

Overview of Pitt Transportation Infrastructure Research

-Brainstorming Session-

Julie Vandebossche

October 25, 2023

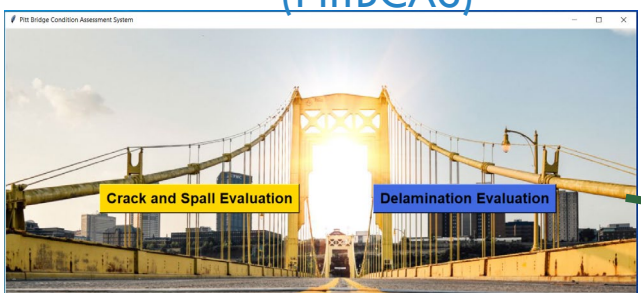
Completed Pitt Research

Bridge

- Steel Bridge Corrosion Prevention and Mitigation Strategies, **Dr. Stephens** PITT | IRISE
- Corrosion Repair Strategies for Steel Girder Ends Using High Performance and Traditional Materials, **Dr. Harries**
- Improving Bridge Assessment Through the Integration of Conventional Visual Inspection, Non-Destructive Evaluation and Structural Health Monitoring Data, **Dr. Alavi** PITT | IRISE
- Data Management, Mining, and Inference for Bridge Monitoring, **Dr. Rizzo**



Pitt Bridge Condition Assessment System (PittBCAS)



Output delamination area

Output

- Crack region density
- Total crack length
- Crack density
- Spall region density

RUTGERS

Center for Advanced Infrastructure and Transportation

WJE

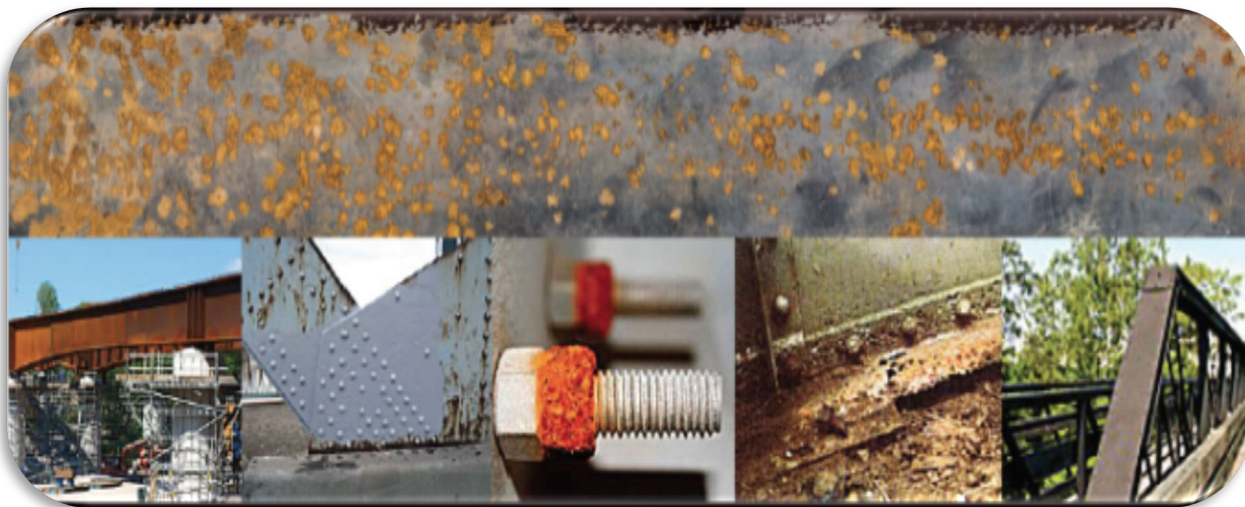
ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

Wiss, Janney, Elstner Associates, Inc.

