UNIVERSITY OF PITTSBURGH | SWANSON SCHOOL OF ENGINEERING

IRISE

IRISE Consortium
Impactful Resilient
Infrastructure Science
and Engineering

Annual Report
2023

IRISE Consortium
Impactful Resilient Infrastructure
Science and Engineering

Dear Friends and Colleagues of IRISE,

I am delighted to extend my heartfelt congratulations to the Impactful Resilient Infrastructure Science and Engineering (IRISE) Consortium as we commemorate the successful completion of its fifth year of operation.

At the Pennsylvania Department of Transportation, we take great pride in acknowledging the remarkable strides made by IRISE in advancing the resilience and sustainability of our infrastructure networks. The challenges we face in this arena are immense, from aging infrastructure to the impacts of climate change and the opportunities presented by rapidly evolving technologies. However, through the collaborative efforts of IRISE, we are pursuing innovative solutions to address these challenges head-on.

At PennDOT, innovation lies at the heart of our organizational ethos. We have recognized the imperative of fostering a culture of creativity and ingenuity, as evidenced by our Strategic Plan's inclusion of innovation as one of our core themes and values. Through initiatives such as our State Transportation Innovation Council, we actively encourage our employees to explore new ideas and approaches to problem-solving.

Our partnership with IRISE is a testament to our commitment to innovation and research-driven solutions. By collaborating with stakeholders from academia, associations, and the construction and design sectors, we have created a dynamic environment for identifying and addressing the most pressing research needs in infrastructure development.

As we look to the future, I am filled with excitement and optimism for the innovations that will emerge from our continued collaboration with IRISE. Together, we are poised to overcome the challenges of today and lay the foundation for a more resilient and sustainable tomorrow.

I extend my deepest gratitude to all members of the Consortium for your dedication and unwavering support. Your contributions have been instrumental in shaping the success of IRISE, and I look forward to our continued partnership in the years to come.

With warm regards,

Mike Carroll
Secretary of Transportation
Pennsylvania Department of Transportation

Greetings,

Collaboration among all stakeholders in the transportation community is vital for identifying opportunities to enhance the performance of our transportation system. This is the essence of what IRISE represents.

As we recognize the first five years of the IRISE Consortium, which comprises volunteers from public agencies, consultants, contractors, and academia, we now turn our attention to the next five years and the challenges that lie ahead.

The IRISE Consortium embodies many essential elements of the transportation community, including public sector owners and operators such as the Pennsylvania Department of Transportation, the Pennsylvania Turnpike, Allegheny County, and the Federal Highway Administration as an ex officio member. Additionally, it includes Golden Triangle Construction and the Constructors Association of Western Pennsylvania representing contractors, and consultants Michael Baker International and CDR Maguire, alongside academia. The collective power and knowledge of consortium members, when combined to address asset management challenges, make IRISE a unique and influential group.

Our members contribute far more than just funding; they play a crucial role in identifying performance challenges related to highway infrastructure design, durability, maintenance, geotechnical features, stormwater systems, and construction worker safety.

Looking ahead to the next five years, our focus will be on advancing material and design performance for structures and roadways, leveraging meta-materials and high-performance lightweight concrete, utilizing digital twin technology for troubleshooting and system maintenance, exploring energy harvesting for electric vehicles, and integrating virtual reality for safety enhancements and advancement.

Implementation of research results will be a key aspect of our strategy moving forward. This annual report provides insights into the evolution of the IRISE Consortium, and as we embark on our sixth year of the research program, we are already planning for our seventh-year program starting in January 2025.

We extend our gratitude to our IRISE members and contributors who generously volunteer their time and resources to advance transportation research at the regional, state, and national levels. The opportunities that lie ahead are indeed exciting!

Joe Szczur, PE
Director
IRISE

PITT | IRISE

CENTER FOR IMPACTFUL RESILIENT
INFRASTRUCTURE SCIENCE & ENGINEERING

Celebrating Five Years of IRISE

The Impactful Resilient Infrastructure Science and Engineering (IRISE) Consortium has been developing innovative solutions that address the durability and resiliency challenges associated with aging highway infrastructure since the fall of 2018.

Over its life, IRISE has brought in over $4 million of member contributions that has funded 33 research projects and resulted in innovative products addressing various aspects of transportation infrastructure including bridge corrosion and condition assessment, concrete pavement design and construction, highway construction worker safety, landslide risks, best practices and data analysis, stormwater management, new materials development and performance, and research product benefits analysis. Some of the projects align with our goals to foster cutting edge research and are by nature more high risk/high reward, for example, exploring the effectiveness of light-weight concrete designs using meta-materials. Other projects are more applied. The development of PittRigid ME, a simplified mechanistic empirical design tool for newly jointed plain concrete pavement, is an example of applied research. Applied research can still be impactful. Another application driven web-based tool called Early Opening Analysis was developed to determine the optimal time when paving projects can be opened to traffic without significant damage. A project where this new technology was employed recently received a national award from the American Concrete Pavement Association.

IRISE continues to work on developing innovative products that will address issues associated with transportation infrastructure durability. Examples include:

- Using augmented and virtual reality to increase worker safety through the creation of a Virtual Reality platform for Health and Safety Training.

- Developing large language model machine learning algorithms to make domain specific information related to pavement design and construction more accessible to practitioners.

- Developing a paving simulator coupled with computer vision to improve and optimize concrete pavement construction.

- Developing novel tools such as software being developed for LiDAR point cloud classification of civil infrastructure to simplify the labor-intensive and complex workflows associated with data extraction of laser-based infrastructure reconstruction models within civil engineering projects.

Julie Vandenbossche, IRISE Director of Research, says, "The goal of IRISE has always been to promote transportation infrastructure innovation with a commitment to identifying relevant issues within the industry and developing impactful solutions. It is with great pride that we celebrate the fifth anniversary of the IRISE consortium. We cannot wait to see the far-reaching impacts IRISE will have in the next five years as we work together in achieving more resilient, sustainable transportation infrastructure."
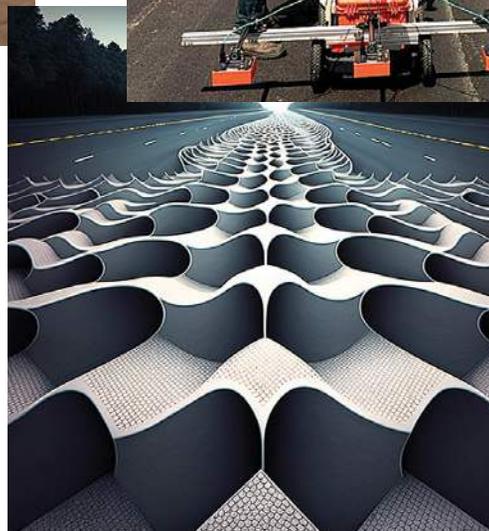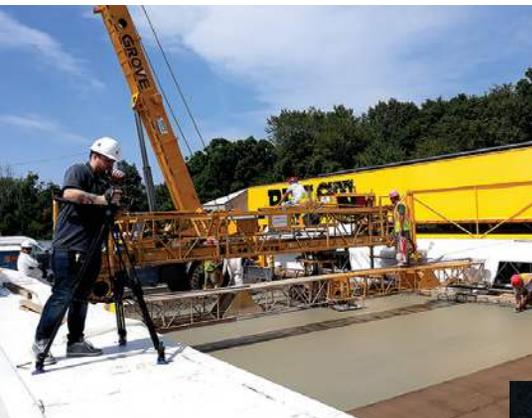
IRISE Partnerships

