ISIC

IN PARTNERSHIP WITH NRRA National Road Research Alliance

TPF TRANSPORTATION POOLED FUND

Summary Report

ISIC 2024

4TH INTERNATIONAL CONFERENCE

Theme: Sustainability Through Technology

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Contents

INTRODUCTION

2024 ISIC INTERNATIONAL CONFERENCE

The International Society for Intelligent Construction 2024 Conference (ISIC 2024) was held in Orlando, Florida, USA, from 10th to 12th September 2024. The theme of the ISIC 2024 conference was "Sustainability through Technologies." The conference topics cover the scope of intelligent construction technologies for infrastructure to improve sustainability and safety:

Intelligent construction technologies (ICT) are combinations of modern science and innovative construction technologies. The International Society for Intelligent Construction (ISIC) provides a forum for disseminating knowledge concerning the collection, analysis, and application of ICT for infrastructure. ISIC's mission is to promote ICT applications to the life cycle of infrastructure (survey, design, construction, operation, and maintenance/rehabilitation) while adapting to environmental conditions and minimizing risk. ISIC aims to improve construction quality, reduce costs, and promote safety.

The mission of ISIC is to promote the use of intelligent construction technologies (ICTs) globally to enhance the quality, efficiency, and safety of infrastructure. ISIC aims to:

1. Advance Research and Development: Foster innovation in ICTs through collaborative research and development efforts.
2. Facilitate Knowledge Sharing: Organize conferences, workshops, webinars, and other events to disseminate the latest advancements and best practices in ICTs.
3. Promote Global Adoption: Encourage the adoption and implementation of ICTs across different regions and sectors to improve infrastructure sustainability.
4. Support Professional Development: Provide resources and opportunities for professionals in the field to enhance their skills and knowledge.
5. Enhance Infrastructure Life Cycle: Focus on improving all phases of the infrastructure life cycle, from construction to maintenance and operation.

By achieving these goals, ISIC strives to make a significant impact on the construction industry, ensuring that infrastructure projects are more sustainable, efficient, and safe.

This document is a summary report for ISIC 2024. The event is a partnership among ISIC, National Road Research Alliance (NRRA), Dielectric Profiling System (DPS), and GPR-Stripping US Transportation Pooled Fund (TPF) studies.

All presentations can be downloaded from the links in the Appendix.

NON-COLLUSION STATEMENT

The purpose of this ISIC conference is to promote the collaboration between federal and state agencies, vendors, manufacturers, consultants, and contractors to advance technology and working knowledge of Intelligent Construction Technologies. In adherence to the Sherman Antitrust Act and applicable Federal and State laws, all persons present acknowledge and agree that they will not be a party to any collusion in restraint of freedom of competition. Topics including, but not limited to, bid submissions, geographical area of business, customer list, or pricing will not be discussed in any capacity at this meeting or in any subsequent meetings.

All presenters have signed the ISIC 2024 speakers' agreement to focus on technology instead of sales pitches. ISIC added special notices (*in italics*) to those presentations that were submitted late for the ISIC 2024 committee's reviews and consisted of the presenters' products/services as disclaimers.

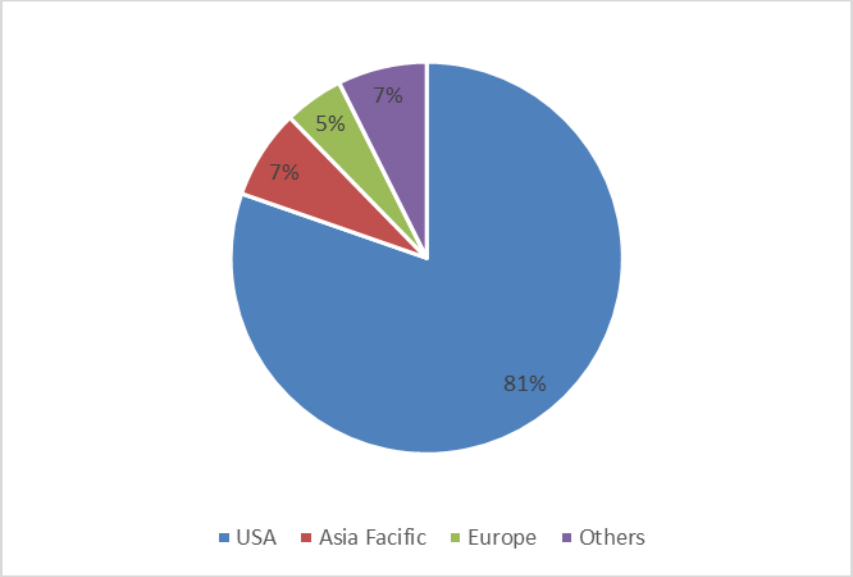
A G E N D A

The following is the agenda.

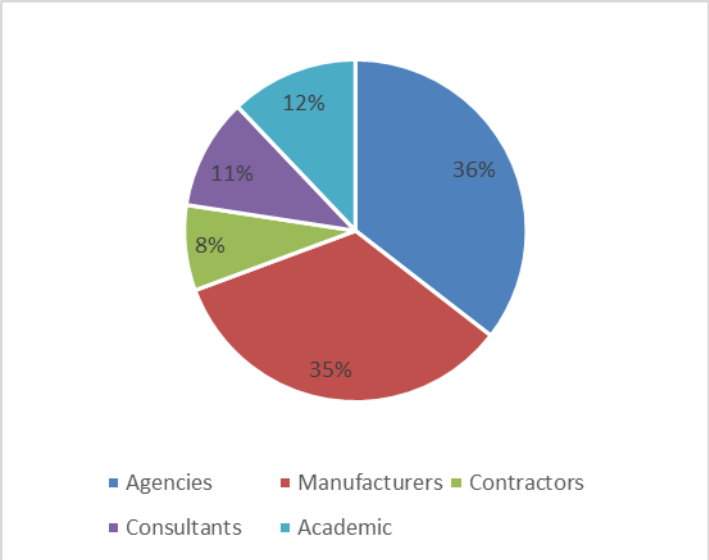
Tuesday, September 10	
08:00 AM – 12:00 PM	NDT & ICT for Asphalt Pavement Construction Workshop
01:00 PM – 05:00 PM	Joint DPS and Stripping TPF TWG Workshop
06:00 PM – 08:00 PM	Ice-Breaker Reception
Wednesday, September 11	
07:00 AM – 08:00 AM	Breakfast with Exhibits
08:00 AM – 09:00 AM	Session 1: Welcome, Keynote, and Vendors Introduction
09:00 AM – 09:30 AM	Break and Visit Exhibits
09:30 AM – 12:00 PM	Session 2: Technologies and Sustainability - I
12:00 PM – 01:00 PM	Lunch Break and Visit Exhibit
01:00 PM – 03:30 PM	Session 3: Quality Monitoring and Sustainability - I
03:30 PM – 03:45 PM	Break and Visit Exhibits
03:45 PM – 05:25 PM	Session 4: Digital Twins and BIM - I
06:00 PM – 10:00 PM	Evening Activities (Gatorland) - Offsite
Thursday, September 12	
07:00 AM – 08:00 AM	Breakfast with Exhibits
08:00 AM – 10:05 AM	Session 5: Quality Monitoring and Sustainability - II
10:05 AM – 10:35 AM	Break and Visit Exhibits
10:30 AM – 11:50 PM	Session 6: Digital Twins and BIM - II
11:50 PM – 01:00 PM	Lunch Break and Visit Exhibits
01:00 PM – 02:30 PM	Session 7: Quality Monitoring and Artificial Intelligence
02:30 PM – 02:50 PM	Break and Visit Exhibits
02:50 PM – 04:30 PM	Session 8: Sustainability through Technologies Open Panel
04:30 PM – 04:55 PM	ISIC Open Business Meeting
04:55 PM – 05:00 PM	ISIC 2024 Adjourned

A T T E N D A N C E

The ISIC 20024 attendance was impacted by other pavement-related conferences that week, but our attendance was a very focused group. The following are the attendance statistics. The US attendees comprised the majority.



The major sectors are agencies and industry.



ICT WORKSHOP

NDT & ICT for Asphalt Pavement Construction Workshop

INTRODUCTION

This was a 4-hour workshop to introduce Non-Destructive Testing (NDT) and Intelligent Construction Technologies (ICT) during asphalt construction. The purposes are to:

- Provide a broad overview of what Non-destructive Intelligent Construction is and the Non-Destructive technologies available for asphalt pavement.
- Summarize PMTP/IC/DPS/Veta technologies, their capabilities, shortfalls, and appropriate usage at the present time to support quality assurance while also meeting the Title 23 Code of Federal Regulations Part 637 Subpart B (CFR) compliance requirements.
- Encourage the attendees to implement NDT and ICT during asphalt construction to improve the quality of construction, safety, and asset management/performance, as well as to reduce costs.

It is open to all ISIC 2024 registrants and anyone who may be interested in ICT.

MODERATOR AND SPEAKERS

The moderator for this session was Moderator: Steve Cooper, FHWA, USA. The speakers included George Chang, Amanda Gilliland, and Subu Sankaranarayanan, Transtec Group, USA.