Ongoing Pitt Research

Bridge

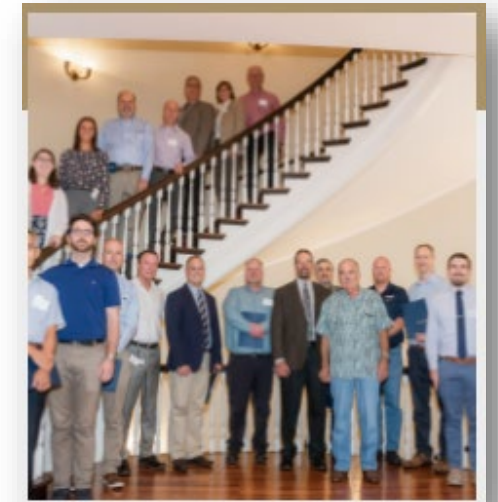
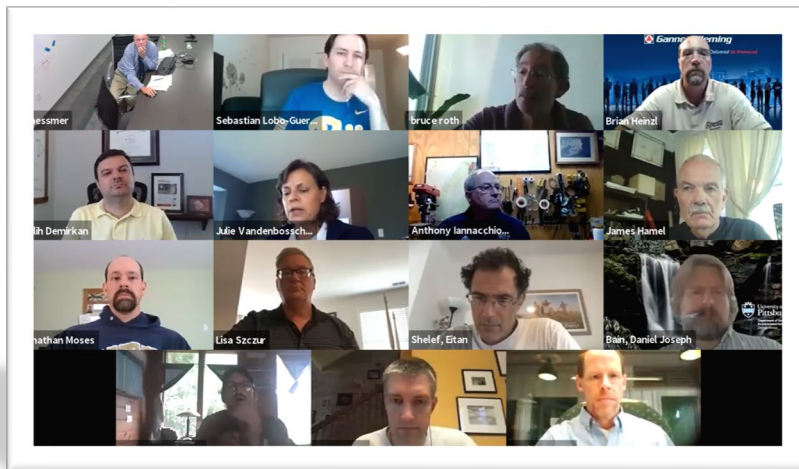
- Integrating Additive Manufacturing with Accelerated Bridge Construction Techniques, *Dr. Alavi* PITT | IRISE
- A Novel Methodology for Structural Optimization of Bridge Decks Against Corrosion, *Dr. Brigham* PITT | IRISE



Completed Pitt Research

Geotechnical

- Subsidence Impact Forecasting: I-70 over Longwall Mine, **Dr. Iannacchione**
- Exploring Approaches to Managing Landslide Risks:
Workshop Summary Report, **Dr. Iannacchione** PITT | IRISE
- Landslide Capacity Building Seminars, **Drs. Iannacchione and Bain** PITT | IRISE
- Depth to Bedrock Seismic Measuring Device, **Dr. Sachs**
- Landslide Best Practices, **Dr. Ciloglu, MBI** PITT | IRISE



Ongoing Pitt Research

Geotechnical

- Development of a Roadway Landslide Inventory and Analytical Tool for Southwestern Pennsylvania, ***Drs. Bain, Iannacchione and Shelef*** PITT | IRISE
- Development of a Regional Landslide Inventory to Advance Hazard and Risk Estimates for Southwestern Pennsylvania, ***Dr. Bain*** PITT | IRISE



Pavements

Completed Pitt Research

- Faulting Models for JPCP and BOCA, ***Drs. Khazanovich (JPCP) Vandenbossche (BCOA)***
- Development of a Simplified Mechanistic-Empirical Design Tool for Rigid Pavements in PA, ***Dr. Khazanovich*** PITT | IRISE
- Early Opening of Concrete Pavements to Traffic, ***Dr. Khazanovich*** PITT | IRISE
- Effect of Super Loads on Pavement Life, ***Dr. Vandenbossche***
- Preliminary Evaluation of Pavement Surface Distresses Related to Pavement Markings, ***Dr. Khazanovich*** PITT | IRISE



PittRigid ME Version 1.0

Help:
Open a PDF file with the project report.

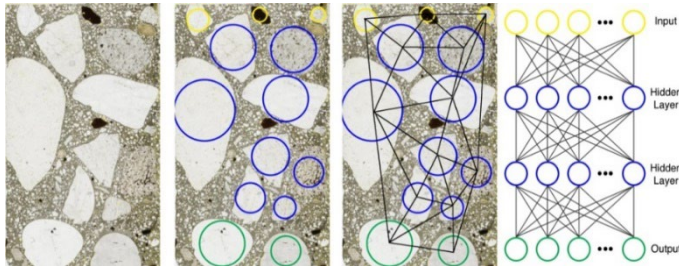
Mode Design	Climate Region 1: Erie County	Map
Design Life, years: 20	Cracking Reliability, % 90	Faulting Reliability, % 90
Two-way AADTT Year 1 1000	Compound Growth, % 3	Number of Lanes (two way) 2
Traffic Pattern Urban Principal Arterial - Interstate		
Joint Spacing, ft 12	Slab Width Conventional width (Shoulder Type Tied PCC
PCC Flexural Strength, psi 631.0	COTE, 10 ⁻⁶ 1/°F 4.5	Base Type Aggregate