The University of Pittsburgh is joined by three public agencies, three private companies and one association that comprise the IRISE consortium partnership. The Federal Highway Administration also serves as an ex-officio member.

Each organization is represented on the IRISE Steering Committee. The individuals shown contribute towards defining each year's research program and appoint representatives from their organizations to individual project panels to help define each project's detailed scope, to keep the research relevant as it proceeds, and to build interest in implementing the resulting innovations.

ALLEGHENY COUNTY
ALWAYS INSPIRING

CAWP
Constructors Association
of Western Pennsylvania

CDR | MAGUIRE ENGINEERING

GOLDEN TRIANGLE CONSTRUCTION®
GENERAL CONTRACTORS

Michael Baker
INTERNATIONAL

pennsylvania
DEPARTMENT OF TRANSPORTATION

PENNA
TURN PIKE

PITT | IRISE

"Our relationship with Pitt IRISE allows our members to collaborate with other industry partners and helps pave the way to find sustainable solutions to infrastructure challenges. CAWP looks forward to continuing to work with consortium partners to make an impact in finding innovative infrastructure solutions for the future."

— **Rich Barcaskey**
Executive Director
Construction Association
of Western Pennsylvania

"Participating in IRISE allows Allegheny County to stay at the forefront of transportation infrastructure advancements, ensuring that we can provide our community with the most efficient and innovative solutions. Our involvement enhances transportation infrastructure within the county and ultimately improves the quality of life for residents and travelers alike."

— **Steve Shanley**
Director
Allegheny County Department
of Public Works

Rich Barcaskey
Executive Director
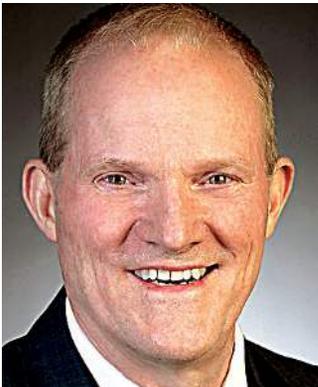Constructors Association
of Western Pennsylvania

H. Daniel Cessna
President
CDR Maguire Engineering

Chuck Niederriter
Chief Operating Officer
Golden Triangle Construction

Joe Sutor
*Planning and Design Services
Manager*
Pennsylvania Turnpike Commission

Steve Shanley
Director
Allegheny County Department
of Public Works

Brian Wall
Research Division Manager
Pennsylvania Department
of Transportation

Tom Zagorski
*Senior Vice President
Construction Services*
Michael Baker International

Thank You!

We want to extend a heartfelt appreciation to Mr. Gary Euler. Gary officially retired from his role as Associate Director at the end of June 2023. Despite his retirement, Gary has continued to play a vital role within the IRISE team, offering invaluable support to his successor, Dana Vidic. We extend our deepest gratitude to Gary for his unwavering dedication and continued support to IRISE's development and growth.
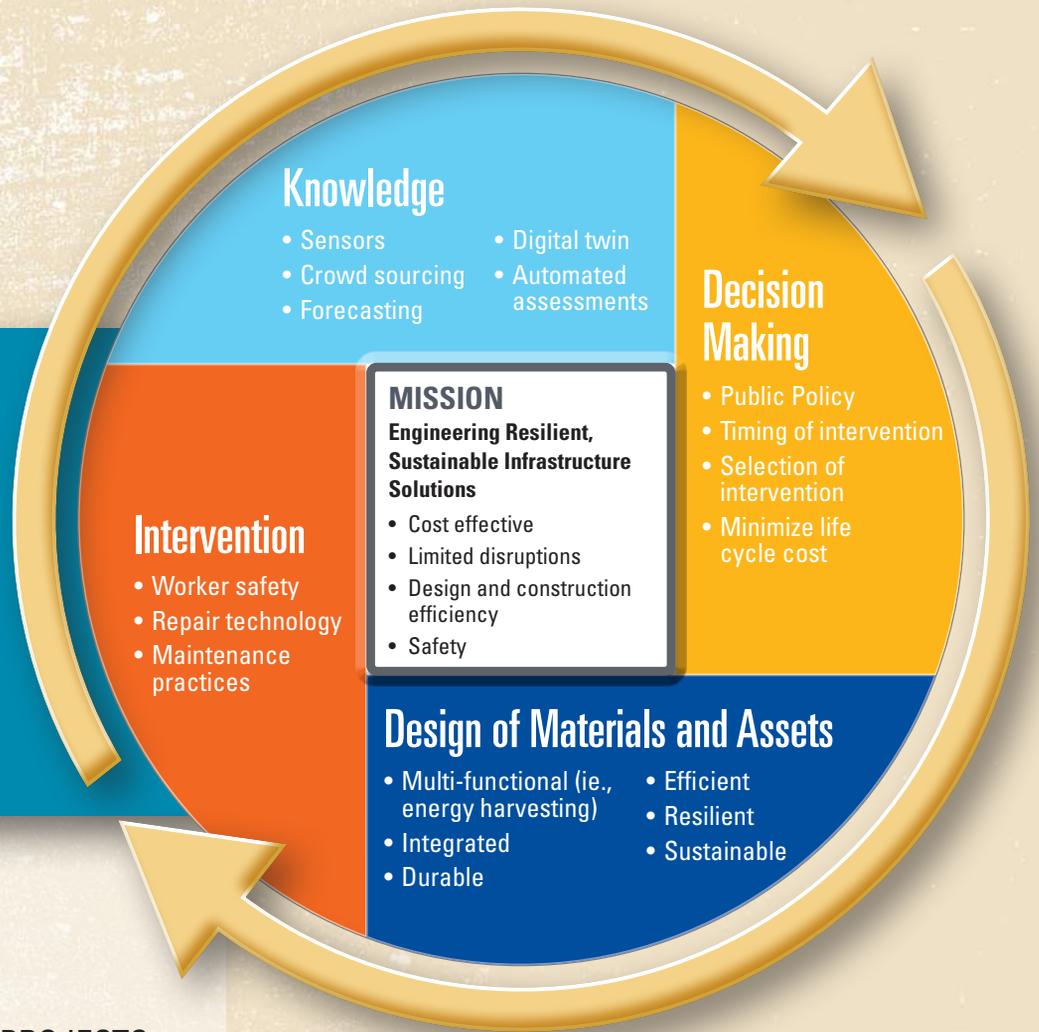
Welcome!

