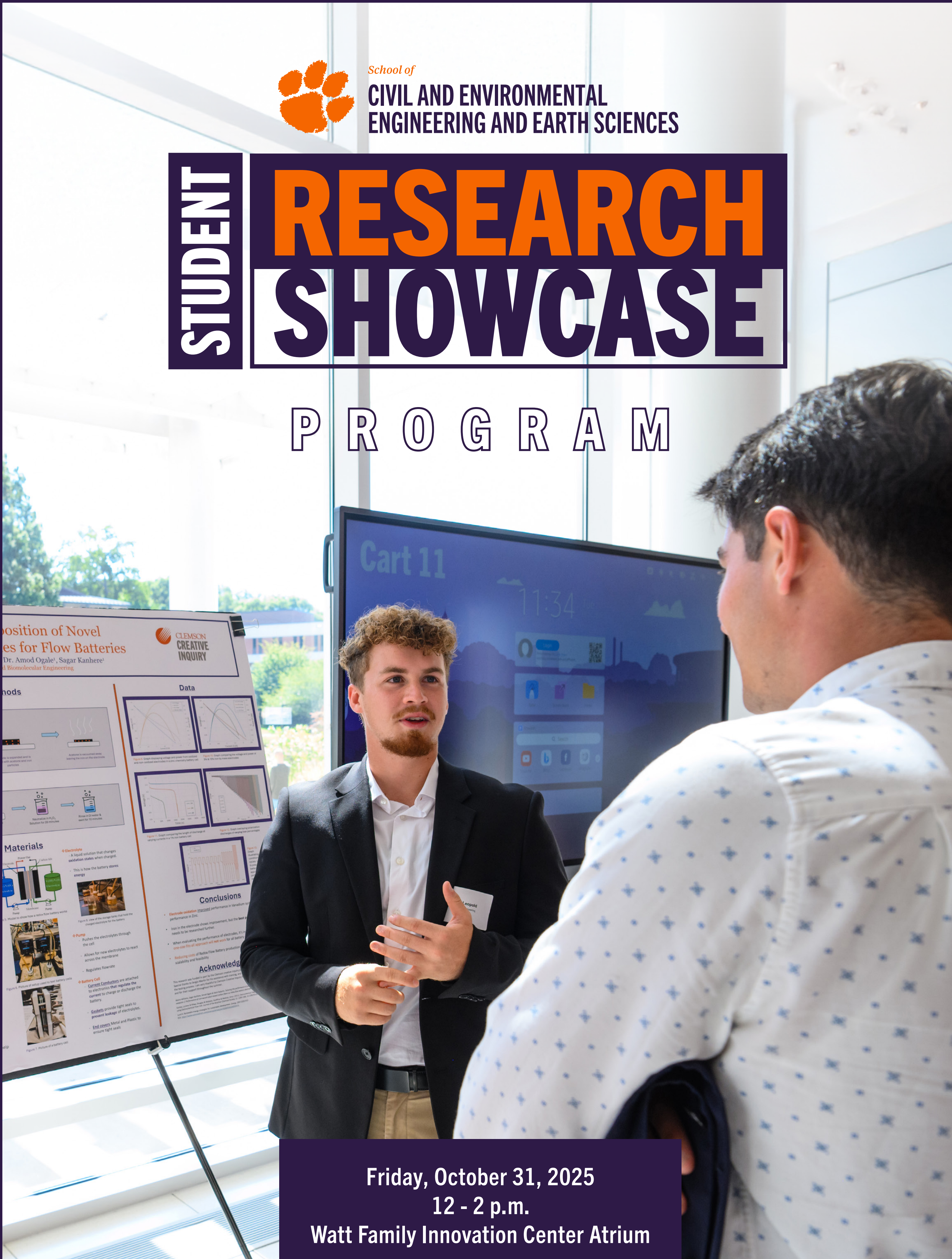
School of

CIVIL AND ENVIRONMENTAL ENGINEERING AND EARTH SCIENCES

STUDENT RESEARCH SHOWCASE

PROGRAM



Friday, October 31, 2025

12 - 2 p.m.

Watt Family Innovation Center Atrium

PRINTED POSTERS

Poster #1

Sustainably improving T.Neapolitana growth media for bio-hydrogen production

Owen Rogers, Undergraduate, Biosystems Engineering
Author(s): Owen Rogers, Caye Drapcho, Ph. D.
Faculty Advisor: Caye Drapcho, Ph. D.

