2015 Mid-Continent Transportation Research Symposium

August 19-20

Gateway Hotel and Conference Center
Ames, IA

Event Program
August 19–20, 2015

Today's innovation, tomorrow's best practice

Iowa State University
Institute for Transportation

IOWA DOT

MID-CONTINENT TRANSPORTATION RESEARCH

About the Symposium

The Mid-Continent Transportation Research Symposium provides an opportunity for transportation professionals from the Midwest and beyond to network with their peers, learn about advancements and applications in their fields, and hear about future directions for research. Researchers and practitioners from around the country will present papers at this ninth biennial event at Iowa State University. The day-and-a-half symposium will cover a broad spectrum of transportation issues with sessions on both basic and applied research.

Featured Speakers

Paul Trombino III, P.E.

Director, Iowa Department of Transportation

Paul Trombino was appointed director of the Iowa Department of Transportation in May 2011. Trombino currently is the 2014-2015 vice president of the American Association of State Highway Transportation Officials (AASHTO); is a member of AASHTO Executive Committee; is chair of the AASHTO Subcommittee on Transportation Communication; is a member of the Transportation Research Board Executive Committee; and is active in the State Strategic Transportation Initiatives (SSTI) group.

He had previously served at the Wisconsin Department of Transportation for 17 years in many roles, including regional operations director of the Division of Transportation System Development, director of the statewide Bureau of Structures, and most recently as director of the Bureau of Transit, Local Roads, Rails and Harbors. Trombino holds a B.S. degree in civil engineering from the University of Wisconsin, Milwaukee and a B.S. degree in economics from the University of Wisconsin, Madison.

Michael R. Crum, Ph.D.

Vice President for Economic Development and Business Engagement, Iowa State University

Mike Crum serves as vice president for economic development and business engagement at Iowa State University. He led the initiative to create the Office of Economic Development and Industry Relations, which serves as the gateway or entry point to campus for organizations wanting to connect with the university's research, technical and business expertise, and workforce development capabilities.

Crum is also a faculty member in the College of Business at Iowa State University, where he has served as department chair, associate dean for graduate programs, and interim Raisbeck Endowed Dean. He currently holds the Ruan Chair in Supply Chain Management and previously held the John and Ruth DeVries Endowed Chair in Business.

Crum teaches business logistics, supply chain management, and transportation management at both the graduate and undergraduate level. He has authored or co-authored more than 100 research publications, and he has been a principal investigator on three U.S. Department of Transportation research projects. He is the former editor of two academic journals and is currently on the editorial review boards of four academic journals. In 1988-89 he was a Fulbright Scholar at the Warsaw School of Economics in Warsaw, Poland. Mike earned his B.S., M.B.A., and D.B.A. degrees from Indiana University.

Symposium Sponsors

Iowa Department of Transportation
Iowa State University
- Institute for Transportation
- Department of Civil, Construction, and Environmental Engineering
- Midwest Transportation Center

University of Wisconsin
- Midwest Transportation Workforce Center

Wisconsin Department of Transportation

SYMPOSIUM 2015

Schedule of Events • August 19–20, 2015

Wednesday, August 19

Continental Breakfast/Registration
Garden Room

7:30 a.m. – 8:00 a.m.

Welcome/Opening Remarks
Paul Trombino III
Director, Iowa Department of Transportation

8:00 a.m. – 9:30 a.m.

Break

9:30 a.m. – 10:30 a.m.

Concurrent Session 1

10:30 a.m. – 12:00 p.m.

- Safety I
- Bridges and Structures I
- Concrete Materials I
- Asset Management and Performance Measures I
- Geotechnical
- Workforce Development

Lunch
Garden Room

12:00 p.m. – 1:00 p.m.

Concurrent Session 2

1:00 p.m. – 2:30 p.m.

- Asphalt Materials I
- Bridges and Structures II
- Concrete Materials II
- Weather
- Construction
- Intermodal I

Break

2:30 p.m. – 3:00 p.m.

Concurrent Session 3

3:00 p.m. – 5:00 p.m.

- Safety II
- Bridges and Structures III
- Asphalt Materials II
- Asset Management and Performance Measures II
- Traffic Operations/ITS
- Intermodal II

Poster Session and Reception
Garden Room

5:00 p.m. – 6:30 p.m.

Thursday, August 20

Continental Breakfast/Registration
Garden Room

7:30 a.m. – 8:00 a.m.

Michael R. Crum
Vice President for Economic Development and Business Engagement, Iowa State University

8:00 a.m. – 9:00 a.m.

Break

9:00 a.m. – 9:30 a.m.

Concurrent Session 4

9:30 a.m. – 11:30 a.m.

- Safety III
- Bridges and Structures IV
- Asphalt Materials III
- Asset Management and Performance Measures III
- Researching Research
- Intermodal III

Concurrent Sessions — Wednesday, August 19 — 10:30 a.m. — 12:00 p.m.

Session 1A
Safety I

Room: South Prairie
Moderator: Jan Laaser-Webb, Iowa Department of Transportation

Safety Effects of Roadway and Roadside Delineation
Bhagwant Persaud, Ryerson University

Can Signs be Too Bright on Rural Highways?
Paul Carlson, Texas A&M University

Investigating the Relationship Between Vehicle Color and Safety Risk at High-Speed Rural Intersections for Young Drivers
Hojr Momeni, Kansas State University
Sunanda Dissanayake, Kansas State University
Thomas Hallaq, Kansas State University
Nick Homburg, Kansas State University

Session 1B
Bridges and Structures I

Room: Central Prairie
Moderator: Lowell Greimann, Iowa State University

Rating and Posting Bridges for SHVs – Iowa Timeline
Ping Lu, Iowa Department of Transportation
Scott Neubauer, Iowa Department of Transportation

A Study of the Effects on Bridge Behavior from Implements of Husbandry on Farm-to-Market Roads During Harvest Season
Justin Dahlberg, Iowa State University
Brent Phares, Iowa State University
Ahmad Abu-Hawash, Iowa Department of Transportation
Ping Lu, Iowa Department of Transportation

An Experimental Investigation on Precast Girder to CIP Bent Cap Connections to Promote ABC
Zhao Cheng, Iowa State University
Sri Sritharan, Iowa State University

Session 1C
Concrete Materials I

Room: North Prairie
Moderator: Halil Ceylan, Iowa State University

Development of Traffic Inputs for Mechanistic-Empirical Pavement Design Guide for the State of Kansas
Shuvo Islam, Kansas State University
Mustaque Hossain, Kansas State University

Overview of Deterioration Mechanisms in Sawn Concrete Joints
Xin Wang, Iowa State University
Peter Taylor, Iowa State University
Jiake Zhang, Hunan University, China

Using a Vibrating Kelly Ball Test (VKelly Test) to Determine the Workability of Slipform Concrete Mixtures
Xuhao Wang, Iowa State University
Peter Taylor, Iowa State University
Xin Wang, Iowa State University

Session 1D
Asset Management and Performance Measures I

Room: North Meadow
Moderator: Matthew Haubrich, Iowa Department of Transportation

Today's Innovation, Tomorrow's Best Practice – FHWA's Notice of Proposed Rulemaking on System Performance Measures
Francine Shaw Whitson, Federal Highway Administration

Getting Ahead of the Performance Measure Curve with New Data and Techniques
Jason Carbee, HDR
Michael Felschow, Metropolitan Area Planning Agency
Jacob Weiss, HDR

Economic Sustainability of Inner City Streets: A Collaborative Sustainable Asset Management Transportation System Model
Fara Zakery, Harris-Stowe State University
Joyce Eisel, Harris-Stowe State University
Robert Kamkwalala, Harris-Stowe State University
Aamir Salaria, Harris-Stowe State University

Session 1E
Geotechnical

Room: South Meadow
Moderator: Vern Schaefer, Iowa State University

Reliability of Shallow Foundations Designed Using LRFD with Different Numbers of Strength Measurements
Dan Ding, University of Missouri-Columbia
J. Erik Loehr, University of Missouri-Columbia
William Likos, University of Wisconsin-Madison
Norbert Maerz, Missouri University of Science and Technology

Stiffness and Permeability Evaluation of a Geocomposite Drainage Layer for Gravel Roads
Cheng Li, Iowa State University
David White, Iowa State University
Jeramy Ashlock, Iowa State University

Cement Modification on Embankment Construction Soil Materials
Shengting Li, Iowa State University
Chao Chen, Iowa State University
David White, Iowa State University

Concurrent Sessions — Wednesday, August 19 — 10:30 a.m. — 12:00 p.m.

Session 1F
Workforce Development

Room: Harvest
Moderator: Teresa Adams, University of Wisconsin-Madison

Women in Transportation Field Jobs - The Hidden Asset
Ray Mundy, University of Missouri-St. Louis
Daniel Rust, University of Missouri-St. Louis
Elizabeth Snowden, University of Missouri-St. Louis

Calling all Transportation Stakeholders: We Have a Workforce Network to Build!
Teresa Adams, University of Wisconsin-Madison
Maria Hart, University of Wisconsin-Madison
Shauna Hallmark, Iowa State University

Concurrent Sessions — Wednesday, August 19 — 1:00 p.m. — 2:30 p.m.

Session 2A
Asphalt Materials I

Room: South Prairie
Moderator: Scott Schram, Iowa Department of Transportation

Evaluation of Bond Strength at Asphalt Layer Interfaces
Abu Sufian, Kansas State University
Mustaque Hossain, Kansas State University

Impact of Lower Asphalt Binder for Coarse Hot Mix Asphalt Mixes
Parnian Ghasemi, Iowa State University
R. Christopher Williams, Iowa State University
Shibin Lin, Iowa State University

Assessment of Nondestructive Testing Technologies for Quality Control/Quality Assurance of Asphalt Mixtures
Jeramy Ashlock, Iowa State University
Shibin Lin, Iowa State University
R. Christopher Williams, Iowa State University
David Lee, University of Iowa

Session 2B
Bridges and Structures II

Room: Central Prairie
Moderator: Norman McDonald, Iowa Department of Transportation

Predicting the Service Life of Reinforced Concrete Bridges in Corrosive Environments
Zhen Cui, Iowa State University
Alice Alipour, Iowa State University

Performance Evaluation of Integral Abutment Curved Bridges Under Thermal Loading
Yaohua Deng, Iowa State University
Brent Phares, Iowa State University
Gary Novey, Iowa Department of Transportation
Ahmad Abu-Hawash, Iowa Department of Transportation

Remaining Fatigue Life of a Vintage Riveted Steel Bridge: Testing and Numerical Modeling
Alaa El-Sisi, University of Missouri-Columbia
Hani Salim, University of Missouri-Columbia

Session 2C
Concrete Materials II

Room: North Prairie
Moderator: Chris Brakke, Iowa Department of Transportation

Optimization of Electrically Conductive Concrete (ECC) Mix Design for Self-Heating Pavement Systems
Alireza Sassani, Iowa State University
Halil Ceylan, Iowa State University
Sunghwan Kim, Iowa State University
Kasthurirangan Gopalakrishnan, Iowa State University
Peter Taylor, Iowa State University

Bond Strength and Failure Mode of New Green High Performance Patching Material
Jennifer Davis, Iowa State University
Gilson Lomboy, Iowa State University
Kejin Wang, Iowa State University

Assessment of the Foam Drainage Test to Quantify Stability of Air Void Systems in Fresh Concrete
Peter Taylor, Iowa State University
Xin Wang, Iowa State University

Concurrent Sessions — Wednesday, August 19 — 1:00 p.m. — 2:30 p.m.

Session 2D
Weather

Room: North Meadow
Moderator: Tina Greenfield-Huitt, Iowa Department of Transportation

Development of Computational Models to Investigate Climate Change Effects on Long-Term Performance of Aging Structures
Dena Khatami, Iowa State University
Behrouz Shafei, Iowa State University
Christopher Anderson, Iowa State University

Feasibility of Alternate Snow Removal Strategies for Small Hub Airports
Pritha Anand, Iowa State University
Halil Ceylan, Iowa State University
Dimitra Pyrialakou, Purdue University
Konstantina "Nadia" Gkritza, Purdue University
Peter Taylor, Iowa State University
Kasthurirangan Gopalakrishnan, Iowa State University
Sunghwan Kim, Iowa State University

Incorporating Climate Projections into Design Metrics with Uncertainty Bounds
Christopher Anderson, Iowa State University
Ricardo Mantilla, University of Iowa

Session 2E
Construction

Room: South Meadow
Moderator: Jennifer Shane, Iowa State University

Data Extraction from Highway Information Model
Tuyen Le, Iowa State University
David Jeong, Iowa State University

Effective Practices for the Optimization of Construction Costs in Indefinite Delivery/Indefinite Quantity Contracts
Jorge Rueda-Benavides, Iowa State University
Douglas Gransberg, Iowa State University

Enhanced Framework for Better Collection and Utilization of Daily Work Report Data
K. Joseph Shrestha, Iowa State University
David Jeong, Iowa State University
Douglas Gransberg, Iowa State University

Session 2F
Intermodal I

Room: Harvest
Moderator: Amanda Martin, Iowa Department of Transportation

Battery System Safety and Health Management for Electric Vehicles
Guangxing Bai, Wichita State University
Pingfeng Wang, Wichita State University

Asset Utilization Potential of Building a Trucking and Rail Mega Intermodal Hub in the Saint Louis Region
Ray Mundy, University of Missouri-St. Louis
Daniel Rust, University of Missouri-St. Louis
Sidra Naseer, University of Missouri-St. Louis

Mass Transit Sustainability
Ray Mundy, University of Missouri-St. Louis
Daniel Rust, University of Missouri-St. Louis
Sareema Koirala Phillips, University of Missouri-St. Louis
Sidra Nasser, University of Missouri-St. Louis
Maria Gabriela Rodriguez Paez, University of Missouri-St. Louis
Elizabeth Snowden, University of Missouri-St. Louis

Concurrent Sessions — Wednesday, August 19 — 3:00 p.m. — 5:00 p.m.

Session 3A
Safety II

Room: South Prairie
Moderator: Brad Estochen, Minnesota Department of Transportation

Calibrating Highway Safety Manual for Rural Multilane Highways by Considering Fatal and Injury Crashes in Kansas
Syeda Rubaiyat Aziz, Kansas State University
Sunanda Dissanayake, Kansas State University

Comparison of Nighttime and Daytime Crash Characteristics Associated with Severity of Work Zone Crashes Using Severity Models
Ishani Dias, Kansas State University
Sunanda Dissanayake, Kansas State University

Calibration of the Highway Safety Manual (HSM) for Freeway in Missouri
Kyoungmin Nam, University of Missouri-Columbia
Mengyuan Zhang, University of Missouri-Columbia
Carlos Sun, University of Missouri-Columbia
Praveen Edara, University of Missouri-Columbia
Henry Brown, University of Missouri-Columbia

An Investigation of the Effect of Environmental Factors on Large Truck Crash Severity as a Function of Gender
Jill Bernard, University of Missouri-St. Louis
Christopher Mondy, University of Missouri-St. Louis

Session 3B
Bridges and Structures III

Room: Central Prairie
Moderator: Ahmad Abu-Hawash, Iowa Department of Transportation

Constructability of Precast Concrete Deck Panels in the Kearney East Bypass Project
George Morcous, University of Nebraska-Lincoln

Behavior of Negative Moment Reinforcement in PPCB Bridge Decks
Sameera Jayathilaka, Iowa State University
Brent Phares, Iowa State University
Lowell Greimann, Iowa State University
Dean Bierwagen, Iowa Department of Transportation
Mike Nop, Iowa Department of Transportation

Case Studies of Complex Girder Erection
Andrew J. Keaschall, Alfred Benesch and Company
Hossam M. Abdou, Alfred Benesch and Company

Laboratory Investigation of Bridge Strip Seal Termination Details
Travis Hosteng, Iowa State University
Sam Redd, Iowa State University
Brent Phares, Iowa State University
Norm McDonald, Iowa Department of Transportation
Ahmad Abu-Hawash, Iowa Department of Transportation

Session 3C
Asphalt Materials II

Room: North Prairie
Moderator: Kevin Jones, Iowa Department of Transportation

Performance Review of Cold In-Place Recycling on the Iowa Pavement Network
Ashley Buss, Iowa State University
R. Christopher Williams, Iowa State University
Scott Schram, Iowa Department of Transportation

Effect of Asphalt Rejuvenating Agent Used in Hot-in-Place Recycling on Reclaimed Asphalt Pavement
Nassim Sabahfar, Kansas State University
Mustaque Hossain, Kansas State University
Greg Schieber, Kansas Department of Transportation

Cracking Propensity of Recycled Superpave Mixtures with Highly Absorptive Aggregates and RAP and RAS
Masoumeh Tavakol, Kansas State University
Mustaque Hossain, Kansas State University
Blair Heptig, Kansas Department of Transportation

Plastic Strain and Modulus of Recycled Unbound Aggregates: Laboratory and Field Observations
Ali Soleimanbeigi, University of Wisconsin-Madison
Tuncer Edil, University of Wisconsin-Madison

Concurrent Sessions	Wednesday, August 19	3:00 p.m. — 5:00 p.m.

Session 3D
Asset Management and Performance Measures II

Room: North Meadow
Moderator: Francine Shaw Whitson, Federal Highway Administration

Pavement Treatment Selection Tool for Iowa Local Agencies
Ahmed Abdelaty, Iowa State University
David Jeong, Iowa State University

Forecasting Bridge Condition Performance for Risk-Based Bridge Management
Basak Aldemir Bektas, Iowa State University

Paint Reflectivity Analysis for Decision Making
Shawn Blaesing-Thompson, Iowa Department of Transportation
Joseph Drahos, Iowa Department of Transportation

Identification of Factors Critical in Converting Roadway Surface Type on Local Roads Based on Survey Responses
Himanshu Patel, Kansas State University
Sunanda Dissanayake, Kansas State University

Infrastructure Condition Evaluation (ICE) Tool
Kyle Barichello, Iowa Department of Transportation
Sam Hiscocks, Iowa Department of Transportation

Session 3E
Traffic Operations / ITS

Room: South Meadow
Moderator: Mark Bush, Transportation Research Board

Deployment of Intelligent Work Zone Systems in Iowa
Tim Simodynes, Iowa Department of Transportation
Jon Jackels, Iowa Department of Transportation

Quantifying the Safety Effects of Access Management Using VISSIM and SSAM: A Lawrence, Kansas Case Study
Eric Fitzsimmons, Kansas State University
Prathmesh Argade, Olsson Associates
Steven Schrock, University of Kansas

Data Inputs and Tools for Analyzing Reliability
James Sturrock, Federal Highway Administration

Oversize-Overweight Permit Mapping and Analysis Project in Wisconsin
Nicholas Coley, University of Wisconsin-Milwaukee
Hani Titi, University of Wisconsin-Milwaukee

Session 3F
Intermodal II

Room: Harvest
Moderator: Tammy Nicholson, Iowa Department of Transportation

The Relationship Among Firm Size and Safety Performance in the U.S. Motor Carrier Industry
David Cantor, Iowa State University
Prab Singh, Iowa State University

Freight Stories: Using ESRI Story Map Journal to Visualize Research
Maria Hart, University of Wisconsin-Madison
Alexis Greenstreet, University of Wisconsin-Madison

Freight Planning Innovation in the MAFC Region
Ernie Perry, Mid-America Freight Coalition
Eric Oberhart, University of Wisconsin-Madison

Economic Benefits of Additional Rail Bridge Capacity
Ray Mundy, University of Missouri-St. Louis
Emma Nix, University of Missouri-St. Louis

Posters Wednesday, August 19 5:00 p.m. — 6:30 p.m.

Topdown Construction Cost Estimating – Achieving Satisfactory Results with the Least Effort
Brendon Gardner, Iowa State University
Douglas Gransberg, Iowa State University
David Jeong, Iowa State University

Local Calibration of AASHTOWare Pavement ME Design Performance Models for Iowa Jointed Plain Concrete Pavements
Orhan Kaya, Iowa State University
Halil Ceylan, Iowa State University
Sunghwan Kim, Iowa State University
Kasthurirangan Gopalakrishnan, Iowa State University

Design and Construction Requirements for Electrically Heated Pavement Systems
Hesham Abdualla, Iowa State University
Halil Ceylan, Iowa State University
Kasthurirangan Gopalakrishnan, Iowa State University
Sunghwan Kim, Iowa State University
Peter Taylor, Iowa State University
Yelda Turkan, Iowa State University

Assessment of Traditional and Alternative Snow Removal Strategies for Airport Apron Operations
Weibin Shen, Iowa State University
Kasthurirangan Gopalakrishnan, Iowa State University
Halil Ceylan, Iowa State University
Sunghwan Kim, Iowa State University

Examination of Contributing Circumstances to Motor Vehicle Crashes in Iowa and Missouri as a Function of Gender
Jill Bernard, University of Missouri-St. Louis
Christopher Mondy, University of Missouri-St. Louis

Assessing Travel Time Reliability Measures Using Inrix Data in Iowa
Chaoru Lu, Iowa State University
Jing Dong, Iowa State University

Improving Evacuation Efficiency Using Intermediate Crossovers and Ramp Closures
Yohan Chang, University of Missouri-Columbia
Praveen Edara, University of Missouri-Columbia

Predicting Traffic Flow and Speed During Disruptions Using Machine Learning Methods
Yohan Chang, University of Missouri-Columbia
Praveen Edara, University of Missouri-Columbia
Carlos Sun, University of Missouri-Columbia

Fatigue Analysis of Composite Beams Strengthened with Externally Post-Tensioned Tendons
Ayman El-Zohairy, University of Missouri-Columbia
Hani Salim, University of Missouri-Columbia

The Change Interval Driving Advisory System (CIDAS) Using In-Vehicle ITS
Zhu Qing, University of Missouri-Columbia

Development of Superhydrophobic Concrete Surfaces for Ice- and Snow-Free Pavement Systems
Therin Young, Iowa State University
Sriram Sundararajan, Iowa State University
Halil Ceylan, Iowa State University
Sunghwan Kim, Iowa State University
Kasthurirangan Gopalakrishnan, Iowa State University

License Plate Recognition Technology's Potential Benefits to ITS: An "Arterial Travel Time Estimation" Case Study
Roozbeh Rahmani, University of Missouri-Columbia
Carlos Sun, University of Missouri-Columbia
Praveen Edara, University of Missouri-Columbia
Henry Brown, University of Missouri-Columbia

Work Zone Safety Assessment Tool
Roozbeh Rahmani, University of Missouri-Columbia
Henry Brown, University of Missouri-Columbia
Praveen Edara, University of Missouri-Columbia
Carlos Sun, University of Missouri-Columbia

Leveraging Mobile Technology for Roadside Feature Inspections
Shawn Blaesing-Thompson, Iowa Department of Transportation
Brad Cutler, Iowa Department of Transportation

Evaluation of Systemic Safety Risk Factor Coefficients
Keith Knapp, Iowa State University
Georges Bou-Saab, Iowa State University

Detecting and Validating Changes in Road Networks
Ahmed Abdaljabbar, University of Missouri-Columbia
Timothy Matisziw, University of Missouri-Columbia

Evaluation of AASHTO Minimum Reinforcement Requirements for Post-Tensioned Segmental Girders
Michael Rosenthal, Iowa State University
Hartanto Wibowo, Iowa State University
Sri Sritharan, Iowa State University

Trends in Non-Fatal Transportation-Related Farm Injuries
Celestin Missikpode, University of Iowa
Tracy Young, University of Iowa
Corinne Peek-Asa, University of Iowa

Study on Particle Packing Effect on High-Strength Mortar for Concrete Repair
Wenjing Cai, Iowa State University
Kejing Wang, Iowa State University
Gilson Lomboy, Iowa State University

Numerical Evaluation of Bridge Expansion Joint Designs
Alaa El-Sisi, University of Missouri-Columbia
Hani Salim, University of Missouri-Columbia

Exploring the Effect of Visibility Distance on Traffic Safety Using RWIS Data in Ohio
Fan Ye, Ohio Northern University

Multi-Hazard Design of Bridges: Lateral Response of Bridges with Scoured Foundations
Ameh Fioklou, Iowa State University
Alice Alipour, Iowa State University

A Non-Destructive Expert System Technology for Application to Highway and Railway Systems
Ashraf Al Hajjeh, University of Wisconsin-Milwaukee
Rani Elhajjar, University of Wisconsin-Milwaukee
Hani Titi, University of Wisconsin-Milwaukee

Mechanical and Durability Properties of High Performance Mortar for Concrete Pavement Repair
Gilson Lomboy, Iowa State University
Jiaxi Ren, Iowa State University
An Cheng, National Ilan University, Taiwan
Lian Bo, Iowa State University
Kejin Wang, Iowa State University

Evaluation of Finger Plate and Flat Plate Connection Design
Andrew Pelikan, University of Missouri-Columbia
Sarah Orton, University of Missouri-Columbia

Pervious Concrete Physical Characteristics and Effectiveness in Storm Water Pollution Reduction
Guyu Shi, Iowa State University
Yifeng Ling, Iowa State University
Kejin Wang, Iowa State University
Say Kee Ong, Iowa State University

Temporary Traffic Control for Innovative Geometric Design Work Zones
Henry Brown, University of Missouri-Columbia
Timothy Cope, Burns and McDonnell
Amirhosein Khezerzadeh, University of Missouri-Columbia
Praveen Edara, University of Missouri-Columbia
Carlos Sun, University of Missouri-Columbia

An Observational Before and After Safety Evaluation Study for Road Segments Provided with Safety Edge in Iowa
Amrita Goswamy, Iowa State University
Shauna Hallmark, Iowa State University
Bo Wang, Iowa State University

Design-Build of US 69 Bridge over Missouri River
Frank Blakemore, Garver

Investigating a Method to Evaluate Oxidation Level of Asphalt Mixtures by Attenuated Total/Diffused Reflection Infrared Spectrometer
Kyle Mason, Iowa Department of Transportation
Michelle Barger, Iowa Department of Transportation

Concurrent Sessions — Thursday, August 20 — 9:30 a.m. — 11:30 a.m.

Session 4A
Safety III

Room: South Prairie
Moderator: Steve Gent, Iowa Department of Transportation

Implementing SHRP-2 Naturalistic Driving Study Data for Use in Driving Simulation Environments
Shawn Allen, University of Iowa
Amanda Beadle, University of Iowa
John Gaspar, University of Iowa

Road Diet Guideline Overview
Keith Knapp, Iowa State University

Characteristics of Farm Equipment-Related Crashes Associated with Injury in Children and Adolescents on Farm Equipment
Maisha Toussaint, University of Iowa
Kayla Smith, University of Iowa
Corinne Peek-Asa, University of Iowa
Marizen Ramirez, University of Iowa

Session 4B
Bridges and Structures IV

Room: Central Prairie
Moderator: Terry Wipf, Iowa State University

Application of Ground Penetrating Radar to Detect Rebar Thinning in Concrete Bridge Structures
David Eisenmann, Iowa State University
Frank Margetan, Iowa State University
Ahmad Abu-Hawash, Iowa Department of Transportation

Effect of Pre-Stressed CFRP Composite Patch on Cracked Steel Plates
Hani Salim, University of Missouri-Columbia
Hesham El-Emam, University of Missouri-Columbia

Post-Tensioned Concrete Box-Girder Bridges: Effects of Superstructure Creep and Shrinkage on Column Design
Ebadollah Honarvar, Iowa State University
Sri Sritharan, Iowa State University
Matt Rouse, Iowa State University

Study of the Reasons that Induce Cracks at Bridge Deck End
Zhengyu Liu, Iowa State University
Brent Phares, Iowa State University
Lowell Greimann, Iowa State University
Mike Nop, Iowa Department of Transportation
Ahmad Abu-Hawash, Iowa Department of Transportation

Session 4C
Asphalt Materials III

Room: North Prairie
Moderator: R. Christopher Williams, Iowa State University

Performance of Local Aggregates in High Friction Surface Treatments
Humaira Zahir, Kansas State University
Shuvo Islam, Kansas State University
Mustaque Hossain, Kansas State University

Feasibility Investigation of Superhydrophobic Engineered Asphalt Concrete for Roadway Winter Maintenance
Ali Arabzadeh, Iowa State University
Therin Young, Iowa State University
Halil Ceylan, Iowa State University
Sriram Sundrarajan, Iowa State University
Sunghwan Kim, Iowa State University
Kasthurirangan Gopalakrishnan, Iowa State University

Laboratory Investigation of Warm Mix Asphalt Performance with Select Bio-Derived/Chemical Additives in the Midwestern United States Using AASHTOWare Pavement ME Design
Joseph Podolsky, Iowa State University
Ashley Buss, Iowa State University
R. Christopher Williams, Iowa State University
Eric Cochran, Iowa State University

Concurrent Sessions — Thursday, August 20 — 9:30 a.m. — 11:30 a.m.

Session 4D
Asset Management and Performance Measures III

Room: North Meadow
Moderator: John Selmer, Iowa Department of Transportation

Asset Management and Transportation Performance Management: Putting the Pieces Together
Tashia Clemons, Federal Highway Administration

A Robust Optimization Model for Highway Network Design and Infrastructure Resilience Assessment
Liu Su, Iowa State University
Guiping Hu, Iowa State University
Lizhi Wang Iowa State University
Jing Dong, Iowa State University
Xuesong Zhou, Arizona State University

Optimized Decision Making Strategies for Deteriorating Civil Infrastructure Components
Dena Khatami, Iowa State University
Behrouz Shafei, Iowa State University
Basak Aldemir Bektas, Iowa State University
Omar Smadi, Iowa State University

Optimization of Retrofit and Recovery Efforts to Maximize the Resilience of Highway Networks Subjected to Extreme Events
Mark Furtado, Iowa State University
Alice Alipour, Iowa State University

Session 4E
Researching Research

Room: South Meadow
Moderator: Vanessa Goetz, Iowa Department of Transportation

Staying Compliant, Staying Connected in the Transportation Research Lifecycle: Disambiguating Transportation Researchers with Unique ORCID Identifiers
Leighton Christiansen, Iowa Department of Transportation Library, InTrans

Public Access to Results of USDOT Sponsored Research
Mary Moulton, U.S. DOT National Transportation Library

Adopting Best Practices from TRB E-Circular E-C14: "Literature Searches and Literature Reviews for Transportation Research Projects"
Leighton Christiansen, Iowa Department of Transportation Library, InTrans

Session 4F
Intermodal III

Room: Harvest
Moderator: David Cantor, Iowa State University

Engineering Resilience for Complex Transportation Systems
Nita Yodo, Wichita State University
Pingfeng Wang, Wichita State University

Modeling Airside Operations at Major Airports for Strategic Decision Support
L. Douglas Smith, University of Missouri-St. Louis
Liang Xu, University of Missouri-St. Louis
Ziyi Wang, University of Missouri-St. Louis
Deng Pan, University of Missouri-St. Louis

Airport Drop Off and Pick Up Charges Coming to the U.S. – The British Experience
Ray Mundy, University of Missouri-St. Louis
Emma Nix, University of Missouri-St. Louis

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2711 South Loop Drive, Suite 4700
Ames, IA 50010–8664

www.intrans.iastate.edu

This topic is "practice ready." ☐ **Yes** ☒ **No**

A Non-Destructive Expert System Technology for Application to Highway and Railway Systems

Ashraf Al Hajjeh[1], Rani Elhajjar[2], and Hani Titi[3]

Abstract

The safety of the highway and railway systems depends on the ability to deploy and assess the numerous Nondestructive Testing Methodologies. This study aims to synthesize and make available information on applicability, effectiveness, and cost of various non-destructive testing techniques for highway and railway systems. An Expert System and Knowledge Based Decision Making system is suggested for online implementation. The interactive knowledge center allows the users to find the right information and builds on the knowledge of professionals and users in the field. The process for building the knowledge base system is performed by defining a series of logical steps. The project also allows users to store information about structures for later retrieval. The proposed methodology allows cross-linking multiple scenarios and NDT solutions across structure and material system. The system can also be expanded to include predictive diagnostics and mobile applications and has the potential to learn from all its users experiences thereby allowing an intelligent system to be built.

Keywords: testing—diagnostics—railway—highway—NDT

[1] Research Assistant; University of Wisconsin-Milwaukee, 3200 N Cramer St, Milwaukee, WI 53211; email: ashraf@uwm.edu

[2] Associate Professor; University of Wisconsin-Milwaukee, 3200 N Cramer St, Milwaukee, WI 53211; email: elhajjar@uwm.edu

[3] Associate Professor; University of Wisconsin-Milwaukee, 3200 N Cramer St, Milwaukee, WI 53211; email: hanititi@uwm.edu

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This topic is "practice ready." ☐ **Yes** ☒ **No**

A robust optimization model for highway network design and infrastructure resilience assessment

Liu Su[1], Guiping Hu[2], Lizhi Wang[3], Jing Dong[4], and Xuesong Zhou[5]

Abstract

Our transportation system is constantly confronted with various sources of threats, ranging from degradation in infrastructure, a growing population, natural or manmade disasters, to the escalating challenges of climate change. A resilient transportation system is able to withstand such threats or recover rapidly from a devastation event to normality. The long-term solution to transportation system resilience calls for data based tools that are able to not only quantitatively measure the infrastructure's vulnerability but also identify investment opportunities for effective enhancement of the system's resilience.