We are delighted to welcome Dana Vidic to our team as the new Associate Director of the IRISE research consortium. As a relatively recent graduate from the University of Pittsburgh's Civil and Environmental Engineering Department, Dana joins us with enthusiasm and a hunger for learning. She is excited to tap into the vast network of expertise within IRISE, learning from seasoned professionals and contributing her unique insights to our collaborative efforts. Dana's previous engagement with the University of Pittsburgh and her experience in civil and environmental consulting further enhances her ability to foster collaboration between academia and industry. We are excited to have Dana on board and look forward to the invaluable contributions she will make to IRISE's continued success.

Activities

The graphic is a depiction of the framework that illustrates the IRISE research mission, that includes a list of all IRISE projects and activities completed or ongoing within each framework area. The following sections contain capsule descriptions of the individual projects that IRISE completed in 2023-2024, are ongoing or that will be initiated in 2024.

Knowledge
- Sensors
- Crowd sourcing
- Forecasting
- Digital twin
- Automated assessments

Decision Making
- Public Policy
- Timing of intervention
- Selection of intervention
- Minimize life cycle cost

MISSION
Engineering Resilient, Sustainable Infrastructure Solutions
- Cost effective
- Limited disruptions
- Design and construction efficiency
- Safety

Intervention
- Worker safety
- Repair technology
- Maintenance practices

Design of Materials and Assets
- Multi-functional (ie., energy harvesting)
- Integrated
- Durable
- Efficient
- Resilient
- Sustainable

COMPLETED PROJECTS

- Material Compatible Repair
- Bridge Corrosion
- Microbes for Construction
- PITT Rigid
- Bridge Assessments
- Early Opening of Pavements
- Landslide Risks Workshop
- Landslide Seminar Series
- Benefits Analysis
- JPCP Joint Design Opt.
- Landslide Best Practices
- AC Pavement Markings
- Safer Pavement Construction
- ABC Construction
- Major Causes of Construction Accidents
- Utility Location
- Stormwater Seminar

ONGOING PROJECTS

- MCR Implementation
- Landslide Inventory
- Vibration and Compaction
- Bridge Decks Corrosion
- Dowel Corrosion
- LWC Metamaterial Concrete
- Seal Coat Best Practices
- Two-lift Pavements
- VR Safety Platform
- Bridge Load Ratings
- Recurring Landslides
- LLM Pavement Model
- Self-Heating Pavement
- 3D LiDAR Point Clouds
- Benefits of IRISE

SCAN HERE

View Completed Projects

View Active Projects

Projects Completed in 2023-2024

More information on each of these projects can be found on the IRISE website:
https://www.engineering.pitt.edu/subsites/consortiums/irise/research/completed

Identifying Major Causes of Construction Accidents

Large Language Models (LLMs) were utilized in this project to analyze past records of road construction incidents in Pennsylvania to identify and rank hazardous scenarios, accounting for near-collisions, within highway and street construction areas. The project formulated recommendations to prevent or reduce such risks in the future and yielded qualitative insights for enhancing safety training and refining safety equipment. The study concludes with a proposal for an "AI Safety Officer Assistant" in the highway construction sector, leveraging natural language processing (NLP) to streamline incident reporting, hazard communication, and safety planning.

Principal Investigator: **Dr. Lev Khazanovich**

Investigating New Underground Technologies and Novel Methods to Improve the Safety and Efficiency of Highway Construction

Underground utility location procedures were improved within this project by emphasizing the importance of careful identification and proactive measures during construction. Major recommendations include integrating advanced technologies like ground-penetrating radar, comprehensive training for construction teams, and collaborative planning between utility providers and construction teams. These recommendations aim to enhance accuracy and efficiency, ensuring the safety and success of future utility installation projects. The project recommends different GPR-based devices for various construction stages, contributing to improved safety and efficiency in highway construction projects.

Principal Investigator: **Dr. Lev Khazanovich**

Integrating Additive Manufacturing with Accelerated Bridge Construction Techniques

This project explored the feasibility of integrating additive manufacturing with Accelerated Bridge Construction (ABC) techniques. Concrete beams were 3D printed with different reinforcement approaches, and mechanical properties were evaluated through various testing methods to identify efficient reinforcement strategies and concrete mixtures. Among the tested methods, beams created using reinforced 3DCP formwork with studs showed the highest flexural strength and reduced costs significantly while maintaining performance. The project developed recommendations to enhance the efficiency of 3DCP in ABC projects, acknowledging both promising possibilities and current limitations.

Principal Investigator: **Dr. Amir Alavi**

(A) (B) (C) (D)

Three-dimensional Micro-Mechanical Characterization of the Effect of Vibration and Compaction in Concrete Pavements

This project optimized concrete paving by investigating the effects of vibration and compaction in slipform paving under variable environmental conditions. Machine learning algorithms were trained to establish cause-effect relationships between paving operations and pavement density. The project developed guidelines for optimized vibration and compaction levels to be utilized in diverse on-site conditions.

Principal Investigator: **Dr. Alessandro Fascetti**
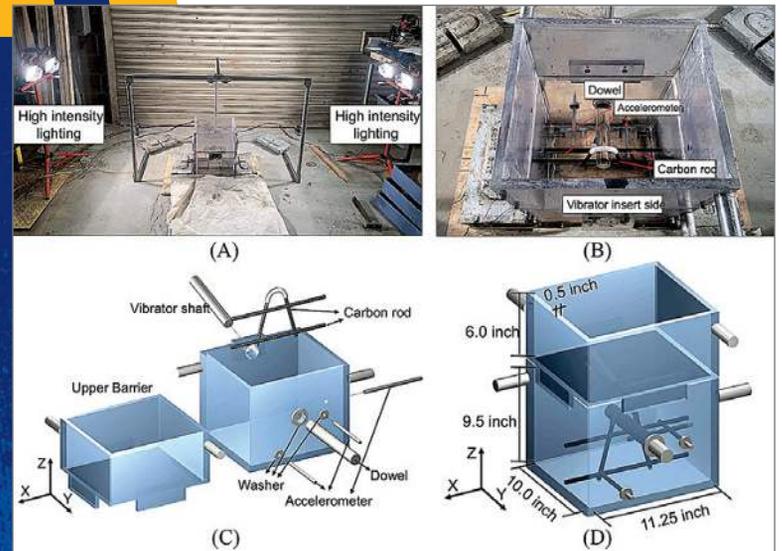
A Seminar Series on Innovative and Comprehensive Stormwater Management to Produce Multiple-Benefits in the Appalachian Plateau

The Stormwater Symposium featured presentations and panel discussions covering various aspects of stormwater management and regulation. Topics included emerging stormwater regulations, maintenance strategies, special considerations such as vegetation and water quality, funding for stormwater infrastructure, and cross-jurisdictional coordination. Expert speakers provided insights and perspectives on these critical issues. The symposium also included opportunities for networking and open discussion to identify next steps in advancing stormwater management practices.