As the effects of climate change become increasingly obvious, alternative energy sources are becoming more necessary to curb greenhouse gas emissions. Hydrogen energy is an emerging alternative energy source however currently the major routes of production still involve greenhouse gas emissions. Thermotoga Neapolitana is a bacterium that is able to produce hydrogen through fermentation with minimal emissions. The goal of this research is to improve the current biohydrogen production process by removing acetic acid coproducts in situ. Activated carbon will be tested for its ability to adsorb acetic acid at the high temperatures of T. Neapolitana incubation. Activated carbon was selected for testing due to both its adsorption capacity and its potential for sustainable production, in the form of biochar. By adsorbing acetic acid in situ, the pH of the reactor will remain in the ideal range for H2 production for longer allowing for greater substrate utilization. The activated carbon could also be extracted post incubation for alternative uses. The effects of activated carbon on T. Neapolitana incubation will be tested through two sets of trials, the first being used to determine the ideal carbon concentration for maximum adsorption and the second to determine what form of carbon is the most effective adsorbent. These results will be quantified using chromatography to find the amount of H2 produced and the amount of acetic acid not adsorbed.This research will hopefully improve the cost effectiveness of the biohydrogen production.

Poster #2

GPU in the Blind Spot: Overlooked Security Risks in Transportation

Sefatun-Noor Puspa, Graduate**,** Civil Engineering
Author(s): Mashrur Chowdhury, Ph. D.
Faculty Advisor: Mashrur Chowdhury, Ph. D.

GPUs are vital for AI-based applications in Intelligent Transportation Systems (ITS), but they often operate without security monitoring, making them vulnerable to unauthorized background programs that silently drain GPU resources. This work presents a case study where a YOLOv8 object detection pipeline, running on an RTX 2060 GPU, was impacted by such a process. Frame rates dropped by up to 50%, and power usage nearly doubled. Using telemetry features collected through tools like nvidia-smi and Nsight Compute, we trained lightweight classifiers that accurately detected performance degradation. This highlights the need for GPU observability in ITS and offers a practical detection approach using on-device profiling. Acknowledgment: This work is based upon the work supported by the National Center for Transportation Cybersecurity and Resiliency (TraCR) (a U.S. Department of Transportation National University Transportation Center) headquartered at Clemson University, Clemson, South Carolina, USA.

Poster #3

Effect of Mechanical Stresses on the Corrosion Behavior of Carbon Steel

Gisoo Diviran, Graduate, Civil Engineering
Author(s): Gisoo Daviran, Amir Poursaee, Ph. D.
Faculty Advisor: Amir Poursaee, Ph. D.

The interaction between mechanical stress and corrosion plays a significant role in determining the long-term durability of steel structures, particularly in reinforced concrete and other load-bearing systems. This work combines electrochemical methods like Scanning Electrochemical Microscopy (SECM) with microstructural analysis to investigate how tensile and compressive stresses affect the corrosion behavior of carbon steel. In order to simulate the extremely alkaline conditions found in concrete environments, which are necessary for the formation of a passive layer, the samples were subjected to a 1 M NaOH solution.

SECM experiments were carried out to evaluate local electrochemical activity, passive film and passive film breakdown behavior, including approach curves, cyclic voltammetry (CV), line scans, and area scans. Approach curves helped assess the reactivity of the passive layer, while line and area scans visualized how corrosion activity varied across the surface. The CV results provided additional information about the redox response and difference in kinetics of the particles caused by mechanical loading. Approach curves, area scan results, and line scan profiles obtained from SECM measurements confirm the heterogeneous electrochemical activity on stressed surfaces and the variation in passive film properties across different stress regions. The findings indicate the strong coupling between mechanical and electrochemical phenomena in carbon steel which emphasizes the importance of accounting for residual and service-induced stresses.

Poster #4

Antibiofilm Efficacy of Zwitterionic 2-methacryloyloxyethyl phosphorylcholine (MPC) Polymer Coatings against Vibrio fischeri

Murchana Sarma, Graduate, Environmental Engineering

Author(s): Murchana Sarma, Ryan O' Hara, Ayse Asatekin, Ashfaqul Khadem, Lihua Lou, Manas Warke and Debora F. Rodrigues, Ph. D.

Faculty Advisor: Debora F. Rodrigues, Ph. D.