The objective of this study is to design a novel resilience measure for the highway infrastructure. For a given transportation system, the resilience measure we propose is a two-dimensional curve, which gives the relationship between the worst possible congestion caused by highway road closure and the length of the closure. This measure requires cutting-edge

[1] PhD candidate; Department of Industrial and Manufacturing Systems Engineering; 3004 Black Engineering, Ames, IA, 50010; phone (515) 294-1682; fax (515) 294-3524; email: suliu@iastate.edu

[2] Assistant Professor; Department of Industrial and Manufacturing Systems Engineering; 3004 Black Engineering, Ames, IA, 50010; phone (515) 294-1682; fax (515) 294-3524; email: gphu@iastate.edu

[3] Associated Professor; Department of Industrial and Manufacturing Systems Engineering; 3004 Black Engineering, Ames, IA, 50010; phone (515) 294-1682; fax (515) 294-3524; email: lzwang@iastate.edu

[4] Assistant Professor; Department of Civil, Construction and Environmental Engineering; 350 Town Engineering, Ames, IA, 50010; phone (515) 294-3957; fax (515) 294-3524; email: jingdong@iastate.edu

[5] Associated Professor; School of Sustainable Engineering; College Avenue Commons, Room 474 660 S. College Avenue Tempe, AZ 85287-530; phone (480) 965-5827; fax (515) 294-3524; email: xzhou74@asu.edu

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bilevel optimization algorithms to compute, but it provides insightful and revealing information about the resilience of the system. To address the uncertainty of link capacities, we build up a model for network design problems with equilibrium flows under the robust optimization paradigm. We use the big-M method for complementary constraints of traffic assignment equilibrium conditions and linear regression for nonlinear travel time function to linearize the model.

Keywords: Optimization, infrastructure, resiliency, assessment, and network design

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This topic is "practice ready." ☒ **Yes** ☐ **No**

A study of the Effects on Bridge Behavior from Implements of Husbandry on Farm-to-Market Roads during Harvest Season

Justin Dahlberg[1], Brent Phares[2], Ahmad Abu-Hawash[3], Ping Lu[4]

Abstract

The weights and configurations of large vehicles traveling the primary interstate system are known with relative certainty due to the information collected at numerous weigh stations. It is uncommon, however, that farm to market vehicles and other implements of husbandry travel the interstate system, thus an accurate assessment of the characteristics of these vehicles is left unknown. Since these vehicles commonly travel rural roads, and often at weights exceeding the legal limit especially during harvest, an accurate understanding of low-volume road usage is necessary to properly plan for the near-term repair and replacement of structures and roadways; even more, the information collected will help improve the long-term performance and asset management activities.

A current pooled-fund project, which the Iowa Department of Transportation is leading, looks to assess the impact of implements of husbandry on bridges. These efforts have produced valuable information especially as it relates to lateral load distribution. Even so, the project was largely completed using a database of virtual vehicles developed through information provided by equipment manufacturers and rules-of-thumb. Though it is believed the database generally represented current vehicles, the accuracy cannot be verified without direct measurement of all vehicles. Further, one piece of missing information is the frequency with which those vehicles cross low-volume road bridges.

The objectives of this project are to determine the frequency of crossings, capture the bridge behavior under dynamic loads, and estimate the characteristics of husbandry vehicles while they are traveling over rural road bridges. From this information, decision makers will have objective qualitative information from which they can base their decisions.

This presentation will focus on the data obtained from a rural county highway bridge during the harvest season of 2014. Specific strain signatures from implements of husbandry were detected and will be included in the presentation.

Keywords: Implements of Husbandry, Harvest, Bridge Behavior

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[1]Bridge Research Engineer, Bridge Engineering Center, Iowa State University, Ames, IA 50010; Tel: 515-294-9360; Email: dahlberg@iastate.edu

[2]Director, Bridge Engineering Center, Iowa State University, Ames, IA 50010; Tel: 515-294-5879; Email: bphares@iastate.edu

[3]Chief Structural Engineer, Office of Bridges and Structures, Iowa Department of Transportation, Ames, IA 50010; Tel: 515-239-1393; Email: Ahmad.Abu-Hawash@dot.iowa.gov

[4]Bridge Rating Engineer, Office of Bridges and Structures, Iowa Department of Transportation, Ames, IA 50010; Tel: 515-239-1290; Email: Ping.Lu@dot.iowa.gov

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Adopting Best Practices from TRB E-Circular E-C14: "Literature Searches and Literature Reviews for Transportation Research Projects"

Leighton L. Christiansen http:// http://orcid.org/0000-0002-0543-4268[1]

Abstract

Literature searches and literature reviews are a key step in the transportation research process. A high quality search or review can make the difference in funding duplicative research or discovering unexplored paths. But how do we know that we are getting the best results? How can we trust that contractors or assistants have been using the most comprehensive transportation research databases or the best search practices? To help answer these questions, improve the quality of future literature searches and literature reviews, and to provide search best practices, a group of transportation librarians, researchers, and information professionals put together "**Literature Searches and Literature Reviews for Transportation Research Projects: How to Search, Where to Search, and How to Put It All Together: Current Practices.**" This TRB Transportation Research Circular, E-C14 <http://www.trb.org/main/blurbs/172271.aspx>, published in March 2015, addresses the necessary steps for producing a high-quality literature review for a transportation research project. The circular explores how to conduct literature searches; where to search for transportation information; how to put it all together as a quality literature review; and defines the related terms.

Co-author and Iowa DOT Librarian, Leighton Christiansen, will highlight key resources, explain best search practices outlined in E-C14, and answer participant questions, with the goal of helping researchers implement these best practices into current and future transportation research projects.

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[1] Author1 Librarian; Iowa Department of Transportation Library; 800 Lincoln Way, Ames, Iowa, 50010; phone (515) 239-1200; fax (xxx) xxx-0000; email: leighton.christiansen@dot.iowa.gov; http://orcid.org/0000-0002-0543-4268

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Keywords: Literature reviews—Best practices—Research reports—Research projects—Researchers

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This topic is "practice ready." ☐ **Yes** ☒ **No**

Airport Drop Off and Pick Up Charges Coming to the U.S. – The British Experience

Ray A. Mundy[1]; Emma Nix[2]

Abstract

A growing trend among British airports has emerged in the last decade which has garnered much controversy. Instead of unloading passengers in front of airport terminals for free, private vehicles must now pay a charge to enter the drop-off zone at many airports. Although the public has not reacted to the practice with enthusiasm, airports justify the charge with motivations of increased safety, better environment, and incentivized use of public transport. However, many of these charging systems were implemented shortly after terminal expansion, and could also be interpreted as a means of paying for the infrastructure projects. While the majority of British airports now impose a drop-off charge, each varies in pricing and structure. Some airports have strict time limits, yet others have established an increasing pricing schedule that allows private vehicles to pay extra to remain in the zone for an extended period of time. Although unpopular, the practice is becoming ubiquitous throughout the United Kingdom, begging the question of if the trend will continue to spread to other countries. The paper examines various airport drop-off charges throughout Great Britain and the effects they have generated, particularly for industries such as taxis, public transportation, and the airports themselves. Additionally, the paper looks at how the practice might exist outside of the United Kingdom and the obstacles it would face if it migrated to the United States.

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[1] Director of Center for Transportation Studies; University of Missouri-Saint Louis Center for Transportation Studies; One University Boulevard JCPN 240, Saint Louis, MO, 63121; phone (314) 516-7270; fax (314) 516-7272; email: mundyr@mail.umsl.edu

[2] Graduate Research Assistant; University of Missouri-Saint Louis; One University Boulevard JCPN 240, Saint Louis, MO, 63121; phone (314) 516-7270; fax (314) 516-7272; email: ejnvw5@mail.umsl.edu

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Keywords: Airport Drop Off—Airport Pick Up—Airport Charges—Drop Off Fee

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This topic is "practice ready." ☒ **Yes** ☐ **No**

An Experimental Investigation on Precast Girder to CIP Bent Cap Connections to Promote ABC

Zhao Cheng [1], Sri Sritharan [2]

Abstract

With a total number of structurally deficient or functionally obsolete bridges at more than 20% of the nation's 607,380 bridges in 2013, the nation needs to work effectively to decrease the total number below 15% over the next decade. **A**ccelerated **B**ridge **C**onstruction (ABC) techniques are routinely preferred to quickly repair and replace the deficient bridges by using the prefabricated components. However, only limited ABC details are currently available to establish moment resisting connections between the concrete girders and the bent cap to promote the use of precast girders. To address this concern, two innovative connection details that can be utilized in seismic and non-seismic regions have been developed and experimentally tested at Iowa State University. These two connections, named the **E**xtend **S**trand with a **M**echanical **S**plice (ESMS) connection and the **E**xtended **S**trand with a **L**ap **S**plice (ESLS) connection, consist of deck reinforcement, unstressed strand extended from girder end into the bent cap, and dowel bars grouted through the web of girder as shown in Figure 1. The deck reinforcement placed over the connection region provides the negative moment tension continuity. The strands spliced by mechanical splice chucks and lap splices within the ESMS and ESLS connection, respectively, provide the tension continuity for the positive moments together with the shear friction mechanism developing due to the presence of dowel bars. The positive moments may be induced by creep, shrinkage and temperature effects as well as by seismic action. Both connection details exhibited adequate positive and negative moment

[1] Graduate Research Assistant; Department of Civil, Construction & Environmental Engineering, Iowa State University; 176 Town Engineering Building, Ames, IA, 50011; phone (515) 708-4618; email: zcheng@iastate.edu

[2] Wilson Engineering Professor; Department of Civil, Construction & Environmental Engineering, Iowa State University; 376 Town Engineering Building, Ames, IA, 50011; phone (515) 294-5238; fax (515) 294-8216; email: sri@iastate.edu

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resistance during tests. The test results revealed that concrete crushing occurring at the bottom of girder-bent cap interface initiate the strength softening of both connections under the high negative moments. For the connection behavior in the positive moment direction, the dowel bars and the diaphragm adjacent to girder developed the shear friction mechanism and contributed to the positive moment resistance. Meanwhile, the strands extended from the girders generated the tension also contributed to the positive moment capacity. Based on the test observations and data, a simple design method is then developed to help design of these innovative connection details.

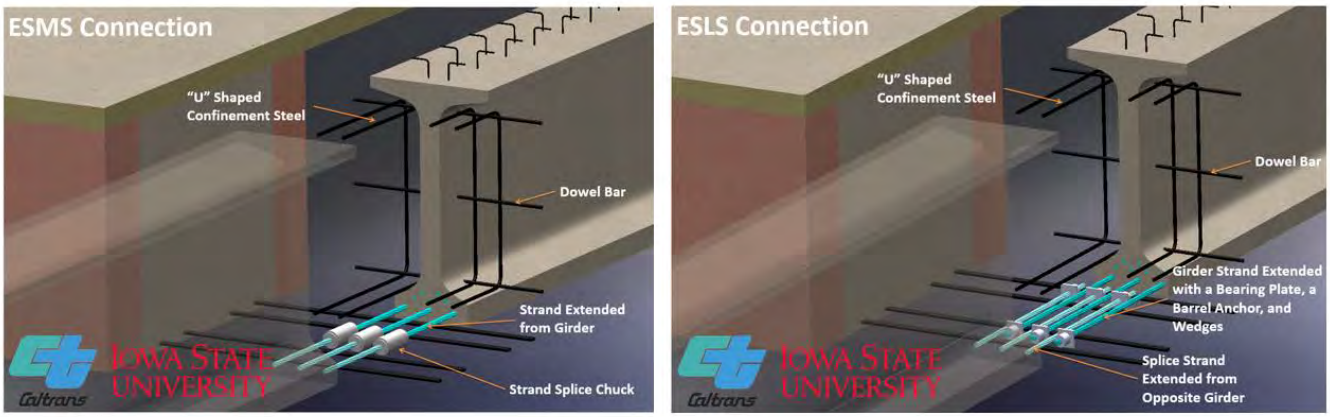

Figure 1 A Schematic View of the ESMS Connection and the ESLS Connection

Keywords: ABC—precast girder to CIP bent cap connection—moment resisting connection

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This topic is "practice ready." X Yes ☐ No

An Investigation of the effect of Environmental Factors on Large Truck Crash Severity as a Function of Gender

Jill M. Bernard[1] and Christopher M. Mondy[2]

Abstract

Large truck transport is vital for freight shipping in the Midwest; yet, it can prove to be a dangerous mode of transportation. Many factors contribute to large truck crash severity, and it is theorized that these factors and their effect on injury severity vary as a function of gender. Prior research has considered the effect of behavioral and environmental effects on crash severity, yet the current body of literature has not adequately considered the effect of environmental circumstances or the interaction of environmental and behavioral circumstances on large truck crash severity as a function of gender. Therefore, the purpose of this study is to examine the interaction of behaviors and environmental factors on large truck crash injury severity at three levels: property damage only, injury and fatality. CHAID decision tree models are developed for male truck drivers and for female truck drivers to examine the effect of weather, temporal and road conditions and behavioral contributing circumstances using Missouri crash data from 2002-2012. Regarding environmental factors, model results suggest that light conditions, road conditions, and road alignment are significant predictors of crash severity for male CDL drivers, while no environmental factors are suggested to be significant for female CDL drivers. However, with the driver shortage and anticipated recruitment push, it is important to understand the danger that inclement environmental factors pose to truck drivers and the motorists

[1] Jill M. Bernard; University of Missouri St. Louis; 240 JCPN, 1 University Blvd. St. Louis, MO 63121-4400; phone (314) 516-7270; fax (314) 516-7272; email: jmbhw9@mail.umsl.edu

[2] Christopher M. Mondy ; University of Missouri St. Louis; 240 JCPN, 1 University Blvd. St. Louis, MO 63121-4400; phone (314) 516-7270; fax (314) 516-7272;email: cmmondy@gmail.com

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with whom they share the roads. A better understanding of how environmental factors affect crash outcomes will help driver schools better train the next generation of truck drivers to safely handle dangerous environmental conditions.

Keywords: Large Truck Crash Severity—CDL Driver Gender Differences—CDL Environmental Factors—CHAID Truck Analysis

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This topic is "practice ready." ☐ **Yes** ☒ **No**

Application of Ground Penetrating Radar to Detect Rebar Thinning in Concrete Bridge Structures

David J. Eisenmann[1], Frank J. Margetan[2], and Ahmad Abu-Hawash[3]

Abstract

In this talk we discuss the use of ground penetrating radar (GPR) to detect corrosion-induced thinning of rebar in concrete bridge structures. We begin with a brief summary of earlier work conducted at a highway overpass in central Iowa. There, GPR measurements identified a number of suspect rebar within the concrete barrier rails of the overpass. The detection method makes use of GPR signals reflected from embedded rebar, in particular, the manner in which the signal strength changes as the GPR antenna is moved. It is assumed that the reflected response from a thinned rebar will be smaller than the similar response from a fully-intact rebar. After the review, we discuss new ongoing work designed to better understand how rebar position and thinning affect the strengths of GPR signals. This new work has two components. The first involves GPR measurements performed on rebar in air where the rebar length, tilt angle, degree of thinning, and distance from the GPR antenna are all varied. The second component focuses on the GPR properties of cured concrete (wave speed and attenuation) and how those properties affect the strength of GPR signals reflected by embedded rebar. The long-range goal of this research is to optimize the proposed inspection method and to determine the minimum degree of rebar thinning that can be reliably detected using GPR. (Acknowledgement: Iowa DOT)

Keywords: Ground Penetrating Radar, Concrete, Rebar, Corrosion, Bridge Inspection

[1] David J. Eisenmann; Center for Nondestructive Evaluation; 1915 Scholl Road, Ames, Iowa 50011, phone (515) 294-3292; fax (515) 294-7771; email: djeisen@iastate.edu

[2] Frank J. Margetan; Center for Nondestructive Evaluation; 1915 Scholl Road, Ames Iowa 50011, phone (515) 294-9747; fax (515) 294-7771; email: fmargeta@iastate.edu

[3] Ahmad Abu-Hawash; Iowa Department of Transportation; 800 Lincoln Way, Ames, Iowa, 50010; phone (515) 239-1393; email: Ahmad.Abu-Hawash@dot.iowa.gov

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Assessing Travel Time Reliability Measures Using Inrix Data in Iowa

Chaoru Lu[1], Jing Dong[2]

Abstract

Travel time and its reliability are key components for many advanced traveler information and traffic management systems, and can help agencies to understand better the performance of their facilities. In practice, travel time reliability measures are often computed from historic travel time data. Various statistical models, such as Weibull, Gamma, lognormal and normal, have been used to fit the travel time distributions. The travel time reliability measures can be extracted from travel time distributions. In this study the above-mentioned travel time are calibrated using travel times inferred from probe vehicle data.

In particular, segment level travel time reliability is used to assess the performance of each road segment, especially at bottlenecks. The route level travel time reliability is computed based on the travel times along a route that consists of multiple segments. Furthermore, there are usually multiple routes connecting an origin to a destination. Based on the route travel time reliabilities, the Origin-destination (OD) travel time reliability could be derived. The OD travel time reliability in a traffic network has an important implication in quantifying door-to-door travel experience. Usually, drivers would choose the shortest route with minimum travel time. However, the shortest route might be unreliable in some situations. Therefore, there is a tradeoff between the shortest travel time and the highest reliability.

[1] Doctoral Student, Dept. of Civil, Construction & Environmental Engineering, Iowa State University, 2711 South Loop Drive, Suite 4700, Ames, IA 50011, luchaoru@iastate.edu, 361-720-1243

2 Assistant Professor, Dept. of Civil, Construction & Environmental Engineering, Iowa State University, 2711 South Loop Drive, Suite 4700, Ames, IA 50011, jingdong@iastate.edu, 515-294-3957

The objective of this study is to assess segment, route and OD based travel time reliability measures using Inrix data in Iowa. The routes between Ames and Ankeny are investigated in this study. Travel times on different routes are compared. Moreover, the travel time distribution of these routes are estimated respectively. Based on these travel time distributions, the travel time reliability performance measures, such as standard deviation of travel times, buffer time, 90th or 95th percentile travel times, buffer index and planning time index, are computed.

Keywords: Origin-Destination—Travel Time—Reliability

This topic is "practice ready." ☒ **Yes** ☐ **No**

Assessment of Nondestructive Testing Technologies for Quality Control/Quality Assurance of Asphalt Mixtures

Jeramy C. Ashlock[1], Shibin Lin[2], R. Christopher Williams[3], and Hosin (David) Lee[4]

Abstract

Results are presented from a recent study sponsored by the Iowa Highway Research Board on assessment of existing and promising new non-destructive testing (NDT) technologies for quality control and quality assurance (QC/QA) of asphalt mixtures. Specifically, the study examined field measurements of density via the PaveTracker electromagnetic gage, shear-wave velocity via surface-wave testing methods, and dynamic stiffness via the Humboldt GeoGauge. NDT measurements and field cores were taken at five representative paving projects covering a range of mixes and traffic loads. The in situ non-destructive tests were compared against laboratory measurements of core density and dynamic modulus obtained by employing the indirect tension (IDT) method on the cores.

The in situ PaveTracker density had a low correlation with laboratory density, and was not sensitive to variations in temperature or asphalt mix type. The in situ shear-wave velocity measured by surface-wave methods was most sensitive to variations in temperature and asphalt mix type. The in situ density and shear-wave velocity tests were combined to obtain in situ dynamic modulus, which is a performance-based quality measurement. It was found that the in situ dynamic modulus changed very little whether using laboratory core density or in situ PaveTracker density, because the modulus is much less sensitive to density than to wave-speed and temperature. The in situ GeoGauge stiffness measured on hot asphalt mixtures several hours after paving had a high correlation with both in situ dynamic modulus and laboratory density. In contrast, the GeoGauge stiffness of asphalt mixtures cooled by dry ice or at

[1] Assistant Professor; Civil, Construction and Environmental Engineering; Iowa State University; 474 Town Engineering Building, Ames, IA, 50011; phone (515) 294-6176; email: jashlock@iastate.edu

[2] Post-Doctoral Research Associate; Civil, Construction and Environmental Engineering; Iowa State University; 353 Town Engineering Building, Ames, IA,50011; email: slin@iastate.edu

[3] Professor; Civil, Construction and Environmental Engineering; Iowa State University; 490 Town Engineering Building, Ames, IA, 50011; phone (515) 294-4419; email: rwilliam@iastate.edu

[4] Professor; Civil and Environmental Engineering; University of Iowa; 4105 Seamans Center, Iowa City, IA, 52242; phone (319) 384-0831; email: hlee@engineering.uiowa.edu

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ambient temperatures more than 24 hours after paving had a very low correlation with the other measurements.

To transform the in situ moduli from surface-wave testing into quantitative quality measurements, a QC/QA procedure was proposed. The QC/QA procedure first corrects the in situ moduli measured at different field temperatures to the moduli at a common reference temperature, using master curves from laboratory dynamic modulus tests at three reference temperatures with a new interpolation method. The corrected in situ moduli can then be compared against the design moduli for an assessment of the actual pavement performance.

A preliminary study of micro-electromechanical systems- (MEMS)-based sensors for QC/QA and health monitoring of asphalt pavements is also presented. Tests were successfully conducted on sensors embedded in asphalt which employ a passively powered and battery-free, wireless, radio-frequency identification (RFID) technology that shows promise for further development of embedded strain gauges for QC/QA and health monitoring of pavements.

Keywords: asphalt mixture—nondestructive testing—quality assurance—quality control

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Assessment of the Foam Drainage Test to Quantify Stability of Air Void Systems in Fresh Concrete

Xin Wang[1], Peter Taylor[2]

Abstract

The stability of air bubbles in fresh concrete can have a profound influence durability of the system. It has been reported that the stability of air void systems in fresh concrete developed by some air entraining admixtures can be affected by the presence of polycarboxylate based water reducing admixtures (Freeman 2012).

In most of cases, the air content of a mixture is normally measured only before concrete is placed into its final position and consolidated. This practice is acceptable only if the air system is stable because otherwise consolidation and placement may cause excessive losses that compromise the ability of the mixture to resist freezing and thawing.

The objective of this presentation is to discuss an investigation of stability of the air system as function of AEA, and WRA types. Tests were conducted using the foam drainage test method (Cross et. al 2000).

The results show that the foam drainage test appears to identify stable and unstable combinations of AEA and WRA, in a way that is consistent with previously reported findings.

Keywords: Fresh Concrete—Air Entraining Agent—Air Stability—Water Reducing Agent

[1] Xin Wang; Iowa State University, 492 Town Engr Ames, IA 50011; phone (555) 708-4308; email: xin@iastate.edu

[2] Peter Taylor; National Concrete Pavement Technology Center, 2711 S Loop Dr, Ames, IA, 50010; phone (515)-294-9333; email: ptaylor@iastate.edu

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Asset Management and Transportation Performance Management: Putting the Pieces together

Tashia J. Clemons, Transportation Specialist, US DOT, Federal Highway Administration, 1200 New Jersey Avenue, SE, Washington DC, 20590, (202) 366-1569

Abstract

There continues to be the need to discuss "*Asset Management*" and "*Transportation Performance Management*" and how each approach is linked to improve system performance. This conversation will continue for many years to come. As we move into the era of implementing outgoing legislation and legislation to come, it will be imperative to take the necessary steps and obtain the necessary knowledge to understand how Asset Management and Transportation Performance Management affect all aspects of system performance. We must effectively accomplish the goals of *Moving Ahead for Progress in the 21 Century* (MAP-21), prepare for unexpected demands and account for situations that will stretch our budgets. The implementation of Asset Management and Transportation Performance Management is a process which provides the ability to not only improve system performance but to foster change, change in the way we think, change in the way we operate and change in the way we function as a transportation industry.

As reported by AASHTO in an NCHRP 20-24 report, "Asset management refers to applying performance management principles to the management of transportation physical assets and provides a strategic approach for the preservation, rehabilitation and maintenance of assets". Performance management is best described as a methodology used to optimize the execution of investment strategy. It consists of a set of integrated, closed-loop, analytic processes, supported by technology and data, addressing financial issues. It enables an agency to define, measure, and manage the performance of its assets against strategic goals against the overall infrastructure needs.

This presentation will discuss the different aspects of "putting the pieces together" to incorporate the principles of Asset Management and Transportation Performance Management for improving system performance. Definitions of these principals will be discussed and how each principal must be used to complement each other and how they can be implemented. The differences between each and how the implementation can vary, and answer the question, "is one approach more important than the other and are we fully implementing each when making better decisions?"

Keywords: Asset Management, Performance Management, MAP-21

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Asset Utilization Potential of Building a Trucking & Rail Mega Intermodal Hub in the Saint Louis Region

Ray A. Mundy[1], Daniel L. Rust[2], and Sidra Naseer[3]

Abstract

Annually, more than one billion tons of cargo pass through Saint Louis, making it the "Gateway to the West (Missouri Department of Transportation, 2014)." In Missouri, 33% of all cargo traffic moves by railroad, and more than 60% is transported via trucking (Wilbur Smith Associates & HNTB Corporation, 2003). As trade continues to flourish in the region, there is increased shipper and carrier demand for making Saint Louis an intermodal hub in order to optimize the region's strategic location, increase profit and lower transportation cost.

The objective of this study was to assess the asset utilization potential of building a common trucking and rail intermodal hub in the Saint Louis region by looking at industry history, examining transportation policies and initiatives in the Saint Louis region, and evaluating the major stakeholders affected by intermodal initiatives. Because today's transportation development decisions greatly impact environmental and economic sustainability, in addition to community welfare, the research project also focused on whether a common intermodal hub combining all railroads in Saint Louis would minimize operational and economic costs. As a result, the primary benefit of reducing intercity transfer costs was explained to showcase the consequential benefits and limitations associated with such an intermodal

[1] Director of Center for Transportation Studies; University of Missouri-Saint Louis Center for Transportation Studies; One University Boulevard JCPN 240, Saint Louis, MO, 63121; phone (314) 516-7270; fax (314) 516-7272; email: mundyr@umsl.edu

[2] Assistant Director for Undergraduate Program Development; University of Missouri-Saint Louis Center for Transportation Studies; One University Boulevard JCPN 240, Saint Louis, MO, 63121; phone (314) 516-7270; fax (314) 516-7272; email: rustd@umsl.edu

[3] Graduate Research Assistant; University of Missouri-Saint Louis; One University Boulevard JCPN 240, Saint Louis, MO, 63121; phone (314) 516-7270; fax (314) 516-7272; email: sn4gb@mail.umsl.edu

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mega-hub expansion in the Saint Louis region. The topics of property rights, externalities, net benefit to society, and technological growth are discussed in this paper.

Case studies of other cities in the United States that have had success with intermodal development are also presented in this paper. The primary methodology for this project focused on geospatial mapping of providers in the Saint Louis region, and used this information to provide a detailed analysis of creating a railroad and trucking hub in Saint Louis to facilitate the interaction of intermodal trade. The research paper also proposes the ideal location of the intermodal hub in Saint Louis.

Keywords: Intermodal hub—Railway—Freight—Trucking—Saint Louis region

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Battery System Safety and Health Management for Electric Vehicles

Guangxing Bai[1] and Pingfeng Wang[2]

Abstract

Prognostics and health management (PHM) is an emerging engineering discipline that diagnoses and predicts how and when a system will degrade its performance and lose its partial or whole functionality. Due to the complexity and invisibility of rules and states of most dynamic systems, developing an effective approach to track evolving system states becomes a major challenge. This research presents a new self-cognizant dynamic system (SCDS) approach that incorporates artificial intelligence into dynamic system modeling for PHM of electric vehicle battery systems. A feed-forward neural network (FFNN) is selected to approximate a complex system response which is challenging task in general due to inaccessible system physics. The trained FFNN model is then embedded into a dual extended Kalman filter algorithm to track down system dynamics. The recursive computation technique used to update the FFNN model using online measurements is also derived. To validate the proposed SCDS approach, a battery dynamic system is considered as an experimental application. After modeling the battery system by a FFNN model and a state-space model, the state-of-charge (SoC) and state-of-health (SoH) are estimated by updating the FFNN model using the proposed approach. Experimental results suggest that the proposed approach improves the efficiency and accuracy for battery health management.

Keywords: Safety—Electric Vehicle—Battery—State of Charge— State of Health

[1] Ph.D. Candidate; Wichita State University; 1845 Fairmount St, Wichita, KS, 67260; phone (316) 978-6735; fax (316) 978-3742; email: gxbai@wichita.edu

[2] Associate Professor; Wichita State University; 1845 Fairmount St, Wichita, KS, 67260; phone (316) 978-5910; fax (316) 978-3742; email: Pingfeng.wang@wichita.edu

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Behavior of negative moment reinforcement in PPCB bridge decks

Sameera T. Jayathilaka[1], Brent M. Phares[2], Lowell Greimann[3], Dean Bierwagen[4], and Mike Nop[5]

Abstract

Multi-span Pre-tensioned Pre-stressed Concrete Beam (PPCB) bridges made continuous usually experience a negative live load moment region over the intermediate supports. The Iowa Department of Transportation (DOT) Office of Bridges and Structures (OBS) current design approach provides a sufficient deck reinforcement amount (longitudinal continuous deck reinforcement (b1) plus additional longitudinal reinforcement over the intermediate supports (b2)) to satisfy the strength and serviceability requirements associated with the tensile stresses in the deck resulting from the induced live loads. However, the AASHTO LRFD bridge design manual recommends the negative moment reinforcement (b2 reinforcement) be extended beyond the inflection point. Based upon satisfactory previous performance and judgment, the Iowa DOT OBS currently terminates b2 reinforcement at 1/8 of the span length. Although the Iowa DOT policy results in approximately 50% shorter b2 reinforcement than the AASHTO LRFD specifications, the Iowa DOT has not experienced any significant deck cracking over the intermediate supports.

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[1] Graduate Research Assistant; Bridge Engineering Center; Iowa State University, Ames, IA, 50014; phone (515) 441-5305; email: sameera@iastate.edu

[2] Director; Bridge Engineering Center; Iowa State University, Ames, IA, 50014; phone (515) 294-5879; email: bphares@iastate.edu

[3] Bridge Engineering Specialist; Bridge Engineering Center; Iowa State University, Ames, IA, 50014; phone (515) 294-8103; email: greimann@iastate.edu

[4] Bridge Engineer; Iowa Department of Transportation; 800 Lincoln way, Ames, IA, 50010; phone (515) 239-1174; email: Dean.Bierwagen@dot.iowa.gov

[5] Bridge Engineer; Iowa Department of Transportation; 800 Lincoln way, Ames, IA, 50010; phone (515) 233-7935; email: Michael.Nop@dot.iowa.gov

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The objective of this project is to investigate the Iowa DOT OBS policy regarding the required amount, termination length and termination pattern of the b2 reinforcement. Live load tests on five bridges with different characteristics were carried out. The data were used to calibrate three-dimensional finite element models of two bridges. A parametric study was conducted on the bridges with three different deck configurations: (1) uncracked deck, (2) cracked deck and (3) cracked deck with cracked diaphragm. These deck configurations were used to understand the behavior of the bridge in multiple "states". The parametric study was conducted with live load and shrinkage load to investigate the effects of the area, length and distribution pattern of the b2 reinforcement. Later, the effect of secondary moments on the performance of the PPCB bridges were also evaluated.

Parametric study results show an increased length and staggered reinforcement pattern slightly reduce the strains of the deck at 1/8 of the span length. The evaluation of the effect of secondary moments illustrate that the secondary moments may actually be large enough to counteract any negative moments resulting from live load. Considering the results, it was concluded that the current Iowa DOT OBS policy regarding the b2 reinforcement is acceptable.