Submit Settings

Ongoing Pitt Research

Pavements

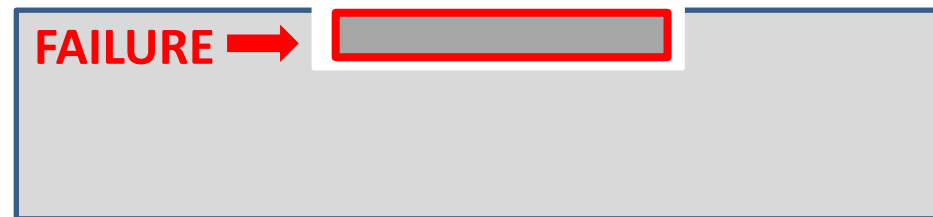
- Faulting Models for JPCP and BOCA, **Drs. Khazanovich (JPCP) Vandenbossche (BCOA)**
- Three-dimensional Micro-mechanical Characterization of the Effect of Vibration and Compaction in Concrete Pavements, **Drs. Fascetti and Vandenbossche** PITT | IRISE
- Joint Performance Optimization for JPCP, **Dr. Vandenbossche** PITT | IRISE
- Prediction of Dowel Corrosion and Effect on Performance of Concrete Pavements, **Dr. Vandenbossche** PITT | IRISE
- Design and Construction of Two-lift Concrete Pavements for Pennsylvania, **Dr. Khazanovich** PITT | IRISE



Completed Pitt Research

Materials

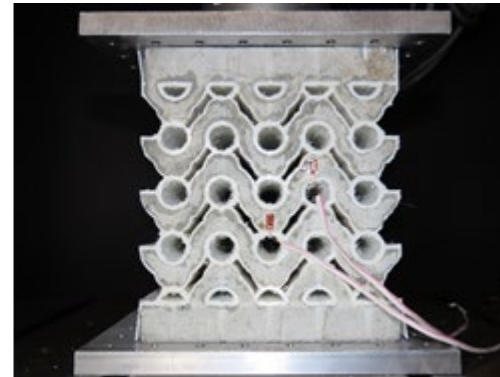
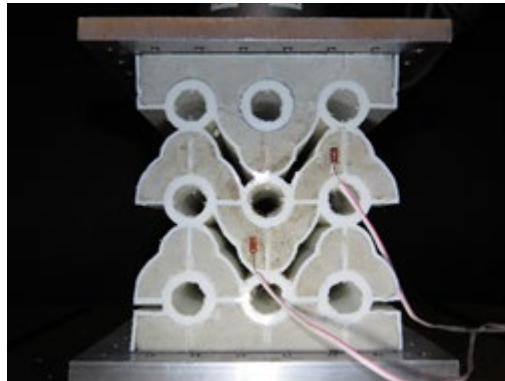
- Microbial Concrete Sealer for RC, ***Drs Sachs and Haig*** PITT | IRISE
- Carbon Nanotube Additives for Structural and Highway Concrete, ***Drs Sachs and Gilbertson***
- Material Compatible Repairs for Concrete Pavements and Bridge Decks, ***Drs. Sachs and Vandenbossche*** PITT | IRISE



Ongoing Pitt Research

Materials

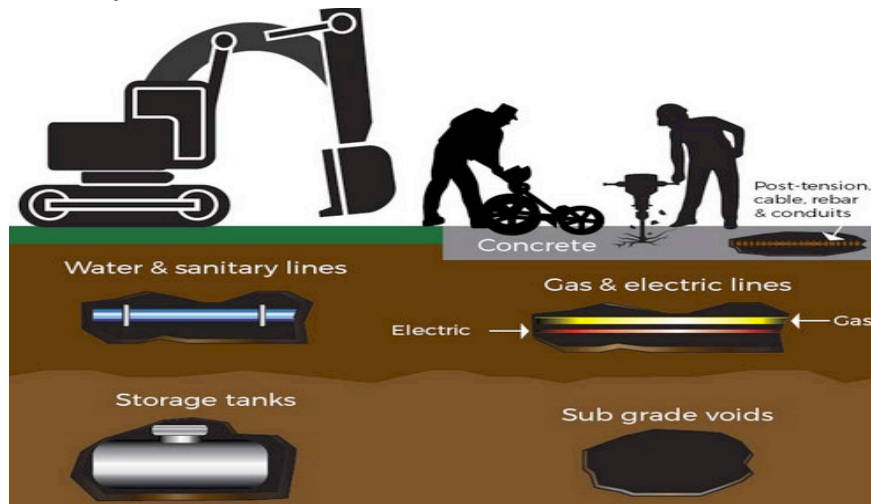
- Material Compatible Repairs Evaluation, ***Drs. Sachs, Khazanovich and Vandembossche*** PITT | IRISE
- Carbon Nanotube Additives for Structural and Highway Concrete (*Continuation*), ***Drs. Sachs and Gilbertson***
- Microbial Concrete Sealer (*Continuation*), ***Drs. Sachs and Haig***
- Developing Light-Weight and High-Performance Metamaterial Concrete, ***Dr. Alavi*** PITT | IRISE