The prevention of bacterial biofilms is critical for maintaining water-associated infrastructure and mitigating biofouling. In this study we investigated zwitterionic amphiphilic copolymer (ZAC) coatings containing 70:30 molar ratios of 2-methacryloyloxyethyl phosphorylcholine (MPC) with both PMMA (PM: MPC) and PTFEMA (PT: MPC), and compared them to homopolymers (PMMA, PTFEMA) and uncoated glass controls. Coatings were applied to glass surfaces and systematically evaluated for antibiofilm activity against Vibrio fischeri. Both ZACs significantly reduced biofilm biomass and thickness relative to homopolymers and control, as quantified by confocal microscopy. At 72-hour time point, PT: MPC 70:30 and PM: MPC 70:30 suppressed biomass accumulation by more than 90% compared to control. Gene expression profiling further revealed strong downregulation of motility (motY, flrC, flgF), adhesion (pilU, pilT, pilA, mshA), and regulatory genes (rscS, luxR, litR), indicating impaired colonization and biofilm maturation. Biofilm matrix genes (sypF, sypG, vpsR) also showed minimal expression on ZAC surfaces, consistent with limited extracellular polymeric substance production. Together, these results demonstrate that MPC-containing ZAC coatings strongly inhibit biofilm development by interfering with bacterial adhesion, motility, and gene regulation, underscoring their potential as antifouling surfaces for water-related applications.

Poster #5

Enhancing Timber Piles Inspection in South Carolina Bridges Using Non-Destructive Methods

Aashish Sapkota, Graduate, Civil Engineering

Author(s): Aashish Sapkota, Brandon Ross, Ph. D., Brunela Rodrigues, Tommy Cousins, Ph.D., Weichiang Pang, Ph.D.

Faculty Advisor: Brandon Ross, Ph. D.

Timber piles form a vital component of bridge substructures and are extensively used throughout South Carolina, with an estimated 75,000 piles supporting the state's transportation infrastructure. However, wood deterioration remains the primary cause of their structural failures, highlighting the need for cost-effective, reliable, and field-deployable methods for evaluating their condition. This research aims to identify and assess nondestructive evaluation (NDE) techniques capable of detecting internal decay in timber piles, thereby facilitating preventive maintenance and repair strategies. To address this, NDE methods called resistance micro-drilling, and stress wave timing were used on 16" shorter pile segments. Resistance micro-drilling measures internal resistance during drilling, revealing low-density zones associated with decay or voids. The stress wave timer determines the propagation velocity of stress waves through wood, where slower travel times indicate deteriorated regions. The collected NDE data are correlated with the compressive strength and modulus of elasticity obtained from compression load tests on pile segments. This approach enables quantitative relationships between nondestructive indicators and the actual mechanical performance of deteriorated timber piles. The current status of the equipment in research shows that their result perfectly aligns with the visual decay observed.

Poster #6

Quantifying Microstructure in Quaternary Sands Near Charleston, South Carolina Using Measured-to-Estimated Velocity Ratio

Bikram Paudel, Graduate, Civil Engineering
Author(s): Bikram Paudel, Ronald D. Andrus, Ph. D.
Faculty Advisor: Ronald Andrus, Ph. D.

Charleston, South Carolina, is one of the most seismically vulnerable regions in the eastern United States. The 1886 Charleston earthquake ($M_w \approx 7.0$) caused widespread damage, resulting in 124 fatalities. This study aims to quantify the degree of microstructure, or the effects of cementation and age, in the soil near Charleston more than 113 years after the 1886 earthquake. A total of 228 seismic cone penetration test (SCPT) profiles from six surficial sandy units are analyzed in this study. The microstructure is quantified using the measured-to-estimated velocity ratio (MEVR). MEVR is defined as the measured shear-wave velocity (Vs) divided by the estimated Vs. The estimated Vs is determined using a relationship with cone tip resistance for young sands. According to Andrus et al. (2009), an MEVR value of 1 indicates a 6-year-old uncemented sand, whereas an MEVR value of 1.5 indicates an 8,000,000-year-old uncemented sand or a cemented sand. The results show that all six Quaternary units contain several sites with MEVR values near 1, suggesting that the 1886 earthquake significantly disturbed the interparticle bonding or microstructure. Some sites exhibited MEVR values more than 1.5, suggesting significant cementation. These findings align well with the liquefaction susceptibility assessment by Gathro (2018).By improving the understanding of soil microstructure in the soils near the Charleston area, this study helps engineers and scientists to better predict the soil behavior during future earthquakes, which can contribute to safer design of infrastructure.

Poster #7

Transportation Cyber Incident Awareness Through Generative AI-Based Incident Analysis and Retrieval-Augmented Question-Answering Systems

Ostonya Thomas, Graduate, Civil Engineering

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Faculty Advisor: Mashrur Chowdhury, Ph. D., P.E.