Keywords: Continuous Deck — Negative Moment Reinforcement — Field Test — Finite Element Model — Parametric Study

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This topic is "practice ready." ☐ **Yes** ☒ **No**

Bond Strength and Failure Mode of a New Green and High Performance Patching Material

Jennifer Davis[1], Gilson Lomboy[2], and Kejin Wang[3]

Abstract

The United States has an aging transportation infrastructure that requires constant maintenance and repair. The study is to investigate the bond strength and failure modes of a newly developed green, rapid-set, high performance, cost effective patch repair material on pavement substrates. This new repair material contains large proportions of fly ash, a by-product of power plants, and limestone fines, waste materials of aggregate quarries, and it has compressive strength and modulus of rupture of 6500psi and 565psi at 24 hours, respectively. Two substrates are studied: (1) pavement concrete (C-3WR-C20), with compressive strength of 5800psi, and (2) bridge deck concrete (O-I/II-4WR-0.32), with compressive strength of 6800psi. Before a repair, the surfaces of the substrates are treated with sandblasting and grouting. At 1, 3, 7 and 28 days after the repair, the bond strength between the new repair material and the substrates are evaluated according to ASTM C1583. The results to date have hindicated excellent bond strength between the new repair material and C-3WR-C20 substrate. With no exception, all tested samples have shown a tensile failure in the C-3WR-C20 substrate, not at the bond. The research is in progress to evaluate the bond between the new repair material and high strength concrete (O-I/II-4WR-0.32) substrates.

Keywords: High Performance Concrete—Bond Strength—Repair Material—Environmentally Sustainable—Infrastructure Maintenance

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[1] Undergraduate Research Assistant; Iowa State University Department of Civil, Construction, and Environmental Engineering; Ames, IA 50011; phone (916) 296-3317; email: jjdavis@iastate.edu

[2] Postdoctoral Research Associate; Iowa State University Department of Civil, Construction, and Environmental Engineering; 407 Town Engineering Building, Ames, IA, 50011; phone (515) 294-5234; email: grlomboy@iastate.edu

[3] Professor; Iowa State University Department of Civil, Construction, and Environmental Engineering; 412 Town Engineering Building, Ames, IA, 50011; phone (515) 294-2152; email: kejinw@iastate.edu

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Calibrating Highway Safety Manual for Rural Multilane Highways by Considering Fatal and Injury Crashes in Kansas

Syeda R. Aziz[1], and Sunanda Dissanayake[2]

Abstract

Rural roads in Kansas account for 90.7% of the total 140,686 roadway mileage in the state. In 2013 rural travel accounted for 47.5% of all vehicle miles majority of which are on state highways. In recent years, rural road crashes accounted for 35% of total crashes while fatal crashes on rural roads accounted for over 66% of fatal crashes in the state. Highway Safety Manual (HSM) published in 2010 by American Association of State Highway & Transport Officials (AASHTO) provides models and methodologies for analyzing different types of highways based on safety. The predictive methods in HSM have been developed based on national trends and statistics or based on a few sample states across the United States. Accordingly, these methodologies are of limited use if they are not calibrated for individual jurisdictions or local conditions. Therefore, the objective of this study was to estimate the calibration factors for the fatal and injury crashes on rural multilane segments in Kansas. Methodology provided in the HSM was used to perform the calibration and required data were obtained from Kansas Crash Reporting System and State Highway Inventory Databases. 283 rural four-lane divided segments and 83 rural four-lane undivided segments from State highway Inventory were considered for analysis. The Safety Performance Function (SPF) requires length of roadway segment and AADT as input parameters to the prediction model. The obtained SPF was multiplied by the Crash Modification Factors (CMF) to obtain the predicted number of fatal and injury crashes. In both models, CMFs were assigned for the following variables: lane width, shoulder width, presence of lighting, median width (for four-lane divided model only), and side slope (for four-lane undivided model only), which are deviating from the base condition. Calibration factors of 0.53 and 0.36 were obtained for fatal and injury crashes on four-lane divided and undivided segments, respectively. Results indicated that HSM is over-predicting the fatal and injury crashes on both rural four-lane divided and undivided roadway segments. As suggested

[1] Graduate Research Assistant & Doctoral Candidate; Kansas State University; Department of Civil Engineering, 2118 Fiedler Hall, Manhattan, KS 66506; phone (785) 532-5862; fax (785) 532-7717; email: sraziz@ksu.edu

[2] Professor; Kansas State University; Department of Civil Engineering, 2118 Fiedler Hall, Manhattan, KS 66506; phone (785) 532-1540; fax (785) 532-7717; email: sunanda@ksu.edu

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by HSM, development of jurisdiction-specific SPF is required under the circumstances, in order to predict crashes with greater reliability than calibrated SPF.

Keywords: Highway Safety Manual—Calibration—Fatal and Injury Crashes—Rural Multilane Segments

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Calibration of the Highway Safety Manual (HSM) for Freeway in Missouri

Kyoungmin NAM[1], Mengyuan Zhang[2], Carlos SUN[3], Praveen Edara[4], and Henry Brown[5]

Abstract

Highway Safety Manual (HSM) published in 2010 is to guide safety evaluation for local engineers. In Missouri, local road safety calibration was performed as the first step. This time freeway interchanges safety level will be evaluated after calibrating local Missouri condition. Enhanced Interchange Safety Analysis Tool (ISATe) was used as a tool to calibrate. First, facility type was selected - terminal, ramp and speed change lane. Each component was categorized by number of lane, rural or urban, diamond or parclo. Ten facility types were selected for terminal; six types for speed change lane; and 4 types for ramp segments.

Samples were randomly collected from master interchange list in Missouri from 30 to 50 sites by districts. Some facility type samples were less than 30 sites, because total available number was less than 30 sites. Before sampling was conducted, Missouri master interchange list was prepared with type of terminal, rural and urban, number of cross road and freeway lane. Diamond four leg (D4) type is the most common one with 34% out of 890 interchanges.

[1] Graduate Student; University of Missouri-Columbia; E1511 Lafferre Hall, University of Missouri, Columbia, MO, 65211; phone (573)489-0320;fax (573) 882-4784; email: kmn5r6@mail.missouri.edu

[2] Graduate Student; University of Missouri-Columbia; E1511 Lafferre Hall, University of Missouri, Columbia, MO, 65211; phone (573)818-5823;fax (573) 882-4784; email: mzn93@mail.missouri.edu

[3] Associate Professor; University of Missouri-Columbia; E2505 Lafferre Hall, University of Missouri, Columbia, MO, 65211; phone (573)884-6330;fax (573) 882-4784; email: CSun@missouri.edu

[4] Associate Professor; University of Missouri-Columbia; C2640 Lafferre Hall, University of Missouri, Columbia, MO, 65211; phone (573)882-1900;fax (573) 882-4784; email: EdaraP@missouri.edu

[5] Research Engineer; University of Missouri-Columbia; E3510 Lafferre Hall, University of Missouri, Columbia, MO, 65211; phone (573)884-0832;fax (573) 882-4784; email: BrownHen@missouri.edu

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Several tools were used at this stage. MoDOT TMS was mainly used to collect road specification, such as log miles. Google Earth was used to collect geometric data. And AutoCAD was used to measure curve radius and length of curve. After data collection, crash report was reviewed to find exact location within interchange.

Keywords: HSM—Safety—Missouri—Calibration

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This topic is "practice ready." ☒ **Yes** ☐ **No**

CAN TRAFFIC SIGNS BE TOO BRIGHT ON LOW-VOLUME ROADS?

Paul J. Carlson, Ph.D., P.E. [1]

Abstract

The objective of this study was to investigate a concern that signs along rural highways can be so bright that they cause reduced legibility and/or glare to the point of being a safety concern. The researchers recruited participants and conducted visibility studies on a closed-course facility to assess how various levels of brightness of Speed Limit signs can impact nighttime participants' ability to read the Speed Limit signs and detect various types of potentially hazardous objects along the edge of the traveled way. Based on the findings, considerations are provided for low-volume rural highways with average daily traffic of 5000 vehicles per day or less. To avoid glare and reduced object detection distances, ASTM Type III or IV materials should be specified for regulatory and nonfluorescent warning signs on these low-volume roads. Also, because of reduced object detection distances, recommendations are made to avoid the installation of unnecessary signs. Not only do unnecessary signs provide a potential hazard for errant vehicles, they also add to the overall maintenance responsibility, breed disrespect for traffic signs, and reduce the visibility of potentially hazardous objects along the roadside.

This abstract is being submitted for presentation only. The paper was submitted and accepted to TRB's 11th International Conference on Low-Volume Roads. (July 12-15, 2015 in Pittsburgh, Pennsylvania). TRB is publishing the paper in an upcoming TRR Journal.

Keywords: traffic control device, visibility, signs, glare, legibility, safety

[1] Senior Research Engineer; Texas A&M Transportation Institute; 2935 Research Parkway, College Station, TX, 77845; phone (979) 847-9272; email: paul-carlson@tamu.edu

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Case Studies of Complex Girder Erection

Andrew J. Keaschall, P.E. S.E.[1], Hossam M. Abdou[2], PhD, P.E., S.E.

Abstract

This presentation will discuss four case studies associated with girder erection of complex, long span plate girder bridges. The four bridges are located in four different geographic locations (Chicago, St. Louis, and two in Tennessee) and erected by four different Contractors using four different methods of construction. Each method of construction was selected to address constraints that were unique and specific to each project. This presentation will illustrate the challenges associated with these various methods of plate girder bridge erection and how they addressed the constraints. There will also be a brief synopsis of common themes of girder erection that are applicable to all methods.

The first bridge is 1,980 foot long with a main span over the navigation channel equal to 490'. The Contractor elected to erect the center segments of the main span via strand jacking in order to minimize impacts to channel navigation below. This method involves installing jacking brackets on the cantilever girder ends on each side of the main span. The strand jacks would then lift pre-assembled center segments, weighing 1.6 million pounds, 60' into their final position. The second bridge is 1,600 foot long with 335' middle spans and is located in a river gorge in Tennessee with 80 foot deep water and piers that were about 100' above the water level. The method here involved the use of pier brackets with balanced cantilever construction and drop-in segments.

[1] Keaschall, Andrew J. P.E., S.E.; Alfred Benesch and Company; 205 N. Michigan Ave. Suite 2400, Chicago, IL 60601; phone (312) 565-0450; fax (312) 565-2497; email: akeaschall@benesch.com

[2] Abdou, Hossam M., PhD, P.E., S.E..; Alfred Benesch and Company; 205 N. Michigan Ave. Suite 2400, Chicago, IL 60601; phone (312) 565-0450; fax (312) 565-2497; email: akeaschall@benesch.com

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The third case study highlights a curved flyover girder structure that is 2,100 feet long and consists of 3 separate units with two different curves and maximum span lengths of 250 feet. The presentation will cover multiple methods of maintaining plumbness of the girders during erection while picking the girder and during the partially erected phases of the structure. The last case study is for a 2,100 foot long bridge over the Clinch River in eastern Tennessee. The center spans of this structure are 278' and again over deep water. The method of construction for this bridge involved the use of a shoring tower that was mounted on a floating barge. Ballast tanks in the barge were used to maintain a level shoring tower while addressing multiple load scenarios associated with the various stages of erection.

Keywords: Girder Erection—Strand Jacking—Pier Bracket—River Construction—Curved Girder

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Cement Modification on Embankment Construction Soil Materials

Shengting Li[1], Chao Chen[2], and David J. White[3]

Abstract

This paper presents the effects of cement modification on embankment construction materials. The soil materials were gathered from nine statewide embankment construction projects. According to soil classification, most of the soil materials used have more than 30% clay content and 25% silt content. The relatively high clay and silt content has risk to cause embankment slope stability issues. To test the effects of stabilization, four contents of type I Portland cement (0%, 4%, 8% and 12%) were mixed with the soil materials to prepare Iowa State 2 inch by 2 inch compaction specimens. To simulate in situ soil material saturation effects, three specimens from each group were selected to conduct vacuum saturation. It is indicated that higher content of cement treated specimens have higher unconfined compressive (UC) strength, and trend of the strength increasing is linear regression. By comparing the UC strength, percentage of soil passing #200 sieve, Atterberg limits between untreated and cement treated specimens, the high fines content soil materials were stabilized and modified as more suitable for embankment construction.

Keywords: cement modification—compaction—embankment—suitable soils

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[1] Graduate Research Assistant; Iowa State University, Center for Earthworks Engineering Research (CEER), 2711 S Loop Drive, Ste 4700, Ames, IA 50011; Phone (515) 817-3555; email: stli@iastate.edu

[2] Graduate Research Assistant; Iowa State University, Center for Earthworks Engineering Research (CEER), 2711 S Loop Drive, Ste 4700, Ames, IA 50011; phone (515) 509-6310; email: chaoc@iastate.edu

[3] Professor; affiliation; Iowa State University, Center for Earthworks Engineering Research (CEER), 422 Town Engineering, Ames, IA 50011; Phone (515) 294-1463; Fax (515) 294-0467; email: djwhite@iastate.edu

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Characteristics of Farm Equipment-Related Crashes Associated with Injury in Children and Adolescents on Farm Equipment

Maisha N. Toussaint[1], Kayla S. Smith[2], Corinne Peek-Asa[3], and Marizen Ramirez[4]

Purpose: Operating or riding on farm equipment is one of the leading causes of farm-related injuries and fatalities among children and adolescents. The aim of this study is to examine environment, crash, vehicle and occupant characteristics and the probability of injury, given a crash, in youth under age 18 on farm equipment.

Method: Data from the Departments of Transportation on farm equipment-related crashes across nine Midwestern states from 2005–2010 were used. Odds ratios were calculated using logistic regression to assess the relationship between environment, crash, vehicle and occupant characteristics and the probability of injury, given a crash.

Findings: A total of 434 farm equipment-related crashes involved 505 child or adolescent occupants on farm equipment; 198 passengers and 307 operators. Passengers of farm equipment had a 4.1 higher odds of injury than operators. Occupants who used protective equipment or restraints had a significantly lower odds of injury than those who did not use protective equipment or restraints. Furthermore, occupants on farm equipment that was rear-ended, sideswiped, or impacted while turning had significantly lower odds of injury compared to occupants on farm equipment involved in non-collision crashes or moving straight.

Conclusion: Precautions should be taken to limit or restrict the use of farm equipment by youth and ensure direct supervision by an adult. These findings reiterate the need to enforce policies that improve safety measures for youth involved in or exposed to agricultural tasks.

Keywords: agriculture—tractor—transportation—youth—injury

[1] Maisha Toussaint MPH; University of Iowa College of Public Health; 145 N. Riverside Drive, Iowa City, IA, 52242; phone (319) 384-1567; email: maisha-frederick@uiowa.edu

[2] Kayla Smith BS; University of Iowa College of Public Health; 145 N. Riverside Drive address, Iowa City, IA, 52242; phone (319) 335-4425; email: kayla-smith-1@uiowa.edu

[3] Corinne Peek-Asa PhD; University of Iowa College of Public Health; 145 N. Riverside Drive, Iowa City, IA, 52242; phone (319) 335-4895; email: corinne-peek-asa@uiowa.edu

[4] Marizen Ramirez PhD; University of Iowa College of Public Health; 145 N. Riverside Drive, Iowa City, IA, 52242; phone (319) 335-4425; email: marizen-ramirez@uiowa.edu

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Comparison of nighttime and daytime crash characteristics associated with severity of work zone crashes using severity models

Ishani Dias[1] and Sunanda Dissanayake[2]

Abstract

Identification of factors associated with motor vehicle crashes in highway work zones is essential in order to establish safe, efficient traffic flow through improved work zones. According to Federal Highway Administration (FHWA), 87,606 crashes (1.6% of total vehicle crashes) occurred in United States at work zones in 2010; 436 of those crashes were fatal. In addition, 576 people were killed in work zones in 2010, making it a significant safety issue. Analysis of data published by the Kansas Department of Transportation (KDOT) showed an increase in Kansas work zone crashes from the years 2009 to 2012. According to their facts book, 1,781 vehicles crashes have occurred in work zones during 2012, which was a 38% increase from 2009. The primary objective of the current study was to identify and compare factors that contribute to higher injury severity of crashes in work zones during nighttime and daytime conditions. Characteristics of work zone crashes were also studied using the preliminary screening. Ordered probit model was used for injury severity modelling separately for nighttime crashes and daytime crashes using Kansas crash data from 2010 to 2013. There were 6,021 work zone crashes during these four years (2010-2013) and 63% of them occurred during the daytime. Different driver aspects and crash locations were found to be associated with higher injury severities. Young drivers (15 to 25 years old) were involved in higher severity injuries in nighttime work zone crashes and middle-aged drivers (25 to 65 years old) were involved in higher severity work zone crashes during daytime. When gender of the

[1] Graduate Research Assistant; Department of Civil Engineering; 2139 Fiedler, Kansas State University, Manhattan, KS, 66506; phone (785) 317-5628; fax (785) 532-7717; email: ishani@ksu.edu

[2] Professor in Civil/Transportation Engineering, Ph.D, P.E.; Department of Civil Engineering; 2118 Fiedler, Kansas State University, Manhattan, KS, 66506; phone (785) 532-1540; fax (785) 532-7717; email: sunanda@ksu.edu

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driver at-fault was considered, male drivers were associated with increased injury severities during nighttime and that was not found as a significant factor for daytime work zone crashes. Work zone crashes that occurred in non-intersection areas were associated with increased crash severities for daytime crashes and lesser severities for nighttime crashes. Higher severity injuries occurred within termination area of the work zone during daytime and, within activity area and advance warning area of the work zone during nighttime. They were some among many findings of this study. Results of this study can effectively identify pending safety issues, leading the way to identify improvement strategies.

Keywords: work zone—injury severity—nighttime—daytime—ordered probit model

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Constructability of Precast Concrete Deck Panels in the Kearney East Bypass Project

The first generation of precast concrete deck system, NUDECK, developed by the University of Nebraska-Lincoln (UNL) for Nebraska Department of Roads (NDOR), was implemented on the Skyline Bridge, Omaha, NE in 2004. The second generation of precast concrete deck system NUDECK was developed recently to further simplify precast panel/girder production, speed up bridge superstructure construction, and improve deck durability. The second generation of NUDECK consists of full-width full-depth precast concrete deck panels that are 12 ft long to minimize the number of deck panels and transverse joints, and consequently accelerate bridge construction. It also uses covered individual pockets and bundled shear connectors at 4 ft spacing to simplify panel and girder production and eliminate the need for deck overlay. Precast deck panels are pre-tensioned in transverse direction and post-tensioned in the longitudinal to enhance deck durability and achieve the same service life of other bridge components. Post-tensioning strands are placed underneath the deck panels (at the haunch area) to eliminate threading strands through ducts and grouting operations.

This paper presents the first implementation of the 2nd generation of NUDECK system to the Kearney East Bypass project in Kearney, NE. The project consists of twin bridges: the south bound bridge constructed using conventional cast-in-place deck; and the north bound bridge constructed using the 2nd generation NUDECK system. Each bridge is a two-span continuous bridge that is 41 ft 8 in. wide and 332 ft long. Each span is 166 ft long and consists of five precast/prestressed concrete girders (NU1800) at 8 ft 6 in. spacing. The paper presents the construction sequence of the new system and summarizes the experimental investigation conducted to evaluate: 1) using self-consolidating concrete (SCC) to fill the gap between precast concrete deck panels and bridge girders as well as covered deck pockets; and 2) using the proposed deviators and anchorage block in the end deck panels for post-tensioning the bridge deck. These investigations includes evaluating the pumpability/pouring of the developed SCC mixture in mockup and full-scale specimens. Sequence of pumping/pouring of SCC as well as its quality control and quality assurance procedures are also demonstrated. The investigations also include pullout testing of the deviators and pushoff testing of the anchorage block used for post-tensioning to evaluate their performance and refine their reinforcement details.

This topic is "practice ready." ☒ **Yes** ☐ **No**

Cracking Propensity of Recycled Superpave Mixtures with Highly Absorptive Aggregates and RAP and RAS

Masoumeh Tavakol[1]; Mustaque Hossain, Ph.D., P.E.[2]; and Blair Heptig, P.E. [3]

Abstract

Use of recycled materials in asphalt pavements has been rapidly increasing in recent years due to the rise in virgin binder price and increased attention to sustainability. Historically, the most broadly used recycled materials for hot-mix asphalt (HMA) is Recycled Asphalt Pavement (RAP). Also, another source of the recycled materials that has recently becoming more widespread in HMA is Recycled Asphalt Shingle (RAS). Unfortunately, HMA pavements containing higher RAP and RAS contents have recently shown higher incidence of cracking. In this study, three mix designs from recent projects of the Kansas Department of Transportation were selected as control mixtures, and three recycled Superpave project mix designs containing higher percentage of RAP and RAS were developed in the laboratory. The mixtures contain very absorptive aggregates and RAP with similar absorptive aggregates. The cracking performance of these recycled mixtures was studied by conducting the Dynamic Modulus tests. The results show that the amount of aged binder from the RAP with absorptive asphalt should be limited to ensure adequate cracking performance of recycled mixtures.

Keywords: Recycled Superpave Mixtures — Highly Absorptive Aggregates — RAP — RAS — Cracking Performance

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[1] Graduate Research Assistant; Department of Civil Engineering, Kansas State University; Manhattan, KS, 66506; Tel. (785) 532-5862; Fax (785) 532-7717; (corresponding Author) E-mail: mtavakol@ksu.edu

[2] Munger Professor; Department of Civil Engineering, Kansas State University; Manhattan, KS, 66506; Tel. (785) 532-1576; Fax (785) 532-7717; E-mail: mustak@ksu.edu

[3] Field Engineer; Kansas Department of Transportation; Topeka, KS, 66506; Tel. (785) 296-7410; E-mail: blairh@ksdot.org

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This topic is "practice ready." ☐ **Yes** ☑**No**

Data extraction from highway information model

Tuyen T. Le[1] and H. David Jeong[2]

Abstract

The objective of this research is to develop a framework that can enable automatic extraction of partial highway information models from LandXML files. LandXML is a neutral data format for digital data exchange between proprietary applications involved in civil projects (pipelines, roadways, railways, etc.). This data standard includes rich sets of as-designed information covering a wide range of use cases. However, for a specific scenario, only a subset of data is required. The proposed framework adopts the Resource Description Framework (RDF) which is an emerging data modeling approach to structure the highway data and information. The conversion from LandXML to RDF format is supported by a highway information ontology which was built on the LandXML specification. A query strategy was then developed using SPARQL, a query language for RDF, to generate a partial model. Illustrative case studies indicated that the proposed framework can successfully extract subsets of data from LandXML files. The simplicity and effectiveness of the data extraction server would beneficially assist practitioners in processing as-designed highway information models for specific use cases. Consequently, the research is expected to leverage the seamless exchange of data and information between digital applications involved in the highway industry.

Keywords: interoperability—highway data model—data extraction—RDF—ontology

[1] Ph.D. student; Iowa State University; 427 Town Engineering, Ames, Iowa, 50011; phone: (515) 203-5273; email: ttle@iastate.edu

[2] Ph.D.; Iowa State University; 404 Town Engineering, Ames, Iowa, 50011; email: djeong@iastate.edu

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Data Inputs and Tools for Analyzing Reliability

James Sturrock[1]

Abstract

This session will discuss the data inputs needed for Reliability Analysis, present an overview of data pre-processing considerations and discuss the current tool set available for analysis and operational improvement of facility reliability.

[1] ITS Operations Engineer; FHWA Resource Center; 4749 Lincoln Mall Drive Suite 600, Matteson, IL 60443; (708) 283-3536; james.sturrock@dot.gov

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Deployment of Intelligent Work Zone Systems in Iowa

Tim Simodynes[1] and Jon Jackels[2]

Abstract

One of the greatest challenges with planning and managing work zones is finding the balance between the often competing demands of construction safety and efficiency (construction costs) and minimizing impacts to traffic (safety and mobility of road users). In 2014, the Iowa DOT began an effort to proactively address construction work zones that qualify as "Traffic Critical Projects" (TCP). The long-term goal of the program is to develop and implement comprehensive processes and procedures to provide improved traffic mobility and safety through major construction projects. In 2014, the initial focus was on deploying Intelligent Work Zone (IWZ) systems via an innovative, state-wide, quality-based service contract, with systems integrated into the state's Advanced Traffic Management System. That contracting method and process has allowed for consistency and integration across the state while minimizing additional demands on DOT construction staff. In 2015 the program again includes IWZ systems, and has also expanded to include more precise lane closure restrictions (by time of day, day of week, and/or seasonal) and targeted Traffic Incident Management (TIM) planning. The benefit of these efforts has been to mitigate the impact projects have on mobility and traffic safety, and to aid in the efficient recognition, mitigation and recovery from incidents in the work zones.

There are many stakeholders involved in making the TCP program a success. Personnel from several DOT offices, district staff, several support consulting companies, academia, and multiple equipment vendors all worked together to accomplish the goals of the program.

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[1] ITS Engineer; Iowa DOT; 800 Lincoln Way, Ames, IA 50010; phone (515)239-1606; email: tim.simodynes@dot.iowa.gov

[2] Senior Associate, SRF Consulting Group, Inc., One Carlson Parkway North, Suite 150, Minneapolis, MN, 44447-4443; phone 763-249-6722; email: jjackels@srfconsulting.com

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Other key components of this program include evaluating the effectiveness of various mitigation efforts, refining the planning process for future traffic critical projects, and expanding the scope to have a better integrated role in project design and construction staging.

Iowa DOT has set a goal for making the TCP program self-sustaining and highly successful in advancing the goals of increasing safety and reducing delay through construction work zones.

Keywords: Intelligent Work Zones—ITS—Work Zone Safety—Intelligent Transportation Systems—Traffic Incident Management—Work Zones

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Design and Construction Requirements for Electrically Heated Pavement Systems

Hesham Abdualla[1], Halil Ceylan[2], Kasthurirangan Gopalakrishnan[3], Sunghwan Kim[4], Peter C. Taylor[5], and Yelda Turkan[6],

Abstract

The effect of ice and snow on airport pavement is a critical concern causing flight cancellations and delays. Traditional de-icing methods, involving the application of chemicals or salt, have the potential to cause negative environmental and structural impacts on airport infrastructure systems. Electrically heated pavement technology, using embedded insulated conductors/conductive materials inside pavement system to transfer electrical heating energy, has been proposed as promising alternative technologies in mitigating snow and ice accumulation by maintaining pavement surface temperature above freezing point.

The objective of this study is to demonstrate the prototype design and construction procedures of electrically heated pavement system technology through 3D artistic rendition and visualization as well as through construction of small-scale experimental concrete slabs in line with the Federal Aviation Administration (FAA) specifications. Comprehensive reviews will be carried out with emphasis on various design and construction aspects including mix design of electrically conductive concrete

[1]Graduate Student; Iowa State University; 24 Town Engineering Building, Ames, IA, 50011; phone (515) 274-4698; fax (515) 294-8216; email: abdualla@iastate.edu

[2]Associate Professor; Iowa State University; 406 Town Engineering Building, Ames, IA, 50011; phone (515) 294-8051; fax (555) 294-8216; email: hceylan@iastate.edu

[3]Research Associate Professor; Iowa State University; 354 Town Engineering Building, Ames, IA, 50011; phone (515) 294-3044; fax (555) 294-8216; email: rangan@iastate.edu

[4]Research Scientist; Iowa State University; 24 Town Engineering Building, Ames, IA, 50011; phone (515) 274-4698; fax (515) 294-8216; email: sunghwan@iastate.edu

[5]Research Associate Professor; Iowa State University; 2711 S Loop Dr, Ames, IA, 50011; phone (515) 294-9333; email: ptaylor@iastate.edu

[6]Assistant Professor; Iowa State University; 428 Town Engineering Building, Ames, IA, 50011; phone (515) 294-7539; fax (555) 294-8216; email: yturkan@iastate.edu

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(ECON), types and installation of electrodes, pavement geometric features, electrical energy requirements, and heating performance. Based on the review results, the design of electrically heated pavement systems will be drafted and detailed using 3D visualization. The design and construction requirements for electrically heated pavement systems identified from this study will be discussed and presented.

Keywords: Electrically Heated Pavement System —— Airport —— Design and construction —— Electrically conductive concrete (ECON) —— 3D visualization

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Design-Build of US 69 Bridge over Missouri River

Frank Blakemore, PE, Garver

ABSTRACT

The American Bridge/Garver Team was the successful proposer to replace the existing US 69 Missouri River crossing in Kansas City, which consists of the southbound Fairfax Bridge and the northbound Platte Purchase Bridge. As lead designer for this design-build project, Garver's fast track design provides an overall bridge length of 2,155 feet and 75'-8" bridge width with two lanes northbound, two lanes southbound, and a shared use path for bicycle/pedestrian traffic. Part of the innovation for a successful score and bid in the design-build competition was to keep the new alignment near the existing southbound bridge and to shorten the bridge as much as possible. This included closing a road on the Kansas side and interaction with the levee on the Missouri side of the River. Another opportunity the design-build team took advantage of was a unique realignment of Argosy Casino Parkway (utilizing the side span of an existing bridge), tied to the existing roadway and the access ramp from northbound US 69 with a roundabout.

To provide the necessary span length over the navigation span, clearance to the levee, and span across the railroad tracks, a continuous composite steel plate girder unit (1,350 feet) was utilized. The plate girder has a maximum depth of 12 feet at the 420-foot long navigation span and then haunches down to 10 feet in the adjacent spans. For the north overbank area, a continuous composite NU-78 prestressed girder unit (804 feet) was utilized. The maximum span length was 165 feet, with the last span skewed 10 degrees to cross the levee.

The substructure design was based on using a two-column bent in all locations, with the column size typically either 9'-0" (steel unit) or 5'-6" (concrete unit). For the concrete unit, the foundation type was typically driven piles with drilled shafts used near the levee. The river piers utilized a 10'-6" drilled shaft integral to each column, along with a tie beam at water level, to accommodate the vessel collision loading.

The new US 69 Missouri River crossing will result with a safe and low maintenance bridge designed for a 100-year life expectancy of service. The advantages of utilizing the steel superstructure unit to meet the design criteria and to speed construction will be discussed, as well as the utilization of the design-build delivery method for this project.

This topic is "practice ready." ☒ **Yes** ☐ **No**

Detecting and Validating Changes in Road Networks

Abdaljabbar, Ahmed S.[1], Timothy C. Matisziw[2]

Abstract

Maintaining an accurate database of roadways and their attributes is essential to effective tracking, modeling, and management of transportation assets. Given the dynamic nature of transportation infrastructure change and use, updating and validation of such roadway databases can be a costly challenge. While Global Positioning System (GPS) data is widely used for monitoring the location of transportation assets, it also provides a wealth of information about the location and condition of the roadways supporting vehicle movements. Current methods for collecting GPS information about roadways involve making use of expensive, specialized cars that are equipped with multiple cameras, GPS units, and other measurement devices. However, given the wide-spread use of GPS in personal and fleet vehicles, there exists a great potential to measure and document the characteristics of roadways at an unprecedented scale. This presentation proposes a new methodology for making use of fleet-based GPS data to assist in the tracking and validation of changes to geographic roadway databases. An application of the developed methodology to an actual fleet GPS dataset is then detailed to demonstrate its utility.

Keywords: Asset Management—Planning—Geographic Information Systems—Decision Support—Transportation Modeling

[1] Department of Civil & Environmental Engineering, E2509 Lafferre Hall, University of Missouri, Columbia, MO, 65211; phone (573) 825-3896; asayb5@mail.missouri.edu

[2] Department of Civil & Environmental Engineering, Department of Geography, Informatics Institute, 8 Stewart Hall, University of Missouri, Columbia, MO 65211; phone (573) 882-1423; fax (573) 884-4239; email: matisziwt@missouri.edu

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This topic is "practice ready." ☐ **Yes** ☒ **No**

Development of Computational Models to Investigate Climate Change Effects on Long-Term Performance of Aging Structures

Dena Khatami[1], Behrouz Shafei[2] and Christopher J. Andersons[3]

Abstract

Corrosion of steel rebars caused by the ingress of carbon dioxide and chloride ions is a major cause for deterioration of highway bridges. The extent and rate of deterioration are found to be directly affected by the environmental parameters, such as temperature and humidity. Therefore, climatic changes, which alter exposure conditions, are expected to influence the estimates of the remained lifetime of aging structures. On the other hand, the intensity and frequency of natural hazards are predicted to change over the years. This can also result in significant extreme events, which potentially cause major structural damage or even sudden failure. The current study presents a comprehensive investigation on the impact of climate change on the integrity of highway bridges with a special focus on the ones located in the State of Iowa. For this purpose, the changing trends of temperature, humidity, and carbon dioxide concentration are projected based on the latest greenhouse gas emission scenarios. The obtained trends are then incorporated into a multi-physical computational framework to predict the extent of deterioration and probability of failure. This study is expected to serve as a guide for both design and assessment of highway bridges by providing the life-cycle predictions that take into account the long-term effects of climate change. Based on the unique capabilities of the developed framework, the outcome of this study can be extended to the other geographic regions given exposure conditions and site-specific characteristics.