EXIT
Galaxy S23 Ultra


EXIT
DPS-Related AASHTO Standards
PP 98
MP 39
PP 114
T 414

PRESENTATIONS

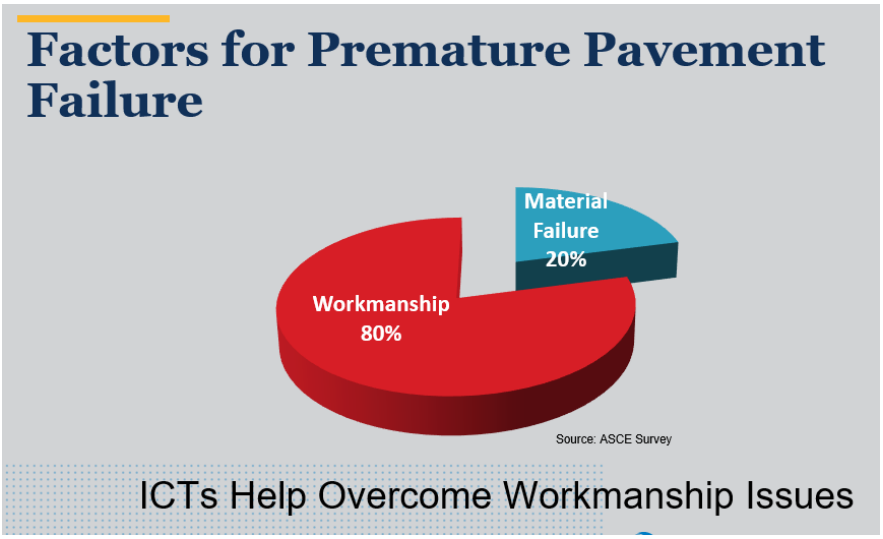
Time	Topics/Durations
08:00 AM to 08:05 AM	Welcome
08:05 AM to 08:30 AM	Introduction and Overview (25 min.)
08:30 AM to 09:05 AM	Paver Mounted Thermal Profile (PMTP) (35 min.)
09:05 AM to 09:40 AM	Intelligent Compaction (IC) (35 min.)
09:40 AM to 09:55 AM	Break (15 min.)
09:55 AM to 10:40 AM	Dielectric Profiling System (DPS) (45 min.)
10:40 AM to 11:25 AM	Veta and Case Studies (45 min.)
11:25 AM to 12:00 PM	Implementation (35 min.)

All presentations are included in the handout, which can be downloaded from the following link (https://www.is-ic.org/wp-content/uploads/2024/09/ICT-workshop-handout.pdf).

There were great discussions during the workshop, esp. on the implementation topic. Key tips to help agency to implement ICTs were provided by the ICT-leading MnDOT as follows:

- Start slow.
- Collect for information purposes only during the first pilots.
- Work with contractors on pilot projects and specification development to increase "buy-in."
- Debriefing meetings.
- Don't forget to keep the local technology suppliers in the loop. They need to have the needed resources (training and supplies) to support the contractors.
- A reminder that no one should have to bid on something that they don't understand.
- When increased requirements are added to the specifications over time, ensure that the technology can handle those requirements and that Veta can also analyze those parameters.
- Could add as Change Orders / Supplemental Agreements for first projects. See which contractors would be interested in piloting technology.
- When do you know that you will indeed move forward with the technology? Be transparent with the contractors and suppliers so that they can gear up accordingly. What will your deployment roadmap look like?
- Will you have to pay for the items used in the technology?
- Will your agency have champions to support it?
- Who will create the submittals (Veta projects and associated summary reports)? Contractor or Agency? How will they get the software training? Who will answer Veta's questions? Will you hire a consultant to provide the training and support or do it internally?

One of the important feedback and expectations from ICTs was to overcome the workmanship issues that account for 80% of premature failure (ASCE survey).



TPF MEETINGS

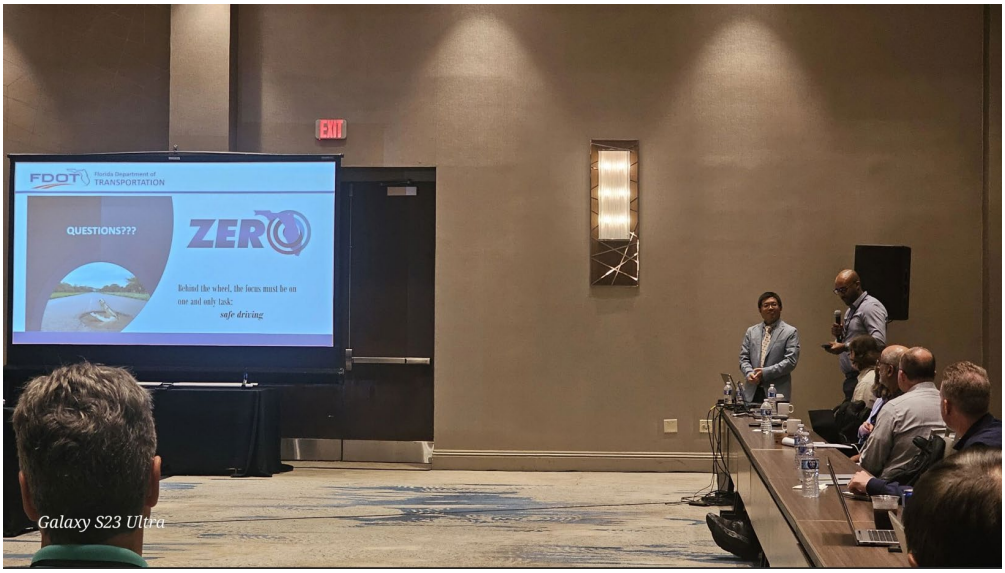
Joint DPS and Stripping TPF TWG meetings

INTRODUCTION

This was a 4-hour workshop that included a GPR-Stripping (TPF-5(504) - Continuous Bituminous Pavements Stripping Assessment Through NDE Technologies) and Dielectric Profiling System (DPS) and a Transportation Pooled Fund (TPF) Task Working Group (TWG) meetings.

MODERATOR AND SPEAKERS

The moderators for this workshop were Kyle Hoegh and Eyoab Zegeye, MnDOT, USA.



PRESENTATIONS

TPF-5 (504) Stripping meeting agenda.

1. Welcomes & Opening statements	**Shongtao Dai (MnDOT)**
2. Meeting agenda	Eyoab Zegeye (MnDOT)
3. Use of 3DGPR for State projects **a. FLDOT Experiences** **b. MnDOT Experiences**	• Guangming Wang (FLDOT) • Thomas Calhoon (MnDOT)
4. Questions & break	
5. Introducing the MnROAD stripping test sections **a. Construction of the sections** **b. Inventory of test sections and preliminary GPR scans**	• Ben Worel (MnDOT) • Chris Herr (MnDOT)

6. Development of an automated software for detection of AC stripping **a. Contract update** **b. Immediate plans (MnROAD test sections)**	• Ken Maser (Infrasense)
7. Inputs for 2nd in person meeting and ope	• All

TPF-5 (443) Density Profiling System (DPS) meeting agenda.

Time (ET)	Content	Speakers
3:00 PM to 3:10 PM	**Welcome, Meeting Format, Introductions**	Katie Johnson, CTC Kyle Hoegh, Minnesota DOT
3:10 PM to 4:05 PM	**Vendor Updates** **Kontur – 10 minutes** **GSSI – 20 minutes** **ESS - 20 minutes** **Discussion – 5 minutes**	Kontur, GSSI, Earth Science Systems
4:05 PM to 4:10 PM	**Break**	
4:10 PM to 4:25 PM	**Industry Update** **Evaluation of a CAT screed with DPS**	Bryce Wuori, Wuori Consulting
4:25 PM to 4:55 PM	**Research Updates** **FHWA Turner Fairbanks -15 minutes** **University of New Hampshire – 15 minutes**	Heng Liu, FHWA Anh Tran, UNH
4:55 to 5 PM	**Adjourn and Announcements**	Kyle Hoegh, MnDOT

There were a lot of great discussions on DPS and GPR/Stripping during the TPF's TWG's meetings. More information can be found on the TPF's websites:

- TPF-5(504) - Continuous Bituminous Pavements Stripping Assessment Through NDE Technologies
- TPF-5(443) - Continuous Asphalt Mixture Compaction Assessment Using Density Profiling System (DPS)

SESSION 1- WELCOME, KEYNOTE, & VENDORS INTRO

INTRODUCTION

This was an opening session for Welcome, Keynote, and Vendors Introduction.

MODERATOR AND SPEAKERS

The moderator for this workshop was Tim Kowalski, Wirtgen America, USA (ISIC Vice President, ISIC NA Chapter – Chair).

PRESENTATIONS

Welcome from the ISIC NA Chapter
Tim Kowalski (Wirtgen America, USA)

Welcome from ISIC International
George Chang (Transtec Group, USA) and Soheil Nazarian (University of Texas at El Paso, USA) delivered welcoming remarks on behalf of the ISIC Executive Committee.

Keynote Speech
Tom Yu (FHWA) delivered a fantastic key speech on Sustainability through Technologies.

Dr. Yu's keynotes highlighted the key issues for pavement performance and maintenance that can be resolved by using innovative technologies (e.g., MIT scans, drones, Intelligent compaction, etc.). Dr. Yu also encouraged the audience to refocus on pavement foundation – the key origin causes for pavement repairs (repeated mill-and-fill), and also why the Roman roads last for 2,000 years! Dr. Yu also announced an upcoming US TPF study that will target pavement foundations using intelligent compaction. It was a very inspiring presentation that many attendees referred to as "empty cups" (open mind), which Dr. Yu mentioned in his keynote as a crucial element for success.

Sponsors and Exhibitors' Oral Introduction

All sponsors and exhibitors' representatives made brief oral self-introductions. This conference would not be possible without the vendors' sponsorship and exhibits.

- CATERPILLAR
- Wirtgen Group
- XCMG
- Dobbs Positioning Solutions
- HaulHub
- Topcon
- Trimble
- Earth Science Systems (ESS)
- FleetWatcher
- MOBA
- TruckIT
- Volvo
- SSI
- GSSI
- Kontur
- TRuckIT
- Transtec Group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TRUCKIT
KONTUR
DUST PODS
ESS
Earth Science Systems
ESSENTIAL UNDERGROUND INFORMATION
THE TRANSTEC GROUP
The World's Pavement Engineering Specialists

SESSION 2 - TECHNOLOGIES AND SUSTAINABILITY

INTRODUCTION

This was an opening session focused on Technologies and Sustainability.

