons responsible for specifying and designing pavement is needed.

Study or Project Focus

Develop an adaptable education program that includes: Life Cycle Cost Analysis, RAP/RAS, Thinlays, Perpetual Pavements, and WMA.

Outcome/Benefits/Deliverables

Educate city, county and state officials and consulting engineers on best practices and benefits of asphalt



pavements. With training well informed customers will be more likely to consider and use asphalt for their pavement needs.

Progress Report

The project was awarded to NCAT in October 2014 with the addition of adult education experts to the team. It is anticipated the final training program will be available December 2015.

PEC Best Quality and Competiveness Task Group

Funding Level: \$100,000

Research Lead: NCAT

Project Dates: October 2014–December 2015

Webinars

PURPOSE: The NAPA Talks Webinar series affords the industry easy access to leading educators on timely topics in research, engineering, health and safety, environmental sustainability, legislation and marketing.

Benefits

With access to premier experts on numerous topics of concern to the industry, NAPA's goal is to be the best educational resource and provider for the entire asphalt pavement industry, our partners, and our clients. Participants can attend a pre-scheduled, live webinar or download an archived webinar at a time convenient to them. This easy access offers relevant educational opportunities that meet users' needs and schedules.



Since 2009, NAPA-hosted webinars have attracted more than 1,200

industry and agency participants. Surveys of webinar participants have found that 95% of respondents either agree or strongly agree that information provided was clear and concise; 98% agree or strongly agree that the information provided was helpful; and

92% of respondents feel that the webinar lived up to their expectations.

List of Webinars Completed in Last Year:

- Introducing PaveXpress
- Sustainability 101
- Improved Sustainability and Performance with High RAP/RAS
- Mix Design for Managers
- Aggregate Management for Asphalt Plants

Announced 2015 Webinars

- Best Practices for Stress Identification
- Best Practices for Patching
- Best Practices for Tack Coat

Marketing/Communications

GOAL: Serve as the communications avenue of the industry, responding to threats and optimizing opportunities that impact the asphalt pavement industry's competitive position. Manage an active market research program that examines the opinions of the pavement specifiers and the public.

Making the Case for Drivability

Drivability — a smooth, well-maintained roadway that provides the safe, quiet, uncomplicated ride that drivers want. Drivability is a primary goal of U.S. transportation system builders and users. We have learned in interviews with transportation secretaries, pavement engineers, and consulting engineers that they understand how asphalt pavements can best deliver on the promise of drivability. Similarly, surveys of the driving public have revealed that their top priority is a well-maintained roadway that gets smoothly and safely them from point A to point B. From what pavement owners know to what the public wants: It's a perfect alignment of the attributes that asphalt pavements offer.

The industry's marketing initiatives build on this common interest in drivability. The advertising, marketing, and communications

materials developed through the Go-To-Market Task Group talk about asphalt's winning attributes in ways that demonstrate its positive impacts on people's everyday lives. Advertisements tying back to relatable activities — driving children around, enjoying a picnic outside — tell the story of transportation and asphalt pavements in a holistic way. Seeing the benefits for both drivers and the community, and how asphalt pavements deliver a superior product that enhances the driving experience while minimizing the impact to the environment and community.

Building upon the science that documents the claims of the advertisements, the creative content — videos, infographics, and related materials — offers another way to share with road owners key research findings in an entertaining and visual manner. Videos and infographics are available, covering topics ranging from drivability from the user's perspective

Go-To-Market Task Group



is rigorously sourced and has a vast library of videos, illustrations, and technical papers. The library is easily searchable and includes research emerging from the Pavement Economics Committee (PEC) and its six NAPA-SAPA Task Groups, as well as third-party research papers and reports.

Looking Forward

In 2015, as additional PEC projects reach completion, the marketing program will include an emphasis on creating articles, guidance memos, fact sheets, creative content, and social media updates that help the industry, specifiers, and our partners put research into practice. These new materials, combined with a continuation of our broader marketing efforts, will convey to all interested parties the asphalt advantage.

to Perpetual Pavement designs. The videos are for the industry to use and share, amplifying positive messages about our product to pavement type selection decision makers and the driving public.