Keywords: Aging Structures, Climate Change, Deterioration, Life-Cycle Performance Assessment

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[1]Graduate Research Assistant; 423 Town Engineering Building, Ames, IA, 50011-3232; phone (515) 294-2181; email: dkhatami@iastate.edu

[2]Assistant Professor; 424 Town Engineering Building, Ames, IA, 50011-3232; phone (515) 294-4058; email: shafei@iastate.edu

[3]Research Assistant Professor; Assistant Director, ISU Climate Science Program; 2021 Agronomy Hall, Ames, IA 50011-1010; phone (515) 294-9948; email: cjames@iastate.edu

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Development of Superhydrophobic Concrete Surfaces for Ice- and Snow-Free Pavement Systems

Therin J. Young[1], Sriram Sundararajan[2], Halil Ceylan[3], Sunghwan Kim[4], and Kasthurirangan Gopalakrishnan[5]

Abstract

Superhydrophobic surfaces that mimic those found in nature, such as the lotus leaf, are becoming an attractive research topic in various fields of study because of their numerous applications. The self-cleaning and anti-wetting properties of superhydrophobic surfaces help reduce labor and maintenance costs and increase the operational lives of weather-exposed infrastructure such as oil platforms and fishing vessels. More recent studies have focused on superhydrophobic surfaces that reduce or completely stop the accretion of ice and snow on power lines and aircraft that operate in cold regions. Concrete pavements located at airports that experience extreme icing conditions and numerous freeze-thaw cycles are perfect candidates for superhydrophobic coatings.

The objective of the current research is to develop a durable superhydrophobic coating that can be spray deposited onto concrete pavement surfaces. Candidate coating materials include polytetrafluoroethylene (PTFE) or Teflon and silica-based diatomaceous earth. Adhesion of the coatings to the concrete pavements was achieved by use of a two-part epoxy resin. Friction and roughness measurements were carried out before and after coatings were deposited. Tangent-line static water contact angles of coated surfaces was used to characterize the wettability of each coating. Friction and abrasive wear tests were conducted using a reciprocation pin-on-flat tribometer to assess the mechanical durability of the

[1] Graduate Research Student; Iowa State University; 2025 Black Engineering, Ames, IA, 50011; phone (229) 310-9836; email: theriny@iastate.edu

[2] Professor; Iowa State University; 2080 Black Engineering, Ames, IA, 50011; phone (515) 294-1050; email: srirams@iastate.edu

[3] Associate Professor, Iowa State University, 406 Town Engineering Building, Ames, IA 50011; phone (515) 294-8051; email: hceylan@iastate.edu

[4] Research Scientist; Iowa State University; 24 Town Engineering Building; Ames, IA 50011; phone: (515)-294-4698, e-mail: sunghwan@iastate.edu

[5] Research Associate Professor; Iowa State University; 354 Town Engineering Building; Ames, IA 50011; phone: (515)-294-3044, e-mail: rangan@iastate.edu

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coatings. Expectations are that this study will provide useful data that shines light on the feasibility of superhydrophobic coatings for non-wetting concrete pavement surfaces.

Keywords: Superhydrophobic—Concrete— Ice and Snow—Durability—Friction—Wettability

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This topic is "practice ready." ☐ **Yes** ☒ **No**

Economic Benefits of Additional Rail Bridge Capacity

Ray A. Mundy[1]; Emma Nix[2]

Abstract

Located in St. Louis, Missouri, the Merchants and MacArthur Bridges comprise the most commonly used Mississippi Rail Bridge crossing, carrying an average of 72.8 trains per day. Unlike other heavily trafficked bridges, these are not owned by a railroad company, and as such, allow any railway to use their tracks. In this way, the Merchants and MacArthur Bridges serve as an integral component of U.S. transportation infrastructure. However, these bridges are aging. Build in 1890, the Merchants Bridge is the eldest, and although it has two tracks, weight restrictions essentially cause it to operate as a single track bridge. Not only does limited capacity decrease the amount of freight able to move across this bridge, it also puts further constraints on the country's already congested rail system. The Federal Railroad Administration estimates that the total tonnage transported by rail will increase 35% by 2050. Without improving the existing infrastructure, the already overburdened system will not be able to accommodate this growth, and the bridges' capacity may decrease further due to structural deficiencies. In this case, freight will have to be diverted along longer rail routes or by truck, which will lead to increased transport times and higher overall costs. By restoring the Merchants Bridge to fully operational status, not only can congestion be alleviated on overburdened routes, but it will also produce

[1] Director of Center for Transportation Studies; University of Missouri-Saint Louis Center for Transportation Studies; One University Boulevard JCPN 240, Saint Louis, MO, 63121; phone (314) 516-7270; fax (314) 516-7272; email: mundyr@mail.umsl.edu

[2] Graduate Research Assistant; University of Missouri-Saint Louis; One University Boulevard JCPN 240, Saint Louis, MO, 63121; phone (314) 516-7270; fax (314) 516-7272; email: ejnvw5@mail.umsl.edu

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economic benefits as railroads will be able to move more freight at a lower price. Overall benefits will include decreased transportation costs, decreased inventory costs, and the environmental benefit of less fuels spent as a result of faster transport times and fewer miles traveled. Also, as transport by rail is marginally cheaper than by truck, additional benefits can be calculated by highway miles saved in accident cost, maintenance cost, congestion cost, and environmental damage cost when compared to that of rail transport. As a result, improving the Merchants Bridge will generate large economic costs for the entire region.

Keywords: Merchant's Bridge – St. Louis—Cost-Benefit Analysis—Freight Transportation—Railroad bridge—Economic benefit

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Harris-Stowe State University

Anheuser-Busch School of Business

Fara Zakery, Ph.D.
Joyce Eisel, Dr. P.H.
Robert Kamkwalala, Dr. Mgt.
Amir Salaria, Dr. Mgt.

Abstract

Economic Sustainability of Inner City Streets

A Collaborative Sustainable Asset Management Transportation System Model

Harris-Stowe State University (HSSU), Anheuser-Busch School of Business was selected by the University of Iowa Institute for Transportation under a U. S. Transportation Grant. The university research team, which included three faculty and three student researchers, proceeded to develop and create a sustainable Asset Management Transportation System Model. Since HSSU is a diverse Historical Black University, the team focused on inner-city road conditions related to municipal asset allocation within three St. Louis City Wards. To facilitate research objectives, the team collaborated with Missouri constituents including the Missouri Department of Transportation, the St. Louis City Street Department, local government officials, universities and stakeholders.

Selection criteria for roadways included roads, traffic, location, safety, utility and demographics. A forty five block area was divided into six sections and roads were surveyed, photographed and evaluated using "The Transportation Engineers Association of Missouri's Pavement Surface Evaluation and Rating" (PASER). Necessary street repairs and costs of each repair were calculated using global mapping technology and historical cost data. Since Aldermen decide street asset allocations, costs were allocated to each City Ward District.

In conclusion, these assessments, which were based on a technology driven model, should assist in the construction of future financial models based on a Need Projection to Dollars Spent ratio per fiscal year. It is expected that this economic model will be implemented in the St. Louis Metropolitan Region and replicated by similar municipalities.

Student Researchers: Brandon Dixon, Jeremi Reed, Micah Stone

This topic is "practice ready." ☐ **Yes** ☒ **No**

Effect of Asphalt Rejuvenating Agent used in Hot-in-Place Recycling on Reclaimed Asphalt Pavement

Nassim Sabahfar[1], Mustaque Hossain[2], and Greg Schieber[3]

Abstract

The necessity for cost effective and more sustainable replacements for virgin paving mixtures is becoming more and more evident in recent years especially with asphalt binder and aggregate economics and the obligations for using greener alternatives. Hot in-place recycling (HIR) is a recycling process that preserves or maintains distressed asphalt pavements while minimizing the use of virgin binder and aggregates. The final quality of HIR mixture depends on the characteristics of the original binder, aging during service, and new binder or rejuvenator added. HIR mixture should maintain desired properties for another service period which makes asphalt binder modification inevitable. Binder modification is commonly done by adding asphalt rejuvenating agent (ARA) during the HIR process. However, there is a concern that ARA may adversely affect the qualities of new HIR or does not improve the quality of the final surface as expected.

The objective of this research was to investigate the effects of rejuvenation on the HIR performance characteristics by checking critical performance indicators such as stiffness, permanent deformation, moisture susceptibility, and resistance to cracking. In order to fulfill the purpose of this study, a two-stage experimental program was designed including measurements of mechanical properties of the HIR mixture and rheological properties of the extracted binder. Besides, the level of mixing that occurs between the new and the aged binder in presence of ARA was investigated using Scan Electron Microscope (SEM). The samples were obtained from three different locations in Kansas and the tests conducted to measure mechanical properties included Hamburg wheel-tracking device (HWTD), complex modulus, flow number, Texas Overlay (OT), and moisture susceptibility. Conducted tests for evaluating mixture rheological properties included dynamic shear rheometer (DSR), bending beam

[1] Ph.D Student; Kansas State University, College of Engineering, 2118 Fiedler Hall, Manhattan, KS, 66506; phone (785) 341-9064; fax (785) 532-7717; email: nnassim@ksu.edu

[2] Professor; Kansas State University, College of Engineering, 2124 Fiedler Hall, Manhattan, KS, 66506; phone (785) 532-1576; fax (785) 532-7717; email: mustak@ksu.edu

[3] Assistant Bureau Chief; Kansas Department of Transportation; Bureau of Construction & Materials, 700 SW Harrison St. Topeka, KS, 66603; phone (785) 296-7136; fax (785) 296-0999; email: gregs@ksdot.org

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rheometer (BBR), and exudation droplet test. Finally, the miscibility of the new and aged binder was investigated utilizing SEM images. The results showed that although ARA can adversely affect performance, HIR mixtures meet the requirements set by the Kansas Department of Transportation (KDOT) for most parts and the reclaimed asphalt binder had an adverse effect on the adhesion properties of the final mixture.**Keywords: Hot in-place recycling—Asphalt rejuvenating agent—Recycling—Blending—Performance evaluation**

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Effect of Pre-Stressed CFRP Composite Patch on Cracked Steel Plates

Hani A. Salim[1], and Hesham M. El-Emam[2],

Abstract

More than 20% of existing bridges in the US are categorized as structurally deficient. Fatigue life of steel bridge superstructures can be extended by externally bonding FRP patches in the elements where cracks are detected. Due to various advantages of composite materials, this method has attracted the engineering design and research communities. In this paper, detailed investigations were performed to highlight the effect of bonded pre-stressed composite patches on the fracture parameters, such as stress intensity factors (SIFs) for different crack lengths. A three-dimensional finite element model of the double sided FRP patch-strengthened specimen is used to study the fracture behavior of an inclined edge crack under different combination of loading modes I and II, and to study the patch effect on the crack tip parameters. The influence of the pretension level and fiber orientation on the stress intensity factor levels are also investigated herein. The introduction of a pretension in the CFRP patch prior to bonding produces a significant reduction in stress intensity factors, crack tip opening displacement, and plastic zone, which in turn leads to enhanced remaining fatigue life of the structural element. The amount of compression stresses transferred to the steel plate increase with increasing the level of pre-strain, which was typically around 40% of the pre-stress in the patch. For example, for the pre-strain levels of 0.058%, 0.1%, and 0.2%, the amount of compression stresses formed in the steel plate for different crack lengths was about 28, 48, and 98 MPa, which reduced the KI values by 30%, 50%, and 80%, respectively. The plastic zone size and the crack tip opening displacement reduced by 80% and 42%, respectively in the case of 0.2% pre-strain in the CFRP composite patch.

Keywords: Composite patch; Pre-stress; Mixed mode I/II; Inclined edge crack; Stress intensity factor; Elastic–plastic finite element analysis.

[1]Associate Professor; Civil and Environmental Engineering, University of Missouri, Columbia, MO, 65211; phone: 573-489-6323; email: salimH@missouri.edu

[2]PhD Student; Civil and Environmental Engineering, University of Missouri, Columbia, MO, 65211; phone: 573-324-7072; email: elemamh@missouri.edu

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Effective Practices for the Optimization of Construction Costs in Indefinite Delivery/Indefinite Quantity Contracts

Jorge A. Rueda-Benavides[1], and Douglas D. Gransberg[2]

Abstract

Previous research conducted on the use of Indefinite Delivery/Indefinite Quantity (IDIQ) contracting has revealed that the principal reason that has led state Departments of Transportation (DOTs) to incorporate the use of IDIQ contracting into their procurement practices is the reduction of project delivery periods, following by a great flexibility in quantity and delivery scheduling, and the ability to provide quick response before, during, and after emergency situations. It seems that reductions in construction costs perceived by DOTs are not significant, or construction costs actually increase when using IDIQ contracting and the logistical and operational benefits obtained are worth the extra costs. The little literature found on this matter suggests three different lines of though in regard to public owners cost implications of using IDIQ contracting: those who think that the possibility of performing work in more than one project should work as an incentive for contractor to submit lower bid unit prices; those who consider that this incentive may be lost by a high level of uncertainty inherent to IDIQ contracts, resulting in higher price proposals; and those who think that this alternative contracting approach has the potential to reduce project costs, but it is actually increasing construction prices as a result of an inappropriate implementation by public owners. The fact is that formal research supporting or opposing any of these opinions is almost nonexistent. This study corresponds to the first phase of a larger project intended to quantify the cost implications of using low-bid IDIQ contracts in the transportation industry.

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[1] Doctoral Candidate; Department of Civil, Construction, and Environmental Engineering; 2711 South Loop Drive, Suite 4700, Ames, Iowa, 50010; phone (641) 745-9422; email: jrueda@iastate.edu

[2] Greenwood Endowed Chair and Professor; Department of Civil, Construction, and Environmental Engineering; 494 Town Engineering Building, Ames, Iowa, 50011; phone (515) 294-4148; email: dgran@iastate.edu

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Taking into consideration that these implications may vary in accordance with the procurement procedures and policies adopted by each agency, this initial study is aimed to identify effective contracting practices to optimize construction costs in IDIQ contracts.

The effective practices contained in this study were identified from the literature and a content analysis of IDIQ procurement documents, policy and procedure manuals from 32 different state DOTs, two local transportation agencies, and 20 federal agencies. The authors also gleaned information from a survey of state DOTs from which 43 responses were received achieving an 84% response rate. Additionally, the industry perspective was derived from 18 contractor survey responses plus four face-to-face structured interviews. The contracting practices described in this study are mainly intended to reduce the high uncertainty typically perceived by contractors when developing price proposals for IDIQ contracts; uncertainty that is reflected in lager contingencies included in the bid unit prices. These practices cover several aspects, including the selection of an appropriate contracting approach, contractor(s) selection procedures, proposal submittal requirements, escalation and mobilization clauses, and other procurement and administrative activities.

Keywords: Indefinite Delivery/Indefinite Quantity—IDIQ—Cost Optimization—Alternative Project Delivery Methods

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Engineering Resilience for Complex Transportation Systems

Nita Yodo[1] and Pingfeng Wang[2]

Abstract

Resilience of an engineered system implies the capability of the system to sense adverse changes, withstand adverse events, and recover from the negative effects of failures. Engineering resilience can be quantified based on the probabilities of passive survival rate (Reliability) and proactive survival rate (Restoration). Although engineering resilience concept is rapidly becoming a common theme in designing complex transportation systems, defining and measuring resilience is still largely problem domain dependent. There is a great need of new theory and tools for the quantification of resilience in engineering domain that can be readily used in complex transportation system design. This research explores the application of Bayesian Network as an assessment tool to measure resilience for complex transportation systems. Measuring resilience quantitatively enables the system development cost being minimized by optimally allocating resilience to subsystem levels while simultaneously satisfying a target resilience level for the system. The effectiveness of the proposed approach is elaborated with a case study of transportation networks for a complex manufacturing supply chain system. The proposed resilience quantification and allocation methodology using Bayesian Networks would empower system designers in the conceptual design stage with a better understanding of the strength and weakness of the systems against disruptions.

Keywords: Resilience—Risk—Transportation Systems—Bayesian Network— Disruptions

[1] Ph.D. Candidate; Wichita State University; 1845 Fairmount St, Wichita, KS, 67260; phone (316) 978-6735; fax (316) 978-3742; email: nxyodo1@wichita.edu

[2] Associate Professor; Wichita State University; 1845 Fairmount St, Wichita, KS, 67260; phone (316) 978-5910; fax (316) 978-3742; email: Pingfeng.wang@wichita.edu

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This topic is "practice ready." ☐ **Yes** ☒ **No**

Enhanced Framework for Better Collection and Utilization of Daily Work Report Data

K. Joseph Shrestha[1], Dr. H. David Jeong[2], and Dr. Douglas D. Gransberg[3]

Abstract

A large amount of data is collected in construction sites regarding the ongoing activities, work quantities, resources utilized by contractors and state Departments of Transportation (DOTs), general site conditions, and significant conversation with contractors. This data is commonly known as Daily Work Report (DWR) data. Although, a lot of time and effort is invested in collecting the data, their use have been very limited despite many potential benefits of the data. The objectives of this study are to a) understand current practices of collecting and utilizing DWR data, b) identify the challenges for better collection and utilization of the data, and c) develop an enhanced framework for an advanced DWR system to improve the current level of utilization of the data. An extensive literature review and two nationwide surveys are conducted for this study. This study identified the current DWR data collection practices, the current and potential benefits of the data, automation of the current benefits, and challenges associated with the better collection and utilization of the data. The study found a huge gap between the potential and current level of benefits of DWR data. The challenges for better collection and utilization of the DWR data are identified and categorized into six categories. An enhanced framework for an advanced DWR system is developed to overcome the challenges and obtain the additional benefits identified in this study. The framework is validated by seven DWR experts from the U.S. The

[1] Graduate Research Assistant; Department of Civil, Construction, and Environmental Engineering, Iowa State University; 423 Town Engineering, Ames, Iowa, 50011; phone (702) 518-1175; fax (515) 294-3845; email: shrestha@iastate.edu

[2] Associate Professor; Department of Civil, Construction, and Environmental Engineering, Iowa State University; 404 Town Engineering, Ames, Iowa, 50011; phone (515) 294-7271; fax (515) 294-3845; email: djeong@iastate.edu

[3] Professor; Department of Civil, Construction, and Environmental Engineering, Iowa State University; 494 Town Engineering, Ames, Iowa, 50011; phone (515) 294-4148; fax (515) 294-3845; email: dgran@iastate.edu

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enhanced framework consists of seven aspects: a) data attributes and its relations, b) integration with existing systems, c) visualization of data, d) advanced data collection systems, e) automation of DWR data analysis and reporting, f) human factors, and g) other technical aspects. The enhanced framework can be used by state DOTs to improve an existing DWR system or to develop a new one. The implementation of the framework is expected to improve the level of DWR data collection and utilization practices. This will aid state DOTs in making data-driven decisions during construction as well as preconstruction phases.

Keywords: construction data utilization—field data—Daily Work Report (DWR) —Inspector's Daily Report (IDR) —Data-driven decision making

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This topic is "practice ready." ☐ **Yes** ☒ **No**

Evaluation of AASHTO Minimum Reinforcement Requirements for Post-Tensioned Segmental Girders

Michael J. Rosenthal[1], Hartanto Wibowo[2], and Sri Sritharan[3]

Abstract

The AASHTO LRFD Specifications require a minimum amount of flexural reinforcement for concrete members to ensure that adequate strength and ductility are reached after the first cracking, and thus prevent brittle failure. However, the use of these minimum reinforcement requirements on unbonded post-tensioned segmental girders may be too conservative and make the member fail in a compression-controlled mode instead of a flexure-controlled mode, hence making the pretensioning less effective. In general, the amount of minimum reinforcement in a segmental girder is dependent on a variety of parameters which include the modulus of rupture, concrete strength, deviator placement, span-to-depth ratio, cross-section type, and the amount of prestressing. The objective of this study is to evaluate the current AASHTO requirements in regards to post-tensioned segmental girders so that more rational and explicit requirements may be proposed. This study consists of an analytical and an experimental portion. Analytical results and plans for the experimental tests will be presented.

Keywords: Minimum Reinforcement, Segmental, Unbonded Tendons, Post-Tensioned

[1] Graduate Research Assistant, Department of Civil, Construction, and Environmental Engineering, Iowa State University, Ames, IA 50014; email: mjr@iastate.edu

[2] Post-Doctoral Research Associate, Department of Civil, Construction, and Environmental Engineering, Iowa State University, Ames, IA 50014; email: hwibowo@iastate.edu

[3] Wilson Engineering Professor, Department of Civil, Construction, and Environmental Engineering, Iowa State University, Ames, IA 50014; email: sri@iastate.edu

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Evaluation of Bond Strength at Asphalt Layer Interfaces

Abu Ahmed Sufian[1], Mustaque Hossain[2]

Abstract

Asphalt pavement rehabilitation that involves placement of a layer of asphalt concrete over an existing or milled asphalt pavement is a common practice. Generally a light application of asphalt emulsion, known as a tack coat, is used between the new and the existing asphalt pavement to create a strong bond between the layers. In this study, the bonding properties of SS-1hP tack coat are being evaluated in terms of performance in the direct tension test. Six-inch diameter cores were collected from the wheel paths of a highway of the Kansas Department of Transportation (KDOT) from both milled and non-milled sections. The cores were trimmed so that the test samples will consist of only one layer with no interfaces. In the laboratory, a fresh hot-mix asphalt (HMA) layer was compacted on top of these milled and non-milled cores with four different application rates of SS-1hP at the interface. Then three two-inch diameter samples were taken from each compacted core and tested in direct tension after two days. From these test results, breaking strength and bond energy were computed to determine the optimal bond strength. An Analysis of Variance (ANOVA) will be performed to find the significant factors (tack coat application rate) based on the experimental results. This presentation will discuss these results.

Keywords: Asphalt Pavement—Tack Coat—Interlayer Bond Strength —Direct Tension Test

[1] M.S. Student; Kansas State University; College of Engineering, 2118 Fiedler Hall, Manhattan, KS, 66506; phone (785) 770-6396; fax (785) 532-7717; email: sufian@ksu.edu

[2] Munger Professor; Kansas State University, College of Engineering, 2124 Fiedler Hall, Manhattan, KS, 66506; phone (785) 532-1576; fax (785) 532-7717; email: mustak@ksu.edu

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This topic is "practice ready." ☐ **Yes** ☒ **No**

Evaluation of Finger Plate and Flat Plate Connection Design

Andrew Pelikan[1] and Dr. Sarah Orton[2]

Abstract

Finger plate and flat plate bridge expansion devices are commonly used bridge connections to allow for expansive and contractive movements of bridge joints over two conjoining spans. Recently these expansion devices have undergone premature deterioration under high traffic loads. The purpose of this project is to determine the mechanisms of these premature deteriorations and develop new design parameters for improved performance.

Investigation into the expansion devices was initiated with a survey of existing literature and design practices. To test the developed theories, instrumentation and testing procedures were performed on both a finger plate and flat plate expansion connection. Finite element models (FEM) of the expansion devices were developed to evaluate other causes of failure and effective improvements implemented to design details. The overall objective of the project is to develop a new expansion device design, as well as repair and replacement details, to meet or exceed the required 40 year service life of any type of superstructure.

Keywords: finger—flat—plate—expansion—deterioration

[1] Andrew Pelikan; University of Missouri – Columbia; 1401 University Avenue Apt. A, Columbia, MO 65201; phone (314) 808-7305; email: Atpf3d@mail.missouri.edu

[2] Dr. Sarah Orton; University of Missouri – Columbia; E2503 Lafferre Hall, Columbia, MO, 65211; phone (573) 884-5089; email: OrtonS@missouri.edu

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This topic is "practice ready." ☐ **Yes** ☒ **No**

Evaluation of Systemic Safety Risk Factor Coefficients

Keith Knapp and Georges Bou-Saab

Abstract

The majority of crash fatalities in the United States occur along rural roadways. These roadways typically have low volumes and widespread crashes. In other words, no one location generally has an unexpectedly high number of crashes. Systemic safety tools/methodologies can be used in this type of situation because they evaluate and prioritize expected crash risk through the consideration of regional data patterns, research results, and engineering judgment. This project investigated two systemic safety tools/methodologies: the approach followed to produce Minnesota county road safety plans (and now described in the FHWA *Systemic Safety Project Selection Tool*) and usRAP. Both tools/methodologies were applied with data collected from two counties in Iowa and a sensitivity analyses completed on their results. It was concluded that changing the "weight" of the safety risk factors considered as part of Minnesota approach could have an impact on some of the locations in the "top 20" of the rankings and subsequent decision-making. However, the amount of that impact varied and a correlation analysis of the original and alternative rankings developed found a statistically insignificant difference. The change in acceptable benefit-cost ratio for the application of usRAP showed that it impacted the type and number of countermeasures, along with the benefit-cost ratio of the plan suggested by the software.

Keywords: rural, safety

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Examination of Contributing Circumstances on Motor Vehicle Crashes in Iowa and Missouri as a Function of Gender

Jill M. Bernard[1] and Christopher M. Mondy[2]

Abstract

Prior research has suggested a disparity in the contributing factors that affect crash severity for male and female drivers, and similar disparities between male and female drivers of neighboring states are expected. It is believed that the key explanatory variables are similar among drivers of the same gender from neighboring states, and corroborating this theory will help to form recommendations for improving driver education. Crash data from 2002-2012 from Missouri and Iowa is partitioned by driver gender and is used for examination of motor vehicle crash contributing circumstances. Cross tabulations are used for evaluating contributing factors for comparison between populations, and proportions are calculated to enhance validity. Results uncover similar primary contributing factors for all crashes for male and female Missouri drivers, yet differing factors for crashes resulting in a fatality (primarily in the categories of exceeding authorized speed and driving under the influence of drugs or alcohol). Additionally, results suggest similarities between the primarily contributing factors for male and female Iowa drivers for all crashes and for fatal crashes. Yet, it was uncovered that the contributing circumstances of crashes greatly differ between genders of each state, which contradicts the formulated hypothesis that similarities between Missouri and Iowa male drivers and Missouri and Iowa female drivers

[1] Jill M. Bernard; University of Missouri St. Louis; 240 JCPN, 1 University Blvd. St. Louis, MO 63121-4400; phone (314) 516-7270; fax (314) 516-7272; email: jmbhw9@mail.umsl.edu

[2] Christopher M. Mondy ; University of Missouri St. Louis; 240 JCPN, 1 University Blvd. St. Louis, MO 63121-4400; phone (314) 516-7270; fax (314) 516-7272;email: cmmondy@gmail.com

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exist. However, the results from this investigation do enhance the understanding of gender specific similarities and differences among states, which can in turn enhance driver education.

Keywords: Missouri Crash Severity—Iowa Crash Severity—Contributing Circumstances—Driver Gender Differences

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Exploring the Effect of Visibility Distance on Traffic Safety Using RWIS Data in Ohio

Fan Ye [1]

Abstract

Some research have been conducted regarding the effects of visibility on traffic safety and it has been found that the reduced visibility condition such as fog and smoke is one of the contributing factors to crashes. However, those research defined reduced visibility conditions based on weather types, i.e., fog, heavy rain, snow, smoke, dust or haze. There hasn't been any attempt to quantify the safety effects of different levels of visibility (or visibility distance), which is mainly due to lack of visibility data in the crash records. This paper aims to study the relationship between roadway crashes and visibility distance, and then derive visibility criteria for safety. With the developed visibility criteria, weather warning system can provide more efficient and reliable responses to counteract reduced visibility conditions at different levels.

In the study, data on a geographic information system (GIS) platform from different sources (including historical traffic crash records, visibility distances from visibility sensors, roadway inventory and traffic count data) in the state of Ohio will be complied and analyzed using a statistical analysis approach to model the relationship between roadway crashes and visibility distances. Meanwhile, two sources of visibility distance records will be explored: one is from 42 airport weather stations in Ohio, and the other is from Ohio Department of Transportation's (ODOT) Road Weather Information System (RWIS) which has approximately 176 stations. By comparing the visibility data from airport weather stations and RWIS, the possibility and reliability of two visibility data sources in crash analysis will be discussed. The result can provide a guidance to future traffic safety data analysis involving weather related crashes, which is another objective of the paper besides developing visibility criteria.

Keywords: Visibility; Crash; RWIS

[1] Assistant Professor; Civil Engineering Department, Ohio Northern University; 525 S. Main St., Ada, Ohio, 45810; phone (419) 772-2376; email: f-ye@onu.edu.

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Fatigue Analysis of Composite Beams Strengthened with Externally Post-Tensioned Tendons

Ayman El-Zohairy[1] and Hani Salim[2]

Abstract

Post-tensioning has been used successfully to improve the performance of existing bridge structures. Due to traffic loads on bridges, the fatigue resistance of studs can govern the design rather than the static resistance. Therefore, this project is focused on evaluating the monotonic and fatigue response of strengthened composite concrete-steel T-beams using externally post-tensioned tendons. Numerical simulations as well as experimental studies are performed. A reliable 3D finite element (FE) model to simulate the nonlinear flexural behavior of the strengthened composite beams that accounts for slippage between the concrete slab and the steel beam is developed. Key parameters, such as effect of tendon position, effect of using deviators, effect of draping tendons, effect of tendon material, effect of post-tensioning force, effect of degree of shear connection, effect of construction stages, and effect of applying fatigue load before post-tensioning, are investigated. The experimental study is used verify the FE simulation models and to closely investigate the effect of externally post-tensioned tendons on the behavior of composite beams under fatigue loads. The experimental work consists of ten steel-concrete composite specimens that are15 feet in length. Using external post-tensioning tendons in the positive moment region for steel-concrete composite beams increased their ultimate capacity by 25%, the stiffness by 33%, and significantly improved the overall response of the bridge structural system under static loads.

Keywords: Composite beams; Finite element; Post-tensioning; Fatigue; Shear connector.

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[1]PhD Student; Department of Civil and Environmental Engineering, University of Missouri, Columbia, MO 65211-2200, USA, ElzohairyA@missouri.edu
[2]Associate Professor; Department of Civil and Environmental Engineering, University of Missouri, Columbia, MO 65211-2200, USA, SalimH@missouri.edu

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Feasibility Investigation of Superhydrophobic Engineered Asphalt Concrete for Roadway Winter Maintenance

Ali Arabzadeh[1], Therin J. Young[2], Halil Ceylan[3], Sriram Sundararajan[4], Sunghwan Kim[5], and Kasthurirangan Gopalakrishnan[6]

Abstract

Presence of water on the asphalt pavement surface can result in reduction of skid resistance, especially when the surface water turns into ice crystals. The formation of ice is dependent upon the physico-chemical properties of the asphalt surface. The above mentioned phenomenon decreases the roadway/runway safety and consequently can endanger the lives of people walking on the paved areas or traveling by vehicles and aircraft.

Superhydrophobic or super water-phobic surfaces that mimic surfaces found in nature, such as the lotus leaf, have attracted the attention of researchers in recent years owing to their potential to engineer ice- and snow-free paved surfaces. The anti-wetting and anti-icing properties of some superhydrophobic surfaces help reduce labor and maintenance costs and increase the operational lives of ice/water-exposed transportation infrastructure assets such as pavements, bridges, traffic signs, etc. Recent studies have focused on superhydrophobic surfaces that reduce or completely stop the accretion of ice and snow on power lines and aircraft that operate in cold regions. The superhydrophobic phenomena is usually achieved by creating a dual-scale roughness that is composed of micro- and nano-scale structures that trap air in-between themselves and reduce the surface energy of water droplets.

The objective of this research is to investigate the feasibility of developing superhydrophobic/ice-phobic engineered asphalt concrete for roadway snow and ice management. The superhydrophobic/ice-phobic engineered asphalt concrete will be created by using candidate hydrophobic materials that exhibit desirable durable properties. Three-dimensional (3-D) surface profilometry and microscopy methods

[1] Graduate Research Student; Iowa State University; 24 Town Engineering Building; Ames, IA 50011; phone: (515)-294-4698; email: arab@iastate.edu

[2] Graduate Research Student; Iowa State University; 2025 Black Engineering, Ames, IA, 50011; phone (229) 310-9836; email: theriny@iastate.edu

[3] Associate Professor, Iowa State University, 406 Town Engineering Building, Ames, IA 50011; phone (515) 294-8051; email: hceylan@iastate.edu

[4] Professor; Iowa State University; 2080 Black Engineering, Ames, IA, 50011; phone (515) 294-1050; email: srirams@iastate.edu

[5] Research Scientist; Iowa State University; 24 Town Engineering Building; Ames, IA 50011; phone: (515)-294-4698, e-mail: sunghwan@iastate.edu

[6] Research Associate Professor; Iowa State University; 354 Town Engineering Building; Ames, IA 50011; phone: (515)-294-3044, e-mail: rangan@iastate.edu

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will be used to analyze height changes and surface morphologies of coated asphalt concrete surfaces before and after wear tests are performed.