MODERATOR AND SPEAKERS

The moderator for this workshop was Jim Preston, Topcon, USA (ISIC NA Chapter -Treasurer). The speakers included Jim Preston (Topcon, USA); Laikram Narsingh (Wirtgen America, USA), Todd Mansell (Caterpillar, USA); Tim Kowalski (Wirtgen America, USA); Eyoab Zegeye (MnDOT, USA), Thomas Calhoon, Steve Henrichs, Dai Shongtao, Jeff Brunner (MnDOT), Jacopo Sala (Kontur); and George K Chang (Transtec, USA)

PRESENTATIONS

Session 2.1: Positioning Technologies by Jim Preston (TOPCON, USA)

This presentation focused on positioning technologies and how they help implement other intelligent construction technologies and achieve sustainability goals. Mr. Preston started with the GNSS definitions to clarify many myths in the industry and followed with some common obstacles/solutions to achieve high-precision RTK GNNS. His presentation laid down the foundation for all ICTs that collect geospatial data.

Session 2.2: Paving Technologies by Laikram Narsingh (Wirtgen America, USA), Todd Mansell (Caterpillar, USA)

This presentation focused on modern paving technologies that can improve pavement quality, along with modern 3D milling, better tracking digital as-built data (such as quantity), and achieve sustainability goals. Mr. Narsingh (Nars) explained the mechanism of paving and the causes of temperature/segregation during paving, which led to technology solutions such as PMTP, MDMS, Veta, etc., to overcome these issues.

Session 2.3: Compaction Technologies by Tim Kowalski (Wirtgen America, USA)

This presentation focused on modern compaction technologies that can improve pavement quality along with modern e-ticketing and paving technologies, better tracking digital as-built data (such as roller passes and compaction temperatures), and achieving sustainability goals. Mr. Kowalski presented a brief history of roller technology evolution and the IC solutions from various vendors, as well as the future development of autonomous rollers. Mr. Kowalski's IC presentation is summarized in the following bullet points.

- Every Manufacturer is always in development of something new
- IC is changing and getting simpler
- Most Manufacturers have an electric roller
- Sustainability is important to all of us
- Don't be afraid to try something new
- You hear the saying "Last line of Defense,".. but Rolling is the "Last Line of Success."

Session 2.4: Incorporating 3D Ground Penetrating Radar in Pavement Project Scoping Efforts: Minnesota Department of Transportation Experience by Eyoab Zegeye (MnDOT, USA), Thomas Calhoon, Steve Henrichs, Dai Shongtao, Jeff Brunner (MnDOT), Jacopo Sala (Kontur)

Project scoping is crucial in selecting an appropriate rehabilitation strategy for pavement needing repair. Traditionally, pavement engineers have relied on coring, boring, Falling Weight Deflectometer (FWD), and occasionally traditional one-channel Ground Penetrating Radar (GPR) to establish the quality, thicknesses, and structural adequacy of the pavement layers. However, these traditional tools present several significant shortcomings that are further exacerbated when dealing with old and deteriorated pavement structures.

In recent years, the Minnesota Department of Transportation (MnDOT) has deployed an innovative 3D-GPR technology to overcome some of these challenges. This Step-Frequency Continuous Waveform (SFCW) GPR unit is equipped with an air-launched antenna array composed of 21 channels, which can generate

continuous full-lane width GPR data collected in a single pass at safe traveling speeds. 3D-GPR has shown promising applications for assessing longitudinal and transversal thickness variabilities and the structural integrity of pavements. The efficient use of 3D-GPR can optimize and, in some cases, reduce the use of traditional spot tests, reducing concerns for cost and safety. Furthermore, 3D-GPR data can provide good insight into the structural quality of the structure and help identify weak spots. This presentation aims to describe some of the lessons learned, tools that were developed, and proposed applications of 3D-GPR in the project scoping phase.

Session 2.5: Automation in Highway Construction by George Chang (Transtec Group, USA)

The presentation stressed the differences between automation and autonomy for highway construction and demonstrated examples of each technology, agency/industry adoption, and future trends. Dr. Chang presented the key motivations for such demand/development, including the following: Workforce

Reduction (Lack of qualified (trained) workers); Safety (Minimize/eliminate human/machine interaction and exposure on job sites.; Operation Efficiency (Efficiently manage engine operation, rpm, on/off, etc., Less fuel burn and lower emissions.); and Quality (Improve precision and consistency, Remote troubleshooting). Dr. Chang also highlighted the key issues/solutions for agency/industry adoption as: Fixed vs. Changing Environments; ROI and Market Acceptance; Safety and Liability. The trend to the future is summarized as follows: Equipment Innovation, Aftermarket Solutions, Industry Adoption and Legal Resolution, Augmented Reality, and Virtual Construction-Play Back, Data Standard, Integration and Management, Digital Twin, Paradigm Shift of Roles/Skills, AI and Machine Learning.

SESSION 3 - QUALITY MONITORING AND SUSTAINABILITY - I

INTRODUCTION

This was an opening session focused on - Quality Monitoring and Sustainability – I. Todd Mansell, Caterpillar, USA (ISIC NA Chapter – Vice Chair)

MODERATOR AND SPEAKERS

The moderator for this workshop was Jim Preston, Topcon, USA (ISIC NA Chapter -Treasurer). The speakers included Jian-shiuh Chen, University, Taiwan), Chin Hung Yang; Yunpeng Zhao (FHWA, USA), Jennifer Aponte Rivera, Atish Nadkarni, Maryam Sadat Sakhaeifar, Migdalia Carrio; Mary Nodine (FHWA, USA); Bryce Wuori (Pavewise, USA); Alexander Bernier (UConn, USA); Jayantha Kodikara (Monash University, Australia) Javad Ghorbani.

PRESENTATIONS

Session 3.1: Sustainable Road Construction: Harnessing Reclaimed Asphalt Pavement as Base Course by Jian-Shiuh Chen (National Cheng Kung University, Taiwan), Chin Hung Yang

The construction and maintenance of roads have a significant impact on the environment, contributing to carbon emissions. This presentation explores the potential of using reclaimed asphalt pavement (RAP) as a sustainable solution for reducing the environmental product declaration (EPD).

Session 3.2: Exploring the Environmental Footprint of Next-Generation Asphalt Pavement with Intelligent Compaction via Life Cycle Assessment by Yunpeng Zhao (FHWA, USA), Jennifer Aponte Rivera, Atish Nadkarni, Maryam Sadat Sakhaeifar, Migdalia Carrion

An energy-intensive process along the life cycle of pavements occurs at the construction stage. The use of innovative solutions, such as Intelligent Compaction (IC), can potentially improve the sustainability of construction operations by reducing compaction energy and the number of roller passes without detrimental effects. The improved compaction uniformity obtained by IC also helps to ensure pavements with higher quality that provide the desired performance and intended service life, which results in lower user and maintenance emissions. This study aims to quantify the environmental impacts of next-generation asphalt pavement that is currently under construction at the FHWA Pavement Testing Facility (PTF) through

Life Cycle Assessment (LCA). The scope of the LCA focuses on cradle-to-site, which includes the impacts of cradle-to-gate (i.e., material production), the transportation of the mixtures to the paving site, and the construction operations of paving in which IC is utilized. The background Life Cycle Inventories (LCI) and data for life cycle stages involving mixture production and construction are collected following a comprehensive data collection protocol. The environmental impacts of eleven pavement structures with various asphalt mixture types (e.g., premium materials, SMA mixtures, high RAP, and inverted pavement) are quantified and examined. This study also demonstrates how to use LCA to assess the environmental impacts associated with alternative construction technologies such as IC and establish more accurate performance indicators. The long-term performance of these pavements will be monitored for more informed performance and a more comprehensive LCA (i.e., cradle to grave, which includes user phase, maintenance, and end of life).

Session 3.3: Use of Installation Data for Streamlined Rigid Inclusion Performance Verification by Mary Nodine (FHWA, USA)

Rigid inclusions are a ground improvement technique that provides soil reinforcement and settlement mitigation using drilled displacement elements. Projects typically have hundreds to thousands of individual elements, with each rig installing 30 to 60 elements per day, resulting in a need for rapid evaluation and approval of element quality. Rigid inclusion installation typically uses a monitoring while drilling (MWD) electronic logging system that captures data such as torque, downward thrust, rotary speed, and grout taken with depth and time. Automatically generated graphic logs are typically reviewed visually by members of a project team for quality control during and after installation. This workflow underutilizes the valuable data provided by these MWD systems.
This presentation discusses the development of an automated process to use MWD installation data for streamlined quality control of rigid inclusions in near-real time. A compound parameter designated the Resistance Index is calculated and plotted for each element. The resistance index can be correlated with cone penetration test (CPT) data to estimate changes in soil properties across the site, and it can be correlated with load test data as a tool for the prediction of geotechnical resistance of production rigid inclusions. This presentation includes examples from case histories where the use of batch-processed MWD data allowed for the identification of localized changes in geotechnical conditions and subsequent verification or optimization of element lengths during construction.

Session 3.4: Building Higher Quality Roads with Innovative and High-Speed Data Collection using DPS/GPR Technologies by Bryce Wuori (Pavewise, USA)

The presentation demonstrated innovative ways in which DPS data can be collected from traditional pushcart manual methods. (Highspeed vehicle mounts, equipment mounting applications) We will demonstrate the new technologies and prototypes with data collected in the field over the past two seasons and compare this data to traditional manual methods of collecting DPS Data in the field. Logistics of the DPS data collection process in the field has been one of the weak points of DPS technology with users. This innovative pivot of data collection will introduce new applications to users regarding the ways in which DPS technology can be utilized in building high-quality asphalt roads.

Session 3.5: A Case Study in Implementation of Intelligent Construction for Ultra-Thin Bonded Overlays in Connecticut and Development of Rapid Spatial Filtering in Veta by Alexander Bernier (UConn, USA)

Since its initial pilot project in 2014, Connecticut has been developing capabilities and expertise to incorporate intelligent construction practices into construction specifications to improve acceptance methodology. This preparatory work included additional pilot projects and the development of rapid analytical techniques using Veta® software.