Principal Investigator: **Dr. Daniel Bain**

View Completed Projects

Landslide Best Practices

A Southwestern Pennsylvania region-specific Landslide Best Practices Handbook was developed, tailored to geotechnical engineers and geologists involved in mitigating the impacts of active landslides or minimizing landslide risks. This comprehensive manual covers various aspects, starting with landslide characteristics, investigation techniques, instrumentation, and monitoring, along with slope maintenance. It also delves into stabilization methods, encompassing design, economic considerations, and construction aspects. It includes a framework for slope maintenance and management systems to ensure effective implementation of the outlined practices.

Principal Investigator: **Dr. Fatma Ciloglu**
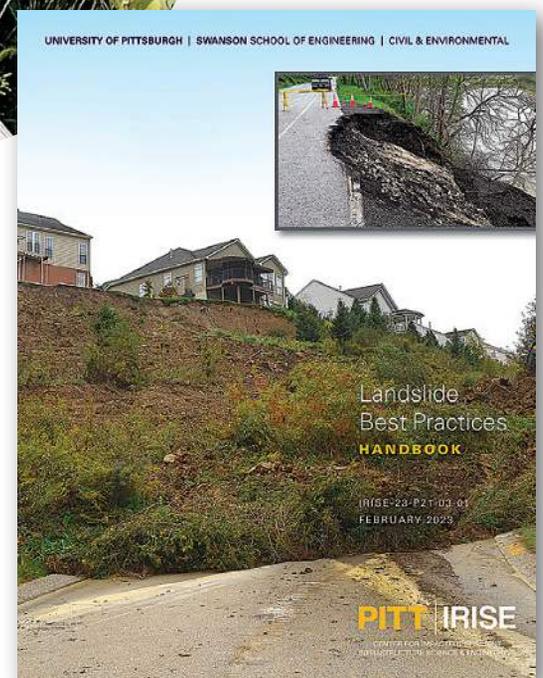
Ongoing Projects

More information on each of these projects can be found on the IRISE website:
https://www.engineering.pitt.edu/subsites/consortiums/irise/research/active-projects

▶ BRIDGE PROJECTS

A Novel Methodology for Structural Optimization of Bridge Decks Against Corrosion

A predictive toolset for bridge deck corrosion is being developed by analyzing structural features through advanced physics-based models. It will investigate corrosion mechanisms in reinforced concrete decks and integrate findings into an optimization framework for improved mitigation practices. Additionally, the project will examine the relationship between salt application, corrosion strategies, and deck condition. Operational guidelines for managing corrosion-prone decks will be developed.

Principal Investigator: **Dr. John Brigham**

▶ GEOTECHNICAL/STORMWATER PROJECTS

Development of a Roadway Landslide Inventory and Analytical Tool for Southwestern Pennsylvania

This project is advancing an effective proactive approach to landslide monitoring and mitigation by creating a unified inventory of landslides by amalgamating data from various agencies in a systematic and standardized format tailored to meet the data needs of stakeholders. This database, reflecting cumulative experience from across the region, will serve as a valuable resource for guiding mitigation efforts, identifying critical causes of slope failure, and pinpointing locations most prone to failure.

Principal Investigator: **Dr. Daniel Bain**

▶ MATERIALS PROJECTS

Material Compatible Repairs Evaluation

Improving partial-depth repairs is the focus of this project by addressing challenges such as bond integrity and repair dimensions. It is evaluating the performance of recommended materials and methods compared to standard PennDOT mixtures, utilizing ultrasonic tomography testing to assess repair dimensions and bond condition. Field testing over a five-year period, including coring and non-destructive testing, will analyze in-situ concrete properties and validate long-term repair material performance. The project will conclude with a comprehensive report containing recommendations for optimizing partial-depth repair practices.

Principal Investigator: **Dr. Stephen Sachs**

crack_openings

1.1e+01
8
6
4
2
0
-2
-5.2e+00
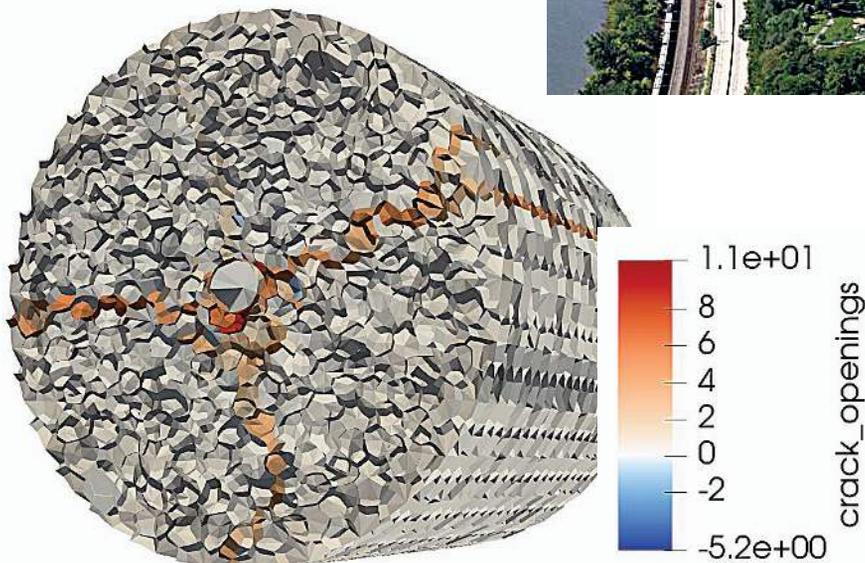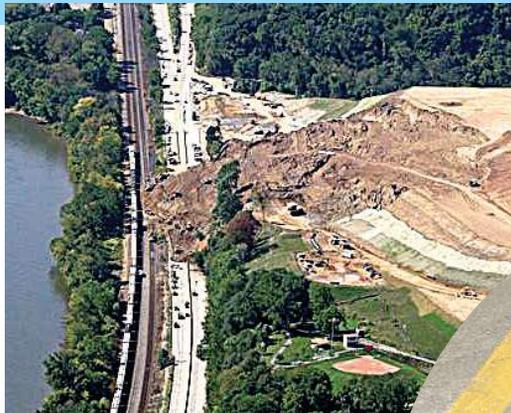
Developing Light-Weight and High-Performance Metamaterial Concrete

This project is developing lightweight concrete (LWC) technology with superior mechanical properties for structural elements in pavement systems, bridge decks, and prefabricated bridge elements. Metamaterial LWC specimens are being engineered for high strength-to-weight ratio and stiffness using mechanical metamaterials. It focuses on creating tunable compressive strength and ductility, employing architectural design principles and 3D reinforcements.