Technological advancements have transformed transportation through digitalization, automation, and connectivity, improving safety and efficiency but also introducing new cyber vulnerabilities. With 95 percent of data breaches linked to human error, promoting cybersecurity awareness in transportation is crucial. Despite numerous global attacks, centralized and comprehensive records remain limited. To address this gap, this project presents a large language model (LLM) based approach to extract and organize transportation related cyber incidents from public datasets. Generative AI is used to convert unstructured and diverse data into structured formats. Incident data were collected from sources including the CSIS List of Significant Cyber Incidents, UMCED, EuRepoC, MCAD, and the U.S. DOT's TraCR database from 2018 to 2022. A fine tuned LLM classified incidents into five transportation modes: aviation, maritime, rail, road, and multimodal, forming a transportation specific cyber incident database. The classification process retained 74 of 75 relevant incidents, demonstrating effective structured data filtering. A Retrieval Augmented Generation (RAG) question answering system was also developed to improve accessibility, allowing users to query the database for specific incident details. Manual inspection confirmed strong factual accuracy, with 49 of 50 questions answered correctly. By combining LLM based data extraction and interactive querying, this study introduces a practical tool to strengthen cybersecurity awareness and resilience in the transportation sector.

PRINTED POSTERS

Poster #8

Efficient Prediction of Seismic Amplification Factors Using Machine Learning Models

Ashish Bahuguna , Graduate, Civil Engineering
Author(s): Ashish Bahuguna, Jatheesan Sundarajan, Nadarajah Ravichandran, Ph. D.
Faculty Advisor: Nadarajah Ravichandran, Ph. D.

Predicting realistic site-specific earthquake hazard is important for designing and constructing earthquake-resistant infrastructure systems. However, due to aleatory and epistemic uncertainties associated with earthquake predictions, accurately estimating earthquake hazards remains challenging. Traditional methods, such as detailed computer simulations, require substantial site-specific data and significant computing time, making them expensive and time-consuming. This study explores machine learning (ML) techniques as a faster, more efficient, and accurate alternative for estimating site-specific earthquake hazard parameters such as seismic site amplification factors (AF). This study used a large dataset of earthquake ground response simulations from South Carolina's Blue Ridge Piedmont region to evaluate five machine learning models: Random Forest, Gradient Boosting, XGBoost, Deep Neural Networks, and Residual Neural Networks. Cross-validation ensured reliable performance comparisons. Gradient Boosting was the most accurate, with prediction errors ranging from 7% to 10%. The most influential input factors were seismic wave velocity in the top 100 ft of soil (V_{s100}ft) and soil layer depth. Results show that ML can streamline seismic analysis while maintaining high accuracy, aiding safer infrastructure design and promoting resilience. Future studies can extend this approach to predict structural response and optimize design strategies for community and transportation infrastructure, such as bridges, buildings, and railways, further improving resilience and sustainability.

Poster #9

Bio-inspired Corrosion Protection Enhanced with Nanoparticles for Sustainable Steel Infrastructure

Rashid Alwashahi , Graduate, Civil Engineering
Author(s): Rashid Alwashahi
Faculty Advisor: Amir Poursaee, Ph. D.

This study presents a bio-inspired, eco-friendly multilayer coating enhanced with nanoparticles to improve long-term corrosion resistance of carbon steel in marine environments. Conventional coatings often depend on petrochemical resins and toxic corrosion inhibitors, which pose sustainability and safety challenges. Inspired by natural protective mechanisms found in plant cuticles and shell structures, this work integrates renewable bio-based polymers with nano-reinforcements to mimic nature's layered defense strategy. The multilayer coating forms a compact, hydrophobic, and mechanically stable film that effectively blocks water and ion diffusion. Nanoparticles were incorporated to strengthen barrier performance, enhance UV stability, and extend coating longevity under saline exposure. Electrochemical impedance and immersion tests confirmed significant improvement in corrosion resistance and structural integrity compared to uncoated steel. This bio-inspired, nano-enhanced system provides a sustainable and high-performance alternative to synthetic coatings, combining environmental responsibility with engineering durability. It demonstrates the potential of merging green chemistry and nanotechnology for next-generation corrosion protection in infrastructure, marine, and industrial applications.

Poster #10

Microbial Allies: Exploring Bacterial Contributions to Fungal Copper Resistance

Lurima Faria , Graduate, Environmental Engineering

Author(s): Lurima Uane S. Faria, Claudio A. Oller do Nascimento, Debora F. Rodrigues, Ph. D.

Faculty Advisor: Debora Rodrigues, Ph. D.