The University of Connecticut's Advanced Pavement Laboratory and the CT DOT's Pavement Design Unity developed a specification in 2021 whereby the construction of Ultra-Thin Bonded Overlays was accepted using roller coverage and temperature restrictions as analyzed post-construction using Veta®, and enforcement of this implementation was undertaken by release of a percent of a retainage of the overall construction costs depending on the conformance of the IC data. It was implemented in 2022 across seven different projects, from unlimited access to limited access routes. The processing technique developed for data acceptance includes the use of alignments in Veta® generated from the State Linear Reference System and paver temperatures to establish spatial paving limits since night work in Connecticut spans two calendar days, thus eliminating the ease of a temporal filter. This presentation presents the overall outcome, lessons learned, and adaptations recommended for future implementation as this same approach has now been written to 2 additional specifications in the state."

Session 3.6: Synchronizing AI and Unsaturated Soil Mechanics: A Leap Forward in Ground Assessment by Jayantha Kodikara (Monash University, Australia), Javad Ghorbani

This presentation explores the development and implementation of an innovative AI tool created to incorporate principles of unsaturated soil mechanics into intelligent compaction and real-time soil assessment.

Our AI-enabled approach is anchored in machine learning algorithms and statistical analysis, opening unparalleled opportunities for enhancing the predictive accuracy of ground conditions and managing the inherent uncertainties present during intelligent compaction.

The primary strength of this tool lies in its versatility. It thrives in a variety of scenarios, regardless of the availability of moisture content and suction data. Its self-improvement capabilities flourish with an improvement in data quality, and it successfully quantifies the degree of certainty in predicting ground conditions. With the flexibility to accommodate a wide spectrum of information, ranging from experimental insights to in-situ measurements, our model offers robust solutions even in the face of limited data - a typical challenge in traditional machine-learning approaches. The AI tool is fundamentally informed by physics, ensuring its operation remains grounded in reality.

We delve into the practical application of this AI tool, presenting the field trial that underscores its revolutionary potential within intelligent compaction.

SESSION 4 - DIGITAL TWINS AND BIM - I

INTRODUCTION

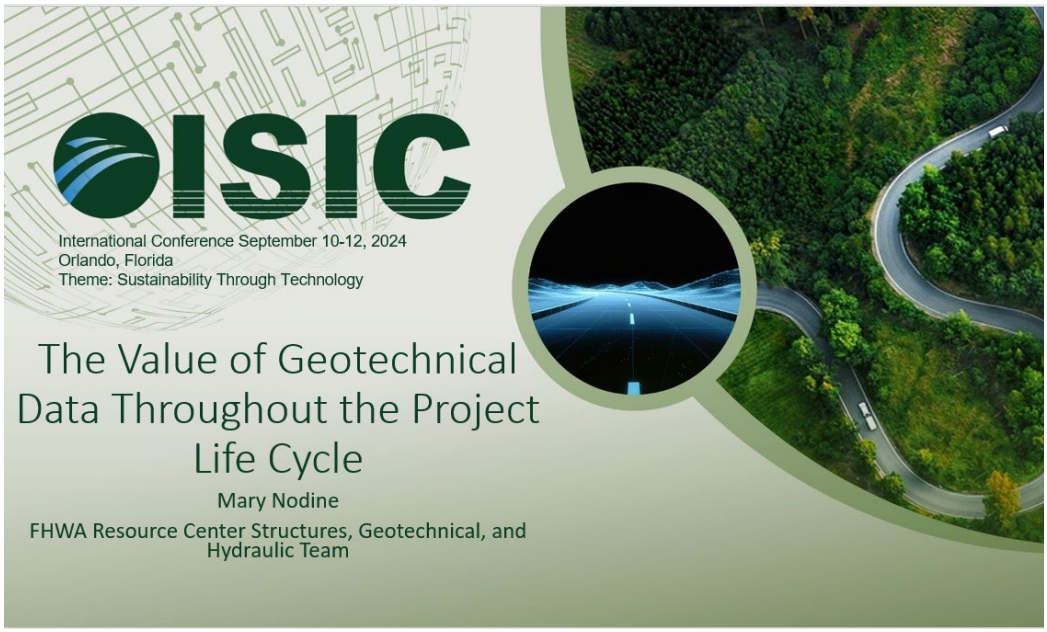
This presentation focused on Digital Twins and BIM - I.

MODERATOR AND SPEAKERS

The moderator for this session was Chuck Hixon, Mott McDonald, USA (ISIC NA Chapter – Digital Delivery Coordinator). The speakers included Mary Nodine (FHWA, USA), Derrick Dasenbrock, Benjamin Rivers; Miguel Azenha (University of Minho, Portugal), Manuel Parente, João Aleixo, Evgenii Ermolenko, Ricardo Dias, João Daniel Pereira, João Marcelo Silva, Raquel Silva, Bruno Figuei-redo, João Pedro Mendonça, João Pedro Couto, José Granja; Russ Tamblyn (Trimble, USA), Ed Shappell, Joseph Poskie; Thanasak Phittayakorn (Chulalongkorn University, Thailand)

PRESENTATIONS

Session 4.1: The Value of Geotechnical Data Throughout the Project Life Cycle by Mary Nodine (FHWA, USA), Derrick Dasenbrock, Benjamin Rivers



Digital data are being increasingly embraced and utilized in many areas of construction, from new developments in e-ticketing and digital As-Builts to the use of BIM for 3D structural modeling and construction scheduling. Some owners are using models as legal documents for construction and creating digital twins that are updated with new information throughout the project life cycle. Geotechnical data are ready to be part of this workspace, including investigation data, design models, and real-time performance monitoring. AASHTO, FHWA, and other organizations have recognized that standardized schemata for data transfer are necessary to convey data efficiently among stakeholders using varied software packages. Historically, geotechnical information for construction projects has been transmitted in the form of "static" PDF or presentation logs, charts, and reports rather than in the form of digital data, significantly limiting efficient exchange, querying, and interoperability. Standardized electronic geotechnical data represents the potential for process improvement, efficiencies, and communication at all stages of a construction project. DIGGS (Data Interchange for Geotechnical and Geoenvironmental Specialists) is an open-source XML schema for geotechnical data developed over the last 20 years and referenced in the AASHTO provisional Standard Practice for Digital Interchange of Geotechnical Data (AASHTO PP 102-20).

This presentation will describe the value of structured digital geotechnical data and integrate it with other data on a construction project. It will include examples of how geotechnical data can be leveraged for streamlined workflow and informed decision-making throughout the project lifecycle, such as:

- Rapid site assessment to determine the feasibility of a project or construction technique
- Data transfer among software programs for design analysis
- Visualization of the subsurface for more informed and cost-competitive bids
- Integration with construction data for streamlined QA/QC and optimization
- Inclusion in as-built models and digital twins

Geotechnical data interoperability creates opportunities for improved or entirely new functionality. The presentation discusses how owners and agencies are beginning to adapt their process workflow and realize new benefits.

Session 4.2: OpenBIM Approach for Integrated Design and Modular Construction: the R2U Project by Miguel Azenha (University of Minho, Portugal), Manuel Parente, João Aleixo, Evgenii Ermolenko, Ricardo Dias, João Daniel Pereira, João Marcelo Silva, Raquel Silva, Bruno Figuei-redo, João Pedro Mendonça, João Pedro Couto, José Granja

Even though the adoption of BIM worldwide has grown very significantly in the last decade, there is still much potential to harvest by properly managing design and construction data. This challenge is even more relevant when open formats are considered, allowing freedom from the restraints of proprietary software and leveraging true possibilities of collaboration in the multi-stakeholder processes inherent to the construction industry.

The work reported in this presentation pertains to the connection of openBIM tools (e.g., IFC, BCF, BsDD, IDS) within the scope of a customized web platform to support integrated design practices, as well as connection to fabrication processes in the

scope of modular construction. This initiative is made within a wider scope of an applied research project named R2U Technologies, which will also be overviewed in the presentation.

Session 4.3: BIM Models for Construction Risks and Benefits by Russ Tamblyn (Trimble, USA), Ed Shappell, Joseph Poskie

Asset Lifecycle Management solutions proactively connect design, project delivery, and maintenance teams through digital workflows, utilizing open data for improved project outcomes and lower ownership costs. Construction is the place where conceptual meets reality. Designers design to meet the requirements per the agency's scope and deliver just what is contractually required. Most of the construction work being done by agencies is design-bid-build, which is then thrown over the fence to the contractor for construction. In most cases, the project is left as a .pdf plan set with no data. The presentation will list all the risks generated if the

contractor creates his own models. The presentation will also present the benefits of a complete model developed by collaborations between the different parties.

Session 4.4: Evaluation and Optimization of Building Performance through Visual Programming, Leveraging BIM-Based Shading Coefficient by Thanasak Phittayakorn (Chulalongkorn University, Thailand)

The shading coefficient is important for building efficiency, particularly in controlling solar heat gain and managing energy consumption. In tropical countries, windows with high shading coefficients are preferred, as they block more solar heat gain, reducing the need for other cooling systems. However, the traditional calculation of the SC, especially in determining the overall thermal transfer value (OTTV) of a building, has been a complex and time-consuming task. The study incorporates the SC as an essential factor due to variables such as diverse climate conditions, alterations in the sun's angle, the size and shape of the shading device, its orientation, and the

materials used for building the envelope, all with the objective of enhancing energy efficiency in buildings. Therefore, this complexity arises from the intricate configuration of the efficient design of the shading device. It measures windows and shading devices that block solar heat compared to different parameters. This presentation enhances the analysis tools of building performance by applying Parento techniques to evaluate and optimize shading devices. The integration of BIM and visual programming offers significant advantages in the analysis and optimization of building designs. This study presents a comprehensive framework that combines BIM, visual programming, and Parento optimization to enable efficient design iterations and informed decision-making. The precision of parametric modeling offers a powerful tool for optimizing complex systems.

SESSION 5 - – QUALITY MONITORING AND SUSTAINABILITY - II

INTRODUCTION

This presentation focused on – Quality Monitoring and Sustainability - II.