Principal Investigator: **Dr. Amir Alavi**

Joint Design Optimization

Enhancing the long-term performance of joints in jointed plain concrete pavements (JPCPs) with minimal maintenance is the focus of this project. The project objectives involve evaluating current sealant types, reservoir designs, and construction practices to identify areas for improvement. The project aims to reassess old methodologies for joint design and provide guidance on optimizing joint performance and include recommendations for improving sealant effectiveness and dowel bar design in Pennsylvania.

Principal Investigator:
Dr. Julie Vandenbossche

Design and Construction of Two-lift Concrete Pavements

Design and construction recommendations are being developed for two-lift concrete pavements tailored to Pennsylvania conditions. It involves testing concrete mixes for both top and bottom layers, prioritizing high-performance for the top layer and sustainability for the bottom layer. The scope includes evaluating an experimental two-lift concrete pavement, documenting challenges related to using two pavers and mixes consecutively, and assessing bonding conditions between layers., evaluating potential cost savings and reductions in carbon footprint.

Principal Investigator:
Dr. Lev Khazanovich

Prediction of Dowel Corrosion and Effect on Performance of Concrete Pavements

Corrosion of metallic dowel bars in concrete pavements is being addressed through four main objectives: understanding corrosion mechanisms, experimentally investigating corrosion development, building predictive models, and creating guidelines for pavement design and management. It involves quantifying corrosion based on environmental and design parameters, conducting accelerated laboratory tests, and developing predictive models validated with field data to enhance joint performance and mitigate corrosion-related pavement failures.

Principal Investigator:
Dr. Julie Vandenbossche

Seal Coat for Asphalt Pavements: Best Practices and Experience

Best practices that will improve the quality and consistency of seal coat applications to maximize pavement preservation benefits are being established by this project. It involves analyzing diverse experiences nationwide and contrasting them with Pennsylvania practices to develop standardized guidelines. The scope includes collecting and analyzing lessons learned, conducting stakeholder interviews, and refining seal coat specifications and guidelines.

Principal Investigator: **Dr. Eshan Dave** (University of New Hampshire)

▶ SAFETY PROJECTS

A Novel Immersive VR Platform for H&S Training of Construction Workers

Health and Safety (H&S) protocols in the construction industry are being enhanced by developing an interactive VR training platform. The platform targets educating construction workers, inspectors, and project site staff about common construction site accidents. Through realistic simulations of hazards, users will learn to identify and mitigate risks. The project seeks to quantify the effectiveness of VR-based H&S training compared to traditional methods and explore the potential of eye-tracking technology for enhanced attention analysis.

Principal Investigator: **Dr. Alessandro Fascetti**

Mon-Fayette Test Bed

IRISE is currently participating in the Pennsylvania Turnpike's Sustainable, Climate Resilient Corridor project facilitated through the design and construction of the Mon-Fayette Expressway extension by developing test bed locations that will consist of innovative infrastructure features. IRISE has received an additional $2.6 million in funding from the Turnpike to develop innovative climate resilient infrastructure solutions. These include:

- The development of a Digital Twin of a selected portion of the expressway that is a high-fidelity virtual reconstruction of the built asset and behaves, lives and ages with it throughout its lifespan.

- A multifunctional acoustic concrete metamaterial wall with noise cancellation and NOx reduction functionalities.

- A study of energy harvesting technologies for a variety of applications such as wireless charging of electric vehicles, ice/snow melting, heating or cooling, lighting and signals.

- The development of an "Electrified Roadways Strategic Plan" with a focus on expanding in-road electric vehicle charging infrastructure.

Principal Investigators: **Dr. Alessandro Fascetti** and **Dr. Amir Alavi**

View Active Projects
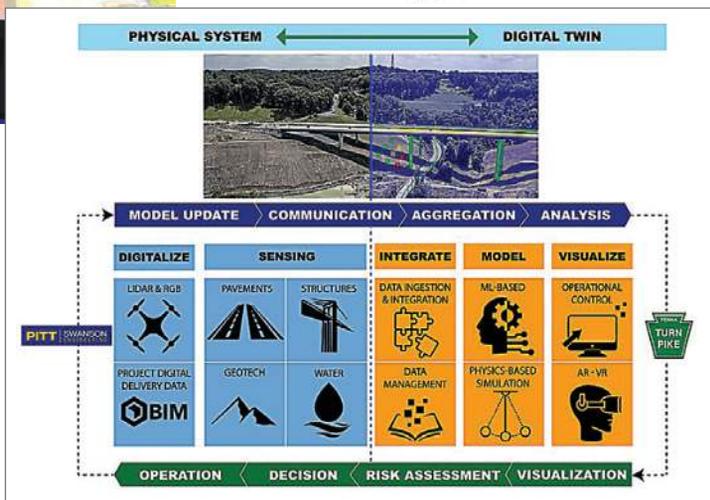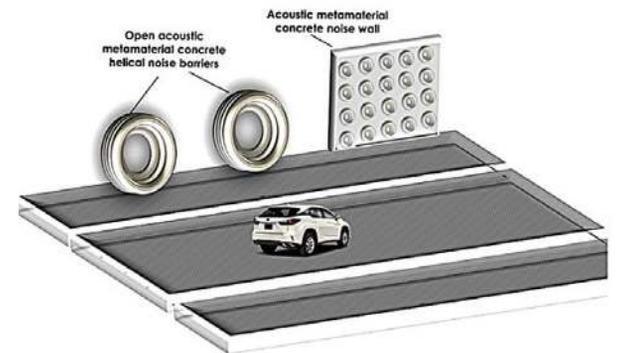
Upcoming Year Six Program

Adaptation of a Language Model for Generation of Expert-like Responses to Pavement-related Questions

An AI model for pavement engineering will be developed, utilizing Large Language Models (LLMs) that will swiftly and accurately answer common pavement engineering questions across design, construction, maintenance, and testing. Through fine-tuning and exposure to diverse pavement-related texts, including manuals and research papers, the model will possess interactive capabilities to assess user knowledge, offer feedback, and retrieve relevant information.