Microbial interactions between fungi and bacteria play crucial roles in metal-contaminated environments, yet their mechanisms remain poorly understood. This study investigated how hyphosphere bacteria influence fungal copper resistance using isolates from a copper mine in Beaver County, Utah. A 3D column system enabled isolation of fungi and associated bacteria. Key fungal genera included Trichoderma, Fusarium, and Aspergillus, alongside hyphosphere bacteria Pseudomonas and Sphingomonas. Minimum inhibitory concentration (MIC) assays showed fungal resistance from 8.17 to 9.37 mmol L^{-1} Cu^{2+}, while fungal–bacterial co-cultures exceeded 9.37 mmol L^{-1}, highlighting the synergistic potential of these communities. Fourier Transform Infrared Spectroscopy (FTIR) of copper-exposed mycelium indicated interactions with lipids, proteins, and phosphate groups, suggesting key functional groups involved in metal binding. Synchrotron X-ray fluorescence (XRF) provided insight into fungal metabolic activity and extracellular metal complexation, revealing copper bound to glutathione, indicating detoxification, and phosphate, suggesting precipitation or binding within the biomass or media. This research highlights the role of hyphosphere bacteria in enhancing fungal resistance to ionic copper, showing that these bacteria could support integrated bioremediation strategies in heavy metal-contaminated environments.

Poster #11

An In-Vehicle Digital Twin-Based Collision Detection Framework with Sybil Attack Detection Capability for Connected Vehicles

Mohammad Imtiaz “Imtiaz” Hasan, Graduate, Civil Engineering

Author(s): Mohammad Imtiaz Hasan, Jean Michel Tine, Araf Rahman, M Sabbir Salek, Abyad Enan, Mashrur Chowdhury, Ph. D.

Faculty Advisor: Mashrur "Ronnie" Chowdhury, Ph. D.

Connected Vehicles (CVs) rely heavily on communication technologies to leverage data-driven and predictive analyses for enhanced performance, optimized emissions, and superior user experience. These data are utilized by safety-critical Intelligent Transportation System (ITS) applications, such as collision detection, lane assistance and many more. However, these communication technologies can also be utilized by malicious attackers to conduct a wide range of cyber-attacks, rendering the vehicle vulnerable and putting human lives in jeopardy. One of the most common cyber-attacks on vehicular networks is the Sybil attack, which can impact both the safety-critical and mobility applications in CVs. In this study, we present an in-vehicle Digital Twin (DT)- based collision detection framework with Sybil attack detection capability. Leveraging a Temporal Convolution Network (TCN) and Hierarchical Navigable Small World (HNSW) algorithm, this framework can detect sybil attacks on a collision detection application and simultaneously act as a reliable failsafe program. The framework has been tested using field data obtained by driving two vehicles on the McGregor Road at Clemson, SC. Cellular Vehicle-to-Everything (C-V2X) radio, Global Positioning System (GPS) data, and a microscopic traffic simulator were used to generate data. During field testing, the framework demonstrated 99.7% accuracy and 98.2% F-1 score in Sybil attack detection. The increasing deployment of CVs underscores the urgency of addressing security vulnerabilities in ITS infrastructures.

Poster #12

Efficient Prediction of Seismic Amplification Factors Using Machine Learning Models

Ashish Bahuguna, Graduate, Civil Engineering
Author(s): Ashish Bahuguna, Jatheesan Sundarajan, Nadarajah Ravichandran, Ph. D.
Faculty Advisor: Nadarajah Ravichandran, Ph. D.

South Carolina (SC) is one of the seismically active states in the Central and Eastern United States, and accurate site-specific hazard estimation is essential for the design of resilient transportation systems. For decades, the South Carolina Department of Transportation (SCDOT) had been using Western U.S. seismic models due to limited seismic recordings and a lack of effort to develop models specific to SC, even though the geologic and seismological conditions are significantly different. As part of a major study funded by the SCDOT, statewide seismic hazard models and maps were developed for hard rock and reference outcrop site conditions for the Blue Ridge and Piedmont and Coastal Plain regions, considering respective geology and seismology. The maps were generated for four return periods: 2,500, 1,000, 500, and 100 years, relevant to seismic design of transportation. Then, a special-purpose software called CarolinaShake with a user-friendly graphical user interface and several special features was developed, implementing the models and maps. These features include (a) selecting seed motions from Central and Eastern United States Seismic Source Characterization (CEUS-SSC) and NGA-East ground motion databases, (b) modifying seed motions using time- or frequency-domain techniques, (c) scaling motions to match the target spectrum at specific period or over the entire range, and (d) displaying and comparing seed and modified time histories for easy selection process. CarolinaShake can predict hazards at any project location in SC, with a 50 km buffer zone outside the state.

Poster #13

Experimental Evaluation of Post-Quantum Homomorphic Encryption for Privacy-Preserving V2X/I2I Communication

Abdullah Al Mamun , Graduate, Civil Engineering

Author(s): Abdullah Al Mamun, Kyle Yates, Antsa Rakotondrafara, Mashrur "Ronnie" Chowdhury, Ph. D., Ryann Cartor, Ph. D., Shuhong Gao, Ph. D.