MODERATOR AND SPEAKERS

The moderator for this session was Amanda Gilliland, Transtec Group, USA (ISIC NA Chapter – Communication Coordinator)). The speakers included Kyle Hoegh (MnDOT, USA); Embacher (MnDOT, USA); Bryce Wuori (Pavewise, USA); Ram Kumar Veeraragavan (FHWA, USA), Leslie Myers, Derek Nener-Plante; Mark Piotto (Teleo, USA).

PRESENTATIONS

Session 5.1: AASHTO Dielectric Profile System (DPS) Implementation by Kyle Hoegh (MnDOT, USA)

This presentation summarized the current and future implementation of the AASHTO Dielectric Profile System (DPS) standard. Dr. Hoegh summarized the DPS pooled fund study's program (including Phase I and Phase II), development of DPS-related AASHTO standards, and on-going research and development. The DPS TPS' research track includes:

R1. Field, lab, and simulation research of critical factors to develop best and worst use conditions for DPS

R2. Evaluation of improved data collection methods

R3. Benefit-cost analysis of DPS compared with other density measurements

R4. Development of advanced analysis techniques

R5. Identification of uses of dielectric data without converting to density.

Its implementation track includes:

I1. Development of training materials, personnel, demonstrations, and pilot projects

I2. Updating American Association of State Highway and Transportation Officials (AASHTO) specifications and ghost implementation protocols

I3. Support of national pilot project ghost implementations

I4. Development of a DPS certification center

Finally, the DPS TPF's marketing and communication track includes:

M1. Support of communication

M2. Continued training and technical assistance

M3. Continued promotion of the technology

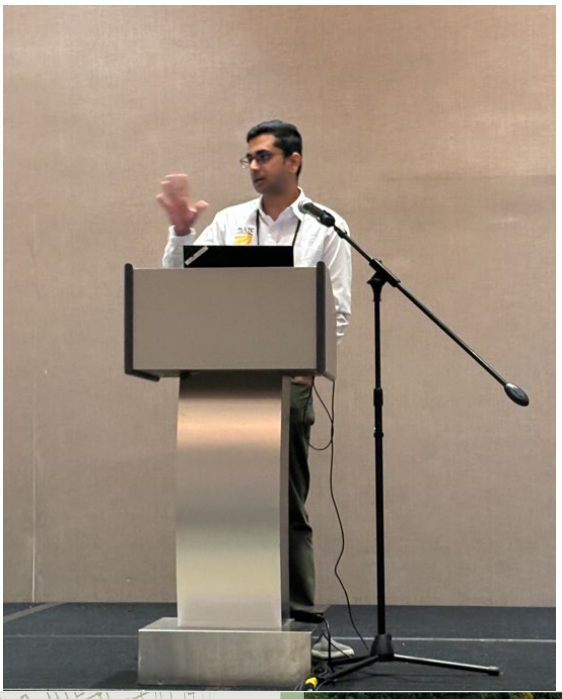
Session 5.2: AASHTO Material Delivery Management System (MDMS) Implementation by Rebecca Embacher (MnDOT, USA)

This presentation summarized the current and future implementation of the AASHTO Material Delivery Management System (MDMS) standard. Ms. Embacher started with the importance of the standardization needs for MSMS implementation, clarification of the AASHTO MDMS standard's intents, followed by the US national implementation of AASHTO MDMS using the national standardized platforms, including Veta MDMS/Web and AASHTOWare. Mr. Embacher then elaborated on the details of MDMS, including all aspects of material delivery to a contract. This includes all pavement construction materials (aggregate, asphalt, concrete, and ready-mixed concrete) and all events/activities (source data-e-Ticket, hauler data, loading/delivery event data, testing/contract administration). Finally, Mr. Embacher demonstrated the current Veta MDMS web portal, test/production servers, and the Veta Web interfaces that will fuse all the above data as well as PMTP, IC, DPS, and acceptance core data as a complete US national standardized platform and solution.

Session 5.3: Improving Asphalt Paving Construction Quality and Efficiency with Technology by Bryce Wuori (Pavewise, USA)

(*ISIC NOTICE: the products were mentioned in this presentation for demonstrate technology purposes, as per the non-collusion clauses mentioned in the Introduction.*) Pavewise is one of the revolutionary construction management software programs that was designed specifically for the asphalt paving industry. The patent pending data engines and operating systems proactively identify potential project impacts and develop project schedules that are 12-18% more accurate than traditional schedules. Asphalt paving construction requires a significant amount of management to develop high amounts of success. Pavewise assists the manager in this strenuous process by identifying impacts and offering expert solutions to the user. Contractors will see improvements in equipment efficiencies, quality incentives, and overall construction quality on paving projects.

Session 5.4: Advancing Quality Control in Asphalt Construction: An FHWA and MATC Initiative Utilizing Pave Mounted Thermal Profiler and Dielectric Profiling Systems by Ram Kumar Veeraragavan (FHWA, USA), Leslie Myers, Derek Nener-Plante



Highway agencies are seeking innovative solutions to enhance quality assurance/quality control to improve the performance of asphalt pavement construction, which surpasses the constraints of traditional sample core analysis. While traditional methods such as visual checks and sample cores are employed to determine the consistency and density of hot-mix asphalt (HMA), they often face challenges in identifying problem areas, especially when working at night. Moreover, these techniques provide limited information about the quality of asphalt pavement construction. Recent advancements in Intelligent Construction Technologies (ICT) have made this possible with the use of non-destructive technologies such as Paver Mounted Thermal Profiler (PMTP) and Dielectric Profiling Systems (DPS). Both these technologies provide continuous data on the quality of construction of asphalt layers over an entire project length, along with the potential to save substantial costs through extended maintenance cycles, and

have stimulated significant interest within State Departments of Transportation (DOTs).

The Federal Highway Administration (FHWA) and the Mobile Asphalt Technology Center (MATC) are actively facilitating the transition from research to implementation of these non-destructive technologies. MATC has been diligently collecting data from a multitude of site project visits and through equipment loan programs from across diverse regions in the country, thereby building a rich repository of use cases showcasing the transformative potential of Intelligent Construction Technologies (ICT) in quality control. The presentation presents the lessons learned from the comprehensive database that reflect the impact of variability in construction quality, including Material Transfer Vehicle (MTV) utilization, haul distances, production variability, and more on construction quality. The benefits of ICT in enhancing the quality of construction of asphalt concrete layers are highlighted. As a result of this progressive initiative, both State Departments of Transportation (DOTs) and contractors have an opportunity to rethink their quality control/ quality assurance strategies. The DOTs can leverage the insights gleaned from MATC's extensive fieldwork to develop safer, more reliable, and cost-effective roadway systems, transforming the landscape of pavement construction.

Session 5.5: Supervised Autonomy for Heavy Construction Equipment by Mark Piotto (Teleo, USA)

(*ISIC NOTICE: the products were mentioned in this presentation to demonstrate technology purpose, as per the non-collusion clauses mentioned in the Introduction.*) Autonomous heavy equipment will revolutionize the construction and mining industries—and the role of equipment operators. With the introduction of the $1T infrastructure bill in the United States, the need to complete critical construction projects is more evident than ever. However, the worsening skilled labor shortage poses a significant hurdle in achieving these vital improvements. Contractors can leverage advanced technology to help existing workers do more and expand the workforce by improving access to these jobs.
A modern solution empowers operators to run heavy equipment without physically being in the machine. This innovation allows a single operator to manage multiple pieces of equipment from one remote command center, multiplying their productivity and significantly enhancing safety and satisfaction.
There is an incremental approach to full autonomy, called Supervised Autonomy, which combines remote operations and autonomy. In an industry where full autonomy for most use cases is years away, and human intervention is still required, this novel approach allows operators to oversee autonomous tasks and remotely handle more complex tasks, ensuring seamless operations.

SESSION 6 - DIGITAL TWINS AND BIM - II

INTRODUCTION

This presentation focused on Digital Twins and BIM – II.

MODERATOR AND SPEAKERS

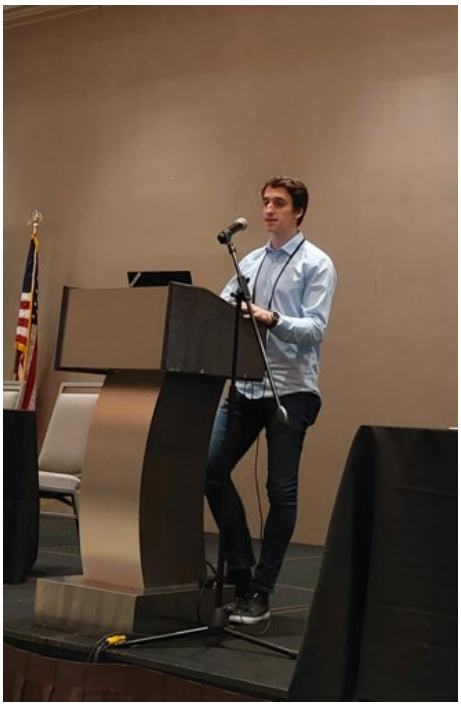
The moderator for this session was Chuck Hixon, Mott McDonald, USA (ISIC NA Chapter – Digital Delivery Coordinator). The speakers included Erol Tutumluer (University of Illinois at Urbana-Champaign, USA); Johannes Beck (Helmut Schmidt University, Germany), Sascha Henke; Joao Manso (National CE Laboratory, Portugal), Martin Figueiredo, Rúben Santos, Liliana Pinheiro, João Marcelino, Nuno Marques.