Principal Investigator: **Dr. Lev Khazanovich**

Self-heating Pavement Systems with Surface-Mounted Heating Elements

Costly and environmentally damaging methods of snow and ice removal on roadways will be addressed through this project by conducting a feasibility study on implementing surface-mounted heating elements for automated snow and ice removal. Unlike existing self-heating concrete systems, this technology will electrify the pavement's surface, reducing the need for deicing chemicals and allowing for both new and existing pavements to be equipped with this capability.

Principal Investigator: **Dr. Amir Alavi**

Bridge Load Ratings

The project will explore whether bridge load ratings have been overly conservative, leading to unnecessary postings and closures. It involves creating digital twins of selected Pennsylvania bridges for static analyses to identify overly conservative postings. Three accurate numerical models for concrete tee beam bridges will be developed, along with three approximate models simulating visible spectrum images. The project will assess the accuracy of a semi-automatic approach and its alignment with current load rating methodologies.

Principal Investigator: **Dr. Piero Rizzo**
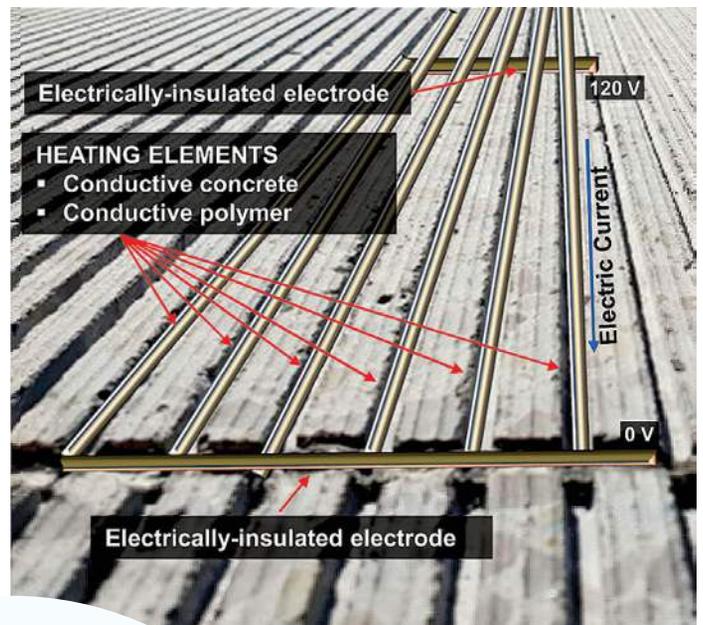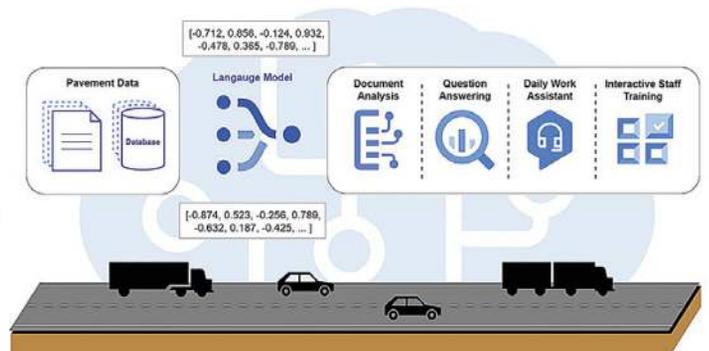
View Active Projects

Analysis of Reoccurring Landslides in SWPA to Advance Hazard and Risk Estimates

Landslide reoccurrence in southwestern Pennsylvania and its interaction with human landscape modifications will be examined by this project. By analyzing regional landslide data and conducting spatial analysis, the project seeks to identify patterns and develop mechanistic models of reoccurrence. Multivariate analysis will compare environmental factors between reoccurring and stable/new landslides. The results will identify high-risk areas, guiding mitigation efforts and informing effective repair methods in landslide-prone areas.

Principal Investigator: **Dr. Daniel Bain**

Supervised Learning for Classification of High-Resolution LiDAR Point Clouds

The efficiency and accuracy of surveying operations will be enhanced by developing novel classification tools for high-resolution LiDAR point clouds. Leveraging Supervised Learning approaches and computer vision, the project seeks to automate the segmentation of point clouds into specific regions, facilitating the translation of 3D data into structural design and assessment. The scope includes creating software tools for classification, focusing on bridge and pavement data, and exploring machine learning-based techniques as well as camera-based classification.

Principal Investigator: **Dr. Alessandro Fascetti**

Developing and Applying Methodologies to Quantify the Benefits of IRISE Projects

This project involves identifying up to five completed or ongoing IRISE research projects that offer implementable results for improving transportation infrastructure. The project will develop unique methodologies to quantify the benefits of implementing the research findings. The goal is to demonstrate how diverse types of research results can be measured and to evaluate their potential for broad-scale implementation, providing recommendations for each project analyzed.

Principal Investigator: **Dr. Mark Magalotti**

Planned Year Seven Program

The planning process for the annual work program at IRISE kicks off each autumn with a collaborative brainstorming session, this year taking place on October 25, 2023. During this session, research concepts were presented and thoroughly deliberated by member representatives. Following this, the IRISE team meticulously sifted through the ideas, identifying those that garnered the most interest and potential. Subsequently, problem statements were crafted for the selected topics and deliberated upon with input from the IRISE Steering Committee. Upon approval from the Steering Committee, detailed scopes of work for the selected problem statements will be formulated. These initial drafts will then be shared with and discussed among member technical representatives for further refinement. The project ideas that emerged from this rigorous process are poised for action pending final approval of the scopes of work by the IRISE Steering Committee.

After the anticipated approval of the scopes, work on the projects is anticipated to commence early to middle of 2025.

Advancing Regional Comprehensive Stormwater Management through Cross-Jurisdictional Coordination and Cooperation

The project aims to enhance stormwater management in Southwestern Pennsylvania by coordinating meetings and training sessions. These efforts, including lunchtime training sessions, consensus-building meetings, and a stormwater symposium, target jurisdictional barriers and regional planning. Collaboration with regional entities and the Pittsburgh Water Collaboratory will ensure effective strategies for cross-jurisdictional stormwater management.

Proposed Principal Investigator: **Dr. Daniel Bain**

Concrete Mixtures with Half the Carbon Footprint

This project plans to halve the carbon footprint of PennDOT concrete paving mixtures by evaluating sustainable alternatives found through a literature review of locally available materials. Lab testing will compare performance to standard mixtures using PennDOT specifications, with Pavement ME predicting performance.