Faculty Advisor: Mashrur Chowdhury, Ph. D.

Intelligent Transportation Systems (ITS) depend on vehicle data for congestion monitoring, route planning, and traffic optimization. Because vehicles and roadside units (RSUs) have limited computing power, much of this data is processed in the cloud, raising privacy concerns as sensitive information may be exposed during decryption. This study evaluates whether Homomorphic Encryption (HE), which enables computation directly on encrypted data without any decryption, can secure ITS analytics. Three post-quantum HE schemes, i.e., BFV, BGV, and CKKS, were tested using the OpenFHE library in a real-world RSU-to-Cloud pipeline over Wi-Fi and Ethernet. BFV and BGV achieved practical end-to-end latency for non-safety-critical applications, while CKKS supported more complex analytics but with higher latency. None of the schemes met the <100 ms real-time threshold for ITS safety-critical operations. Findings indicate that post-quantum HE can support near-real-time, privacy-preserving ITS data processing, paving the way for quantum-resilient privacy-preserving cryptography in ITS.Acknowledgment: This research was supported by the National Center for Transportation Cybersecurity and Resiliency (TraCR), a U.S. Department of Transportation National University Transportation Center at Clemson University.

Poster #14

Spatial Quantification of Microplastic Contents in Lake Jocassee, South Carolina

Tiffany Barker-Edwards , Graduate, Hydrogeology

Author(s): Tiffany Barker-Edwards, Kelly Best Lazar, Ph. D.

Faculty Advisor: Kelly Best Lazar, Ph. D.

In 2004, Richard Thompson coined the term 'microplastics" after he observed a daily tide of plastic litter appearing while completing research. Each day, Thompson removed the bits of plastic, but they always returned. Since then, the term microplastics has been used to describe plastic particles less than 5 millimeters in size, and they have been found in most aquatic systems on Earth. Microplastics are more than just an environmental nuisance; they are of particular concern due to their direct biological effects and roles as sorbents of other chemical compounds as they are transported through different environments. This study used two different sampling methods to spatially quantify microplastic concentrations within a man-made lake in South Carolina. Within the epipelagic zone, a plankton net was used to sift through the lake surface and collect microplastics. Additionally, within the benthic zone, an Ekman dredge was used to grab sediment samples along the lake bed. Sampling in these two zones will allow us to compare microplastics within surface waters and in the bedload. These research findings will provide a characterization of microplastic particle types within Lake Jocassee, including various polymer types, shapes, sizes, and colors. The collection methods selected will help determine the vertical distribution, illustrating the vertical movement and accumulation of microplastics. By developing a spatial concentration map of microplastics in this lake system, we are furthering our understanding of microplastic transport and fate within marine environments.

Poster #15

Mitigation of Shrinkage Cracking in Concrete Bridge Decks Using Internal Curing

Sanish Kottarathil Bhaskaramarar , Graduate, Civil Engineering
Author(s): Sanish K. Bhaskaramarar, Prasad Rangaraju, Ph.D., P.E.
Faculty Advisor: Prasad Rangaraju, Ph. D.

High-performance concrete (HPC) has become the material of choice for bridge decks due to its superior strength, low permeability, and enhanced durability. However, the very low water-to-cement ratio and frequent incorporation of supplementary cementitious materials make HPC mixtures particularly vulnerable to autogenous and drying shrinkage. These shrinkage mechanisms often result in early-age cracking, which can compromise durability. This study investigates internal curing as a practical and scalable strategy to mitigate shrinkage in HPC bridge decks. Initial experiments utilized lightweight aggregate (LWA) as an internal water reservoir. Results demonstrated that LWA incorporation reduced shrinkage relative to control mixtures, though cracking was not fully eliminated. To further enhance performance, additional internal curing agents-including polyethylene glycol, and superabsorbent polymers (SAP), are being evaluated. These materials offer the potential to enhance moisture retention, reduce costs, and maintain the mechanical properties. Non-destructive testing (NDT) techniques, including electrical impedance and dielectric measurements, are being used to enable optimization of material combinations. The overarching objective of this research is to develop a cost-effective and durable internal curing approach that minimizes shrinkage-induced cracking in HPC bridge decks. By enhancing durability and extending service life, the findings aim to support the design of more resilient, sustainable, and reliable transportation infrastructure.

Poster #16

Geologic Mapping of Cretaceous and Tertiary volcanic and hypabyssal rocks at Highland Lakes, California

Joseph “Joe” Dixon , Undergraduate, Geology
Author(s): Joe Dixon, Joe Constantino, Sloan McNelly, Mary Kate Fidler, Ph. D.
Faculty Advisor: Mary Kate Fidler, Ph. D.