PRESENTATIONS

Session 6.1: Bender Element Field Sensor for Quality Assessment of Pavement Construction by Erol Tutumluer (University of Illinois at Urbana-Champaign, USA)

Unbound aggregate layer modulus is an important material property for mechanistic-empirical pavement design and construction quality control. Granular base/subbase stiffness is typically characterized by resilient modulus due to repeated traffic loading. An innovative bender element (BE) shear wave transducer was recently developed as a field sensor for assessing in situ modulus characteristics of constructed base/subbase layers through elastic wave velocities. This presentation discusses the field instrumentation process with the BE field sensor as an intelligent construction and layer modulus characterization tool during the construction and trafficking of full-scale pavement test sections. The first full-scale test section, where five BE field sensors were installed, was the Smart Runway airport pavement section at the Hill Air Force Base in Utah. The US Army Corps of Engineers Engineer Research and Development Center (ERDC) heavily instrumented the Smart Runway test section to monitor its mechanistic response characteristics when subjected to various mixed aircraft loads. The second test section, equipped with three BE sensors installed in both geogrid-stabilized and control base course layers, was the Construction Cycle 9 (CC9) flexible pavement test sections at the Federal Aviation Administration (FAA) 's National Airport Pavement Test Facility (NAPTF) in New Jersey. Lastly, the third test site included full-scale highway pavement test sections constructed by the Federal Highway Administration (FHWA) in Virginia, where eight BE sensors were installed in granular layers. This presentation describes in detail the development, organization, and revision of the instrumentation procedure with BE sensors amongst these three diverse testing environments. Successful BE sensor data measurements have provided valuable insights into the layer modulus behavior trends from different stages of pavement layer construction, including confinement effects quantified with locked-in residual stress buildup in the aggregate layer during the construction process.

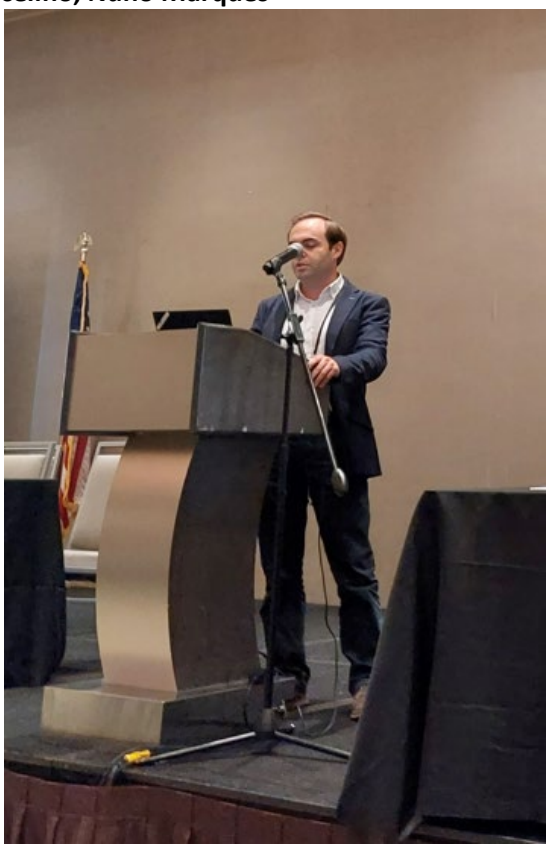
Session 6.2: Multi-Objective Optimization of Excavation Pits Using a Geotechnical Digital Twin by Johannes Beck (Helmut Schmidt University, Germany), Sascha Henke



Excavation pits are currently planned based on one or more soil profiles at decisive points. A separate and disconnected engineering model is then created. It includes disadvantageous assumptions in geometry, soil properties, and loads to compensate for simplifications. Within that model, optimizations are usually performed by varying very few parameters, aiming for a degree of utilization close to the desired safety factor. This approach does neither allow the consideration of complex boundary conditions and constraints nor the evaluation of criteria besides structural ones. In order to address these shortcomings, an approach to planning excavation pits using a geotechnical digital twin is proposed. A holistic evaluation and multi-objective optimizations are made possible by using multidimensional, parametric models with common data sources. A case study is conducted using an adapted real-world project. The excavation pit is evaluated and optimized based on ecological, economic, static, and constructability metrics. The Non-Dominated Sorting Genetic

Algorithm II (NSGA-II) is used for the multi-objective optimization. It is demonstrated that geotechnical digital twins can be used for numerous analyses and that multi-objective optimizations can be applied. The outcomes indicate that this new method allows for finding more sustainable design solutions for excavation pits than the traditional approach.

Session 6.3: Vessel Berthing Monitoring using Digital Twins by Joao Manso (National CE Laboratory, Portugal), Martin Figueiredo, Rúben Santos, Liliana Pinheiro, João Marcelino, Nuno Marques



Vessel berthing monitoring plays a crucial role in ensuring the safety and efficiency of maritime operations. Docking structures are heavily subjected to dynamic forces resulting from both the docking process of the vessels and the effects of wind, sea

agitation, and tides on the moored vessels. Due to the high-wear environments they are in, these structures need to be properly monitored to assess better the investment cycles associated with their maintenance. Traditional monitoring methods often rely on visual inspections and limited sensor data, resulting in potential risks and inefficiencies. In this context, there is an increasing interest in developing tools to estimate the impact of a vessel during its docking to the quay where it will be moored. The emergence of digital twins and smart mooring systems offers innovative solutions to enhance berthing monitoring. This presentation describes a digital twin of the Port of Leixões and a smart mooring system developed for monitoring vessel berthing. Digital twins are virtual replicas of physical assets that simulate their behavior and performance in real time. By integrating data from various sensors, such as load cells, motion sensors, and environmental detectors, digital twins can provide a comprehensive view of the mooring process. Smart mooring systems leverage advanced technologies, including IoT sensors, real-time data analytics, and automated control systems, to optimize the mooring operations. These systems enable continuous monitoring of mooring line tensions, vessel movements, and environmental conditions. In this particular aspect, an open-source algorithm that uses several IoT sensors and surveillance cameras installed in Port of Leixões was developed by LNEC and NOVA FCT to monitor vessels berthing. By combining this data with the digital twin, operators can gain valuable insights into the berthing process, identify potential risks, and make informed decisions to enhance safety and efficiency. To calibrate this system, an experimental installation was built in LNECs' facilities to measure the effects of dynamic actions on docking structures.

SESSION 7 - QUALITY MONITORING AND ARTIFICIAL INTELLIGENCE

INTRODUCTION

This presentation focused on Quality Monitoring and Artificial Intelligence.

MODERATOR AND SPEAKERS

The moderator for this session was Soheil Nazarian, University of Texas at El Paso, USA (ISIC International – Vice President)). The speakers included Sam Afkar (ARRB-NTRO, Australia), and Arooran Rajah (TMR, Australia); Amanda Gilliland (Transtec Group, USA), George Chang, Subu Sankaranarayanan; Taewook Kang (Korea Institute of Civil Engineering and Building Technology), Jin-woo Cho, Yunjeong Mo; and Soheil Nazarian (University of Texas at El Paso, USA).

PRESENTATIONS

Session 7.1: Implementation of intelligent Compaction in Australia by Sam Afkar (ARRB-NTRO, Australia), Arooran Rajah (TMR, Australia)

Effective compaction is crucial for ensuring optimal performance of all pavement layers. It has a significant impact on the longevity and overall cost-effectiveness of a road over its service life.

Improving the quality of road construction and increasing productivity and uniformity of the projects requires measurement (testing), which is currently a costly and time-consuming process. As compaction is critical for the performance of pavement layers, Intelligent Compaction (IC) is a solution to this growing need to provide a more efficient and reliable way of collecting compaction data. It also assesses the work consistency, and amongst other benefits, this technology provides on-the-fly feedback.

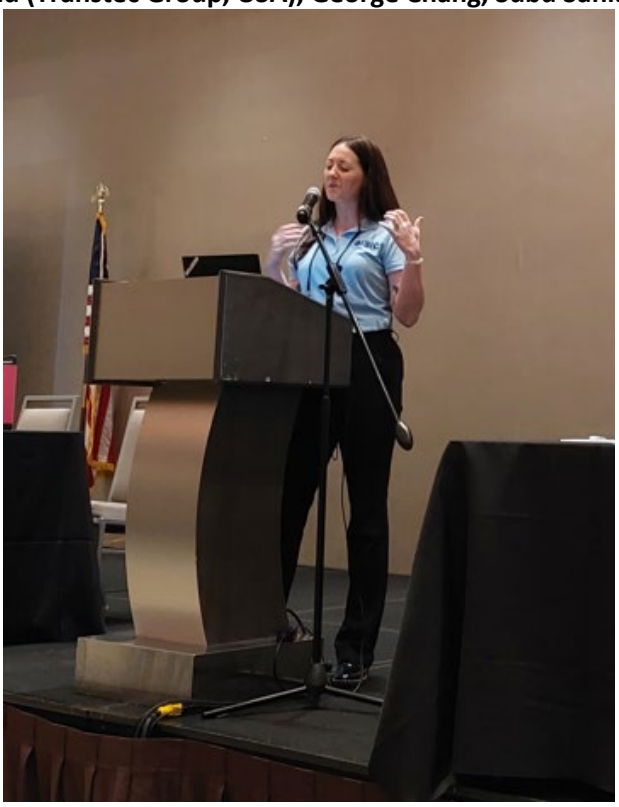
During the implementation of IC technology in Australia, various pavement materials were included in IC demonstration projects, the aim of which was to use the technology for the purpose of quality control, quality assurance, and, ultimately, work acceptance.

Various benefits and features of IC, such as coverage, uniformity of compaction, compaction temperature, pre-mapping, and identifying the weak areas, were successfully trialed, and the learnings from demonstration projects were shared.

To better illustrate and quantify the benefits of IC technology, based on the data achieved during projects, the Benefit-Cost Analysis was also undertaken to identify the financial impact of using IC on both client and contractor. This gives the road authorities the opportunity to understand the requirements and details of how they can set the future roadmap.

Along with the other major findings, the IC demonstrations have provided a wealth of information and knowledge (in the form of technical reports, guides and specifications, information sessions, and trainings/workshops) to share with the industry and get benefits. This presentation shares the experiences gained in different areas during these projects, including the technical and operational work in data collection, analysis, and practical conclusions for quality control and project acceptance.