Completed Pitt Research

Workers Safety

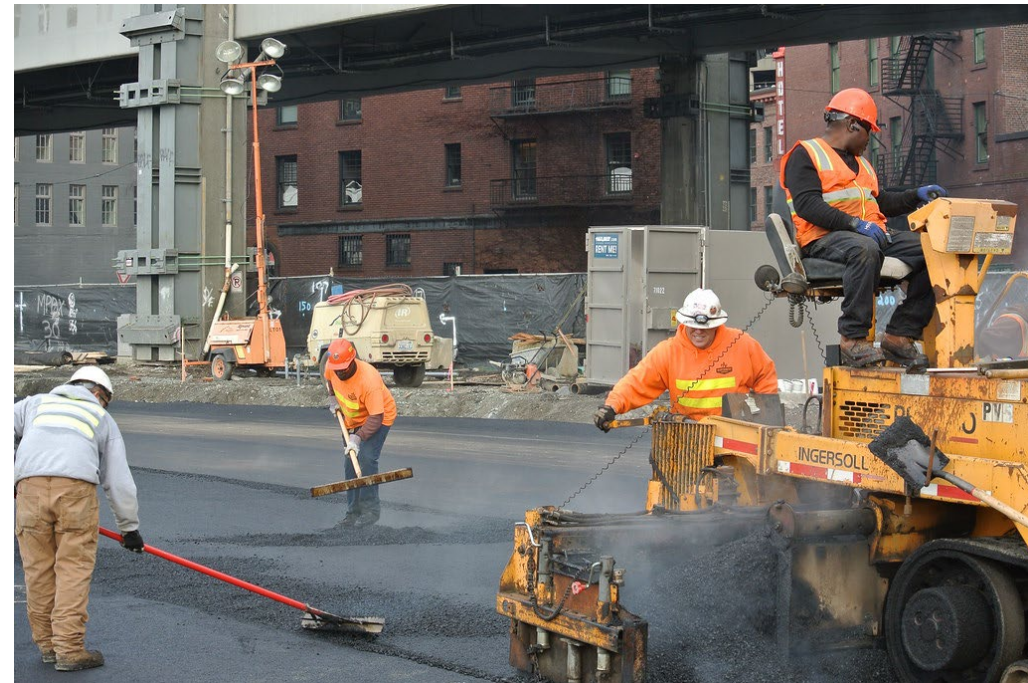
- Investigating New Underground Utility Location Technologies and Novel Methods to Improve the Safety and Efficiency of Highway Construction, **Drs. Khazanovich** PITT | IRISE
- Identifying Major Causes of Construction Accidents for the Paving Industry in Pennsylvania, **Dr. Khazanovich** PITT | IRISE



Ongoing Pitt Research

Workers Safety

- Identifying Major Causes of Construction Accidents for the Paving Industry in Pennsylvania, *Dr. Khazanovich* PITT | IRISE
- Novel Immersive VR Platform for H&S Training of Construction Workers, *Dr. Fascetti* PITT | IRISE

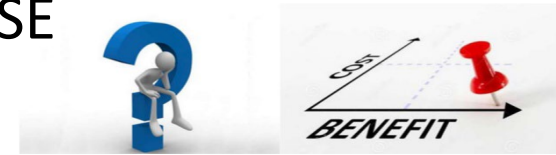


Ongoing Pitt Research

Other

- Developing Methodologies to Predict and Quantify the Benefits of IRISE Research, **Dr. Magalotti** PITT | IRISE
- Tactical Urbanism/Demonstration Projects Guide, **Dr. Stevanovic**
- A Seminar Series on Innovative and Comprehensive Stormwater Management, **Dr. Bain** PITT | IRISE