New geologic mapping in the vicinity of Highland Lakes, California, provides new insights into the Neogene volcanic and intrusive history of this understudied region of the Sierra Nevada basin and range, where crustal thinning and extension have taken place. Previous geologic mapping by others suggests the presence of radial dikes, but their compositions and orientations were not well documented, and different authors disagree on the rock units present. Field data were collected to construct a detailed geologic map (1:5,000 scale) and record dike orientations. Mapping and stereonet analysis of over 80 dikes confirms that the dikes around Highland Lakes do exhibit a radial arrangement, and the vast majority share the same composition and phenocryst assemblage. From this, we infer that Highland Lakes was the site of a previously undocumented ancient volcanic center. Future work to date these dikes may reveal whether this volcano is distinct in age from the other vents in the central Sierra Nevada.

Poster #17

Active tracer shows promise in solving geothermal short circuit problem

Charles "Pearson" Midgley , Undergraduate, Environmental Engineering

Author(s): Pearson Midgley, Carolyn Pierce, Evan Visaggio-Lopez, Josh Parris, Camila Santander, and Adam J. Hawkins, Ph. D.

Faculty Advisor: Adam J. Hawkins, Ph. D.

Commercially-successful geothermal systems require balance between thermal and hydraulic performance. An injector-producer well pair with exceptional hydraulic performance, for instance, may have inadequate thermal performance if the effective heat transfer surface area is insufficient. In such a circumstance the current state-of-the-art is to abandon such well pairs once production well temperatures fall below design/operating criteria. This research aims to further develop controls for water viscosity with the aid of hydrogel microsphere tracers. An "active" tracer is as a novel solution that enables cooled "short circuits" to be sealed off and circulating fluids to be redirected to hotter flow paths. Specifically, temperature-responsive tracers that spontaneously transition from a passive shrunken state to an active swollen state when local temperature falls below a critical threshold, called volume phase transition temperature (VPTT). This treatment increases the effective heat transfer area and subsequently improves thermal performance by increasing production well temperatures. Here, we utilize a temperature-controlled microscope to investigate the transition properties of specially-designed hydrogel microspheres to serve as an active tracer solution to the short circuit problem. We measured the volume phase transition temperature and volume ratios of four specific recipes that differ by varying ratios of comonomers. Our results show dramatic changes in the particle volumes which suggest this novel material holds promise for controlling short circuits.

Poster #18

Comparison of winter and summer temperatures during storm events in a bioretention cell

Jack Cuneo, Undergraduate, Biosystems Engineering

Author(s): Jack Cuneo, Allison Curl, Debabrata Sahoo, Ph. D.

Faculty Advisor: Debabrata Sahoo, Ph. D.

Bioretention cells (BRCs) are one of the stormwater best management practices (BMPs) that treat and mitigate urban stormwater runoff while providing multiple ecosystem services. While BRCs are effective in trapping many pollutants, very little information is available on their effectiveness in regulating temperature within the cell as water moves through the system. Temperature is the fundamental state variable that affects various ecological processes within these BMPs. Much of the research conducted on BRC temperature focuses on monitoring the BRC in the inlet and outlet during storm events, particularly to understand their role in regulating downstream temperatures. However, based on the literature review, few studies have examined temperature seasonally within BRCs during storm events. This team's overall goal is to develop a system to measure high-frequency temperature at multiple locations within a bioretention cell with minimal disturbance and simple instrumentation, providing better temporal temperature characterization of the cell. This team designed a sensing apparatus using ibutton temperature sensors and a perforated steel rod to assess the system's feasibility. Three winter storms were monitored, followed by three summer storms. Capturing the seasonal differences in temperature during storm events allows for the efficacy of BRCs to be assessed in terms of temperature pollution treatment capabilities, especially during the summer when water temperatures entering the BRC are at an annual high.

PRINTED POSTERS

Poster #19

Enhancing optimization strategies for cable-supporting system design optimization in cable-stayed bridges

Sujal Sapkota, Graduate, Civil Engineering
Author(s): Sujal Sapkota, Miguel Cid Montoya, Ph. D.
Faculty Advisor: Miguel Cid Montoya, Ph. D.