Keywords: Superhydrophobic—Asphalt — Ice-phobic—Winter Maintenance—Durability

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Feasibility of Alternate Snow Removal Strategies for Small Hub Airports

Pritha Anand[1], Halil Ceylan[2], Dimitra V. Pyrialakou[3], Konstantina "Nadia" Gkritza[4], Peter C. Taylor[5], Kasthurirangan Gopalakrishnan[6] and Sunghwan Kim[7]

Abstract

As air travel is the only means of rapid transport connecting large geographical locations in a short period of time, it is imperative to keep airports functional during severe winter months. Conventional ice and snow removal practices of mechanical methods (e.g., plows and brushes) and chemical deicing agents are labor intensive and have environmental concerns such as the contamination of nearby water bodies. Alternative snow removal methodologies have the potential to reduce these concerns in a cost-effective manner. One such approach is the potential use of a heated pavement system using either conventional or renewable energy as a heat source to keep the surface temperature of concrete pavements above freezing so that any frozen precipitation melts upon contact. In this work, the Iowa Des Moines International (DSM) airport representing a small hub (0.05% to 0.25% of total U.S. passenger enplanements) airport was studied to understand the relative economic benefits of using such an alternative technology compared to conventional strategies for snow removal. The benefit cost

[1] Graduate Research Student; Iowa State University; 24 Town Engineering Building, Ames, IA 50011-3232; phone (515) 294-4698; email: pritha@iastate.edu

[2] Associate Professor, Iowa State University, 406 Town Engineering Building, Ames, IA 50011-3232; phone (515) 294-8051; email: hceylan@iastate.edu

[3] Graduate Research Student; Purdue University; 550 Stadium Mall Drive, West Lafayette, IN 47907-2051; phone (515) 294-4698; e-mail: vdp@purdue.edu

[4] Associate Professor; Purdue University, 550 Stadium Mall Drive, West Lafayette, IN 47907-2051; Phone: (765)-494-4597; e-mail: nadia@purdue.edu

[5] Research Associate Professor; Iowa State University; 2711 South Loop Drive, Suite 4700, Ames, IA 50010-8664; Phone: (515)-294-9333, e-mail: ptaylor@iastate.edu

[6] Research Associate Professor; Iowa State University; 354 Town Engineering Building; Ames, IA 50011-3232; Phone: (515)-294-3044, e-mail: rangan@iastate.edu

[7] Research Scientist; Iowa State University; 24 Town Engineering Building; Ames, IA 50011-3232; Phone: (515)-294-4698, e-mail: sunghwan@iastate.edu

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analysis focused on the apron and gate areas since conventional snow-removal equipment has difficulty in accessing such areas when a flight remains. Safety is a major issue in such areas due to high level of human activity in the form of baggage handlers, ground staff and oil refueling operations.

Acquisition of necessary data to conduct a full-fledged economic analysis has been a significant challenge owing to the large number of variables involved and associated uncertainties. To overcome this challenge, "what-if" case studies were carried out to examine the feasibility of heated pavement systems at DSM. The analysis concluded that it is feasible to install heated pavement systems under the given assumptions, and the application may be extended to smaller general aviation (GA) airports.

Keywords: Airport—Winter Maintenance — Heated Pavement System—Economic Analysis

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2015 Mid-Continent Transportation Research Forum.

Draft Abstract title: Freight Planning Innovation in the MAFC Region

Author/Presenter:
Ernie Perry, PhD
MAFC/CFIRE
University of Wisconsin – Madison
ebperry@wisc.edu
608-890-2310

This presentation reviews and assesses the freight plans completed by the ten MAASTO State DOTs, as well as MAFC Regional Freight Study. The reviews are completed with an eye towards development of the National Freight Plan as directed under MAP-21. This analysis examines opportunities for greater collaboration and alignment across the multi-state region in the areas of freight corridors, logistics alignment, economic development, freight policy and strategic development goals. Findings indicate that the state freight plans are providing innovation in freight planning and collaborating in advance of federal support and action. Further, the freight planning standards set at the state and regional level can support even greater collaboration and the development of a national agenda and plan. However, at the federal and state levels, the institutional and the collaborative mechanisms are not yet established to support a complete systems approach to multi-state, multimodal freight development. Recent collaborative efforts across the MAASTO states are highlighted as a conceptual approach to advancing a collaborative, National Freight Plan.

This topic is "practice ready." ☒ **Yes** ☐ **No**

Freight Stories: Using ESRI Story Map Journal to Visualize Research

Maria Hart[1] Alexis Greenstreet[2]

Abstract

Storytelling has, throughout the centuries, engaged audiences by threading various elements together to capture and spread ideas, or lessons, or to share memorable events. Today, visualization techniques help us to tell a story, organize and share data and allow for users to learn about the world by interacting with data. Simplicity in digital visualizations is the goal yet many times research is complex.

This presentation will provide two examples, one simple and one complex example of using ESRI Story Map Journal as a means for packaging research results and visualizing data.

The first Story Map Journal, Intermodal Terminals in the Midwest is a simple example of packaging research
results. http://uwmad.maps.arcgis.com/apps/MapJournal/?appid=08a0a5fb67534bd2bd82db99b44e72fb

This example is based on research titled: Visualizing the Role of Intermodal Terminals on the Primary Freight Network: Uncovering Data Gaps for Systems Analysis

In 2014, the Mid-America Freight Coalition (MAFC) profiled and mapped 57 intermodal terminals in the ten MAFC states: Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. This inventory, geared to state DOTs, provides information about truck access to/from interstates, intermodal movements (lifts), intermodal lane information, and intermodal connectors. Each profile includes an access map, shown against aerial photography, that displays the extent of the intermodal terminal, the location of the intermodal terminal gates, intermodal connectors, MAP-21 National Highway System routes, and Highway Performance Monitoring System (HPMS) truck data or state DOT truck counts. Another map shows warehouses and distribution centers surrounding the intermodal terminal.

Beyond providing a spatial understanding of the data gaps when comparing one terminal to another, the maps serve as a starting point for the classification of intermodal terminals in the MAFC region and as resource for local-level freight planning.

The second visualization, Living with Freight: Memphis and Livability, is an example of embedding interactive maps in ESRI Story Map Journal providing a guided introduction to the topic. The interactive maps were developed within an open-source environment using Bootstrap as a front end, Leaflet, Java

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[1] Maria Hart, Associate Researcher, Center for Freight and Infrastructure, Research & Education; University of Wisconsin-Madison; 1415 Engineering Drive #2205, Madison, WI, 53706; phone 608-262-6639; fax (608) 263-3512; email: maria.hart@wisc.edu

[2] Alexis Greenstreet, Spatial IT Programmer, Center for Freight and Infrastructure, Research & Education; University of Wisconsin-Madison; 1415 Engineering Drive #2205, Madison, WI, 53706; phone 608-262-2655; fax (608) 263-3512; email: agstreet11@gmail.com

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Script, HTML and CSS among others for back-end programming and styling. The interactive maps show complex functionality, and numerous features such as timeline, multiple layers, and tabs. Work in progress on the interactive map website can be seen here http://www.wistrans.org/livability/MemphisLamarAve.htm

This example is based on research titled: Measuring the Impact of Advanced Technologies in Freight-Centric Communities

Researchers, through studying Memphis, a national hub of freight activity, define what a freight-centric community is, explore factors important for community livability, examine whether the priorities and barriers to livability differ between freight-centric and non-freight-centric communities, question whether freight has a significant impact on livability perceptions, as well as testing some strategies to improve air-quality –an externality of freight.

Keywords: freight—visualization—intermodal—livability—story

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Getting Ahead of the Performance Measure Curve with New Data and Techniques

Jason Carbee, AICP [1], Michael Felschow[2], and Jacob Weiss, EIT[3]

Abstract

The ongoing Metro Travel Improvement Study (MTIS) has used a variety of innovative and state-of-the-practice approaches, tools, and data sources to assess multi-modal system performance for the Omaha – Council Bluffs metro area's transportation goals. Many of the study performance measures relied on emerging data sources and new techniques, applied through the framework provided by the regional transportation vision and the Moving Ahead for Progress in the 21st Century (MAP-21) authorization.

MTIS was originally conceived by the Nebraska Department of Roads (NDOR) as an Omaha urban area freeway system master plan. The study evolved into a partnership between NDOR and the Metropolitan Area Planning Agency (MAPA) to deploy a comprehensive, multi-phased plan for long-term regional mobility needs by using a range of tools, including a regional dynamic traffic assignment simulation model, to test the performance of a range of traditional and new / innovative travel strategies for the region. MTIS strives to identify a multi-modal, multi-system investment plan to best meet regional mobility and safety goals, tied to a finance and implementation plan.

From MAPA's perspective, the study was an opportunity to push the envelope with new performance measures and get ahead of the curve on national performance requirements. The exercise has allowed MAPA to test the effectiveness of various, tools, data sources, and system performance measures prior to formal establishment of performance requirements. The performance measures are linked to the

[1] Sr. Transportation Planner; HDR; 8404 Indian Hills Drive, Omaha, NE, 68114; (402) 399-1370; Jason.Carbee@hdrinc.com
[2] Program Director; MAPA; 2222 Cuming Street Omaha, NE 68102; (402) 444-6866; mfelschow@mapacog.org
[3] Traffic Engineer; HDR; 8404 Indian Hills Drive, Omaha, NE, 68114; (402) 399-4870; Jacob.Weiss@hdrinc.com

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performance goals of System Preservation, Congestion Reduction, Mobility & Accessibility, Stewardship & Environment, and Safety. Tying the performance measures to regional goals allows the study team to assess current and future "do nothing" system performance and needs / deficiencies, evaluate the efficacy of a range of potential travel alternatives, and prioritize investment strategies / alternatives scenarios. The presentation would focus on performance measures related to three of the goal areas: Congestion Reduction, Mobility & Accessibility, and Stewardship & Environment. Beyond the traditional regional performance measures applied such as vehicle miles traveled, delay, and transit mode share targets, some of the new tools and performance perspectives that will be discussed include:

- Evaluating the effect various strategies have on **regional employment accessibility** via transit and automobile. Employment accessibility was evaluated by using the regional TransCAD travel model, enhanced through application of AirSage mobile phone data. The percentage of regional jobs accessible by mode for each individual travel analysis zone (TAZ) was tested for Environmental Justice populations, and for the entire region.
- Using INRIX GPS probe-based travel time data with a GIS platform to establish the **travel time reliability** of individual corridors and the regional system. Several months' of historical data were analyzed, and peak condition Reliability Indices (RI_{80}) were developed to identify the corridors with the highest levels of typical travel variability in the metro area.
- Using EPA's MOVES model tied to TransCAD travel model runs to identify **criteria pollutant emissions** outcomes by scenario. Particular attention was paid to nitrogen oxides (NOx) and volatile organic compounds (VOCs), as these pollutants are the sensitive components in ground level ozone formation, the target of an ongoing emissions reduction campaign in the metro area.

Keywords: Performance Measures—Metropolitan Transportation Planning—Travel Time Reliability—Employment Accessibility—INRIX

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An Observational Before and After Safety Evaluation Study for Road Segments Provided With Safety Edge in Iowa

Abstract

Pavement edge drop-off proves to be a serious concern to the vehicles that drift off the pavement and encounters a difference in height between the pavement and the adjacent ground. The errant vehicles, in order to restore its position back on the paved road, exerts greater amount of force which may result in loss of control of the driver over the vehicle. According to an estimation by the Federal Highway Administration about 11,000 people suffers from injuries and about 160 people lose their lives each year in crashes related to unsafe pavement edges in the United States. A study by Georgia Tech estimated 150 fatal crashes on rural two-lane roads in Georgia suggested that 55% of the crashes included edge drop off issue. Pavement edge drop offs contribute to about 18% of rural ROR crashes with paved roadways and unpaved shoulders and it is two times more likely that a fatal crash may occur due to pavement drop off than any other factor. Safety Edge is a treatment that allows drivers who drift off roadways to return safely to the roads. It is a design feature that creates a fillet (preferably 30 degrees) along the edge of the pavement of the roadway which has the capability to reduce the resistance of the tires. A total of 82 undivided roadway segments of total length of 483 miles were identified all over Iowa having Safety Edge installed in them. Locations of the Safety Edges were obtained Institute of Transportation, Iowa State University and Iowa Department of Transportation. Compilation of 11 years of GIMS data and crash data was carried out to obtain the roadway, traffic lane characteristics and corresponding crashes for the treatment segments. An observational before and after safety evaluation study was carried out. Positive safety impacts of Safety Edge was observed from the fact that the crashes in the after period significantly went down compared to that of the before period. Both scenarios of all types of crashes and target crashes specific to Safety Edge were considered for the observational before and after analysis and both scenarios showed comparable reduction in crashes.

Keywords: Safety Edge—Observational before and after crash evaluation—Safety Analysis

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Identification of factors critical in converting roadway surface type on local roads based on survey responses.

Himanshu Patel[1], Sunanda Dissanayake[2]

Abstract

Kansas ranks 4th in the country in terms of total road mileage with 140,614 miles, and approximately 70% of those are local roads. For the year 2013, around 81,500 miles of roads in Kansas were maintained by counties which included 53,675 miles of gravel roads. In recent years, the population shifts from farming areas to more urban areas has led to low population density and lower traffic volumes in rural areas. With the increasing constraints on transportation budgets, local road agencies face the question of how to maintain their county local roads in the most cost effective manner. Specifically, the decision makers are facing a challenge of determining when it is most economical to maintain, upgrade or downgrade a roadway surface. This research identifies various factors and their importance to be considered while making such decisions. The importance of various factors like maintenance cost, conversion cost, maintenance frequency, traffic volume, vehicle operating cost, safety and purpose of road usage are ranked based on survey results from Kansas county transportation professionals.

The survey was conducted by sending out the survey forms through emails, fax and mailing to the representative from each county. Online survey link and follow up calls helped to get more survey responses. Out of 105 counties in Kansas, a fairly good response rate of 72% covering 75 counties was

[1] Graduate Research Assistant; Department of Civil Engineering; 2118 Fiedler Hall, Kansas State University, Manhattan, Kansas, 66506; phone (785) 317-4934; fax (785) 532-7717; email: himanshu205@ksu.edu

[2] Professor; Department of Civil Engineering; 2118 Fiedler Hall, Kansas State University, Manhattan, Kansas, 66506; phone (785) 532-1540; fax (785) 532-7717; email: sunanda@ksu.edu

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recorded. Likert scale rating system with five levelled Likert item was used to collect equidistant feedback with no skew in the recorded responses. Likert scaled value was used to convert the recorded observation into a score (1.00 for Very Important to 0.00 for Not Important) and the factors were ranked. Based on the analysis, conversion cost and maintenance cost were ranked 1st and 2nd in terms of importance with overall scores of 0.90 and 0.86 respectively. When considering the purpose of road usage, heavy vehicle route was ranked first with an overall score of 0.84 and was determined to be the most important route which should be considered first while performing a conversion. Survey also focused on getting a rough idea about traffic volume on gravel roads and paved roads in different counties. This information can be used to estimate the vehicle operating costs which can be compared and help in making a decision on whether or not to implement the roadway surface conversion.

Keywords: Local roads, gravel roads, paved roads, Likert scale.

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This topic is "practice ready." ☒ **Yes** ☐ **No**

IMPACT OF LOWER ASPHALT BINDER FOR COARSE HOT MIX ASPHALT MIXES

Parnian Ghasemi[1], R. Christopher Williams[2], and Shibin Lin[3]

Abstract

Formerly, asphalt mixes in Minnesota have been produced with fine-graded aggregates, but recently, more coarse-graded mixes are being produced. The latter needs less asphalt binder rather than the former, consequently, is more susceptible to premature cracking, and other distresses related to higher permeability. Thus quantifying the pavement performance has become important for these two types of mixes. Field cores of the coarse-graded mixes are undergoing performance evaluation using fracture energy, dynamic modulus, and permeability measurements using the Disk-shaped compact tension fracture, Unconfined Dynamic Modulus (E*), and falling head permeability tests, respectively. Additional volumetric characterization of the field mixes were done including density, asphalt content gradation. Dynamic Shear Rheometer (DSR) testing is also done on the recovered binders. The obtain results will be related to the measured field performance of the mixes.

Keywords: Asphalt Mixture, Coarse-graded mixtures, Field performance.

[1] Graduate Research Assistant, Iowa State University, Department of Civil, Construction and Environmental Engineering, 174 Town Engineering Building, Ames, IA 50011; email: pghasemi@iastate.edu

[2] Professor, Department of Civil, Construction and Environmental Engineering, 490 Town Engineering Building Iowa State University, Ames, IA 50011; Phone (515) 294-4419; Fax (515) 294-8216; email: rwilliam@iastate.edu

[3] Postdoctoral researcher, Iowa State University, Department of Civil, Construction and Environmental Engineering, 405 Town Engineering Building, Ames, IA 50011; email: slin@iastate.edu

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Implementing SHRP-2 Naturalistic Driving Study Data for Use in Driving Simulation Environments

Shawn F. Allen[1], Amanda Beadle[2], and John Gaspar[3]

Abstract

The use of driving simulation for interactive 3D visualization provides an idealized environment for research, but widespread use of this technology in transportation research remains highly dependent on simulation domain experts. Part of the reason for this lack of broader use is due in large part to the technical nature of preparing data for simulation. It is therefore necessary to identify those processes which can be automated and to develop the necessary tools and processes for ease of use in creating driving simulation environments.

This presentation describes our project to implement driving simulator environments based on SHRP-2 naturalistic driving study data across two simulation platforms. The methods used for conversion are able to be applied to a broad range of data, and thus extend the feasibility of developing quality driving simulator environment content for research applications with high levels of external validity. Human subjects data collected from these simulator environments will be used to validate the simulator scenarios against naturalistic driving data. The end product includes documentation for the conversion processes and tools that automate technology-dependent requirements, thus lowering the bar for non-experts to expand the use of driving simulation for transportation research.

Keywords: SHRP-2 data—Driving Simulation—Converting SHRP-2 data for simulation—Simulation Environment

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[1] Mr. Shawn F. Allen; The National Advanced Driving Simulator at the University of Iowa; 2401 Oakdale Blvd., Iowa City, IA, 52242-5003; phone (319) 335-4598; fax (319) 335-4658; email: shawn-allen@uiowa.edu

[2] Ms. Amanda Beadle; The National Advanced Driving Simulator at the University of Iowa; 2401 Oakdale Blvd., Iowa City, IA, 52242-5003; email: amanda.beadle128@gmail.com

[3] Dr. John Gaspar; The National Advanced Driving Simulator at the University of Iowa; 2401 Oakdale Blvd., Iowa City, IA, 52242-5003; phone (319) 335-4776; fax (319) 335-4658; email: john-gaspar@uiowa.edu

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Improving Evacuation Efficiency Using Intermediate Crossovers and Ramp Closures

Yohan Chang[1], and Praveen Edara, Ph.D., P.E.[2]

Abstract

Although current evacuation plans of coastal states incorporate both contraflow and ramp closures on some facilities, there is no evidence that these plans actively coordinate the two techniques. Due to the sharing of common resources such as infrastructure funding, enforcement personnel to operate, it is argued that coordinating the contraflow and ramp closure locations for a freeway facility would result in best utilization of resources. In this research, contraflow and ramp closure techniques are explicitly integrated and optimized to achieve higher evacuation efficiency. A framework to use simulation-based optimization methods for identifying the intermediate crossover and ramp closure locations is proposed. The framework is applied to a case study of the Hampton Roads region evacuation using models developed based on evacuee behavioral data, real-world network and traffic control data. The case study utilizes dynamic traffic assignment to compute the objective function values in two heuristic techniques - Genetic algorithm (GA) and Tabu search. The GA outperformed Tabu search for the limited experiments conducted in the case study.

Keywords: hurricane evacuation – intermediate crossovers – contraflow — heuristic algorithm— dynamic traffic assignment

[1] Graduate research assistant; University of Missouri-Columbia; Department of Civil Engineering C2640 Lafferre Hall, Columbia, Missouri, 65201; phone (573) 882-6269; fax (573) 882-4784; email: ychang@mail.missouri.edu

[2] Associate professor; University of Missouri-Columbia; Department of Civil Engineering C2640 Lafferre Hall, Columbia, Missouri, 65201; phone (573) 882-1900; fax (573) 882-4784; email: edarap@missouri.edu

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Incorporating climate projections into design metrics with uncertainty bounds

Christopher J. Andersion, Iowa State University
Ricardo Mantilla, University of Iowa State University

Uncertainty estimates are used in design problems, but the standard protocols for quantifying uncertainty have been developed for application to historical data. This means the protocols are not configured to accept multiple data series and integrate uncertainty bounds from all input data series. We address this problem in the context of bridge design. Quantiles of streamflow discharge are used to estimate the frequency of various loads on the bridge and inundation of the bridge. A particularly difficult nuance was the requirement to use all available streamflow data. This protocol lost meaning for simulations of future conditions that have arbitrary end points relative to the expected life of a bridge. Also, the way climate scientists have evaluated climate projections was incompatible with this protocol. Rather than use the entire continuous precipitation or streamflow series to estimate quantiles, a climate scientist would compare values in segments or time slices of the data series.

Our solution to this problem was to define two periods over which the standard protocols would be applied. We defined an historical period in order to emulate the standard approach of using the entire record of measured (historical) streamflow. We defined the bridge lifetime period as the 100-yr period beginning at the time the bridge was built.

We developed a methodology to compare projection streamflow quantiles estimated for the historical and bridge lifetime periods. For each projection and quantile of interest, USGS PeakFQ software was used to obtain the estimator for the return-interval discharge and its 95% confidence interval. We generated estimators and confidence intervals for each climate projection. We selected the median of the estimators and the median of the high and low bounds of the 95% confidence intervals. The extent to which the 95% confidence intervals do not overlap for the two periods provides guidance on whether climate change might change the exposure of bridges to damaging conditions.

In our illustration, the 95% confidence intervals have significant overlap and we would conclude climate change does not create a statistically significant change in streamlfow. Nevertheless, the use of confidence intervals enabled engineering judgement to consider the merits of designing and planning to future climate conditions. In our discussions, we noted the consistency in direction of change across basins, though the flood mechanism was different across basins, and the high bound of bridge lifetime quantiles exceeded that of the historical period. This suggested the change was not isolated, and it systemically altered the risk profile. One suggestion to incorporate engineering judgement for design analysis was to consider degrees of vulnerability using the median discharge of the

historical period and the upper bound discharge of the 95% confidence interval for the bridge lifetime period.

Nevertheless, the use of confidence intervals enabled engineering judgement to consider the merits of designing and planning to future climate conditions. In our discussions, we noted the consistency in direction of change in both basins, though the rainfall-streamflow timing mechanism was different in the basins, and the high bound of bridge lifetime quantiles exceeded that of the historical period. This suggested the change was not isolated, and it systemically altered the risk profile. One suggestion to incorporate engineering judgement for design analysis was to consider degrees of vulnerability using the median discharge of the historical period and the upper bound discharge of the 95% confidence interval for the bridge lifetime period.

The Infrastructure Condition Evaluation (ICE) tool contains the results of a seven individual criteria merge using a linear overlay process that includes Iowa DOT's in-house Geographic Information Management System (GIMS) and Pavement Management Information Systems (PMIS). Through the ICE tool, Iowa DOT is able to evaluate road segments using a single composite rating. Initially, this evaluation was the basis for development of the Interstate Corridor Plan and now has been expanded to address Iowa's entire primary highway system. Development of the ICE tool relied heavily on the use of Linear Referencing System (LRS) and linear overlay processing. Through the linear overlay process, a single table is created and stored in Oracle Spatial. This table is then further analyzed and processed using Structure Query Language (SQL) to achieve data normalization, weighting, and composite rating as determined by input from the internal stakeholder group. The results from the ICE tool are presented in the planning report and webmap applications including ArcGIS Online and Geocortex.

2015 Mid-Continent Transportation Research Symposium, Ames, Iowa, August 2015

This topic is "practice ready." ☒ **Yes** ☐ **No**

Investigating the Relationship between Vehicle Color and Safety Risk at High-Speed Rural Intersections for Young Drivers

Hojr Momeni[1], Sunanda Dissanayake[2], Thomas Hallaq[3], and Nick Homburg[4]

Abstract

Fatalities due to motor crashes are among the highest number of deaths in many countries. To reduce the number of crashes and their severity it is required to identify effective parameters appropriately. Few studies investigated the relationship between crash occurrence and vehicle color, but the effect of vehicle color on their visibility and subsequently the probability of crash occurrence has not been fully explored. There has been some speculation that the combination of the vehicle color and the background environment can cause a camouflage effect on the visibility for the drivers stopped at an intersection which potentially can increase the safety risk at rural intersections. Since the speed of passing vehicles at rural intersections is relatively high, the severity of crashes can also be high which shows the importance of studying the effect of vehicle visibility at intersections.

In order to investigate the effect of vehicle color on vehicle detection, a stopped vehicle was simulated at a rural intersection with a history of high number of crashes. For this purpose, videos of different vehicle colors and from point of view of a driver of a stopped vehicle at the intersection and at different times of a day were recorded. Several passenger vehicle colors in various daylight conditions for two opposite

[1] Graduate Teaching Assistant; Kansas State University; 2136 Fiedler Hall, Manhattan, KS, 66506; phone (785) 317-5945; email: hmomeni@ksu.edu

[2] Professor; Kansas State University; 2128Fiedler Hall, Manhattan, KS, 66506; phone (785) 532-1540; email: sunanda@ksu.edu

[3] Assistant Professor; Kansas State University; A.Q. Miller School of Journalism and Mass Communications , 107B Kedzie Hall, Manhattan, KS, 66506; phone (785) 532-3908; email: thallaq@ksu.edu

[4] Graduate Teaching Assistant; Kansas State University; A.Q. Miller School of Journalism and Mass Communications , 159 Dole Hall, Manhattan, KS, 66506; phone (208) 520-5327; email: nhomburg@ksu.edu

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directions were selected and shown to a large group of young drivers. Response times of participants were collected and recorded by the researchers for different vehicle colors in random orders.

The means of response times of participants of vehicle colors were compared in two different ways: first various vehicle colors of same direction and same daytime light condition and second same vehicle color and same direction in different daytime light conditions. To analyze the collected data an Analysis of Variance (ANOVA) test was used to determine whether the means of response times are different or not. A Tukey-Kramer Honestly Significant (HSD) test was used to identify which vehicle colors or daytime light conditions are different from the others using SAS statistical software.

Although at first glance it seems the results of ANOVA and Tukey-Kramer HSD tests show significant differences for some vehicle colors or daytime light conditions considering all of the results together reveals that the differences are not consistent. In other words, a specific vehicle color or daytime light condition does not stand out above the others. Overall, according to the findings of this research there is not enough evidence to determine that the camouflaging of vehicles due to vehicle color is the main cause of crashes at the study location.

Keywords: intersection crashes—vehicle color—camouflage—daytime light condition

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This topic is "practice ready." ☐ **Yes** ☒ **No**

Laboratory Investigation of Bridge Strip Seal Termination Details

Travis K. Hosteng[1], Sam Redd[2], Brent M. Phares[3], Norman McDonald[4], and Ahmad Abu-Hawash[5]

Abstract

Strip seal expansion joints have been used on numerous bridges in Iowa and when installed and maintained properly, may last 15 to 20 years. Quality of installation and durability are two of the main factors affecting the performance of the strip seal expansion joint; however, one area of particular concern is where the strip seal joint terminates at the barrier rail, i.e. the strip seal termination detail. This area is difficult to construct, and often involves complex geometries especially as the skew of the bridge abutment increases. Often times, the plans are confusing to read and as a result many newly constructed bridges have their strip seal expansion joints/terminations built incorrectly or inadequately. This research project studies other State DOT termination details and searches for new details to potentially improve or replace the current termination detail used by the Iowa DOT. To evaluate the alternative details, each termination detail, including the current termination detail used by the Iowa DOT, will be fabricated and constructed in the laboratory for evaluation of its constructability and durability during ponding tests. Findings from laboratory investigations may result in revisions to the

[1] Research Engineer; Bridge Engineering Center, Iowa State University; 2711 S. Loop Drive, Ames, IA, 50010, phone (515) 294-7197; fax (515) 294-0467; email: kickhos@iastate.edu

[2] Graduate Student; Bridge Engineering Center, Iowa State University; 2711 S. Loop Drive, Ames, IA, 50010, phone (515) 294-8103; fax (515) 294-0467; email: sredd@iastate.edu

[3] Director; Bridge Engineering Center, Iowa State University; 2711 S. Loop Drive, Ames, IA, 50010, phone (515) 294-5879; fax (515) 294-0467; email: bphares@iastate.edu

[4] Bridge Engineer; Iowa Department of Transportation; 800 Lincoln Way, Ames, IA, 50010; phone (515) 239-1564; email: Norman.McDonald@dot.iowa.gov

[5] Chief Structural Engineer; Iowa Department of Transportation; 800 Lincoln Way, Ames, IA, 50010; phone (515) 239-1393; email: Abu-Hawash, Ahmad.Abu-Hawash@dot.iowa.gov

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current strip seal termination detail or utilization of a completely different termination detail should it perform better than the current detail being used by the Iowa DOT.

Keywords: strip seal—expansion joint—bridge—termination detail—bridge joint

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Laboratory Investigation of Warm Mix Asphalt Performance with select bio-derived/chemical additives in the Midwestern United States using AASHTOWare Pavement ME Design

Joseph H. Podolsky[1], Ashley F. Buss[2], R. Christopher Williams[3], and Eric W. Cochran[4]

Abstract

An industry wide emphasis on sustainable asphalt practices has given rise to increasing use of warm mix asphalt technologies. WMA reduces both binder viscosity and mixing and compaction temperatures by 20-55 °C. The objective of this research is to use the new AASHTOWare Pavement ME Design to compare established forest product WMA additives with a new corn-derived WMA additive that is in development. In addition to material evaluation, the results of this research work will compare the sensitivity of AASHTOWare to pavement design parameters such as climate. The WMA material responses used in AASHTOWare binder and mixture test results. The test results are used to forecast pavement performance in the AASHTOWare Pavement ME Design program to understand how the material parameters will influence overall pavement performance. All binder testing used a performance grade (PG) 64-22 binder and the same binder was polymer modified with an SBS polymer to attain a PG 70-22 binder. Dynamic modulus testing on a State DOT approved 10 million ESAL mix design was performed to compare stiffness at a wide range of temperatures and frequencies. The predicted pavement performance using these test results was evaluated for sensitivity to additive choice, polymer

[1] Postdoctoral Research Associate; Iowa State University; Civil, Construction and Environmental Engineering Department; 174 Town Engineering, Ames, IA, 50011; phone (515) 294-4419; fax (515) 294-4419; email: podolsky@iastate.edu

[2] Postdoctoral Research Associate; Iowa State University; Civil, Construction and Environmental Engineering Department; 403 Town Engineering, Ames, IA, 50011; phone (515) 294-4419; fax (515) 294-4419; email: abuss@iastate.edu

[3] Gerald and Audrey Olson Professor; Iowa State University; Civil, Construction and Environmental Engineering Department; 490 Town Engineering, Ames, IA, 50011; phone (515) 294-4419; fax (515) 294-4419; email: rwilliam@iastate.edu

[4] Associate Professor; Iowa State University; Chemical and Biological Engineering Department; 1035 Sweeney, Ames, IA, 50011; phone (515) 294-0625; fax (515) 294-2689; email: ecochran@iastate.edu

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modification, as well as climatic location. Results indicate that climate, pavement additives and polymer modification all play a critical role in pavement performance.

Keywords: Warm mix asphalt—AASHTOWare Pavement ME Design—Climate—Corn-derived

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This topic is "practice ready." ☒ **Yes** ☐ **No**

License Plate Recognition Technology's Potential Benefits to ITS: an 'Arterial Travel Time Estimation' Case Study

Roozbeh. Rahmani[1], Carlos. Sun[2], Praveen. Edara[3] and Henry. Brown[4]

Abstract

One of the most important performance measures for both travelers and transportation system operators is travel time. Not only is average travel time essential to drivers, but more importantly, travel time reliability. People tend to remember the few unexpected long travel times that they faced throughout a year. An advanced data collection system is needed to calculate average travel times, analyze travel time reliability and predict future travel times.

Intelligent Transportation System (ITS) devices are commonly used for mass data collection for transportation networks. Two main data collection methods exist: travel time estimation and direct travel time measurement. Travel time estimation averages speeds from specific points into an *average link travel time*. This approach can lead to inaccurate estimations, especially when the travel time is quickly changing such as during congested traffic flow or on arterials. In addition, point speed estimation methods are not able to include control delays at intersections. In contrast, tempo-spatial vehicle tracking measures *actual travel time*.