Session 7.2: Intelligent Highways: Missouri DOT's Success in Intelligent Compaction and Paver-Mounted Thermal Profiling (IC-PMTP) Deployment by Amanda Gilliland (Transtec Group, USA), George Chang, Subu Sankaranarayanan



This presentation focused on the Missouri Department of Transportation's (MoDOT's) successful implementation of Intelligent Compaction (IC) and Paver-Mounted Thermal Profiling (PMTP) technologies in asphalt paving projects from 2017 to 2023. These intelligent construction technologies (ICTs) promote sustainability by enhancing pavement quality and longevity by monitoring and optimizing real-time paving and compaction temperatures and roller coverages. MoDOT's adoption of ICTs led to improved IC pass count coverage, reduced temperature segregation, and consistent compaction temperatures, increasing uniformity and construction quality.

To overcome the industry's potential reluctance to adopt new technologies, MoDOT employed a well-executed implementation strategy emphasizing gradual

rollout, feedback, and refinement of protocols and specifications. This approach facilitated effective technology adoption by engaging all stakeholders and addressing challenges.
MoDOT has also implemented data quality assurance (QA) tools for IC pass count and PMTP temperatures to verify contractor equipment and ensure data quality. With new data verification tools, MoDOT can use the data for acceptance-making decisions, potentially reducing the need for manual testing and core-taking by on-site personnel, thereby improving safety.
MoDOT's systematic approach and active feedback-seeking enabled the successful navigation of IC and PMTP implementation complexities, providing valuable insights for transportation agencies and industries aiming to leverage new technologies for enhanced quality, safety, and cost savings. This presentation underscores the importance of a well-planned implementation strategy to fully realize the potential of innovative construction technologies.

Session 7.3: BIM-based Digital Twin Framework and Architecture for Building Environment Monitoring by Taewook Kang (Korea Institute of Civil Engineering And Building Technology), Jin woo Cho, Yunjeong Mo

The concept of digital twins has been applied to various industries, but its application in the construction field is still in the early stages. Real-time connectivity and predictability of data exchange between the physical and virtual worlds are necessary for effective digital twin implementation. A digital twin framework and architecture based on this concept is proposed, and its effectiveness is evaluated by implementing a digital twin for monitoring the environmental performance of existing buildings. This research can serve as a reference for developing a BIM-based digital twin platform for construction monitoring.

Session 7.4: Intelligent Compaction for 100-Year Pavements by Soheil Nazarian (University of Texas at El Paso, USA)

The satisfactory performance of well-designed pavement sections hinges on the appropriate compaction of layers in the field, especially compacted geomaterials forming the foundation layers. In-situ spot density tests are standard practice for assessing the compaction effort, even though the mechanistic-empirical design procedures are based on layer moduli. The state of the practice in in-situ density measurements, and more recently modulus measurements, relies on limited in-situ spot testing meant to represent a large area of compacted geomaterial. Intelligent compaction (IC) can be utilized to access the as-built moduli by vibratory rollers across the entire compacted geomaterial area to overcome the limitation of spot density tests.

This presentation presents an approach to assess the layer-by-layer variation in the as-built moduli. The real-time IC mapping process has proved to be practical, efficient, and robust. The assessment results can be obtained by combining the IC measurement values (ICMV) with limited lightweight deflectometer (LWD) measurements for local calibration and laboratory-based resilient modulus

nonlinear parameters. The comprehensive data collected in the last few years demonstrates the method's veracity and applicability. The assessment results showed that the local in situ calibration of IC-measured values with the limited LWD modulus is necessary to obtain accurate layer-specific as-built moduli.

SESSION 8 - SUSTAINABILITY THROUGH TECHNOLOGIES OPEN PANEL

INTRODUCTION

This session was a panel discussion comprised of all topics concerning Sustainability through Technologies Open Panel.

MODERATOR AND SPEAKERS

The moderator for this session was Dave Johnson, Asphalt Institute – AI, USA (ISIC NA Chapter – Secretary. The speakers included: ISIC Executive Committee: Soheil Nazarian (University of Texas at El Paso, USA); FHWA: Tom Yu (FHWA, USA); DOTs: Rebecca Embacher (MnDOT, USA); Contractors: Matt Ohley (Ajax, USA), Bryan Pidwerbesky (Fulton Hogan, New Zealand), Michael Lapaluccio (Middlesex, USA); Manufacturers: Tim Kowalski (Wirtgen American, USA), Paul Angerhofer (Moba, USA), Andrew Lindsay, (TruckIT, USA)

DISCUSSION


ISIC

Why do we have ISIC?

- **Soheil Nazarian, UTEP, USA (ISIC Executive Committee):** The visions of ISIC are to create a global platform for intelligent construction technologiest experts, users, and manufacturers to advance the technologies and promote adoptions and implementaitons.

How are road smoothness and sustainability connected?

- **Rebecca Embacher, MnDOT, USA:** ProVAL will be integrated into Veta to tie smoothness with construction quality. MDMS can overlay with paver stop and flow rates to assess the impact on smoothness. Smoothness is a significant contributor to reducing emissions during a road's use phase. MnDOT has observed improvements in smoothness with 3D or AMG milling, which also helped resolve concrete overruns.
- **Dave Johnson, Asphalt Institute, USA:** Tracking the deterioration of smoothness shows it significantly impacts fuel consumption and wear on trucks, even with small changes.
- **Bryan Pidwerbesky, Fulton Hogan, New Zealand:** Milling might be more effective than paving for achieving smoothness, as it allows for greater control.

- **Michael Lapaluccio, Middlesex, USA**: In Florida, contractors have limited opportunities to achieve smoothness due to the minimal amount of asphalt placed. Quality is emphasized as crucial.
- **Tim Kowalski, Wirtgen America, USA**: Proper paving techniques, like shutting down entire lanes to eliminate joints, are key to improving quality. Echelon paving is common on airport projects to enhance smoothness.

Can you identify what technologies have had the most impact on sustainability?

- **Paul Angerhofer, Moba, USA**: PMTP is essential because it begins at the paver, giving a better chance for success with IC and DPS.
- **Andrew Lindsay, TruckIT, USA**: The paver's efficiency depends on the timely delivery of materials, making MDMS crucial.
- **Dave Johnson, Asphalt Institute, USA**: Basic practices, like tarping trucks, are still essential and sometimes face resistance.
- **Matt Ohley, Ajax, USA**: Tracking trucking is critical for understanding traffic effects and improving smoothness.
- **Dave Johnson, Asphalt Institute, USA**: Autonomous construction technology can eliminate human errors and optimize trucking and equipment efficiency.
- **Michael Lapaluccio, Middlesex, USA**: It's important for the team to understand technology to maintain balance in the paving process and ensure consistent operation.
- **Todd Mansell, Caterpillar, USA**: PMTP provides a quick way to identify paving issues, with other technologies helping to dig deeper.
- **Tim Kowalski, Wirtgen America, USA**: Technology must be simple for operators to use effectively. The roller is the last line of defense (also the last line of success).
- **Tom Yu, FHWA, USA**: The focus on reducing carbon footprint emphasizes the need to build long-lasting pavements with intelligent compaction.
- **Bryan Pidwerbesky, Fulton Hogan, New Zealand**: The most sustainable approach is to eliminate the need for maintenance altogether.

What is restricting agencies from using technologies?

- **Rebecca Embacher, MnDOT, USA**: Regulations and risk aversion make it difficult to implement new technologies and change practices.
- **Rob Hinman, FHWA, USA**: Verifying contractor data is a challenge, partially due to regulatory constraints.
- **Tom Yu, FHWA, USA**: Implementing technologies requires collaboration across different perspectives. Building better roads is a collective effort.
- **Dave Johnson, Asphalt Institute, USA**: FHWA's EDC program deserves credit for promoting advanced technologies. The MATC loan program also supports technology adoption.
- **Ross (OAK) Metcalf, MTDOT, USA**: In Montana, some upper management views technology as a contractor's QC tool, which can slow down adoption. Resistance at higher levels can be a barrier to innovation.
- **Michael Lapaluccio, Middlesex, USA**: In a low-bid environment, contractors may keep innovations to themselves to maintain a competitive edge.
- **Tom Yu, FHWA, USA**: Paying for data could incentivize technology use and promote quality.
- **Bryan Pidwerbesky, Fulton Hogan, New Zealand**: New Zealand agencies incentivize technology by attributing value to it, moving away from low-bid environments.

- **Rebecca Embacher, MnDOT, USA**: Continuity of staffing is a challenge, but education and training are critical. Incentives and transparency can help drive adoption.
- **Andrew Lindsay, TruckIT, USA**: Technology verification could be similar to scale certification at quarries.
- **Bryce Wuori, PaveWise, USA**: Incentives ("carrots") are needed to encourage technology adoption.

How can we maximize the reuse of materials with technology?

- **Soheil Nazarian, UTEP, USA**: Full-depth reclamation is highly beneficial from all aspects.
- **Rebecca Embacher, MnDOT, USA**: Technologies that control and quantify RAP are crucial for maximizing material reuse.
- **Laikram Narsingh, Wirtgen America, USA**: Full-depth reclamation with a paver is superior to grading.
- **Rob Hinman, FHWA, USA**: Material management systems offer significant opportunities for tracking and optimizing RAP usage.

How many contractors are using the technologies even if they are not specified?

- **Andrew Lindsay, TruckIT, USA**: Many customers use technology for efficiency, even when it's not specified in contracts.
- **Paul Angerhofer, Moba, USA**: Competitive pressures can drive contractors to adopt systems, as seen in examples from Minnesota and Wisconsin.
- **Laikram Narsingh, Wirtgen America, USA**: Some contractors use technology without specifications, seeing value in efficiency gains.
- **Jim Preston, Topcon, USA**: Smaller contractors may invest in technology due to their pride in workmanship, facing less bureaucracy.
- **Dave Johnson, Asphalt Institute, USA**: Contractors may not share the advantages they gain from using technology.
- **Tom Yu, FHWA, USA**: If technology provides a clear advantage, it will be adopted, especially if it benefits the agency.
- **Matt Ohley, Ajax, USA**: Technologies must be user-friendly to be effectively implemented in the field.
- **Todd Mansell, Caterpillar, USA**: Contractors who use technology without specifications are often those who need it the least.
- **John Gravatt, Bomag, USA**: There is growing interest in technology among smaller contractors as it becomes more affordable and accessible.
- **Soheil Nazarian, UTEP, USA**: The process often involves initial failures followed by adjustments to make technology work in the field.
- **Dave Johnson, Asphalt Institute, USA**: NAPA shows that younger generations are interested in technology, which can attract new talent.
- **Michael Lapaluccio, Middlesex, USA**: Engagement and growth opportunities are key to gaining buy-in from younger workers.