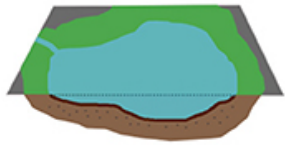
COST BENEFIT ANALYSIS



Eco

Techno

Intact wetlands & forest



Detention basins



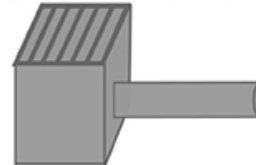
Curbside bioswales



Green roofs



Underground filter & infiltration facilities



Green infrastructure (GI)

Green stormwater infrastructure (GSI)

Stormwater control measures (SCMs)

PittRigid ME Could Save Millions in Concrete Pavement Costs

PittRigid ME gives highway designers a practical tool to select the optimal design parameters in Pennsylvania for concrete pavement sections. The PittRigid ME tool is based upon the Mechanistic-Empirical Pavement Design Guide (MEPDG) and AASHTOWare Pavement ME Design software. The MEPDG method has been shown to produce more efficient and equally durable pavement designs than the AASHTO 93 method currently used in Pennsylvania. Use of the Pavement ME software is currently recommended by AASHTO and FHWA. PittRigid ME produces similar results to Pavement ME for Pennsylvania conditions.

Case study projects were selected from the Pennsylvania Turnpike Commission, PennDOT and Allegheny County of Pennsylvania to demonstrate the benefit of using the methodology for more efficient pavement designs. These case studies represented a variety of conditions in order to illustrate how the application of the ME Guide through use of PittRigid ME tool could reduce costs. However, other factors are considered when selecting a pavement design method for a wider variety of conditions.

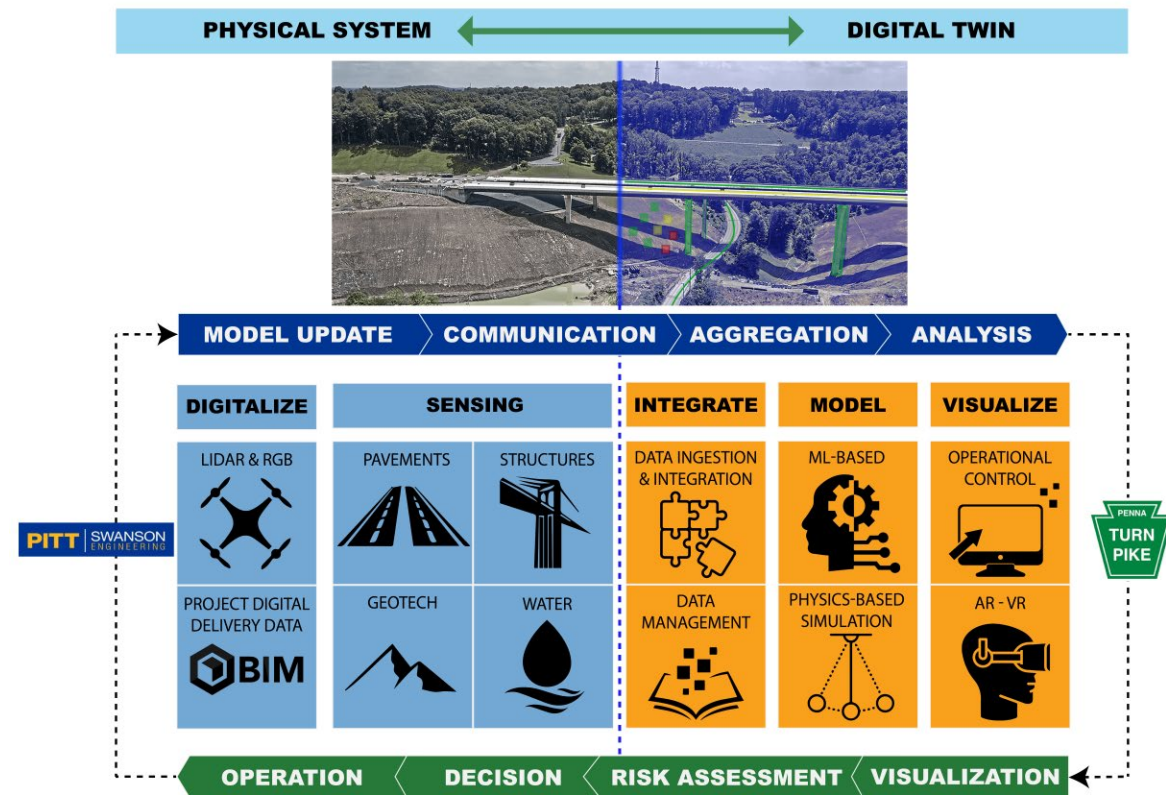
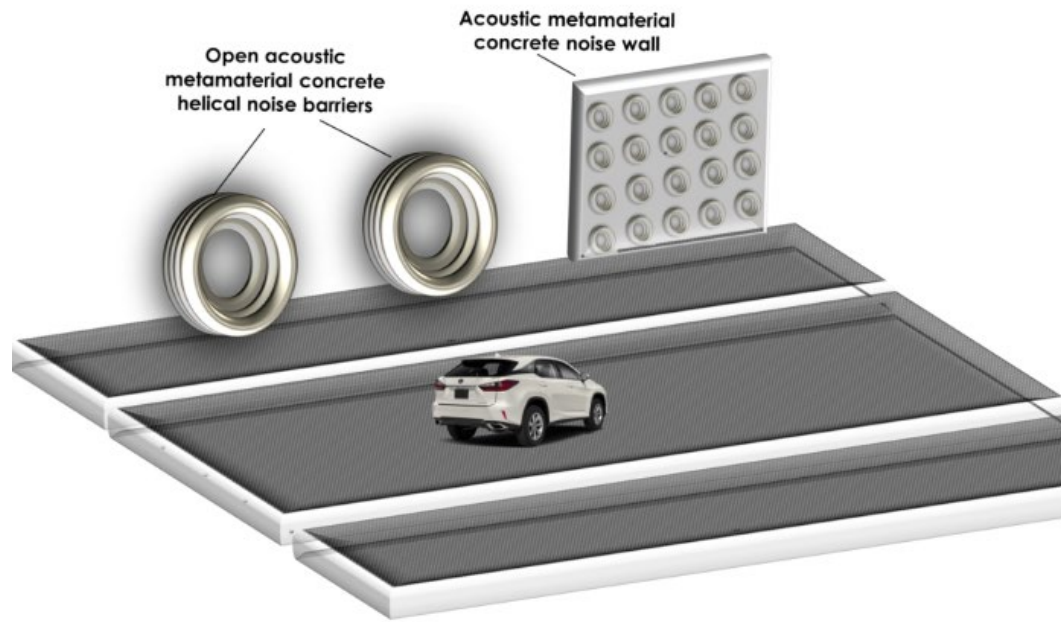
Potential cost reductions were determined by performing an alternative design using the MEPDG/PittRigid ME design method and calculating the resulting cost reductions based on the project quantities. The results of the analysis revealed these potential cost reductions.