[1] Graduate Research Assistant; University of Missouri – Columbia; E1509 Lafferre Hall, Columbia, MO, 65211; phone (573)-529-1692; email: rrdpd@mail.missouri.edu

[2] Associate Professor; University of Missouri – Columbia; E2509 Lafferre Hall, Columbia, MO, 65211; phone (573) 884-6330; fax (573) 882-4784 email: csun@missouri.edu

[3] Associate Professor; University of Missouri – Columbia; C2640 Lafferre Hall, Columbia, MO, 65211; phone (573) 882-1900; email: edarap@missouri.edu

[4] Research Engineer; University of Missouri – Columbia; E2509 Lafferre Hall, Columbia, MO, 65211; phone (573) 882-0832; email: brownhen@missouri.edu

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Some vehicle tracking methods include cell phone multilateration, Global Positioning System (GPS), Bluetooth, toll tag, vehicle inductive/magnetic signature, and license plate recognition. GPS/Bluetooth tracking or probe vehicles require an On-Board-Unit (OBU) and user consent, thus are limited by the percentage of vehicles that are equipped. Toll collection data is restricted to specific toll roads where the toll-collecting infrastructure is available.

Vehicle inductive/magnetic signature (VIMS) identification and License Plate Recognition (LPR) do not need any OBU, leading to a higher sampling rate. To measure *actual travel time*, each specific vehicle must be identified and matched at two different locations and times. Temporal-spatial vehicle matching contributes not only to travel time measurement, but also to Origin-Destination (OD) demand studies.

This poster aims to comprehensively review the potential applications of LPR and compare its benefits and drawbacks with other available data collection techniques available in ITS literature. In addition, this poster discusses a vehicle re-identification case study on an arterial to illustrate the high potential of LPR for use in actual travel time and OD studies. The successful vehicle re-identification rate of the case study was 91%, while most other vehicle matching studies in the literature have matching rate of less than 50%.

Keywords: License Plate Recognition — Arterial Travel Time — Vehicle Re-identification — Vehicle Tracking

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Life Cycle Assessment of Traditional and Alternative Snow Removal Strategies for Airport Apron Operations

Weibin Shen[1], Kasthurirangan Gopalakrishnan[2], Halil Ceylan[3], and Sunghwan Kim[4]

Abstract

An alternative snow removal system called the heated pavement system (HPS) can be utilized in the airport apron area to save airline delay time and reduce man-power instead of using any mechanical or chemical snow removal methods. Although heated pavement system has been used commonly in driveways, walkways and parking areas in roadways, its environmental impacts are still not well known. Assessment of greenhouse gas (GHG) emissions has been recognized as a valuable environmental impact tool in analyzing global warming potential of newly developed alternative systems or techniques. This study evaluates environmental impacts resulting from the operation of three HPS types as using the environmental Life Cycle Assessment (LCA) approach. The energy consumption, operating cost, and GHG emissions from the operations of Geothermal heated pavement system (GHPS), hydronic heated pavement system (HHPS), and electrically heated pavement system (EHPS) are estimated and compared with those of a traditional snow removal system (TSRS). The detailed LCA procedure and analysis of both traditional and alternative snow removal strategies are presented with an emphasis on sustainability aspects of HPS operations in the airport apron area.

Keywords: Life Cycle Assessment — Greenhouse Gas — Heated Pavement System —Snow Removal — Airport — Sustainability

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[1] Graduate Student; Iowa State University, 24 Town Engineering Building, IA 50011-3232; phone (515) 708-4327; email: wshen@iastate.edu

[2] Research Associate Professor; Iowa State University; 354 Town Engineering Building; Ames, IA 50011; phone: (515)-294-3044, e-mail: rangan@iastate.edu

[3] Associate Professor, Iowa State University, 406 Town Engineering Building, Ames, IA 50011; phone (515) 294-8051; email: hceylan@iastate.edu

[4] Research Scientist; Iowa State University; 24 Town Engineering Building; Ames, IA 50011; phone: (515)-294-4698, e-mail: sunghwan@iastate.edu

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Local Calibration of AASHTOWare Pavement ME Design Performance Models for Iowa Jointed Plain Concrete Pavements

Orhan Kaya[1], Halil Ceylan[2], Sunghwan Kim[3], and Kasthurirangan Gopalakrishnan[4]

Abstract

The Mechanistic Empirical Pavement Design Guide (MEPDG) developed under the National Cooperative Highway Research Program (NCHRP) Project 1-37A employed the mechanistic structural response models to calculate pavement responses (stresses, strains, and deflection) and the nationally calibrated empirical distress transfer functions for predicting pavement performance. The MEPDG was subsequently renamed as DARWin-ME in April 2011 and, most recently, marketed as AASHTOWare Pavement ME Design. The overall design process and computational tools have remained essentially intact during the transition from the original research-grade version of the MEPDG software into Pavement ME Design. However, the Pavement ME Design has enhanced features including reporting structural response model results as intermediate output files, utilization of more hourly climate data for future climate condition predictions, tool to optimize for thickness design, tool to run sensitivity analysis of key inputs of a trial design, tool to import backcalculation results for rehabilitation designs, etc. Such enhanced features allows the user to employ the tool more effectively for various local conditions. Following the transition from MEPDG into Pavement ME design, this study evaluates accuracy of Pavement ME Design performance predictions and investigates accuracy improvements of these for

[1] Graduate Research Student; Iowa State University; 24 Town Engineering Building, Ames, IA, 50011; phone (515) 274-4698; fax (515) 294-8216; email: okaya@iastate.edu

[2]Associate Professor; Iowa State University; 406 Town Engineering Building, Ames, IA, 50011; phone (515) 294-8051; fax (555) 294-8216; email: hceylan@iastate.edu

[3] Research Scientist; Iowa State University; 24 Town Engineering Building, Ames, IA, 50011; phone (515) 274-4698; fax (515) 294-8216; email: sunghwan@iastate.edu

[4]Research Associate Professor; Iowa State University; 354 Town Engineering Building, Ames, IA, 50011; phone (515) 294-3044; fax (555) 294-8216; email: rangan@iastate.edu

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Iowa Jointed Plain Concrete Pavement (JPCP) systems by incorporating enhanced Pavement ME features into local calibration methodologies. The detailed inputs and procedures of JPCP performance prediction models are reviewed and discussed with emphasis on local calibration considerations. Based on review results, different optimization techniques are explored to determine local calibration coefficients to improve the accuracy of JPCP performance prediction models. Emphasis is given to detailed local calibration procedures and results by utilizing the enhanced features (e.g. structural response model results) of Pavement ME design.

Keywords: Pavement design and analysis — JPCP —— Calibration——Optimization techniques

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POSTER PRESENTATION

Presentation Title:

Investigating a method to evaluate oxidation level of asphalt mixtures by attenuated total/diffused reflection infrared spectrometer

Presenters:

First author: Kyle Mason, Iowa Department of Transportation, Engineering Coop Student
Second author: Michelle Barger, Iowa Department of Transportation, Chemist

Abstract:

Recycled asphalt pavement (RAP) is used in highway road surface projects. During use, RAP will experience degradation due to oxidation. Traditionally, evaluation of asphalt quality involves physical tests that measure mechanical properties of the material, such as tension or rutting. These properties are a function of asphalt oxidation. A test to directly measure asphalt oxidation may provide a better understanding of the factors that influence RAP performance. This study explores an unpublished method developed as part of the Strategic Highway Research Program (SHRP 2) R06B. The R06B program seeks to advance spectroscopy techniques to better analyze construction materials[1]. This American Association of State Highway and Transportation Officials (AASHTO) proposed method attempts to provide a semi-qualitative technique for measuring oxidation levels in RAP by attenuated total/diffused reflection infrared spectrometer[2].

To test the proposed method, binder oxidation standards were produced using AASHTO method R28, Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV). Binder was subjected to several iterations of PAV aging. RAP samples from the field were compared against the PAV calibration standards, RAP was found to fall within range of the PAV standards. However complications from binder matrix versus RAP matrix prevent positive correlation. At this time the proposed AASHTO method shows promise and further work is being conducted to obtain standards representative of true aged RAP to eliminate matrix effects and provide better measurements of RAP oxidation.

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Mass Transit Sustainability

This topic is "practice ready." ☒ **Yes** ☐ **No**

Ray M. Mundy[1]; Daniel Rust[2]; Sareema Koirala Phillips[3]; Sidra Nasser[4]; Maria Gabriela Rodriguez Paez[5]; Elizabeth Snowden[6]

ABSTRACT

It has been often suggested that the definition of insanity is doing the same thing and expecting a different outcome. Unfortunately a dispassionate evaluation of the current state of public transit in the United States would easily fit this definition. Public transportation funding continues to require federal, state, and local tax reserves in an attempt to address the needs and trends of growing urban communities and support sustainable mass transit solutions. Fifty years of increased funding toward domestic mass transit infrastructure and services has been met with a slight overall ridership decline (as a percentage of our urban population). With all this public support, transit ridership has consistently hovered around 5% of the urban travel trips. Caught between a looming deficit and failure to attract consumers exists a mangled web of inefficient operations, financially unsustainable funding segments, and an inability to

[1] Director of Center for Transportation Studies; University of Missouri-Saint Louis Center for Transportation Studies; One University Boulevard JCPN 240, Saint Louis, MO, 63121; phone (314) 516-7270; fax (314) 516-7272; email: mundyr@umsl.edu

[2] Assistant Director for Undergraduate Program Development; University of Missouri-Saint Louis Center for Transportation Studies; One University Boulevard JCPN 240, Saint Louis, MO, 63121; phone (314) 516-7270; fax (314) 516-7272; email: rustd@umsl.edu

[3] Graduate Research Assistant; University of Missouri-Saint Louis; One University Boulevard JCPN 240, Saint Louis, MO, 63121; phone (314) 516-7270; fax (314) 516-7272; email: sk2nf@mail.umsl.edu

[4] Graduate Research Assistant; University of Missouri-Saint Louis; One University Boulevard JCPN 240, Saint Louis, MO, 63121; phone (314) 516-7270; fax (314) 516-7272; email: sn4gb@mail.umsl.edu

[5] Graduate Research Assistant; University of Missouri-Saint Louis; One University Boulevard JCPN 240, Saint Louis, MO, 63121; phone (314) 516-7270; fax (314) 516-7272

[6] Graduate Research Assistant; University of Missouri-Saint Louis; One University Boulevard JCPN 240, Saint Louis, MO, 63121; phone (314) 516-7270; fax (314) 516-7272; email: esgg3@mail.umsl.edu

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adequately modernize transit system changes. Despite all the good intentions devoted to funds contributed, investments are now contributing toward an unsustainable trend. The federal government's rigid rules for requiring public transit's labor agreement before lower cost private provision of public transportation is severely straining the financial viability of public transit and its future.

Successful and scalable examples of ways to improve sustainability are already in place around the globe and promote an era of responsibility between public and private sectors in mass transit. Latin America, being the earliest adopter of modern and sustainable mass transit systems, operations and infrastructure, has seen great economic and consumer success. Now other countries around the globe – China, India, South Africa, North America, and Eastern Europe – are all committing to more innovative and rewarding approaches to leveraging and restructuring mass transit systems and other alternatives in urban travel.

Although still a work in progress for some cities, the partnering between government infrastructure and private investors supports a future of flexibility, accountability, and profitability for mass transit in growing urban populations, and is a viable resolution for large populations regarding transportation and subsequent environmental concerns. This paper details the financial trends in public mass transit in two major metropolitan cities and explores alternatives implemented in various countries that contributed to successful increases in ridership and lower costs through the application of private sector labor. However, most victories tend to lie in the collaboration itself of each sector's common triumph – government stability through less dependency on public subsidies and more on private innovation.

These new innovative solutions of improving mass transit are sustainable and scalable and require no additional government funding or subsidies. They may be the only viable group of options available in favor of sustainable mass transit system.

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Keywords: Mass Transit—Sustainability—Public transit—Financial Trends—Mass transit Solutions

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This topic is "practice ready." ☐ **Yes** ☒ **No**

Mechanical and Durability Properties of High Performance Mortar for Concrete Pavement Repair

Gilson R. Lomboy[1], Jiaxi Ren[2], An Cheng[3], Lian Bo[4], and Kejin Wang[5]

Abstract

High performance mortar is being developed for rapid repair of concrete pavements. The mortar contains fly ash, silica fume and limestone fines, which are by/co-products. The mortar is self-consolidating and achieve 1-day compressive strengths of greater than 6000 psi. To ensure the suitability of the mortar for rapid patch repair applications, the development of compressive and rupture strength and elastic modulus were measured. The bond with C-3WR-C20, a common concrete pavement mix, was evaluated by slant shear and direct pull-off test. Cyclic freezing-and-thawing (F-T) and autogenous and free drying shrinkage were conducted to determine the durability of the new mortar mixture. Steel microfibers were added to a variation of the mortar mixture to study improvements in rupture strength and durability. The new mortar mixture performance was compared to a commercially available rapid set concrete (RSC) mix. The new mortar mixture exhibits significantly better performance than RSC, except for shrinkage; RSC exhibits very minimal shrinkage. However, RSC is not F-T durable, while the new mortar mixture is durable, even without air entrainment.

Keywords: Strength; Modulus; Slant Shear; Bond; Freezing-Thawing Durability; Shrinkage

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[1] Postdoctoral Research Associate; Department of Civil, Construction and Environmental Engineering, Iowa State University; 407 Town Engineering Building, Ames IA 50011; (515) 294-5234; fax (515) 294-8216; email: grlomboy@iastate.edu

[2] Graduate Student; CCEE, Iowa State University; 397 Town Engg Building, Ames IA 50011; email: nealren@iastate.edu

[3] Associate Professor; Department of Civil Engineering, National ILan University; No.1, Sec.1,Shen-Nong Rd., I-Lan, Taiwan 26046; phone (03) 931-7557; fax (03) 932-9286; email: ancheng@niu.edu.tw

[4] Graduate Student; CCEE, Iowa State University; 397 Town Engg Building, Ames IA 50011; email: blian@iastate.edu

[5] Professor; CCEE, Iowa State University; 492 Town Engg Building, Ames, Iowa, 50011; phone (515) 294-2151; fax (555) 294-8216; email: kejinw@iastate.edu

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Forecasting bridge condition performance for risk-based bridge management

Başak Aldemir Bektaş, PhD (Presenter)
Associate Scientist
Iowa State University
Institute for Transportation (InTrans)
2711 South Loop Drive Suite 4700
Ames IA 50010-8664
Office Phone: (515) 294-4033
Email: basak@iastate.edu

In recent years, risk-based management of infrastructure assets has gained precedence in infrastructure asset management. The "Moving Ahead for Progress in the 21st Century Act'' ('MAP–21), aligned with this progress, requires state transportation agencies to incorporate risk-based management in planning systematic preventative maintenance, replacement, or rehabilitation decisions for their bridge networks. However, the legislation does not provide guidance on a methodology; states are flexible in what type of methodology they choose or how they define risk. At present, state agencies are challenged by identifying and quantifying these risks and developing procedures to address these risks at the network level. This presentation will present continuing work under a UTC project at Intrans to identify, model, and quantify network-level bridge risks in order to develop a methodology to incorporate them into decision making at the network level. The presentation will focus on completed work on modeling and quantifying deterioration risks and translating these risks to condition performance measures for the Iowa bridge network. While the research will focus on regional risks and expertise, resulting methodology will be exemplary for all state transportation agencies. Keywords: bridge deterioration, risk management, bridge condition, performance measurement

This topic is "practice ready." ☐ **Yes** ☒ **No**

Calling all Transportation Stakeholders: We have a Network to Build

Teresa Adams[1], Maria Hart[2], Shauna Hallmark[3]

Abstract

In April of 2015, the Midwest Transportation Workforce Center, (MTWC) held its inaugural Advisory Meeting in Madison Wisconsin. This networking intensive event brought together 35 workforce leaders representing many sectors: State DOTs, economic development, industry, community college and technical schools, state workforce agencies/labor market experts/one-stop agencies, tribal and K-12 interests as well as national labor.

A goal of the meeting was to identify current workforce initiatives and analyze which initiatives could be scaled-up to a regional level. Out of 45 initiatives identified, eleven initiatives were moved forward to serve as basis for a Midwest Strategy. The initiatives are:

- Best Practices in Building a Pipeline into the Industry
- Notify Me
- Technical Transportation Career Clearinghouse
- Job Vacancy Survey
- Summer Job League
- Tribal Career Partnership
- Transportation Day
- Flexible CDL Training
- Transportation Career App
- Outreach for Inclusion
- Urban Diversity Strategy

These initiatives will serve as the scope for further work to be accomplished with the broader transportation community including university educators at a Midwest Transportation Workforce Summit to be held October 1-2 in Madison, Wisconsin.

About the MTWC: The Federal Highway Administration has established the National Network for the Transportation Workforce (NNTW) to consist of five Regional Surface Transportation Workforce Centers. The Centers will serve as a resource to support, grow and maintain a skilled and career-ready transportation workforce in their respective regions. The Centers are network rather than program

[1] Teresa Adams, PhD. Director, Midwest Transportation Workforce Center; University of Wisconsin-Madison; 1415 Drive Engineering Drive #2205, Madison, WI, 53706; phone 608-263-3175; fax (608) 263-3512; email: teresa.adams@wisc.edu

[2] Maria Hart, Program Manager, Midwest Transportation Workforce Center; University of Wisconsin-Madison; 1415 Engineering Drive #2205, Madison, WI, 53706; phone 608-262-6639; fax (608) 263-3512; email: maria.hart@wisc.edu

[3] Shauna Hallmark, Director, Director, Midwest Transportation Center, Iowa State University, 2711 South Loop Drive, Suite 4700, Ames, IA 50010-8664, phone: 515-294-5249; email: shallmar@iastate.edu

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focused and will engage *existing* regionally based programs, to catalyze new strategic partnerships and to communicate programs and best practices to educators, employers and those on the transportation career pathway.

Keywords: workforce—partnerships—training—career pathways—career awareness

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Temporary Traffic Control for Innovative Geometric Design Work Zones

Henry Brown[1], Timothy Cope[2], Amirhosein Khezerzadeh[3], Praveen Edara[4] and Carlos Sun[5]

Abstract

Currently there are no guidelines within the Manual on Uniform Traffic Control Devices (MUTCD) on construction phasing and maintenance of traffic (MOT) through retrofit construction and maintenance projects involving innovative geometric designs. This research addressed this gap in existing knowledge by investigating the state of the practice of construction phasing and MOT for several types of innovative geometric designs including the roundabout, single point urban interchange (SPUI), diverging diamond interchange (DDI), restricted-crossing left turn (RCUT), median U-turn (MUT), and displaced left turn (DLT). The goal of this research is to provide guidelines for transportation practitioners in developing construction phasing and MOT plans for innovative geometric designs. This involves providing MOT Phasing Diagrams to assist in developing traffic control measures such as barriers, delineators, and striping. Guidelines were developed for MOT through a review of literature, survey of practitioners and interview of industry experts, and review of plans from innovative geometric design projects. These guidelines are provided as a tool to assist in improving work zone safety through construction of projects with innovative geometric designs. The aforementioned synthesis of existing knowledge documented existing practices for these types of designs. This process allowed

[1] Research Engineer; University of Missouri – Columbia; E2509 Lafferre Hall, Columbia, MO, 65211; phone (573) 882-0832; email: brownhen@missouri.edu

[2] Assistant Civil Engineer; Burns and McDonnell; 9400 Ward Parkway, Kansas City, MO, 64114; phone (816)-333-9400; email: tbcope90@gmail.com

[3] Graduate Research Assistant; University of Missouri – Columbia; E1509 Lafferre Hall, Columbia, MO, 65211; phone (573)-882-6269; email: akhezerzadeh@mail.missouri.edu

[4] Associate Professor; University of Missouri – Columbia; C2640 Lafferre Hall, Columbia, MO, 65211; phone (573) 882-1900; email: edarap@missouri.edu

[5] Associate Professor; University of Missouri – Columbia; E2509 Lafferre Hall, Columbia, MO, 65211; phone (573) 884-6330; fax (573) 882-4784 email: csun@missouri.edu

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for the development of MOT Phasing Diagrams and recommended guidelines for each of these intersection types.

Keywords: Work Zone — Innovative Geometric Design — Temporary Traffic Control

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Leveraging Mobile Technology for Roadside Feature Inspections

Shawn Blaesing-Thompson[1] Brad Cutler[2]

Abstract

In 2013, Iowa DOT finished research to streamline field inventory/inspection of culverts by Maintenance and Construction staff, maximizing the use of tablet technologies. After a small-scale deployment of tablets in spring 2013, the DOT moved forward with a plan to use ArcGIS Server, ArcGIS Online and Collector for feature inventory and inspection. The roll out of the first of a series of production field inspection applications on a tablet is ongoing beginning with guardrail and expanding to culverts, signs and a series of other features over the following months. The development of inspection documents and an updated workflow process is underway. Inspection information will feed into IA DOTs LRS and asset management system and make the information available enterprise-wide for decision making.

Keywords: mobile, roadside, mapping, condition, GIS, tablet

[1] GIS Coordinator; Iowa Department of Transportation, Office of Maintenance; 800 Lincoln Way, Ames, IA 50010; phone (515) 239-1805; fax (515) 239-1005; email: shawn.blaesing-thompson@dot.iowa.gov

[2] GIS Coordinator; Iowa Department of Transportation, Office of Traffic and Safety; 800 Lincoln Way, Ames, IA 50010; phone (515) 239-1306; fax (515) 239-1891; email: brad.cutler@dot.iowa.gov

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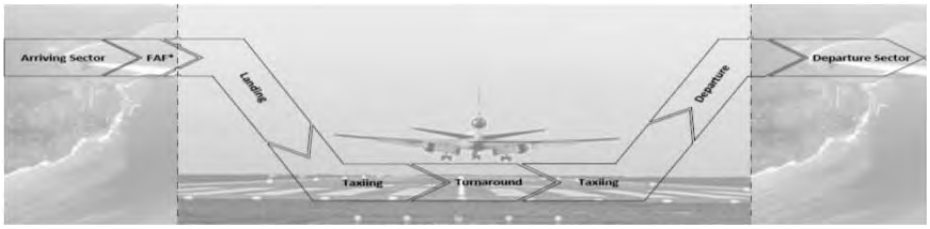
This topic is "practice ready." ☒ **Yes** ☐ **No**

Modeling Airside Operations at Major Airports for Strategic Decision Support

L. Douglas Smith[1], Liang Xu[2], Ziyi Wang[3] and Deng Pan[4]

Abstract

We discuss the construction and validation of a discrete-event simulation model to support planning for physical infrastructure and airside operating practice at major airports. The following figure illustrates the scope of activity encompassed by the model. Covered are aircraft movements from final approach to the airport; touchdown on the runway; taxiing to the gate for airlines, or to designated ramps for airfreight carriers and corporate aircraft; turnaround activities for continuing flights; pushback for departure; taxiing to the departure runway; and take-off with departure to a designated airspace sector.



System performance is affected by runway, taxiway and ramp layouts, terminal configurations, allocation of gates to individual airlines, the concentration of airlines' flight schedules, air traffic control procedures for aircraft on the ground and in the air, adverse weather conditions, traffic backups at major

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[1] Professor and Director; Center for Business and Industrial Studies, College of Business Administration, University of Missouri-St. Louis; One University Blvd. St. Louis, MO 63121; phone (314) 516-6108; fax (314) 516-6827; email: ldsmith@umsl.edu

[2] Doctoral candidate in Logistics and Supply Chain Management; College of Business Administration, University of Missouri-St. Louis; One University Blvd. St. Louis, MO 63121; phone (314) 516-4881; fax (314) 516-6827; email: lxpx2@mail.umsl.edu

[3] Doctoral student in Logistics and Supply Chain Management; College of Business Administration, University of Missouri-St. Louis; One University Blvd. St. Louis, MO 63121; phone (314) 516-6626; fax (314) 516-6827; email: ziyi.wang@mail.umsl.edu

[4] Doctoral student in Logistics and Supply Chain Management; College of Business Administration, University of Missouri-St. Louis; One University Blvd. St. Louis, MO 63121; phone (314) 516-4882; fax (314) 516-6827; email: dpkq8@mail.umsl.edu

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connecting hubs, etc. Multivariate statistical analysis reveals how flight delays and ground movements of individual aircraft depend on: (1) time-period of the day, (2) day of the week, (3) runway used, (4) type of aircraft (light, medium or heavy), (5) airline, and (6) whether the flight is to or from a major hub airport.

We model the three domains (airline operations, airport facilities and traffic control) with Arena 14.7 by moving simulated aircraft through the network of staged queues – some physical, others conceptual. Ground movements are controlled by signals and routings that consider the capacities of ramps and taxiway segments. Aircraft arrivals are generated by a SAS (Statistical Analysis System) pre-processor and placed in conceptual queues at the final approach fix (FAF) for an active runway. Scenarios are defined by active runways for takeoffs and arrivals, weather in airspace sectors through which arrivals and departures take place, and conditions at major hub airports which may cause bunching of arrivals and traffic holds for departures. With a detailed log of simulated events (arrivals at the FAF, touchdowns on specific runways, arrivals at gates, departures from gates, and liftoffs for departure), we analyze simulated activity to estimate the effects of changes in infrastructure and operating practice on system performance. With this modeling approach, we strive for balance between highly detailed engineering simulations of airspace and airports with microscopic detail (which carry enormous overhead and require excessive time to perform) and operations research models designed for strategic optimization of parts of the system (which often ignore interacting elements of the system).

In our presentation, we discuss the integration of FAA flight data from air traffic control, airline gate data, and direct observations of ground operations to calibrate the simulation model. We illustrate the model-validation process and apply the model to estimate the impact of changes to airport assets and operating procedures under different traffic demands.

Keywords: Airport simulation; Decision support, Transportation infrastructure; Airport operations

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Multi-Hazard Design of Bridges: Lateral Response of Bridges with Scoured Foundations

A. Fioklou[1], and A. Alipour[2]

Abstract

Erosion of soil around the piles and abutments of a bridge, which is also known as bridge scour, can result in large displacements, tilting, and partial or complete failure of the structural system. This condition combined with a ground motion excitation is a critical multi-hazard scenario that could occur at the bridge sites overpassing waterways in seismically-active zones. To address this critical issue, this paper develops multi-hazard fragility curves that take into account variation in structural boundary conditions due to flood-induced scour. In this case, flood and earthquake are two uncorrelated extreme events that may occur simultaneously or the effect of one may weaken the structural system before the following one occurs. The probability of occurrence of different flood levels and their associated scour depths is calculated in the current study. The scour depths resulted from the 100-year and 500-year design floods are estimated for the design recommendations. The seismic performance of the bridges under different scour depths is, then, estimated. For this purpose, three-dimensional nonlinear models of a set of representative structures has been simulated in OpenSees and nonlinear time history analysis is conducted to measure the extent of variability in the performance measures of the bridges under consideration. To develop the multi-hazard fragility curves, the conditional probability of occurrence of the earthquake and flood is evaluated. The estimated probability is used to construct a matrix that represents the combined probability of failure under both extreme events. It has been shown that the effect of scour on the seismic performance of a bridge is dependent on the dynamic characteristics of the intact one. Development of multi-dimensional fragility curves can be considered as an important step towards the development of the next generation of multi-hazard load combinations. The outcome of this research will be useful for bridge designers, engineers, and code developers.

Keywords: Multi-hazard design, Bridge, Scour, Earthquake

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[1] PhD Candidate; Department of Civil, Construction and Environmental Engineering, Iowa State University; 336 Town Engineering, Ames, IA, 50011; email: afioklou@iastate.edu

[2] Assistant Professor; Department of Civil, Construction and Environmental Engineering, Iowa State University; 358 Town Engineering, Ames, IA, 50011-3232; phone (515) 294-3280; email: alipour@iastate.edu

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Numerical Evaluation of Bridge Expansion Joint Designs

Alaa A. Elsisi[1] and Hani A. Salim[2]

Abstract

Finger plate and flat plate bridge expansion devices are commonly used bridge connections to allow for expansive and contractive movements of bridge joints over two conjoining spans. Some expansion device designs experience premature fatigue failure under high traffic loads. Due to the high maintenance cost of such joints, it very important to determine the mechanisms of these premature failures and to develop new designs for improved performance. In this study, finite element models of finger and flat plate expansion devices were developed to evaluate the main causes of failure and recommend effective improvements to be implemented for design details. The finite element models were validated using filed strain and displacement measurements. It was observed that the joints under investigation experience stress concentrations at critical locations, which are expected to be prone to potential fatigue failure. A parametric study was created to evaluate the effect of plate thickness, position and number stiffeners, location of wheel load, and supporting beam geometry. It was observed that by increasing the number of stiffeners, the stress concentration decreases in the finger and flat plates considered in this study.

Keywords: Bridges expansion joints—Finite Element Modeling—Fatigue—Field testing

[1] PhD Student; Civil and Environmental Engineering; University of Missouri, Columbia, Mo, 65211; phone (573) 529-6931; fax (573) 882-4784; email: aep64@mail.missouri.edu

[2] LaPierre Associate Professor; Civil and Environmental Engineering; University of Missouri, Columbia, Mo, 65211; phone (573) 884-6761; fax (573) 882-4784; email: salimh@missouri.edu

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Optimization of Electrically Conductive Concrete (ECC) Mix Design for Self-Heating Pavement Systems

Alireza Sassani[1], Halil Ceylan[2], Sunghwan Kim[3], Kasthurirangan Gopalakrishnan[4], and Peter C. Taylor[5]

Abstract

The pavement deicing methods currently predominant in the world rely on mechanical methods (e.g., plows and brushes) and chemical deicing agents. The limitations of these approaches include relatively high investment of time/labor, damage to pavement, and the need for interrupting traffic operations during their application. Therefore, to eliminate the problems associated with conventional deicing methods, self-heating pavement systems have been proposed and successfully applied in several cases. Electrically conductive concrete (ECC), containing a conductive phase in addition to conventional concrete components, provide a very efficient means of producing self-heating pavement systems. The majority of ECC developed up to date has utilized steel materials as the conductive component in ECC mixing. However, durability, aesthetic and safety concerns have arisen in the use of steel materials in ECC for critical transportation structures.

Carbon based conductive materials (carbon fiber, graphite powder, carbon nano-platelet, etc.) can be considered as an alternative to steel-based products in ECC construction. However, successful and safe application of these materials in large-scale real projects should be guaranteed by a reliable

[1] Graduate Research Student; Iowa State University; 24 Town Engineering Building, Ames, IA, 50011; phone (515) 274-4698; fax (515) 294-8216; email: asassani@iastate.edu

[2]Associate Professor; Iowa State University; 406 Town Engineering Building, Ames, IA, 50011; phone (515) 294-8051; fax (555) 294-8216; email: hceylan@iastate.edu

[3]Research Scientist; Iowa State University; 24 Town Engineering Building, Ames, IA, 50011; phone (515) 274-4698; fax (515) 294-8216; email: sunghwan@iastate.edu

[4]Research Associate Professor; Iowa State University; 354 Town Engineering Building, Ames, IA, 50011; phone (515) 294-3044; fax (555) 294-8216; email: rangan@iastate.edu

[5]Research Associate Professor; Iowa State University; 2711 S Loop Dr, Ames, IA, 50011; phone (515) 294-9333; email: ptaylor@iastate.edu

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performance-based ECC mix design. As a key step in developing such mix design, this study explores identification of type and content of a single carbon conductive material or a combination of two or more different carbon materials to meet mechanistic and thermodynamic performance requirements of self-heating pavement systems. A set of trial mortar tests is carried out to identify desirable single material or combination material types and contents. Based on the results from trial mortar tests, a set of trial ECC mix designs is developed and evaluated to optimize ECC mix design to achieve desirable system-level engineering properties.

Keywords: Heated Pavements — Electrically Conductive Concrete —— Pavement Deicing —— Airport Pavements

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Optimization of Retrofit and Recovery Efforts to Maximize the Resilience of Highway Networks Subjected to Extreme Events

M. Furtado[1], and A. Alipour[2]

Abstract

Ensuring the resilience of critical infrastructure systems after extreme events is of the greatest importance to the engineers, stake holders and decision makers. Providing optimal strategies to strengthen the infrastructure systems performance and to recover rapidly after the extreme events requires a rigorous decision making process. For this purpose, a probabilistic approach is used in this paper to optimize the mean-risk objective of the system loss considering pre- or post-event actions. For this purpose, a series of resilience-based improvement strategies are highlighted and their effects on the different dimensions of resilience are identified. To account for the effect of different improvement strategies before and after earthquake (as the case study extreme event), an original highway network is compared with several hypothetical models in both pre- and post-earthquake improved conditions. The effectiveness of each scenario is measured by comparing the resilience measure associated with the system after earthquake. The pre-earthquake scenarios represent any retrofitting or planning activities that could contribute to increasing the robustness or redundancy of the system. The post-event scenarios include those planning activities that contribute to effective and rapid recovery strategies. For this case, a series of repair acceleration techniques are applied in order to shorten the repair time and restore the network to an acceptable level of functionality with minimum resources. It is shown that each of these scenarios, although carrying a larger construction cost, reduce the indirect costs associated with network disruption. The outcome of this study will be examined in the San Francisco Bay area network as a test bed. This network is an appropriate test bed as a populated urban area highly dependent on the functionality of the highway network while located in a high seismic zone.