Proposed Principal Investigators: **Dr. Vikas Khanna** and **Dr. Julie Vandenbossche**
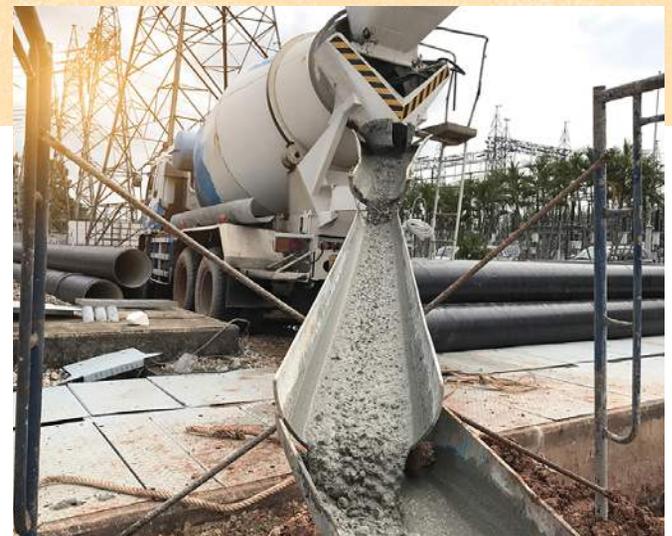
Concrete Pavement Life Cycle Assessment Tool

A Life Cycle Assessment (LCA) tool will be developed that is tailored for concrete pavements in Pennsylvania to quantify and reduce carbon emissions. Key objectives include estimating lifecycle CO2 emissions, quantifying materials flow, and evaluating end-of-life management strategies. Integration with existing concrete pavement design tools will enhance performance-LCA design capabilities.

Proposed Principal Investigators:
Dr. Melissa Bilec and
Dr. Lev Khazanovich

AI Safety Assistant

An "AI Safety Assistant" tool will be developed to enhance safety management in highway construction. By leveraging advanced natural language processing, the tool will assist in daily work planning, hazard communication, and incident reporting, ensuring comprehensive safety practices. Through iterative development and field deployment, the project seeks to optimize safety workflows, ultimately reducing accidents and improving risk assessment in construction zones.

Proposed Principal Investigator:
Dr. Lev Khazanovich

Improved Collection of Earthwork Quantities Utilizing UAV-Based LiDAR

Earthwork quantity estimation accuracy will be improved for large earth-moving projects using UAV-mounted LiDAR and RGB sensors. Workshops and field demonstrations, involving industry partners and UAV technology, will showcase its potential for improving earthwork planning and management.

Proposed Principal Investigator:
Dr. Alessandro Fascetti

Common Sense Compactions for Soils and Embankments

Dynamic Cone Penetrometer (DCP) and lightweight deflectometer (LWD) technologies will be evaluated for compaction quality control in Pennsylvania. It aims to replace current nuclear gauge-based methods with accurate, cost-effective, and nonradioactive alternatives. The project outcomes will include recommendations for implementing these technologies and drafting a new specification for compaction quality control.

Proposed Principal Investigator:
Dr. Lucio Salles de Salles

People of IRISE

STUDENT AND POST-DOC INVOLVEMENT

The students below were financially supported and directly involved in IRISE projects, in total 12 undergraduate students, 11 graduate students and three postdocs. Project involvement led to students co-authoring papers and making presentations at conferences of organizations such as the American Concrete Pavement Association, the ASCE Conference on Transportation and Development, and the Transportation Research Board.

Undergraduate Students

- Quinn Aker
- Elliot Breech
- Callum Grealy
- Ariel Holstein
- Eugene Kwon
- Ben Markworth
- Bailey McCausland
- Catherine Namyotov
- Jack Parkhurst
- Kara Schmitt
- Johnson Yan
- Addeline Ziegler

Graduate Students

- Megan Darnell
- Charles Donnelly
- Bashear El-Hajj
- Alireza Enshaeian
- Katherine Kennebeck
- Katelyn Kosar
- Wendy Lu
- Trevor Neece
- Mason Smetana
- Igor Sukharev
- Xiangdong Yan

Postdocs

- **Daeik Jang, PhD** has been leading several IRISE projects: Self-heating concrete pavements systems with surface-mounted heating elements, Multifunctional acoustic concrete metamaterial wall with noise cancellation and NOx reduction functionalities, PA Turnpike electrified roadways strategic plan, and Sustainable and multifunctional geogrids made from recycled materials for energy harvesting and active sensing.

- **Dongge Jia, PhD** has been the lead researcher for development of the lattice discrete particle method (LDPM) for analyzing reinforced concrete deck deterioration due to corrosion.

- **Yingbo Zhu, PhD** has been assisting with the development of the lattice discrete particle method (LDPM) for analyzing reinforced concrete deck deterioration due to corrosion.

Students also benefited from participating in IRISE events such as the Annual Meeting, Brainstorming session, and Transportation Forum. IRISE members provide co-op and internship opportunities and exposure to engineering projects in the region. For example:

- Undergraduate and graduate students had the opportunity to share their work during the Annual IRISE Transportation Forum. The forum included participants from major transportation industry organizations.
- Students throughout the Civil and Environmental Engineering and Geology Departments also benefited from having information from IRISE projects included in their courses to help bridge the gap between research and practical application when they enter the workforce.

Other Contributors

IRISE would also like to recognize the contributions of **Fatma Ciloglu, PhD**. She served as the Principal Investigator for the Landslide Best Practices project. Dr. Ciloglu is an Associate Vice President and the Geotechnical Department Manager for IRISE member Michael Baker International.

1

2

3

4

5

6

7

8

9

10

11

12

13

14

5

16

17
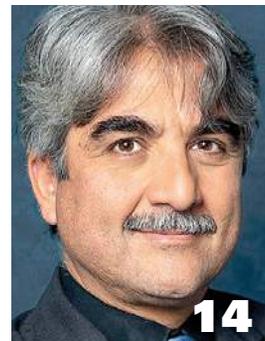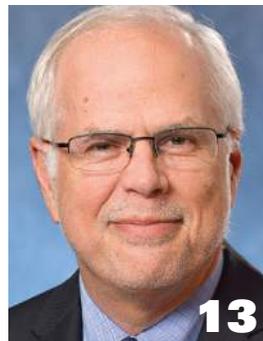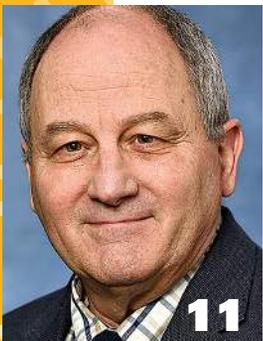
Faculty

1. **Joe Szczur, PE** serves as the IRISE Consortium Director. His leadership reflects a unique perspective on challenges facing the industry based having worked for over 35 years for the Pennsylvania Department of Transportation and served for over 16 years as the District Executive for PennDOT's Engineering District 12 in Southwestern Pennsylvania. Mr. Szczur served as faculty lead for the Landslide Best Practices project.

