4th ICTG Workshop on Sustainability & Climatic Effects in Mechanistic based Designs of Road Infrastructure Systems

May 24, 2021, 9:00 am to 4:30 pm CDT

Moderators: Halil Ceylan, Chair, ASCE Geo-Institute Pavements Committee
Hasan Ozer, Chair, ASCE T&DI Highway Pavements Committee

Workshop Program

9:00-9:15	Introductions and Workshop Overview	Halil Ceylan Hasan Ozer
9:15-10:15	Multiscale Multiphysics Processes in Frozen Soils: Incorporating Frost Actions into Pavement Design	Claudia Zapata Xiong (Bill) Yu
10:15-11:15	Climatic Effects on Performance of Recycled Bases in MnROAD	Raul Velasquez
11:15-12:15	Climate Change and Its Impact on Transportation Pavements/Tracks and Their Foundations	Andrew Dawson
12:15-12:30	Break	
12:30-1:30	FWD-Based Decision Matrix for Flood Inundated Roadways: Florida Case Study	Guangming Wang
1:30-2:30	Challenges Faced with Unpaved and Local Road Infrastructure Systems in Iowa	Brian Moore
2:30-3:30	Long-Term Seasonal Assessment of Pavement Base Aggregates Using Recycled and Natural Materials	Bora Cetin
3:30-4:30	Panel Discussion	

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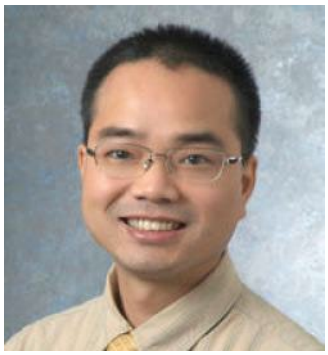
Dr. Claudia E. Zapata is an Associate Professor in the School of Sustainable Engineering and Built Environment and current Deputy Director of the Engineering Research Center for Bio-mediated & Bio-inspired Geotechnics. Dr. Zapata's research interests include unsaturated soil behavior, laboratory and field characterization of problematic soils, applications related to thermo-hydro-mechanical behavior of soils due to static and repeated loading, empirical modeling of fluid flow and volume change of soils applied to pavement structures and residential foundation systems, environmental effects on soil behavior; and soil improvement. Dr. Zapata has authored more than 60 technical publications; is the Chair of the Transportation Research Board committee on the Behavior of Unsaturated Geomaterials and active member of several committees for TRB and the ASCE. Consulting expertise include the evaluation of airfield design procedures, forensic investigations of pavement failures, and the assessment of environmental effects on pavement design; for several companies and agencies, including the Louisiana State DOT, US Army Corps of Engineers, AMEC, Parsons and ZW Consultants.



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Dr. Xiong (Bill) Yu is the Opal J. and Richard A. Vanderhoof professor and Interim Chair of Civil and Environmental Engineering, Case Western Reserve University. His research emphasizes the use of interdisciplinary approaches to address the engineering problems in geosystem, civil infrastructure, energy and environment. Dr. Yu is the PI of over 40 research projects funded by federal, state agencies and private industry, including 14 competitively selected projects from NSF. He is a recipient of a NSF CAREER award in 2009. He has published over 300 papers in journals and referred conference proceedings, including over 120 journal papers. A number of these papers received awards and recognitions. He is committed to graduate student mentorship with large number of students successfully launched academic positions, including 2 received NSF CAREER awards.

Multiscale Multiphysics Processes in Frozen Soils: Incorporating Frost Actions into Pavement Design

Frost heave and thaw weakening leads to change of pavement IRI and compromise pavement performance. This presentation will firstly introduce the theoretical framework that aims to understand the multi-physics processes in frozen soils and its influence on the pavement. Thecoupling phenomena is described with continuous finite element model as well as a random finite element model that allows holistic simulation of frozen soil behaviors, including the effects of phase transition and the consequent internal stress and volume changes. The performance of the model is firstly validated with laboratory experiments. The model is implemented to simulate the effects of frost action on pavement. The coupled thermal-mechanical actions including the mechanical responses of subgrade soils subjected to freezing temperature and its effects on the pavement structure are analyzed. The results show that the frost action and expansion of ice lenses change the interaction modes between pavement layers, and that the detrimental effects of frost heave on the pavement structure can be mitigated by increasing the thickness of base layer, use of thermal insulation layer or improve drainage in the subgrade layer.

For implementation in the pavement design and performance prediction, a simplified model is formulated to estimate the frost depth and frost heave. The results are evaluated and calibrated with data from instrumented sites. The calibrated model identifies the critical factors on frost heave and thaw weakening as well as the change in pavement IRI due to seasonal freezing-thawing processes. It will allow to predict the effects of climate on the long-term pavement performance.

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Dr. Raul A. Velasquez works as a Geomechanics Research Engineer in the Office of Materials and Road Research (OMRR) at the Minnesota Department of Transportation (MnDOT). He is mainly involved in conducting subsurface research with a focus on pavement foundation and related new technologies. Additionally, he provides technical assistance to the MnDOT Office of Materials Specialty Sections (e.g., Geotechnical Section), District Materials and Construction Engineers, and Local Agencies through the Local Road Research Board (LRRB) in the areas of pavement foundation analysis and design, in-situ and laboratory testing, and performance evaluation.

He worked as a Post-Doctoral Researcher at the University of Wisconsin-Madison dealing with research and educational efforts related to the thermal and mechanical behavior of asphalt materials and later as a Senior Geotechnical Engineer at Barr Engineering where he provided general geotechnical consultant services (e.g., slope stability, foundation design, etc.) and advanced computational modeling services to government agencies and clients in the mining and energy industry.