Keywords: Transportation network, Extreme event, Resilience, Planning, Management

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[1] PhD Candidate; Department of Civil, Construction and Environmental Engineering, Iowa State University; 423 Town Engineering, Ames, IA, 50011; email: mfurtado@iastate.edu

[2] Assistant Professor; Department of Civil, Construction and Environmental Engineering, Iowa State University; 358 Town Engineering, Ames, IA, 50011-3232; phone (515) 294-3280; email: alipour@iastate.edu

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Optimized Decision Making Strategies for Deteriorating Civil Infrastructure Components

Dena Khatami[1], Behrouz Shafei[2], Basak Aldemir-Bektas[3] and Omar G. Smadi[4]

Abstract

Civil infrastructure components are exposed to a variety of environmental and mechanical stressors during their service life. The deterioration of such components must be considered as a stochastic process since it is affected by several uncertain factors, which are not always captured by available data, e.g., uncertainty due to internal parameters such as concrete properties or environmental variables such as surface chloride concentration. Considering that maintenance strategies are planned based on the estimates of the extent of structural deterioration, a systematic effort is needed to incorporate various sources of uncertainty in the predictive models and decision-making algorithms. To this end, the current study utilizes Markovian transition probability models to investigate the deterioration process of civil infrastructure components. In the developed models, a set of condition states are used to describe the level of structural degradation characterized by different performance rates, ranging from the perfect functioning to complete failure condition. The Markovian transition probabilities between the deterioration states are obtained by different hazard models where the values of the required hazard parameters are estimated using the field observations and inspection data. Further to evaluate the accuracy of the available hazard models, a set of possible maintenance actions are examined depending on the expected damage state. By taking into account the important factor of cost, the developed probabilistic framework directly contributes to improve the current maintenance policies through the identification of the most optimized preventive and corrective actions that ensure the safety and performance of the existing civil infrastructure components.

Keywords: Civil Infrastructure Components, Deterioration, Decision-Making Strategies, Uncertainty Assessment, Hazard Function, Life-Cycle Cost

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[1]Graduate Research Assistant; 423 Town Engineering Building, Ames, IA, 50011; phone (515) 294-2181; email: dkhatami@iastate.edu

[2]Assistant Professor; 424 Town Engineering Building, Ames, IA, 50011; phone (515) 294-4058; email: shafei@iastate.edu

[3]Associate Scientist; 2711 S Loop Dr., Suite 4700, Ames, IA 50010-8664; phone (515) 294-4033; email: basak@iastate.edu

[4]Associate Professor; 2711 S Loop Dr., Suite 4700, Ames, IA 50010-8664; phone (515) 294-7110; email: smadi@iastate.edu

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Oversize-Overweight Permit Mapping and Analysis Project in Wisconsin

Nicholas J. Coley[1] and Hani H. Titi[2]

Abstract

State-issued Oversize-Overweight (OSOW) permits allow freight carriers to haul loads which exceed vehicle size or weight restrictions on state and federal highways. OSOW permit volumes have been growing nationwide, including in Wisconsin, which highlights the importance of analyzing OSOW permit programs. The Wisconsin Department of Transportation (WisDOT) has funded a research project to comprehensively map and analyze all single-trip OSOW permits issued in recent years. Building on a previous research project focused only on overweight vehicles, this project developed a documented, reusable GIS-based route mapping algorithm to match single-trip OSOW permits with WisDOT-managed highways and bridge structures. In addition to providing insights into permit vehicle trends, the analysis identified possible OSOW priority corridors as well as segments within the highway system which may be limiting efficient OSOW routes due to vehicle restrictions on those segments. Furthermore, estimates of pavement deterioration due to single-trip OSOW permits were developed. The project resulted in an analysis database of single-trip OSOW permits including a user-friendly query tool to facilitate continued permit program analyses by WisDOT staff.

Keywords: Oversize, overweight, permits, freight, GIS

[1] Research Associate; Civil & Environmental Engineering, University of Wisconsin – Milwaukee; 3200 North Cramer Street, Milwaukee, WI, 53211; phone (414) 559-4857; njcoley@uwm.edu

[2] Associate Professor; Civil & Environmental Engineering, University of Wisconsin – Milwaukee; 3200 North Cramer Street, Milwaukee, WI, 53211; phone (414) 229-6893; hanititi@uwm.edu

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This topic is "practice ready." ☐ **Yes** ☒ **No**

Overview of Deterioration Mechanisms in Sawn Concrete Joints

Xin Wang[1], Peter Taylor[2], and Jiake Zhang[3]

Abstract

In the cold regions of U.S., concrete pavements may suffer from premature deterioration of sawn joints, often related to freezing and thawing of saturated concrete. However, another form of distress occurs as cracks forming about one inch from, and parallel to, the free surface. Concrete between cracks was observed to be sound, which is atypical of freeze thaw distress. It is believed that this is related to paste expansion due to oxychloride formation related to the use of magnesium chloride de-icing salts. In addition, confounding effects such as the presence of popouts and d-cracking makes forensic analysis difficult.

This paper reviews and describes the forms of distress that may occur at a joint, and discusses causes, prevention and repair options. These forms will include saturated freeze thaw, d-cracking, ASR, popouts and oxychloride expansion.

Keywords: Durability—Concrete Joint—Deterioration—F-T Damage

[1] Xin Wang; Iowa State University, 492 Town Engr Ames, IA 50011, phone (555) 708-4308, email: xin@iastate.edu

[2] Peter Taylor; National Concrete Pavement Technology Center, 2711 S Loop Dr, Ames, IA, 50010; (515)-294-9333; email: ptaylor@iastate.edu

[3] Jiake Zhang; Hunan University; Changsha, Hunan, China; phone : 8618874101690; email: zhjiake@hotmail.com

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Paint Reflectivity Analysis for Decision Making

Shawn Blaesing-Thompson[1] and Joe Drahos[2]

Abstract

Iowa Department of Transportation (IA DOT) spends almost $7 million in paint, equipment, and staff repainting the yellow and white pavement markings across six maintenance districts. While traffic account for part of the wear and tear of these markings, some of the degradation is thought to be due to the use of snow plows and deicing materials in the winter. As part of the performance measure of paint reflectivity, data is collected every spring and fall which can be used to evaluate the longevity of paint. IA DOT is working towards a process to compare the change between fall and spring reflectivity readings, in order to identify where paint is underperforming. This will leverage existing datasets such as historical reflectivity readings, snow plow passes through our GPS AVL system and identifying existing areas of grooved stripes to assess paint longevity.

Keywords: reflectivity, analysis, gps/avl, performance measures

[1] GIS Coordinator; Iowa Department of Transportation, Office of Maintenance; 800 Lincoln Way, Ames, IA 50010; phone (515) 239-1805; fax (515) 239-1005; email: shawn.blaesing-thompson@dot.iowa.gov

[2] Program Planner; Iowa Department of Transportation, Office of Systems Planning; 800 Lincoln Way, Ames, IA 50010; phone (515) 239-1724; email: joseph.drahos@dot.iowa.gov

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Pavement Treatment Selection Tool for Iowa Local Agencies

Ahmed Abdelaty[1] and H. David Jeong, Ph.D[2]

Abstract

There is a huge funding needed over the coming period to bring the nation's infrastructure to a good condition. Approximately 55% of the road network in Iowa is in fair to poor condition. Iowa local agencies need to enhance their pavement asset management system to develop an effective and reliable short term and long term pavement management plans. When the pavement condition falls below a certain threshold value, various treatment options are considered and one of them is selected and applied to the pavement. The current treatment selection tool lacks the ability to evaluate the return on investment for different alternatives. There is also a need to address Iowa's local conditions and practices. A questionnaire survey targeting city and county engineers was conducted to investigate the common distresses of pavements in Iowa and to identify the common decision practices and treatments applied by local agencies. A Microsoft Excel based treatment selection tool was developed to assist locals in selecting technically feasible treatments and assess the economic value for each treatment. The tool also provides an optional scoring system that considers non-financial related selection criteria such as user satisfaction, environmental impacts and so forth. The developed tool provides a defensible framework for local agencies to maintain their pavements. It is also expected to maximize the benefits of investment decisions based on the developed tool.

[1] PhD Student; Dept. of Civil, Construction and Environmental Engineering, Iowa State University, Ames, Iowa, 50010; phone (515) 708-5652; email: abdelaty@iastate.edu

[2] Associate Professor; 404 Town Engineering

Dept. of Civil, Construction, and Environmental Engineering

Iowa State University, Ames, Iowa, 50010; phone (515)-294-7271; fax (555) 555-0000; email: djeong@iastate.edu

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Keywords: Pavement maintenance—Return on investment—Level of service —Local agencies — Decision making

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Performance Evaluation of Integral Abutment Curved Bridges under Thermal Loading

Yaohua Deng[1], Brent Phares[2], Gary Novey[3], and Ahmad Abu-Hawash[4]

Abstract

Curved steel girder bridges are used in up to one-quarter of the nation's steel superstructure bridges. Curved girder bridges are also being designed with integral abutments due to the advantages in cost, constructability and maintenance observed in non-curved bridge. However, the National Cooperative Highway Research Program (NCHRP) has raised concerns regarding the design, fabrication, and erection of horizontally curved steel girder bridges due to difficult-to-predict girder displacements, fit-up issues, and unintended locked-in stresses. And further, the combined use of horizontally curved steel girder bridges with integral abutments is relatively new to the United States and the behavior of such bridges during thermal loading is not well understood and code guidelines are not sufficiently provided. The purpose of this study was to investigate the thermal behavior of curved bridges with integral abutments through a monitoring and evaluation program. For the monitoring program, four in-service, horizontally curved, steel I-girder bridges with integral and semi-integral abutments and one straight bridge were monitored to provide comparisons of general performance of in-service bridges, utilizing an array of strain gauges, pressure transducers, and movement monitors. The long-term assessment indicated that additional stresses were induced in the girders due to restrained expansion and contraction of the bridge. The analysis results based fielding monitoring data indicate that no noticeable differences were observed between these curved and straight bridges based on varying curvature, skew, or support conditions partly due to the fact that the curvatures in these bridges are relatively small. Parametric study results through finite element simulation under design conditions demonstrate that, the stresses in girders changed significantly along with skew and curvature; and if the total induced stresses (maximum stress) is increased by 10%, the curved and skewed integral abutment bridges with a 10^0 skew and 0.06 radians arc span length to radius ratio can be designed as a straight bridge. Thermal stress can reach up to 3 ksi which contributes to about 15% of the maximum design stress.

Key words: Curved Bridges—Integral Abutments—Semi-Integral Abutments—Field Monitoring—Thermal Behavior.

[1]Bridge Research Scientist, Bridge Engineering Center, Institute for Transportation, Iowa State University Research Park, Ames, IA 50010; Email: jimdeng@iastate.edu; Tel: 515-294-2882.

[2]Research Associate Professor & Director, Bridge Engineering Center, Institute for Transportation, Iowa State University Research Park, Ames, IA 50010; Email: bphares@iastate.edu; Tel: 515-294-5879.

[3]Assistant bridge engineer, Office of Bridges and Structures, Iowa Department of Transportation, Ames, IA 50010; Email: Gary.Novey@dot.iowa.gov; Tel: 515-233- 1564.

[4]Chief structural engineer, Office of Bridges and Structures, Iowa Department of Transportation, Ames, IA 50010; Email: Ahmad.Abu-Hawash@dot.iowa.gov; Tel: 515-239-1393.

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This topic is "practice ready." ☐ **Yes** ☒ **No**

Performance of Local Aggregates in High Friction Surface Treatments

Humaira Zahir[1], Shuvo Islam[2], and Mustaque Hossain[3]

Abstract

Road surfaces may prematurely lose pavement friction due to polished aggregates on sharp horizontal curves, steep grades, or near intersections resulting in vehicle skids. The problem gets exacerbated during wet weather. The Federal Highway Administration (FHWA) estimates that about 70% of wet pavement crashes can be prevented or minimized by improving pavement friction. High Friction Surface Treatments (HFST), a specially-designed thin surface application of hard aggregates and thermosetting resins like epoxy, has been proven to be an effective method to increase road surface friction. Calcined bauxite has been predominantly used in the United States as the hard aggregate in combination with an epoxy binder for HFST. However, this treatment is expensive since the calcined bauxite needs to be imported. The objective of this study is to evaluate the performance of a local aggregate in HFST. The calcined bauxite will be used as a control. Slab specimens of hot-mix asphalt (HMA) will be compacted in the laboratory. These slabs will be treated with HFST systems incorporating both aggregates. The treated specimens will then be tested with Dynamic Friction Tester (DFT) and Circular Texture Meter (CTM) to determine the frictional coefficient and the mean profile depth (MPD), respectively. Additionally, Hamburg Wheel Tracking Device Testing will be conducted on these HFST systems to evaluate wearing resistance under repetitive wheel load. The proposed presentation will present these results.

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[1] M.S. Student; Kansas State University; College of Engineering, 2118 Fiedler Hall, Manhattan, KS, 66506; phone (785) 770-6252; fax (785) 532-7717; email: humaira@ksu.edu

[2] Ph.D. Student; Kansas State University; College of Engineering, 2118 Fiedler Hall, Manhattan, KS, 66506; phone (919) 744-8240; fax (785) 532-7717; email: sislam@ksu.edu

[3] Munger Professor; Kansas State University, College of Engineering, 2124 Fiedler Hall, Manhattan, KS, 66506; phone (785) 532-1576; fax (785) 532-7717; email: mustak@ksu.edu

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Keywords: High Friction Surface——Skid Resistance—— Dynamic Friction Tester—Circular Texture Meter—Transportation Safety

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Performance review of cold-in place recycling on the Iowa pavement network

Ashley Buss[1], R. Chris Williams[2], and Scott Schram[3]

Abstract

A steady increase in the use of cold in-place recycling (CIR) for pavement rehabilitation has highlighted the need for a performance review of the CIR pavements on the Iowa network. This review will be of interest to owner/agencies, contractors and the research community. Performance reviews of successful pavement rehabilitation strategies can be implemented into life cycle cost analyses to assist engineers in making the best rehabilitation choices for their pavement network. Pavement performance indicators for approximately 100 CIR projects were analyzed using the pavement management information system (PMIS) which includes: transverse, longitudinal, fatigue, rutting, patching and IRI data. The data was collected biennially with pavements constructed as early as 1995. The findings show that CIR significantly reduced transverse cracking. Many of the pavements are still being monitored and show excellent performance. Longitudinal cracking and rutting appear to reoccur more often in the CIR compared to transverse cracking. Project selection, appropriate materials and adequate subgrade support will help to mitigate the occurrence of these types of distresses. A model of IRI based on network observations was developed to provide an estimate of pavement performance life as a function of time and CIR thickness.

Keywords: cold in-place recycling—performance—pavement distress

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[1] Ashley Buss, Post-doctoral Research Associate; Iowa State University; 394 Town Engineering Building, Ames, IA, 50011; phone (563) 880-8098; email: abuss@iastate.edu

[2] R. Christopher Williams, Professor ; Iowa State University; 394 Town Engineering Building, Ames, IA, 50011; phone (515) 294-4419; email: rwilliam@iastate.edu

[3] Scott Schram, State Bituminous Engineer; Iowa Department of Transportation; 800 Lincoln Way, Ames, IA 50010; phone (515) 239-1604; email: scott.schram@dot.iowa.gov

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This topic is "practice ready." ☐ **Yes** ☒ **No**

Pervious Concrete Physical Characteristics and Effectiveness in Stormwater Pollution Reduction

Guyu Shi[1], Yifeng Ling[2], Kejin Wang[3], Say Kee Ong[4]

Abstract

Pervious pavements have been promoted as an environmentally friendly and sustainable infrastructure by allowing water to percolate through its voids which, in turn, reduces surface water runoff, increases groundwater recharge, and attenuates water pollution. The objectives of the study are to design pervious concrete mixtures to obtain different pore structures and porosities and to assess the pervious concrete pavements on attenuating water pollution under clean and clogged conditions. Different pervious concrete mixes were prepared using Portland cement, fly ash, blast furnace slag, and lime stone fines. Porosities obtained from these mixes ranged from 15% to 30%. Experiments are being conducted to physically characterize the pervious concrete. Laboratory experiments were conducted by exposing the several pervious concrete pieces to common roadside pollutants such as petroleum products (naphthalene, phenanthrene, and methyl-tert-butyl-ether (MTBE)). Results showed that between 2% and 30% of naphthalene and phenanthrene were attenuated in batch experiments. Experiments are ongoing and further work will be done to assess effectiveness of the pervious concrete for water flow and the mechanism of pollutant attenuation.

Keywords: pervious concrete, pollution, abatement, flow, porosity

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[1] Graduate Student, e-mail: shiguyu@iastate.edu
[2] Graduate Student, e-mail: yling@iastate.edu
[3] Professor, e-mail: kejinw@iastate.edu
[4] Professor, e-mail: skong@iastate.edu
Department of Civil, Construction and Environmental Engineering, Iowa State University, Ames, Iowa, 50011, Tel. No. 515 294 3927, Fax. No. 515 294 8216

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This topic is "practice ready." ☐ **Yes *** ☐ **No**

Plastic Strain and Modulus of Recycled Unbound Aggregates: Laboratory and Field Observations

Ali Soleimanbeigi[1] and Tuncer B. Edil[2]

Abstract

Plastic strain and resilient modulus (MR) of different sources of recycled asphalt pavements (RAP) and recycled concrete aggregates (RCA) were evaluated at differet temperatures typical of field temperatures based on the results of laboratory temperature-controlled MR tests. Freeze-thaw tests were also conducted on samples of RAP and RCA. Tests were also conducted on a conventional Class 5 aggregate for comparison. Field falling weight deflectometer (FWD) tests at different seasons over five years were conducted on three pavement sections constructed with RAP, RCA, and Class 5 as base course materials at MNROAD facility in Minnesota. Laboratory test results showed that temperature rise increased plastic strain and reduced MR of RAP under cyclic loads but had negligible effect on plastic strain and MR of RCA. Freeze-thaw cycles steadily reduced the MR of RAP; however, long-term freeze-thaw cycles increase the MR of RCA. Thermal preloading reduced plastic strain and increased the MR of the compacted RAP thus construction of pavement system made with RAP is recommended during warm seasons to induce thermal preloading. The elastic modulus back-calculated from the FWD tests did not show consistent trend with respect to temperature change at different seasons. No significant change on elastic modulus of RAP, RCA, and Class 5 due to freeze-thaw cycles was observed in the field in Minnesota over five years.

Keywords: plastic strain—resilient modulus—recycled asphalt pavement—recycled concrete aggregate—temperature

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[1] Research Scientist; Recycled Materials Resource Center; University of Wisconsin-Madison, Madison, WI, 53706; phone (608) 444-3460; email: soleimanbeig@wisc.edu

[2] Professor Emeritus and Director; Recycled Materials Resource Center; University of Wisconsin-Madison, Madison, WI, 53706; phone (608) 444-0515; email: tbedil@wisc.edu

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Post-Tensioned Concrete Box-Girder Bridges: Effects of Superstructure Creep and Shrinkage on Column Design

Ebadollah Honarvar [1], Sri Sritharan [2], and Matt Rouse [3]

Abstract

Creep and shrinkage of post-tensioned concrete box-girders are expected to produce significant lateral displacement demands and thus shear and flexural stresses in columns of a multi-span bridge frame. Current design practice addresses these stresses by assuming a strain rate for the box-girders calculated as per AASHTO, which is deemed an upper bound, since it was originally established for joints and bearings. While this is assumed a satisfactory design approach, a systematic evaluation on the time dependent forces developed in columns has not been undertaken. Since column experience noticeable flexural cracks and stress state of columns at the completion of bridge construction has been disputed.

Using a selection of multi-span bridges with different configurations, located in California, a systematic evaluation of the bridges has been completed using detailed finite element bridge models together with appropriate creep and shrinkage model. The paper will provide detailed analysis of the bridge frames, compare the buildup of column forces with the current design approach and suggest realistic stress given consideration to change in prestressing forces and stress relaxation that takes place in concrete.

Keywords: Post-tensioned concrete box-girders —Creep—Shrinkage—finite element analysis (FEA)—Time-step analysis

[1] Ph.D. candidate; Iowa State University; 351 Town Eng., Ames, IA, 50011; phone (505) 720-6857; email: honarvar@iastate.edu

[2] Wilson engineering professor; Iowa State University; 376 Town Eng., Ames, IA, 50011; phone (515) 294-5238; email: sri@iastate.edu

[3] Senior lecturer; Iowa State University; 481 Town Eng., Ames, IA, 50011; phone (515) 294-6139; email: jmr19@iastate.edu

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Predicting the Service Life of Reinforced Concrete Bridges in Corrosive Environments

Z. Cui[1], and A. Alipour[2]

Abstract

Poor concrete durability and reinforcement corrosion due to chloride attack has been identified as the major cause of the deterioration of reinforced concrete (RC) bridges. The life cycle design of RC bridge girders subjected to chloride-induced corrosion is expected to satisfy reliability requirements during their service life. For this purpose, three-dimensional finite element (FE) models which are capable of considering the nonlinearity of material and geometric properties are developed to measure the corrosion-induced crack initiation time and predict the performance degradation of individual members considering steel cross sectional loss, bond deterioration and crack propagation. The FE models are verified and validated against a set of experimental test data. Furthermore, in order to integrate various sources of uncertainties into the predictions, the spatial variability of influencing parameters in the models of chloride ingress into concrete and corrosion-induced cover cracking is studied. The damage limit states are defined as the conditions in which certain durability failure criteria are attained. Analytical derivations inspired from time-variant reliability approaches lead to tractable formulas for the mean and standard deviation of key failure measures. The outcome of this study will provide engineers, stake holders and decision makers with a reliability-based tool to optimize the inspection and maintenance and rehabilitation strategies for RC bridges.

Keywords: Reliability—RC bridges—Deterioration —Stochastic framework—FE model

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[1] PhD Candidate; Department of Civil, Construction and Environmental Engineering, Iowa State University; 136 Town Engineering, Ames, IA, 50011; email: zhenc@iastate.edu

[2] Assistant Professor; Department of Civil, Construction and Environmental Engineering, Iowa State University; 358 Town Engineering, Ames, IA, 50011-3232; phone (515) 294-3280; email: alipour@iastate.edu

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Predicting Traffic Flow and Speed during Disruptions using Machine Learning Methods

Yohan Chang[1], Praveen Edara, Ph. D., P.E.[2], and Carlos Sun Ph. D. P.E., J.D.[3]

Abstract

Traffic information such as travel time, flow, and speed in an urban traffic environment have highly complex and time-dependent characteristics due to the dynamic nature of travel demand involving disruptions such as construction projects, incidents, weather events. Accurate information for traffic flow and speed is important to traffic management centers. Although a wealth of research exists on predicting flow and speed for normal traffic conditions, the same is not true for disruptions and special events. In this research, traffic flow and speed prediction models were developed for one type of network disruptions in urban areas – work zones. Both long-term and short-term forecasting models were developed using two machine-learning methods: random forest (RF) and multilayer feedforward neural network (MFNN). Long-term predictions were designed to predict 24 hours in advance, and short-term were designed to predict 2 hours, 1 hour, 45 minutes, 30 minutes, 15 minutes, and 5 minutes in advance. Models were developed using data for freeways (I-270) and arterials (MO-141), in St. Louis, Missouri. The results show that RF produced lower prediction error than MFNN for both freeways and arterials. Insight into the effect and importance of different variables on prediction accuracy was also investigated. The investigation shows that look-back intervals with upstream and downstream information has a highest significance than other variables such as weather, geographical information.

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[1] Graduate research assistant; University of Missouri-Columbia; Department of Civil Engineering C2640 Lafferre Hall, Columbia, Missouri, 65201; phone (573) 882-6269; fax (573) 882-4784; email: ychang@mail.missouri.edu

[2] Associate professor; University of Missouri-Columbia; Department of Civil Engineering C2640 Lafferre Hall, Columbia, Missouri, 65201; phone (573) 882-1900; fax (573) 882-4784; email: edarap@missouri.edu

[3] Associate professor; University of Missouri-Columbia; Department of Civil Engineering C2505 Lafferre Hall, Columbia, Missouri, 65201; phone (573) 884-6330; fax (573) 882-4784; email: csun@missouri.edu

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Keywords: flow forecasting — speed prediction — Random Forest — Neural Network — look-back

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Public Access to Results of USDOT Sponsored Research

Mary E. Moulton[1]

Abstract

The White House Office of Science & Technology Policy's (OSTP's) Feb. 22, 2013 memorandum *Increasing Access to the Results of Federally Funded Scientific Research* (www.whitehouse.gov) describes new requirements for providing public access to federally funded scientific research publications and digital data sets. OSTP directed all Executive Departments with greater than $100 million in yearly research and development expenditures to prepare a plan for improving the public's access to the results of federally funded research. The requirements of each plan apply to researchers both within the Federal Government (intramural) and in organizations funded by the Federal Government (extramural). The U.S. Department of Transportation's (USDOT's) implementation plan focuses on publications, data, and projects.

The National Transportation Library has a MAP-21 (49 USC 6304) mandate to be the central repository for USDOT research and technical reports, and a clearinghouse for Government transportation data. This presentation will discuss new obligations for awardees of USDOT research funding, data management planning, use of permanent identifiers, and appropriate archiving strategies for long-term preservation and compliance.

Keywords: Public access—Researchers—Research management—Research planning—Data management.

[1] Digital Librarian; USDOT National Transportation Library; 1200 New Jersey Avenue SE, Washington, DC, 20590; phone (202) 366-0303; fax (202) 366-3670; email: mary.moulton@dot.gov

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Quantifying the Safety Effects of Access Management Using VISSIM and SSAM: A Lawrence, Kansas Case Study

Eric J. Fitzsimmons[1], Prathmesh Argade[2] and Steven D. Schrock[3]

Abstract

Access management is a proven technique to help increase safety and operational efficiency in an urban corridor through various strategies to reduce conflict points, mainly midblock between major signalized intersections. These strategies are intended to move traffic away from these potential conflict points with using backage roads, driveway consolidation, median treatments, or adjusting geometric improvements within the right-of-way. Access management strategy effectiveness has been researched widely across the country at various sites and their benefits are well documented.

However, one area of access management that has been explored in depth is the use of microsimulation to help quantity the safety effects of access management. Traditionally, micro-simulation is used as a powerful tool to investigate and quantify the operational impacts of implementing access management strategies through a before-and-after study that mainly relies on travel time. Additionally, the ability to visualize proposed changes through access management has been a powerful tool to explain the concept to the public.

This study took micro-simulating an urban corridor one step further by quantifying the safety effects of access management using micro-simulation data. A well-known urban corridor in Lawrence, Kansas was selected for investigation which currently has limited access management strategies implemented. The research team used VISSIM to calibrate a model of existing conditions and operational data was recorded. The research team then created three additional models that included various levels of access management including "low", "medium", and "high". Each level of access management included different strategies or a combination of strategies. Operational data from each of the three additional models were recorded.

The research team then extracted vehicle trajectory data from each model and used these data as an input to the FHWA's Safety Surrogate Assessment Model (SSAM). SSAM evaluated the number of potential conflicts for each model using maximum time to collision and post-encroachment time to identity critical vehicle-vehicle interactions.

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[1] Assistant Professor; Kansas State University; Department of Civil Engineering, 2109 Fiedler Hall, Manhattan, Kansas, 66506; phone (785) 532-7889; fax (785) 532-7717; email: fitzsimmons@k-state.edu

[2] Civil Engineering Technician; Olsson Associates; 1802 East 123rd Street, Olathe, Kansas, 66061; phone (913) 829-0078; fax (913) 829-0258; email: Prathmesh.Argade@gmail.com

[3] Associate Professor; University of Kansas; Department of Civil, Environmental and Architectural Engineering, 2159B Learned Hall, 1530 West 15th Street, Lawrence, Kansas, 66045; phone (785) 864-3418; fax (785) 864-5631; email: schrock@ku.edu

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The research team found that there was an increase in the travel times for the “low” and the “high” levels of access management compared to existing conditions. The “medium” level of access management experienced a slight decrease in the travel time compared to the existing conditions. In case of the total simulated conflicts, there was a significant decrease and a slight decrease in the low level and the medium level respectively when compared with the existing conditions. The total simulated conflicts increased significantly for the high level compared to the existing conditions. There was a significant decrease in the crossing conflicts in all the levels compared to the existing conditions.

Keywords: Access Management—Micro-simulation—VISSIM—Conflict Analysis—SSAM

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Rating and Posting Bridges for SHVs

--- Iowa Timeline

Ping Lu & Scott Neubauer

Abstract

SHVs are closely-spaced multi-axle single unit trucks introduced by the trucking industry in the last decade. Examples include dump trucks, construction vehicles, solid waste trucks and other hauling trucks, SHVs generally comply with Bridge Formula B and are for this reason considered legal in all states unless a state's laws explicitly exclude the use of such vehicle; and they are legal in Iowa. Truck models for SHVs were developed and adopted by AASHTO in 2005. The design truck HS20 might not envelope SHVs, especially for short span bridges.

To comply with the requirements of NBIS, bridges in Iowa should be rated and posted for SHVs. However, rating more than twenty-thousand bridges all in one time is impractical, if not impossible. As a guideline, FHWA published a memo with regarding to the timeline of rating bridges for SHVs in 2013. However, this memo is considered impractical for Iowa practice, because the grouping criteria are based on legal load rating which is not typically available in our inventory. Therefore, a parametric study and state bridge study were carried out to determine a practical Iowa timeline to rate bridges for SHVs. The boundary criteria for bridges that need to be re-rated and possibly posted for SHVs are determined from the studies. The impact of rating bridges for SHVs, posting strategy, and the work Iowa DOT already done will also be discussed in this presentation.

This topic is "practice ready." ☒ **Yes** ☐ **No**

Reliability of Shallow Foundations Designed Using LRFD with Different Numbers of Strength Measurements

Dan Ding[1], J. Erik Loehr[2], William J. Likos[3] and Norbert Maerz[4]

Abstract

Geotechnical site investigations are often limited by having a small number of samples available for laboratory determination of soil design parameters. The effects of limited number of measurements are sometimes underestimated and can bring uncertainty, bias, and inaccuracy into load and resistance factor (LRFD) design of geotechnical systems. This paper considers results from a large suite of laboratory tests performed on samples from three clayey soil sites in Missouri. Unconsolidated-undrained (UU) type triaxial compression tests were performed on more than 50 high-quality samples from each site to develop design profiles for undrained shear strength and to quantify uncertainty in the site characterization. Relationships between LRFD resistance factor and coefficient of variation (*COV*) in soil parameters were

[1] Adjunct Assistant Professor; Dept. of Civil and Environmental Engineering, University of Missouri, Columbia, MO, 65211; phone: (573) 289-2921, email: ddn56@mail.missouri.edu

[2] Assoc. Professor; Dept. of Civil and Environmental Engineering, University of Missouri, Columbia, MO, 65211; phone: (573) 882-6380; email: eloehr@missouri.edu

[3] Assoc. Professor; Dept. of Geological Engineering, University of Wisconsin, Madison, WI, 53706; phone: (608) 890-2662; email: likos@wisc.edu

[4] Assoc. Professor; Dept. of Geological Engineering; Missouri University of Science and Technology; phone: (573) 341-6714; email: norbert@mst.edu

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calibrated for design of shallow foundations. Random subsamples of the undrained shear strength measurements were then used to simulate design using smaller numbers of measurements. The probabilities of failure for the simulated designs were determined using Monte Carlo simulations and compared to target values of the probability of failure to evaluate the accuracy with which the designs achieve the target value. Results show that LRFD methods that adopt resistance factors that are dependent on the uncertainty in design input parameters tend to produce a consistently low percentage of under reliable designs and to produce increasing percentages of designs that practically achieve the target probability of failure as greater numbers of measurements are considered.