All these materials are publically available through the industry's DriveAsphalt.org website. The site

APA Deployment Activities

GOAL: To utilize the products and resources developed through the scientific and engineering research community, including the Pavement Economic Committee (PEC) Task Groups, and through the Go-To-Market program to get key industry messages before decision makers with the goal of making asphalt the pavement of choice.

Selling Drivability

Do good work and then tell the world. One of the most important tasks the industry has undertaken is selling the drivability message to our customers and the public. This activity requires a defined strategy to move forward a set of goals and principals in an organized and coherent manner. In 2014, the Asphalt Pavement Alliance (APA) focused on deploying the Pavement Economics Committee's scientific research and the Go-To-Market Task Group's marketing materials to our industry customers.

Working with industry representatives, the deployment efforts have centered on two primary audiences: pavement specifiers and regulators. To broaden specifiers' knowledge base, the APA has conducted multiple webinars on pavement design, in particular the PaveXpress web-based pavement scoping tool. At the same time regulations developed by green construction code writers require

constant monitoring. The deployment program, working with industry experts, has attended meetings to advocate for fairness and transparency in the codes and requesting that the codes not dictate a pavement choice, but rather a set of standards to achieve green credits. This issue will remain a priority in 2015 as we begin to see local, state, and municipal governments adopt standards and questions about interpretation and implementation arise.

The tradeshow program provides an opportunity to meet directly with the industry's primary audiences to talk about scientific facts and technological innovations. Covering almost one trade show a month, the deployment program was able to get the latest industry information in front of key stakeholders in the pavement, architectural, green construction, parking, and other industries of interest.

Key to advancing the adoption of long-life asphalt pavement designs, the

Deployment Task Group



Perpetual Pavement Awards program recognizes asphalt pavements that are at least 35 years old, have never had a structural failure, and receive periodic resurfacing no more than every 13 years on average. These awards help departments of transportation convey the added value of constructing a long-life asphalt Perpetual Pavement.

All these efforts are undertaken with the support of the State Asphalt Pavement Associations, a constituent part of the APA and the industry's frontlines for both deploying messages and materials, as well as responding to local legislative or regulatory threats.

Looking Forward

Throughout 2015, the deployment program will continue to amplify the latest news and messages from the industry; the APA will be the voice of the industry, with the support of the Asphalt Institute, the National Asphalt Pavement Association, and the State Asphalt Pavement Associations.

NAPA gratefully acknowledges the generous support of the State Asphalt Pavement Associations for the programs of the Pavement Economics Committee.

Alabama Asphalt Pavement Association

Arkansas Asphalt Pavement Association

California Asphalt Pavement Association

Colorado Asphalt Pavement Association

Connecticut Asphalt & Aggregate
Producers Association

Asphalt Contractors Association of Florida

Georgia Asphalt Pavement Association

Hawaii Asphalt Paving Industry

Illinois Asphalt Pavement Association

Asphalt Pavement Association of Indiana

Asphalt Paving Association of Iowa

Kansas Asphalt Pavement Association

The Plantmix Asphalt Industry of Kentucky

Louisiana Asphalt Pavement Association

Maine Asphalt Pavement Association

The Maryland Asphalt Association

Massachusetts Aggregate & Asphalt
Pavement Association

Asphalt Pavement Association of Michigan

Minnesota Asphalt Pavement Association

Mississippi Asphalt Pavement Association

Missouri Asphalt Pavement Association

New Jersey Asphalt Pavement Association

New York Construction Materials
Association

Carolina Asphalt Pavement Association

Flexible Pavements of Ohio

Oklahoma Asphalt Pavement Association

Asphalt Pavement Association of Oregon

Pennsylvania Asphalt Pavement
Association

South Carolina Asphalt Pavement
Association

Tennessee Road Builders Association

Texas Asphalt Pavement Association

Utah Asphalt Pavement Association

Virginia Asphalt Association

Washington Asphalt Pavement Association

Asphalt Pavement Association of
West Virginia

Wisconsin Asphalt Pavement Association



SAPA

State Asphalt Pavement Associations

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PAVEMENT ASSOCIATION