His past experience involves the experimental characterization and numerical modeling of geo-materials subjected to static, cyclic, and thermal loads. Experimental experience includes elementary and indirect testing under monotonic and cyclic loading as well as non-destructive methods. Numerical modeling includes the use of the finite element and finite difference methods.

Climatic Effects on Performance of Recycled Bases in MnROAD

This presentation summarizes on-going geotechnical research at MnROAD related to environmental impacts on the performance of recycled aggregate bases (including RCA and RAP). Emphasis is placed on the effect of drastic temperature changes on the response of recycled pavement foundation. Furthermore, the importance of the relative shallow groundwater condition present at research facility is discussed.

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After 2.5 years with a UK site investigation contractor and around 5 years with two consulting engineers working as a geotechnical engineer, Andrew Dawson moved to the University of Nottingham, UK, where he was a teacher & researcher for almost 37 years. Recently he retired and continue with "Associate" status. He continue as chair of the US Transportation Research Board's Aggregates Committee (AKM80).

Climate Change and Its Impact on Transportation Pavements/Tracks and Their Foundations

How has our climate changed since the engineering community wrote its specifications and design guides – and what future changes can we expect? Recognition that engineers can't rely on historic weather patterns is widespread, so this workshop contribution will attempt an overview of what important changes have occurred … and what changes can reasonably be anticipated by those charged with providing safe, reliable and resilient road and rail infrastructure for the future. As climate changes, what are the climate stressors with most impacts on road pavements and rail tracks? For example, temperature (average and extreme) can have significant impacts on constructed elements while freeze-thaw has greater impact on the supporting geotechnical layers. Storms bring rain, snow, and winds with the first of these having potential to seriously impact supporting soil response to loading. Somewhat indirectly, but critically, both temperature change and rainfall can lead to flooding with major consequences for the resilience of transport corridors. In this way, together with a little educated "crystal ball gazing", the presentation will aim to deduce the engineering issues that are most likely to affect those geotechnical assets on which road and rail pavement infrastructure relies and to outline possible strategies for dealing with the challenges faced.

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Dr. Guangming Wang is a Florida registered professional engineer with more than 10 years of experience in pavement engineering. He graduated from the University of Florida with Ph.D. degree in Civil Engineering and a Master of Science in Management. After graduation, he joined a private consulting company and had been working as a pavement/geotechnical engineer and project manager for more than 5 years before he joined FDOT. His areas of expertise include pavement non-destructive testing and evaluation, pavement design and analysis, pavement management, pavement marking management (PMM) and pavement modeling. Dr. Wang currently works as State Pavement Performance Engineer and manages several statewide programs, including FWD, GPR, PMM, high friction surface treatment (HFST) and green colored pavement markings (GCPM).

FWD-Based Decision Matrix for Flood Inundated Roadways: Florida Case Study

Flooding can not only cause significant damage to roadway assets but also pose a safety threat to the road users. Thereby, flooded pavements are closed to traffic to restrict further deterioration of pavements and to ensure safety of the traveling public. However, when the flood waters recede, the pavements are structurally vulnerable and may lead to structural and functional failures if traffic is allowed immediately onto the roadway. Therefore, a well-informed and sound methodology is required to determine the structural adequacy of the pavement to carry vehicular traffic post flooding. For this purpose, Florida Department of Transportation (FDOT) initiated a study that resulted in a practical and easily understood decision matrix based on Falling Weight Deflectometer (FWD) data for opening roadways to traffic after flood events. The decision matrix considers pavement performance parameters such as subgrade modulus, truck traffic, and the present flood condition to determine whether the roadway is safe to be re-opened to traffic. In this presentation, a brief overview of the decision matrix methodology along with a case study where the tool was successfully employed is presented.

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Brian is currently the Iowa Secondary Road Research Engineer with the Iowa County Engineers Association Service Bureau. Prior to 2018, Brian spent his career in local Iowa county government serving 3 years as the County Engineer in Ringgold and Decatur Counties, and 17 years in Wapello County. He is a 1996 graduate of Iowa State University with a Bachelor of Science in Civil Engineering.

Challenges Faced with Unpaved and Local Road Infrastructure Systems in Iowa

Iowa is the United States leader in corn, soybean, and pork production. The network of over 72,000 miles of granular unpaved roads is the backbone of Iowa's agricultural and manufacturing economy that help feed the world. Local road owners spend millions of dollars annually on the maintenance of this system. The presentation will highlight the challenges faced by local road owners and research solutions put into practice to help maintain the network.

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Dr. Bora Cetin is an Associate Professor at Michigan State University in the Department of Civil and Environmental Engineering. He has over 15 years of experience in academia in the field of geotechnical and geoenvironmental engineering. He received his Ph.D. from University of Maryland-College Park (2012). He is the head of the Sustainable Geotechnical Infrastructure Group (SGIG). His research program encompasses multiple research fields including transportation infrastructure, nuclear waste disposal, municipal solid waste landfill design, remediation of mine waste/contaminated soils, and sustainable geotechnical practices.

Long-Term Seasonal Assessment of Pavement Base Aggregates Using Recycled and Natural Materials

In this presentation long term performance of seven pavement test sections built with various base materials, including recycled Portland cement concrete (RPCC), reclaimed asphalt pavement (RAP), commonly used natural aggregates that are classified as MnDOT (Minnesota Department of Transportation) Class 3 through Class 6, and blended aggregates with recycled and natural materials along with aggregate base section stabilized with 14% fly ash. Each test site was monitored for 7-10 years via conducting falling weight deflectometer (FWD), international roughness index (IRI), rutting tests. Results of FWD, IRI, and rutting tests will be presented and discussed.