2. **Dana Vidic** serves as the IRISE Associate Director with day-to-day management responsibilities.

3. **Julie Vandenbossche, PhD, PE** serves as the IRISE Director of Research serving as a conduit between IRISE and Pitt faculty members. She is the Principal Investigator (PI) for the Joint Design Optimization and the Dowel Corrosion projects. Her research interests are concrete pavement analysis, design, evaluation, rehabilitation, and construction, including Instrumentation and advanced material characterization.

4. **Amir Alavi, PhD** served as the PI for the Additive Manufacturing and Accelerated Bridge Construction project and the Metamaterial Concrete project. He currently serves as the PI for the Mon-Fayette Test bed Multifunctional Acoustic Concrete Metamaterial Wall with Noise Cancellation and NOx Reduction Functionalities project, Sustainable and Multifunctional Geogrids made from Recycled Materials for Energy Harvesting and Active Sensing project, and the Electrified Roadways Strategic Plan project. He will serve as the PI for the proposed Self-Heating Pavements project. His research interests include structural health monitoring, smart civil infrastructure systems, deployment of advanced sensors and engineering informatics.

5. **Daniel Bain, PhD** served as the PI for the Landslide Inventory and Analytical Tool project and the seminar series on Comprehensive Stormwater Management. Dr. Bain is in the University's Department of Geology and Environmental Science. His research focuses on human driven changes in environmental systems.

6. **Melissa Bilec, PhD** is the co-director of the University's Mascaro Center for Sustainable Innovation. Dr. Bilec led the discussion on sustainability research needs during IRISE's 2023 Brainstorming session. Her research focuses on exploring how the built environment can be an integral part of climate change solutions.

7. **John Brigham, PhD** serves as the PI for the Structural Optimization of Bridge Decks Against Corrosion project. He provides expertise in computational diagnostics and inverse mechanics related to the testing of materials.

8. **Eshan Dave, PhD** serves as the PI for the Asphalt Pavement Seal Coating Best Practices project. Dr. Dave is affiliated with the University of New Hampshire. His research interests include performance evaluation of pavements and materials, performance-based specifications, resilient design, climate variability impacts and life cycle assessment.

9. **Alessandro Fascetti, PhD** is the PI for the Effect of Vibration and Compaction in Concrete Pavements project and the Virtual Reality Health & Safety Training of Construction Workers project. He also serves as the PI for the Mon-Fayette Test Bed Digital Twin Technology for a Climate Resilient Corridor project. His research interests revolve around the physical processes that contribute to the degradation of civil infrastructure systems.

10. **Kent Harries, PhD, P.Eng.** contributed ideas on bridge research needs during the 2023 Brainstorming session. His research interests include the use of nonconventional materials in civil infrastructure.

11. **Anthony Iannacchione, PhD, PE, PG** is a Senior Advisor participating in the Landslide Inventory and Analytical Tool project. His expertise is in the design of underground facilities with minimal risk of environmental or workplace harm.

12. **Lev Khazanovich, PhD** served as the PI for the Utility Location Technologies and the Major Causes of Construction Accidents projects and currently serves as the PI for the Two-lift Pavement project. He will serve as the PI for the proposed Pavements Artificial Language Model project. His research has featured performance prediction modeling, non-destructive testing, and finite element modeling.

13. **Mark Magalotti, PhD, PE** served as a Senior Advisor to IRISE leadership and as the PI for the completed Benefits Analysis project, and the upcoming Benefits Analysis Project. His research interest is multi-modal transportation planning and technology transfer of research products.

14. **Piervincenzo Rizzo, PhD** contributed ideas on bridge research needs during IRISE's 2023 Brainstorming session. He will serve as the PI for the proposed Bridge Load Ratings project. His research interests are structural health monitoring, nondestructive evaluation, and smart structures.

15. **Steve Sachs, PhD** is the PI for the Materials Compatible Repairs Evaluation project. His research interests include pavement design and analysis, finite element modeling, and experimental characterization of structures and materials.

16. **Lucio Salles de Salles, PhD** played important roles on several IRISE projects: Major Causes of Highway Construction Accidents and Technology Assessment for Safer Construction and Utility Location Technologies. His research interests include full-scale and non-destructive pavement testing, finite element modeling and simulation, road markings, and pavement design and performance. He is currently an assistant professor at the Department of Civil Engineering Technology, Environmental Management and Safety at the Rochester Institute of Technology.

17. **Eitan Shelef, PhD** is participating in the Landslide Inventory and Analytical Tool project. He is in the University's Department of Geology and Environmental Science. His research interests include linking climate change with hill slope processes and modeling landscape evolution by various types of erosive processes.

Looking Ahead at the Next Five Years

As we chart the course for the future of the IRISE Consortium, we are driven by a shared vision of tackling the key challenges facing our members with renewed vigor and innovation. We envision a future where IRISE continues to push the boundaries of applied research while simultaneously investing in fundamental exploration to unlock groundbreaking solutions.

With a keen eye on the horizon, we recognize the importance of balancing high risk/high reward ventures with lower risk initiatives, ensuring that our investments align with the evolving needs of our members. By fostering an environment of collaboration and idea-sharing, we aim to identify priority research topics that hold the potential to revolutionize the transportation infrastructure landscape.

As we expand our membership and welcome new voices to the table, we remain committed to our mission of driving impactful research outcomes that benefit, not only our members but, society as a whole. Our strategic focus on component research will be complemented by a concerted effort to explore system-level solutions, paving the way for breakthroughs in the years to come.

Furthermore, we are excited to leverage emerging technologies and foster cross-sectoral partnerships to maximize the impact of our research efforts. Through planned initiatives such as technology transfer and international information exchange, we will amplify the reach of our findings and accelerate the adoption of innovative practices in the field.

At the heart of our vision lies a commitment to excellence and a dedication to serving as a catalyst for positive change in the realm of transportation infrastructure science and engineering. As we continue on this journey together, we are filled with excitement and optimism for the future of IRISE, confident in our ability to shape a more resilient and sustainable transportation infrastructure for generations to come.

IRISE Consortium

Impactful Resilient
Infrastructure Science
and Engineering

University of
Pittsburgh

**Swanson School
of Engineering**

Department of Civil and
Environmental Engineering
742 Benedum Hall
3700 O'Hara Street
Pittsburgh, PA 15261

engineering.pitt.edu/irise