Project	Original Design Total Costs/Depth of Pavement	PittRigid ME Design Total Costs/Depth of Pavement	Cost Reduction
Southern Railway Plain Concrete Pavement RPS	\$44,025,966	\$37,422,088	\$6,603,878
US-119 Plain Concrete Pavement RPS	\$10,840,273	\$9,044,232	\$1,796,041
Ivory Avenue Plain Concrete Pavement RPS	\$210,375	\$178,819	\$31,556
Total			\$8,231,475

This benefit analysis reveals that if the PittRigid ME Designs for the three case studies had been used total pavement construction costs would have been reduced by a total of \$8,231,475. As shown, the benefits were significant for all three case studies representing different project scales but not all pavement design scenarios.

Mon Fayette Expressway Test Bed

- Absorptive Sound Walls: **Dr. Alavi**
- Digital Twin Technology: **Dr. Fascetti**
- Electrified Roadway Strategic Plan: **Dr. Alavi**
- Energy Harvesting: **Dr. Alavi**



IRISE Year 6 Projects Being Initiated

1. *Bridge*: Bridge Load Ratings, **Dr. Rizzo**
2. *Geotechnical*: Why do they keep sliding? Analysis of Reoccurring Landslides in SWPA to Advance Hazard and Risk Estimates, **Dr. Bain**
3. *Pavement*: Adaptation of a Large Language Model for Facilitating Pavement-Related Information Retrieval and Knowledge Discovery, **Dr. Khazanovich**
4. *Materials*: Self-Heating Concrete Pavement Systems with Surface-Mounted Heating Elements, **Dr. Alavi**
5. *Other*: Supervised Learning for Classification of High-Resolution LiDAR Point Clouds, **Dr. Fascetti**
6. *Other*: Developing and Applying Methodologies to Quantify the Benefits of IRISE Projects, **Dr. Mark Magalotti and Matt Macey, PE**