Keywords: Reliability, Load and resistance factor design, Number of Measurements, Site characterization, Monte Carlo simulation

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This topic is "practice ready." ☒ **Yes** ☒ **No**

Remaining Fatigue Life of a Vintage Riveted Steel Bridge: Testing and Numerical Modeling

Alaa A. Elsisi[1] and Hani A. Salim[2]

Abstract

Fatigue may occur in a bridge superstructure under heavy cyclic moving loads. Under the application of repeated stresses, microscopic cracks in the structural members can propagate into large cracks. Several steel bridges were built during the late nineteenth to early twentieth centuries. At that time, riveted construction was the method used for built-up members and for connecting members together. Determining the remaining fatigue life of such bridges is very important due to their age and the increasing axle load demands. A fatigue evaluation of an existing riveted steel bridge, which was built in 1960 and is still in service, was performed in this study. Field strain measurements and numerical modeling were performed for the bridge. The experimental results were used to develop and validate the numerical finite element model, which was used to evaluate the remaining fatigue life of the bridge. AASHTO and S-N curves from literature were used to carry out the fatigue life evaluation of the bridge. It was observed that, provided that the bridge is environmentally protected, all stress ranges for this bridge were less than the code limits and the remaining fatigue life was about 22 years,

Keywords: Fatigue life—Riveted bridges—Numerical modeling—Field testing

[1] PhD Student; Civil and Environmental Engineering; University of Missouri, Columbia, MO, 65211; phone (573) 529-6931; fax (573) 882-4784; email: aep64@mail.missouri.edu

[2] LaPierre Associate Professor; Civil and Environmental Engineering; University of Missouri, Columbia, MO, 65211; phone (573) 884-6761; fax (573) 882-4784; email: salimh@missouri.edu

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Road Diet Guideline Overview

Keith Knapp

Abstract

In the last year the Road Diet Informational guide form FHWA was created. This document includes an introduction to Road Diets and the reasons they might be implemented. It also contains a discussion of Road Diet feasibility determination factors and a summary of what should be considered and used for designing and evaluating a Road Diet. This presentation will focus on the feasibility determination factors of Road Diets and their safety improvement impacts.

Keywords: roadway safety, urban

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This topic is "practice ready." ☐ **Yes** ☐ **No**

Safety Effects of Roadway and Roadside Delineation

Bhagwant Persaud

Abstract

The evolution of extant knowledge on safety effects of roadway and roadside delineation will first be traced, culminating in a presentation of results of recent research undertaken for FHWA's Development of Crash Modification Factors (DCMF) Pooled Fund Study for several tried and experimental strategies that had not previously been rigorously evaluated. Strategies to be addressed in the presentation include enhanced curve delineation (including increased retro-reflectivity of existing signs, post-mounted delineators, chevrons, and wide edge-lines), raised pavement markers, wet reflective pavement markings, center line and shoulder rumble strips used in combination, edge line rumble stripEs on curves, cable median barriers with inside shoulder rumble strips, and increased retroreflectivity of pavement markings and markers. The potential for, and implications of driver adaptation to some of these improvements will be a key element of the presentation.

Keywords: Safety evaluation; crash modification factors, driver adaptation, crash analysis; delineation

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Staying Compliant, Staying Connected in the Transportation Research Lifecycle: Disambiguating Transportation Researchers with Unique ORCID Identifiers

Leighton L. Christiansen http://orcid.org/0000-0002-0543-4268[1]

Abstract

With its new open publication access and data management policy, the United States Department of Transportation will require funded researchers to have an ORCID iD.

What is an ORCID? An ORCID, or Open Researcher and Contributor ID is a unique identifier linked to a specific person, much in the same way a DOI is linked to a specific publication.

Over the past few years, assigning digital object identifiers (DOIs) to specific journal articles has become a best practice in publishing. A DOI uses a unique string of characters to distinguish one electronic document from another, making it easier disambiguate two objects with the same or similar title(s). However, distinguishing two authors, researchers, or contributors, who might have the same or similar names, has been more difficult. Disambiguation also becomes challenging as researchers move from one organization to another. ORCID identifiers may help researchers disambiguate themselves from others with the same name, even in the same research field. In 2012 the Open Researcher and Contributor ID registry was launched as an open registry to specifically disambiguate authors and contributors. When a researcher creates an ORCID record they are issued a unique ORCID identifier, in the form of a URI. Researchers may then include their ORCID identifier when authoring or contributing to a work. The ORCID iD acts as digital signature and link, directing readers to the unique ORCID record for that researcher, and all of the projects for which they are a contributor.

An increasing number of journal publishers – including transportation journals -- are adopting, or are planning to adopt, unique researcher and author identifiers as a best practice. Further, a number of federal research funding agencies, in recently released open access publication and data management policies, are requiring researchers to include a unique personal identifiers in dataset and publication metadata, in order to be able to link data, publications, and people throughout the data and publication lifecycle.

This session will discuss the problem of researcher disambiguation; the role ORCID identifiers in disambiguating researchers and linking researchers to their outputs; how ORCID iDs are similar and different from other author identification tools; how the ORICD API can be used to automate a great deal of disambiguation; and, how the use of ORCID iDs can keep researchers and organizations compliant with new U.S. DOT and other federal open publication and data policies.

Keywords: Identification systems—Authors—Researchers—Research Management—ORCID

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[1] Author1 Librarian; Iowa Department of Transportation Library; 800 Lincoln Way, Ames, Iowa, 50010; phone (515) 239-1200; fax (xxx) xxx-0000; email: leighton.christiansen@dot.iowa.gov

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Stiffness and permeability evaluation of a geocomposite drainage layer for gravel roads

Cheng Li[1], David J. White[2], and Jeramy C. Ashlock[3]

Abstract

Gravel road surfaces frequently experience extensive damage such as rutting, potholes, thaw weakening, and surface water erosion which adversely affects public safety, inconveniences agricultural traffic, and increases maintenance costs. Many previous studies found that technologies which can permanently increase strength or improve drainage of surface course of gravel roads can mitigate or prevent the damage. In this study, a geocomposite drainage layer was installed for a section of a gravel road demonstration project in Hamilton County, Iowa. Falling weight deflectometer (FWD) and air permeameter tests (APT) were conducted on the geocomposite and a control section to compare the in-situ stiffness and permeability. Laboratory large-scale horizontal permeameter tests (HPT) were also conducted to compare horizontal saturated hydraulic conductivity of surface gravel specimens with and without an embedded geocomposite drainage layer. A two-dimensional (2D) water infiltration model that uses the Richards' equation and Haverkamp's pressure-saturation function for granular material was also developed to estimate how effective the geocomposite drainage layer can remove water from the surface course under transient flow condition. The FWD tests results showed the geocomposite drainage layer did not increase the stiffness of the road section. The APT and HPT results showed both the vertical and horizontal saturated hydraulic conductivities of the surface course material were increased more than two orders of magnitude by installing the geocomposite drainage layer. The 2D water infiltration model also showed that the geocomposite drainage layer can quickly remove water from the surface course under a heavy rainfall condition.

Keywords: Gravel roads—Geocomposite—Stiffness—Permeability—Water infiltration model

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[1] Ph.D. Student; Iowa State University; 394 Town Engineering Building, Ames, IA 50010-8664; phone (515) 509-6050; email: cheng@iastate.edu

[2] R.L. Handy Professor; Iowa State University; 422 Town Engineering Building, Ames, Iowa, USA 50011-3232; phone (515) 294-1463; fax (515) 294-8216; email: djwhite@iastate.edu

[3] Assistant Professor; Iowa State University; 474 Town Engineering Building, Ames, Iowa, USA 50011-3232; phone (515) 294-6176; email: jashlock@iastate.edu

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Study of the Reasons that Induce Cracks at Bridge Deck End

Zhengyu. Liu[1], Brent M. Phares[2], Lowell F. Greimann[3], Michael Nop[4], and Ahmad Abu-Hawash[5]

Abstract

The objective of this research is to study what bridge geometries tend to lead to the development of cracks in bridge decks at the bridge end. Parameters studied included bridge width, bridge skew, girder spacing and type, abutment type, pier type and number of bridge spans. To achieve this objective, one bridge was selected to conduct live-load and long-term testing. The data obtained from both field tests were used to calibrate a three-dimensional (3D) Finite Element Model (FEM). Three different types of loading-live loading, thermal loading and shrinkage loading-were applied. The predicted crack pattern from the FEM was compared to the crack pattern from bridge inspection results. A parametric study was conducted using the calibrated FEM. The general conclusions were as follows:

- Longitudinal and diagonal cracking in the deck on an integral abutment bridge is due to the restraint of the abutment and the temperature differences between the abutment and the deck. Shrinkage of the deck concrete may further exacerbate cracks developed from thermal effects.

[1] Ph.D. Student; Iowa State University Bridge Engineering Center; Ames, Iowa, 50010; phone (515) 817-3815; zhengyu@iastate.edu

[2] Research Associate Professor, Director; Iowa State University Bridge Engineering Center; 2711 S. Loop Dr., Ste. 4700, Ames, Iowa, 50010; phone (515) 294-5879; bphares@iastate.edu

[3] Bridge Research Specialist; Iowa State University Bridge Engineering Center; 2711 S. Loop Dr., Ste. 4700, Ames, Iowa, 50010; phone (515) 294-8103; greimann@iastate.edu

[4] Bridge Engineer; Iowa Department of Transportation; 800 Lincoln way, Ames, Iowa, 50010; phone (515) 233-7935; Michael.nop@dot.iowa.gov

[5] Bridge Engineer; Iowa Department of Transportation; 800 Lincoln way, Ames, Iowa, 50010; phone (515) 239-1393; Ahmad.Abu-Hawash@dot.iowa.gov

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- Based upon a limited review of bridges in the Iowa DOT inventory, it appears that, regardless of bridge width, longitudinal and diagonal cracks are prevalent in integral abutment bridges but not in bridges with stub abutments.

- The parametric study results show that bridge width and skew have minimal effect on the strain in the deck bridge resulting from restrained thermal expansion.

- Pier type, girder type, girder spacing and number of spans also appear to have no influence on the level of restrained thermal expansion in the deck near the abutment.

Keywords: bridge deck—cracks—Finite Element Model—temperature loading—field testing

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This topic is "practice ready." ☐ **Yes** ☒ **No**

Study on Particle Packing Effect on High Strength Mortar for Concrete Repair

Wenjing Cai[1], Kejin Wang[2], and Gilson Lomboy[3]

Abstract

Optimum packing of mortar materials is one of the key components in mix design. Having optimum packing can lead to the beneficial effects of minimizing the amount of binder, denser aggregate distribution, reduction in creep and shrinkage and higher strength. The present study uses an optimum packing approach to develop rapid repair mortars. Following an environmentally friendly approach, the present mortar mixtures utilizes industry by-products such as Class F fly ash, silica fume and limestone fines in combination with Type I/II portland cement and river sand. The combination of these mortar materials are optimized by the Andreasen and Andersen (A&A) model for particle packing. Three types of mixtures are studied: (1) optimum proportion without changes in constituent material gradations, (2) modified limestone fine gradation and (3) modified river sand gradation. The packing is verified by the value of the sum of the squares of the residuals, which can indicate how mixing curve fits the target curve, and the effects in fresh and hardened properties are investigated by the dry particles density, flowability, heat of hydration, and compress strength. It is expected that based on optimizing particle packing density by proportioning and material gradation modification, high performance mixtures for concrete repair will be obtained that will be durable, cost effective and environment friendly.

[1] Wenjing Cai; Iowa Sate University; 905 Dickinson Ave Unit 211, Ames, Iowa, 50014; phone (515) 708-8799; email: wenjcai@iastate.edu

[2] Kejin Wang; Iowa State University; 492 Town Engr, Ames, Iowa, 50011; phone (515) 294-2151; fax (555) 294-2152; email: kejinw@iastate.edu

[3] Gilson Lomboy; Iowa State University; 394 Town Engr, Ames, Iowa, 50011; phone (515) 294-3232; email: grlomboy@iastate.edu

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Keywords: keyword 1— particle packing 2— A&A model 3— high strength mortar 4— limestone fine 5— river sand

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This topic is "practice ready." ☐ **Yes** ☒ **No**

The Change Interval Driving Advisory System (CIDAS) using In-Vehicle ITS

Zhu Qing[1]

Abstract

The problem of the change interval driving, also known as the dilemma-zone, means the driver has a difficulty in making a stop-go decision during the change interval i.e., the yellow time. A major survey by the car insurance industry found that nearly 85% of drivers could not identify the correct action to take when approaching a yellow traffic light at an intersection.

Current solutions to the problem mainly rely on road-based infrastructures related to pavement and signal control areas. With the development of connected, cooperative transportation technologies, ITS helps to provide a vista for solving the problem. The intelligent detection-control system, such as advanced dilemma-zone detection, can adjust the start time of the yellow phase to coincide with the point when the fewest possible vehicles are in their respective projected dilemma zones. However, it may not cover every vehicle. Thus, a more feasible solution could be in-vehicle ITS which provides driving advices during the change interval.

The Change Interval Driving Advisory System (CIDAS) was designed to enhance safety at signalized intersections by providing the driver a stop-go decision during the interval change and alert the rear driver of the potential rear-end collision. In the system, seven independent variables collected:

- Initial speed of vehicle;
- Deceleration value;

[1] Graduate Research Assistant; University of Missouri - Columbia; E1510 Lafferre Hall, Columbia, MO, 65201; phone (573) 808-7166; email: zqxqb@mail.missouri.edu

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- Length of the interval change;
- Reaction time of drivers;
- Distance to the intersection;
- Distance to rear vehicle;
- Comparative speed to rear vehicle.

Two algorithms were designed to give the optimal decision for the driver. One is the judgment algorithm to analyze the possibility of red light running. If the status of the interval change is longer than the time needed to pass the intersection, the system conduct a "go" decision to drivers. If the time needed to pass the intersection is close to the length of the interval change, the system will calculate whether a slight acceleration under the speed limit will be feasible. If there is not enough time, the system will ask the driver to slow down and prepare to stop immediately. Meanwhile, the second algorithm begins to assess the probability of rear-end collision. If it is high-risk, the system will automatically remind the rear vehicle before the front vehicle's driver begins to brake, thus it gives the rear driver more reaction time to decrease the stopping distance.

Before it being established in the vehicle, the CIDAS was tested in a driving simulator for two reasons. Firstly, the in-vehicle technology actually may undermine driver safety when it provided redundant information or conducted in a bad timing. Unnecessary information may distract the driver. A message issued too early may be ignored and an alert occurs too late may be viewed as ineffective and even disrupt an ongoing braking process. Secondly, to fulfill the purpose of CIDAS, lots of vehicle-based and infrastructure-based technologies need to be applied at intersections. The outcome of the driving simulator will find whether it is worth to make further investments.

Keywords: driving advisory system—change interval—yellow time—driving simulator— ITS

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A Firm Size and Safety Performance Profile of the U.S. Motor Carrier Industry

Dr. David E. Cantor
Department of Supply Chain and Information Systems
College of Business
Iowa State University
2340 Gerdin Business Building
Ames, Iowa 50011
dcantor@iastate.edu

Mr. Prab Singh
Department of Supply Chain and Information Systems
College of Business
Iowa State University
2340 Gerdin Business Building
Ames, Iowa 50011
pjsingh@iastate.edu

The purpose of this study is to present a profile of the relationship among firm size and safety performance of firms in the U.S. motor carrier industry. This study develops theoretical insights based on the resource-based view of the firm and provides an important managerial and public policy implications. A short coming in the motor carrier literature is the development of a truck crash prediction model with a particular focus on the size of the carrier. This study presents a firm size safety model so that the FMCSA can continue to target the most serious carriers who violate US DOT rules and regulations (FMCSA, 2014). We seek to fill this void in the literature by documenting some of these relationships.

This topic is "practice ready." ☒ **Yes** ☐ **No**

Today's Innovation, Tomorrow's Best Practice – FHWA's Notice of Proposed Rulemaking on System Performance Measures

Francine Shaw Whitson[1]

Abstract

This summer, FHWA will publish its third Notice of Proposed Rulemaking which will cover proposed measures for the performance of the National Highway System, freight movement on the Interstate and Congestion Mitigation and Air Quality program measures for traffic congestion and on-road mobile source emissions. Much of the proposed information will be based on innovated ideas which we hope to become best practices for States and metropolitan planning organizations in the future. This presentation will provide an overview of the proposed measures and provide an opportunity for stakeholders to ask clarifying questions on the proposal. Although comments cannot be accepted at the time of presentation; stakeholders will be encouraged to submit their new ideas or proposals to the comment docket. All ideas/proposals will be considered for inclusion in the final rule.

Keywords: performance measures

[1] Francine Shaw Whitson, Transportation Manager, Office of Transportation Performance Management, FHWA, HIPM-10, Suite E76-338, 1200 New Jersey Ave., SE, Washington, DC 20590; phone (202) 366-8028; fax (202) 366-9981; email: Francine.shaw-whitson@dot.gov

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This topic is "practice ready." ☐ **Yes** ☒ **No**

Topdown early construction cost estimating – achieving satisfactory confidence with the least effort

Brendon Gardner[1], Dr. Douglas Gransberg[2], and Dr David Jeong[3]

Abstract

The aim of project nomination stage estimates for Highway DOTs is to produce a reliable cost estimate with the least amount of effort. Nomination stage estimates are defined as very early in the project life when little information is known about the project. Many existing estimation models in the literature, developed for the nomination stage estimate, do not consider the effort expended in gathering input variables for the model. The authors of those studies instead concentrated on improving prediction ability through various computational techniques. Figure 1 shows the desired objectives hierarchy for nomination stage estimates. Objective 1 has been commonly focused on in previous literature with infrequent reference to the effort expended in objective 2. Incorporating additional input variables into the nomination stage estimate takes time and delays the result. Further cost influencing information gathered over time can be included in a later more confident estimate.

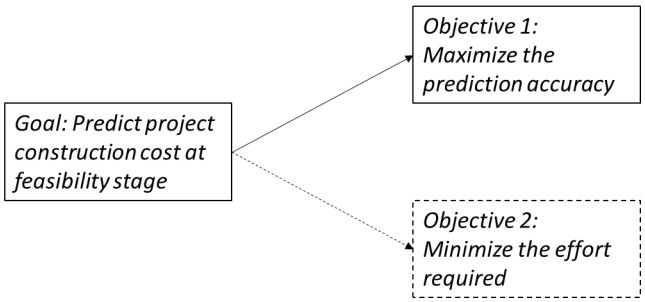

Figure 1 - Conflicting objectives in early cost estimating models

[1] Brendon Gardner; Iowa State University; 3801 Lincoln Way #211, Ames, IA, 50014; phone (515) 708-0117; email: bgardner@iastate.edu

[2] Dr Douglas Gransberg; Iowa State University; 2711 South Loop Drive, Suite 4700, Ames, IA, 50010-8664; phone (555) 555-5555; fax (555) 555-0000; email: author.email@domain.edu

[3] Dr David Jeong; Iowa State University; 2711 South Loop Drive, Suite 4700, Ames, IA, 50010-8664; phone (515) 294-7271; email: djeong@iastate.edu

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This research quantifies the effort expended to undertake estimates for neural network and regression analysis models used in the nomination estimate. Input variables which have a large influence on the final predicted cost and require a low amount of effort are desired in early construction cost estimating models. Input variables with these qualities will be visible in the bottom right quadrant as shown in Figure 1. At the conceptual stage of a project life-cycle, an earlier satisfactory result is superior to a delayed but slightly more accurate result.

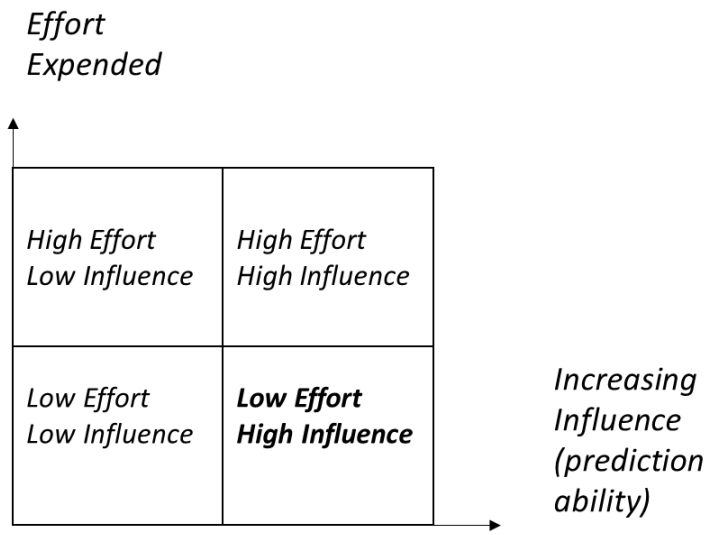

Figure 2 - Desired input variables with low effort and high influence

Focusing on all input variables that have a high influence on the prediction accuracy does not meet the overall goal shown in Figure 1. Effort and prediction accuracy are conflicting objectives because variables that are easily quantifiable are not always great cost predictors. Perception and experience from DOT personnel are gathered to help influence selection of the input variables for cost estimating models. This research presents a procedure to identify those variables that are 'low effort and high influence' (bottom right quadrant of Figure 2). It is important that these variables are identified and then included in the nomination stage cost prediction models. The framework and concepts developed could be extended beyond the nomination stage estimate for Highway DOTs.

Keywords: Cost Estimating—Neural Network—Regression Analysis—Data—Feasibility Estimate

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This topic is "practice ready." ☐ **Yes** ☐ **No**

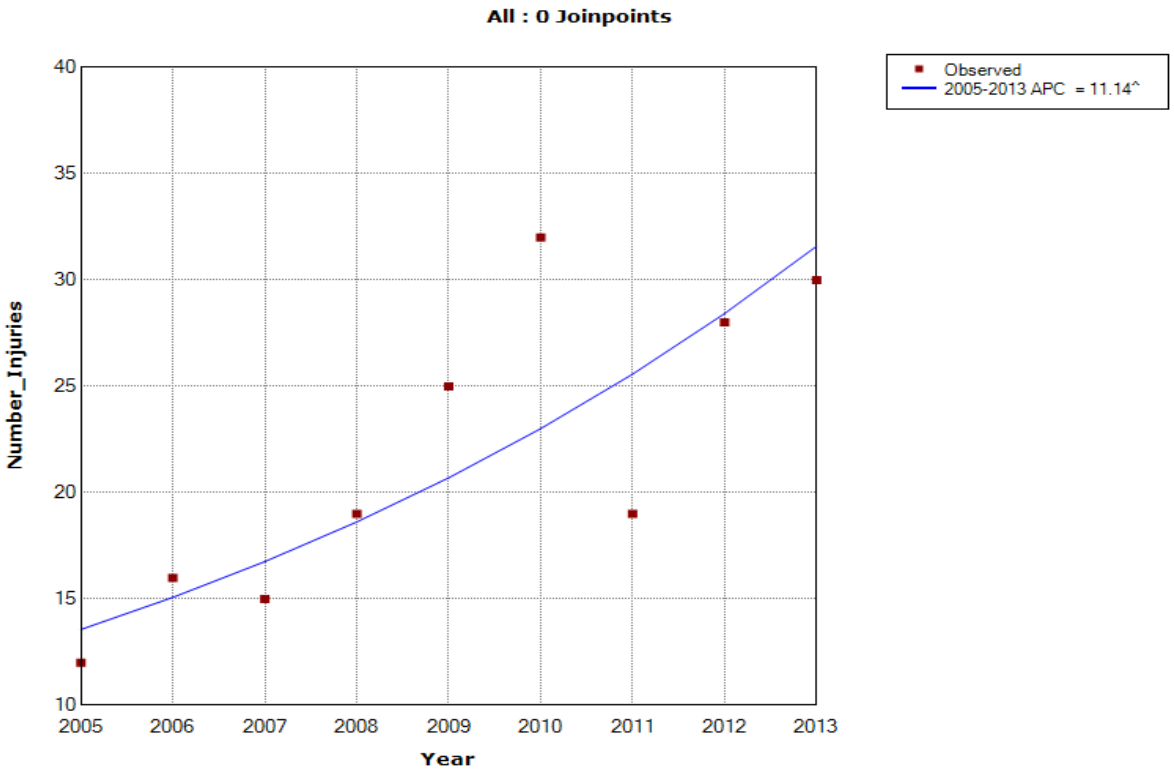
Trends in non-fatal transportation-related farm injuries

Celestin Missikpode[1], Tracy Young[2], Corinne Peek-Asa[3]

Abstract

Farming ranks among the most dangerous occupations worldwide and is associated with high risk of injury, disability, and death. Surveillance of farm-related injuries is important to track their progression and increase knowledge about the burden and associated risk factors. Transportation is one of the leading causes of farm-related injuries, yet little is known about the trends of agricultural farm injuries over time, particularly for non-fatal injuries. Using Iowa Trauma Registry data maintained by the Iowa Department of Public Health, we examined trends in non-fatal transportation-related farm injuries reported by hospitals accredited as Level I, II, and III Trauma Hospitals from 2005 to 2013. Joinpoint regression program software was used to perform the analysis. We found that non-fatal transportation-related farm injuries significantly increased over the entire study period at an overall annual rate of 11%. This study suggests that more research is needed to further clarify factors that have contributed to this increase in transportation-related farm injuries over time.

Keywords: Farm; injury; transportation; trends.



[1] Celestin Missikpode, PhD Candidate; Injury Prevention Research Center; College of Public Health, University of Iowa; email: celestin-missikpode@uiowa.edu

[2] Tracy Young, MS, Injury Epidemiologist; Injury Prevention Research Center; College of Public Health, University of Iowa; email: tracy-young@uiowa.edu

[3] Corinne Peek-Asa, PhD; Professor and Injury Prevention Research Center Director; College of Public Health, University of Iowa; email: corinne-peek-asa@uiowa.edu

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This topic is "practice ready." ☒ **Yes** ☐ **No**

Using a Vibrating Kelly Ball Test (VKelly Test) to Determine the Workability of Slipform Concrete Mixtures

Xuhao Wang[1], Peter Taylor[2], and Xin Wang[3]

Abstract

The science of rheology is not strictly applicable for low workability of slipform concrete mixtures. However, it is necessary to determine the workability of slipform concrete mixture using the concept of rheological behavior. Too dry a mixture may cause problematic paving and vibrating process while too wet a mixture may result in edge slump. A novel workability test method (Vibrating Kelly Ball Test or VKelly Test) presented in this paper would quantitatively assess the responsiveness of a dry concrete mixture to vibration, as desired of a slipform paving mixture. The development process is carried out by three phases as follows in order to achieve cost-effectiveness, portability, ability of rheological parameter measurements, paving process simulation, and repeatability.

1. Assess the sensitivity of the VKelly test to check whether it can signal variations of laboratory mixtures with a wide range of materials and proportions;
2. Evaluate the VKelly test through the field application at a number of construction sites
3. Validate the VKelly test using Box Test developed by Oklahoma State University for slipform paving mixtures.

[1] Post-Doctoral Research Associate, National Concrete Pavement Technology Center, Iowa State University, Ames, Iowa 50011, Tel: 515-294-7481, Email: wangxh@iastate.edu
[2] Associate Director, National Concrete Pavement Technology Center, Iowa State University, Ames, Iowa 50011, Tel: 515-294-9333, Email: ptaylor@iastate.edu
[3] Graduate Research Assistant, Department of Civil, Construction and Environmental Engineering, Iowa State University, 136 Town Engineering, Ames, Iowa 50011, Tel: 515-294-2152, Email: xin@iastate.edu

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It is shown that the VKelly test appears to be suitable for assessing a mixtures response to vibration (workability) with a low multiple operator variability. A unique defined parameter, VKelly index, is introduced, and a mixture in the range of 0.8 to 1.2 in./√s seems to be suitable for slipform paving.

Keywords: Vibrating Kelly Ball Test—workability test—slipform paving concrete—rheology—Box Test

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This topic is "practice ready." ☐ **Yes** ☒ **No**

"Women in Transportation Field Jobs – The Hidden Asset"

Ray A. Mundy, Ph.D[1].; Daniel L. Rust, Ph.D[2].; and Elizabeth Snowden[3], MBA

Abstract

The US rail, barge, and trucking industries have long labored under the image of a diversity-challenged sector with few women employed in field jobs. The vast majority of truck and forklift drivers, railroad track and train crews, and towboat deckhands and pilots are men. However, due to a prevalence of vacant operating positions in an increasingly demanding economic market, change is imminent as companies seek to hire more women—an under-utilized asset in the transportation industry. For example, according to Deborah Lockridge, Editor in Chief of TruckingInfo.com, "With an estimated 5-7% of the commercial truck driving population made up of women, there is a large labor pool that could be tapped. Carriers are increasingly highlighting the successes and experiences of their women drivers." A 2014 study from the Conference Board stated that industries with higher concentrations of older workers, specifically the rail and trucking industries, will "be at the highest risk for labor shortages" in the immediate future because so many employees are eligible for retirement. This is also true of the inland barge industry, yet few women work aboard towboats except as cooks. In light of current and looming labor shortages, the number of female field employees in the transportation industry will likely increase as both physical and physiological barriers are identified and addressed.

This project will include compiling current public and private demographic data regarding the number of women in operating positions from the US Census and transportation companies. Executives will be interviewed and surveyed as to their current attitudes regarding women in these traditionally male dominated positions and what needs to be done to expand opportunities to women. In turn, current

[1] Director of Center for Transportation Studies; University of Missouri-Saint Louis Center for Transportation Studies; One University Boulevard JCPN 240, Saint Louis, MO, 63121; phone (314) 516-7270; fax (314) 516-7272; email: mundyr@umsl.edu

[2] Assistant Director for Undergraduate Program Development; University of Missouri-Saint Louis Center for Transportation Studies; One University Boulevard JCPN 240, Saint Louis, MO, 63121; phone (314) 516-7270; fax (314) 516-7272; email: rustd@umsl.edu

[3] Graduate Research Assistant; University of Missouri-Saint Louis; One University Boulevard JCPN 240, Saint Louis, MO, 63121; phone (314) 516-7270; fax (314) 516-7272; email: esgg3@mail.umsl.edu

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women field employees will also be interviewed and surveyed as to their impressions about these positions—the long hours, time away from home, pay and benefits structure, etc.—to gauge their attitudes and what changing some of these attitudes may entail. Finally, in addition to analyzing trends and challenges of employing women in male-dominated roles, this project will consider the economic impact women will make by filling more field positions in transportation, how the job vacancies should be marketed to gain the interest of potential female employees, and forecast future trends and benefits of a more diverse workforce.

Keywords: transportation, women, diversity, field jobs, business change

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This topic is "practice ready." ☐ **Yes** ☒ **No**

Work Zone Safety Assessment Tool

Roozbeh. Rahmani[1], Henry. Brown[2], Praveen. Edara[3] and Carlos. Sun[4]

Abstract

The Highway Safety Manual (HSM) provides a quantitative way to evaluate traffic safety. The Safety Performance Function (SPF) and the Crash modification Factor (CMF) are the essential quantitative tools designed for different facilities safety assessment with different geometric design, climate and traffic control devices. HSM introduces two CMFs for work zone length and duration, but there is no work zone SPF included in HSM. This project focuses on calibrating a group of SPFs and CMFs for freeways and arterials work zones in Missouri. The work zone, crash and pavement database were used to create a work-zone-related-crash database. There were 110,280 work zones during years 2009 to 2014 in Missouri. Among these, 107,662 work zones had no crashes and the rest (i.e. 2618) had 6869 crashes. Different statistical distributions were tested on Missouri work zone crash data, and Negative Binomial represented the data the best. Table 1 shows the Akaike Information Criterion (AIC) of four different statistical distributions on Missouri work zone crash data (the less, the better).

Table 1. AIC of four different statistical distributions on the work zone crash data.

Distribution	AIC
Negative Binomial	32670
Zero Inflated Negative Binomial	32701
Zero Inflated Poisson	41745
Poisson	68818

[1] Graduate Research Assistant; University of Missouri – Columbia; E1509 Lafferre Hall, Columbia, MO, 65211; phone (573)-529-1692; email: rrdpd@mail.missouri.edu

[2] Research Engineer; University of Missouri – Columbia; E2509 Lafferre Hall, Columbia, MO, 65211; phone (573) 882-0832; email: brownhen@missouri.edu

[3] Associate Professor; University of Missouri – Columbia; C2640 Lafferre Hall, Columbia, MO, 65211; phone (573) 882-1900; email: edarap@missouri.edu

[4] Associate Professor; University of Missouri – Columbia; E2509 Lafferre Hall, Columbia, MO, 65211; phone (573) 884-6330; fax (573) 882-4784 email: csun@missouri.edu

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Crashes from the same location and similar periods without work zones were used as control group to implement a Before-After study. Data processing is ongoing. After random sampling to include various work zone durations and lengths, several negative binomial SPFs will be developed to account for crash frequencies in work zones based on different severities. These models will then be tested and compared to Khattak's model from the HSM. The final goal of this study is to provide a work zone safety assessment tool in the form of a user-friendly spreadsheet.

Keywords: Work Zone — Safety Performance Function — Crash Modification Factor

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