How does MDMS contribute to sustainability and safety?

- **Andrew Lindsay, TruckIT, USA**: Efficiency through MDMS reduces environmental impact and minimizes truck stacking.
- **Todd Mansell, Caterpillar, USA**: E-ticketing improves safety by reducing the risks associated with paper ticket handling.
- **Dave Johnson, Asphalt Institute, USA**: FHWA has done an excellent job with e-ticketing and EDC-6.

- **Rob Hinman, FHWA, USA**: Fewer trucks in and out of traffic enhance overall safety.
- **Michael Lapaluccio, Middlesex, USA**: Reducing speeds in work zones is a continuous priority.
- **Rebecca Embacher, MnDOT, USA**: Digitization of data allows for integration with other systems and automation of issue detection.

What is your roadmap for introduction and training for new technology?

- **Eyoab Zegeye, MnDOT, USA**: Over-simplification of technology may not be necessary, especially if younger workers are interested in its complexity.
- **Andrew Lindsay, TruckIT, USA**: The interface for data capture should be simple, even if the data analysis tools are sophisticated.
- **Michael Lapaluccio, Middlesex, USA**: Engaging team members is crucial for effective training.

How do you find and maintain a champion to keep technology innovations going?

- **Dave Johnson, Asphalt Institute, USA**: Champions often present themselves naturally.
- **Paul Angerhofer, Moba, USA**: The key is to sustain the passion for technology, not necessarily the individual championing it.

What is the biggest hurdle to implementing technology?

- **Bryan Pidwerbesky, Fulton Hogan, New Zealand**: Proving the value of technology is essential.
- **Paul Angerhofer, Moba, USA**: Overcoming contractor fears by demonstrating how technology improves efficiency and quality is important.

Where do we stand with earthwork and subgrade and intelligent compaction?

- **Tim Kowalski, Wirtgen America, USA**: The use of intelligent compaction technology started with soil applications and has expanded from there.

For a DOT that has not yet incorporated many of the technologies discussed, what type of initial cost/time commitments can we expect?

- **Rebecca Embacher, MnDOT, USA**: Initial costs may be higher due to the perceived risk, making it difficult to estimate bids accurately.

CONCLUSIONS

ISIC 2024's program focused on how intelligent construction technologies can improve infrastructure sustainability. The workshops, TPF task working group meetings, technical sessions, and panel discussions were highly successful in conveying the latest technologies and future research and development of ICTs. These important topics cover not only the construction phase but also the entire life cycle of infrastructure assets. The panel discussions also addressed all aspects of ICT adoption and implementation.

As always, ISIC shared this summary and most of the presentations (*see the Appendix for download links*) with the world, which is in line with its vision to promote ICTs globally to enhance infrastructure quality, efficiency, and safety.

This is ISIC's 4th International Conference: the 1st in Minneapolis, MN, USA (2017); the 2nd in Beijing, China (2019); and the 3rd in Guimaraes, Portugal (2022). ISIC also conducted local chapter conferences by teaming up with others, such as MTC&E, in 2022 and 2023 to provide ISIC track programs in the US. Additionally, ISIC conducted webinars aimed at global ISIC members and friends. Please check out our webpage for the content of these conferences (https://www.is-ic.org/conferences/).

Lastly, we invite you to join ISIC as a member, if you haven't done so already, by using the form on this webpage (https://www.is-ic.org/membership/).

We look forward to seeing you at the next ISIC events as we work together to use intelligent construction technologies to improve our infrastructure.

by
ISIC Executive Committee.

23rd September 2024

PRESENTATION DOWNLOAD

- Session No. 0.1: NDT & ICT for Asphalt Pavement Construction Workshop by George Chang (Transtec Group, USA), Amanda Gilliland, Subu Sankaranarayanan (Transtec Group)
- Session No. 2.1: Positioning Technologies by Jim Preston (TOPCON, USA)
- Session No. 2.2: Paving Technologies by Laikram Narsingh (Wirtgen America, USA), Todd Mansell (Caterpillar, USA)
- Session No. 2.3: Compaction Technologies by Tim Kowalski (Wirtgen America, USA)
- Session No. 2.4: Incorporating 3D Ground Penetrating Radar in Pavement Project Scoping Efforts: Minnesota Department of Transportation Experience by Eyoab Zegeye (MnDOT, USA), Thomas Calhoon, Steve Henrichs, Dai Shongtao, Jeff Brunner (MnDOT), Jacopo Sala (Kontur)
- Session No. 2.5: Automation in Highway Construction by George Chang (Transtec Group, USA)
- Session No. 3.1: Sustainable Road Construction: Harnessing Reclaimed Asphalt Pavement as Base Course by Jian-Shiuh Chen (National Cheng Kung University, Taiwan), Chin Hung Yang
- Session No. 3.2: Exploring the Environmental Footprint of Next-Generation Asphalt Pavement with Intelligent Compaction via Life Cycle Assessment by Yunpeng Zhao (FHWA, USA), Jennifer Aponte Rivera, Atish Nadkarni, Maryam Sadat Sakhaeifar, Migdalia Carrion
- Session No. 3.3: Use of Installation Data for Streamlined Rigid Inclusion Performance Verification by Mary Nodine (FHWA, USA)
- Session No. 3.4: Building Higher Quality Roads with Innovative and High-Speed Data Collection using DPS/GPR Technologies by Bryce Wuori (Pavewise, USA)
- Session No. 3.5: A Case Study in Implementation of Intelligent Construction for Ultra-Thin Bonded Overlays in Connecticut and Development of Rapid Spatial Filtering in Veta by Alexander Bernier (UConn, USA)
- Session No. 3.6: Synchronizing AI and Unsaturated Soil Mechanics: A Leap Forward in Ground Assessment by Jayantha Kodikara (Monash University, Australia), Javad Ghorbani

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- Session No. 4.1: The Value of Geotechnical Data Throughout the Project Life Cycle by Mary Nodine (FHWA, USA), Derrick Dasenbrock, Benjamin Rivers
- Session No. 4.2: OpenBIM Approach for Integrated Design and Modular Construction: the R2U Project by Miguel Azenha (University of Minho, Portugal), Manuel Parente, João Aleixo, Evgenii Ermolenko, Ricardo Dias, João Daniel Pereira, João Marcelo Silva, Raquel Silva, Bruno Figuei-redo, João Pedro Mendonça, João Pedro Couto, José Granja
- Session No. 4.3: BIM Models for Construction Risks and Benefits by Russ Tamblyn (Trimble, USA), Ed Shappell, Joseph Poskie
- Session No. 4.4: Evaluation and Optimization of Building Performance through Visual Programming, Leveraging BIM-Based Shading Coefficient by Thanasak Phittayakorn (Chulalongkorn University, Thailand)
- Session No. 5.1: AASHTO Dielectric Profile System (DPS) Implementation by Kyle Hoegh (MnDOT, USA)
- Session No. 5.2: AASHTO Material Delivery Management System (MDMS) Implementation by Rebecca Embacher (MnDOT, USA)
- Session No. 5.3: Improving Asphalt Paving Construction Quality and Efficiency with Technology by Bryce Wuori (Pavewise, USA)
- Session No. 5.4: ~~Advancing Quality Control in Asphalt Construction: An FHWA and MATC Initiative Utilizing Pave Mounted Thermal Profiler and Dielectric Profiling Systems~~ by Ram Kumar Veeraragavan (FHWA, USA), Leslie Myers, Derek Nener-Plante
- Session No. 5.5: ~~Supervised Autonomy for Heavy Construction Equipment~~ by Mark Piotto (Teleo, USA)
- Session No. 6.1: Bender Element Field Sensor for Quality Assessment of Pavement Construction by Erol Tutumluer (University of Illinois at Urbana-Champaign, USA)
- Session No. 6.2: Multi-Objective Optimization of Excavation Pits Using a Geotechnical Digital Twin by Johannes Beck (Helmut Schmidt University, Germany), Sascha Henke
- Session No. 6.3: Vessel Berthing Monitoring using Digital Twins by Joao Manso (National CE Laboratory, Portugal), Martin Figueiredo, Rúben Santos, Liliana Pinheiro, João Marcelino, Nuno Marques
- Session No. 7.1: Implementation of intelligent Compaction in Australia by Sam Afkar (ARRB-NTRO, Australia), Arooran Rajah (TMR, Australia)
- Session No. 7.2: Intelligent Highways: Missouri DOT's Success in Intelligent Compaction and Paver-Mounted Thermal Profiling

(IC-PMTP) Deployment by Amanda Gilliland (Transtec Group, USA), George Chang, Subu Sankaranarayanan

- Session No. 7.3: BIM-based Digital Twin Framework and Architecture for Building Environment Monitoring by Taewook Kang (Korea Institute of Civil Engineering And Building Technology), Jin woo Cho, Yunjeong Mo
- Session No. 7.4: Intelligent Compaction for 100-Year Pavements by Soheil Nazarian (University of Texas at El Paso, USA)
- Session No. 8.1: Sustainability through Technologies by Dave Johnson (Asphalt Institute- AI, USA), ISIC Executive Committee: Soheil Nazarian (University of Texas at El Paso, USA) FHWA: Tom Yu (FHWA, USA) DOTs: Rebecca Embacher (MnDOT, USA) Contractors: Matt Ohley (Ajax, USA), Bryan Pidwerbesky (Fulton Hogan, New Zealand) Manufacturers: Tim Kowalski (Wirtgen American, USA), Paul Angerhofer (Moba, USA), Andrew Lindsay, (TruckIT, USA)

Coordination Committee of ISIC 2024

ISIC president and ISIC NA Chapter officers