Bridge

Bridge Load Ratings

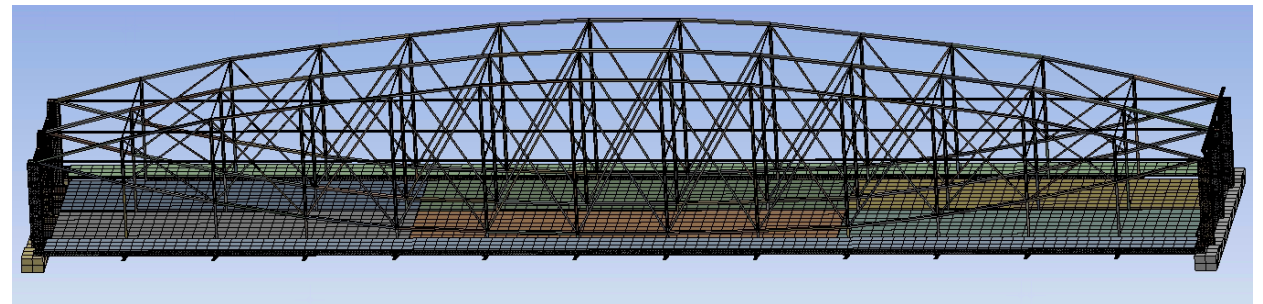
Problem: Need to improve load rating analysis methods as the current approach results in an elevated number of bridges being deemed unsafe due to rising load demands

Approach:

- Bridge Selection and Digital Twin Creation
- Load Bridge Rating Analysis and Comparison
- Software Tool Development

Dr. Rizzo

Duration: 17-months



Geotechnical **Why do they keep sliding? Analysis of Reoccurring Landslides in SWPA to Advance Hazard and Risk Estimates**

Problem: Need to investigate the factors leading to the recurrent landslides in Southwestern Pennsylvania

Approach:

- Conduct Spatial Analysis
- Develop Mechanistic Models
- Comparative Multivariate Analysis

Drs. Bain, Shelef and Iannacchione

Duration: 12-months



Pavements

Problem: There is a need for an AI language model tailored to pavement engineering, capable of answering technical questions, providing training, and facilitating knowledge discovery within this specialized domain.

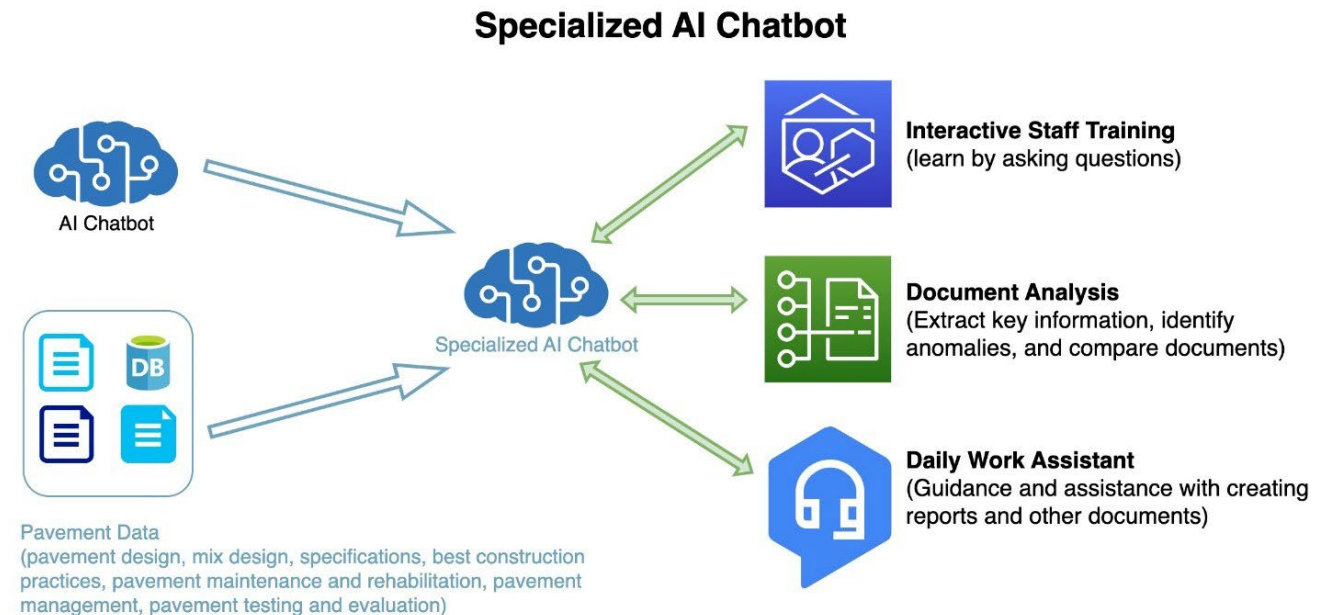
Approach:

- AI Model development
- Task-specific fine-tuning
- User-focused capabilities

Dr. Khazanovich

Duration: 12-months

Chat for Facilitating Pavement-Related Information Retrieval and Knowledge Discovery



Pavements Self-Heating Concrete Pavement Systems with Surface-Mounted Heating Elements

Problem: There is a need to find a sustainable and efficient solution for snow and ice removal from roadways to reduce the environmental impact of deicing chemicals and the disruptions caused by conventional methods.

Approach:

- Review of the State-of-the-Art of Self-heating Pavement Research
- Characterization and Optimization of the Heating Performance of the Conductive Elements
- Design and Fabrication of Self-heating Concrete Slabs with Surface-Mounted Heating Elements and Field Demonstration

Drs. Alavi and Khazanovich

Duration: 24-months

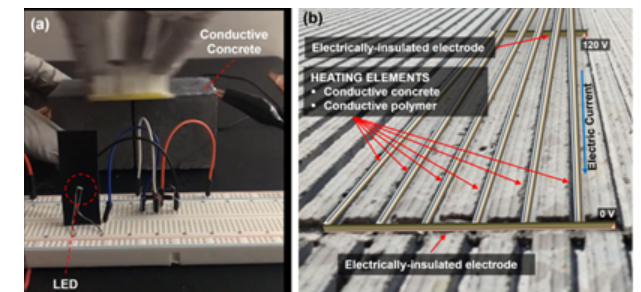


Fig. 2. (a) Conductive concrete developed at Pitt powers an LED [14]. (b) Vision for self-heating concrete pavement with surface-mounted heating elements partially filling the grooves.

Other Supervised Learning for Classification of High-Resolution LiDAR Point Clouds

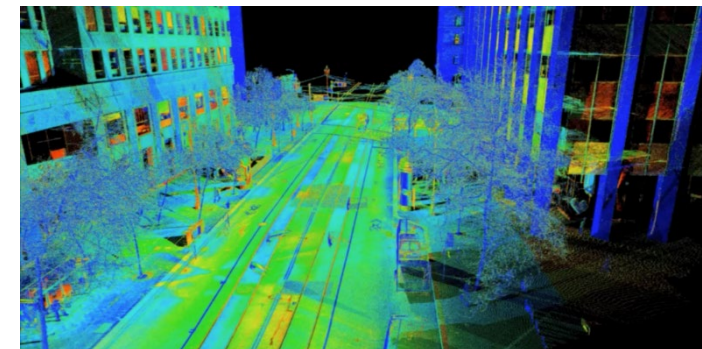
Problem: Critical need to streamline the extraction of valuable information from high-resolution LiDAR point clouds in civil infrastructure projects, as current manual classification methods are labor-intensive and inefficient.

Approach: Develop innovative classification tools using supervised learning for the segmentation of 3D point clouds.

- Review of current practices in point cloud segmentation
- Dual Approach: 3D Scene and 2D Camera-Based Classification
- Development of Segmentation Algorithms

Dr. Fascetti

Duration: 24-months



Other **Developing and Applying Methodologies to Quantify the Benefits of IRISE Projects**

Problem: There is a need to develop and apply methodologies to quantitatively measure the benefits of completed or ongoing IRISE research projects that enhance transportation infrastructure, reduce life cycle costs, and inform the decision-making of transportation agencies.

Approach:

- Identification and Selection of IRISE projects
- Methodology development and Benefit Analysis
- Evaluations and Recommendation

Dr. Mark Magalotti and Matt Macey, PE CDR Maguire

Duration: 12-months

COST BENEFIT ANALYSIS



Other Activities

- Student involvement
- Workshops/seminars
- Demonstration projects
- Tech days
- Presentations to help tech deployment
- Other ideas ????



Three Sisters Bridges – Allegheny Cnty



Thank You!