The performance of cable-stayed bridges is drastically conditioned by the design of the cable-supporting system. Finding the optimal combination of cross-sectional areas and prestressing forces for a given cable-supporting system configuration is crucial to ensure safety and cost-effectiveness. Despite the clear benefits of structural optimization techniques for this goal, their implementation in the industry and the research realm when addressing natural hazards is quite limited due to their high computational demands and implementation challenges.This study proposes and compares four different optimization strategies aiming at reducing the computational burden, laying the foundation for their effective formulation and implementation. The first strategy is a traditional nested approach, which considers all cable cross-section areas as design variables and calculates the prestressing forces in each evaluation by solving a system of linear equations to achieve zero dead load displacement. The second method, simultaneous optimization, involves both area and prestressing forces as design variables, while solving the zero-displacement constraint throughout the optimization process. Moreover, two new sequential optimization methods divide the optimization into two stages: area optimization and prestressing forces calculation. This second phase is solved by either standalone optimization or by solving equations for zero displacement. The results suggest that adopting methods 2 or 4 can significantly reduce the use of computational resources compared to the traditional approach.

Poster #20

Sustainable Use of Pond Fines as an Agglomerated Material in Portland Cement Mixtures and Masonry

Kensley Dantzler, Graduate, Civil Engineering
Author(s): Kensley Dantzler, Prasad Rangaraju, Ph.D., P.E.,
Faculty Advisor: Prasad Rangaraju, Ph. D.

Pond fines are a by-product generated during the crushing and washing of aggregates in quarry operations. Produced in large volumes and often stockpiled, these fines present both environmental and economic challenges due to their extremely fine particle size, which makes them prone to dispersion by wind and water. Without effective reuse strategies, pond fines contribute to waste management burdens while valuable resources remain underutilized. In the context of resource depletion and the global push toward carbon-neutral construction practices, the sustainable use of quarry by-products has become increasingly important. This research investigates the development of agglomerated pond fines as a sustainable construction material by utilizing alkali-activated geopolymers. Ground granulated blast furnace slag, activated with a 4N sodium hydroxide solution, is employed as the primary binder. Pond fines sourced from four distinct quarries are being evaluated to account for variability in mineralogical and physical properties. The study aims to produce a synthetic lightweight aggregate with three potential applications: (1) as a lightweight aggregate in concrete mixtures with moderate performance requirements, (2) as an internal curing agent to enhance hydration and durability in concrete, and 3) as a masonry material.

Poster #21

A GAN-based Defense Strategy for Adversarial Patch Attack Resilient Traffic Sign Classification for Autonomous Vehicles

Abyad Enan, Graduate, Civil Engineering
Author(s): Abyad Enan, Mashrur Chowdhury, Ph. D.
Faculty Advisor: Mashrur "Ronnie" Chowdhury, Ph. D.

Adversarial Machine Learning poses a major threat to systems relying on Artificial Intelligence models. Among them the Adversarial Patch Attack (APA) is a notable physical attack in computer vision, where an adversary places a crafted patch on an object to deceive an image classifier. Autonomous Vehicles (AVs), depending heavily on computer vision for perception and decision-making, are particularly vulnerable to such attacks. The perception module of an AV detects traffic signs, road markings, and other elements to ensure safe navigation. However, if an adversarial patch is placed on a traffic sign, the classifier may misidentify it, for instance, a stop sign could be misclassified as a speed limit sign, potentially leading to severe consequences. To address this issue, this work introduces a Generative Adversarial Network (GAN)-based single-stage defense mechanism to mitigate APAs in traffic sign classification. Unlike multi-stage defenses that are computationally intensive, this method neutralizes adversarial patches in real time within a single stage without requiring any prior knowledge of the patch design. Experimental results demonstrate that under APA conditions, the defense improves classification accuracy by up to 80.8% and boosts overall accuracy by 58% compared to an undefended classifier. The model-agnostic design allows integration with any traffic sign classifier regardless of architecture. Moreover, evaluations on benchmark datasets confirm the method's scalability and transferability, ensuring robust protection for AV perception systems against APAs.

Poster #22

WIP: Developing Seismic Design Procedure for Concrete-Filled Steel Tube Pile to Concrete Cap Bridge Connection

Abigail Reno, Graduate, Civil Engineering
Author(s): Abigail Reno, Ashish Bahuguna, and Ravi Ravichandran, Ph. D.
Faculty Advisor: Ravi Ravichandran, Ph. D.

During natural disasters, accessible transportation is essential for mobilizing emergency services and citizens. The goal of civil engineers is to provide a safe, economical design for these systems. Bridges are an important component of these systems, as they provide safe passage across obstacles. This study focuses on improving the performance of bridges during earthquakes by focusing on a common bridge connection. This is important because bridges use the connections between elements to transfer loads throughout the structure and into the ground. Previous research yielded an improved design; however, it still needs refinement. The objective of this research is to develop an accurate design procedure for the connection of concrete-filled steel tube piles to a concrete cap for seismic loads, using advanced finite element modeling in OpenSees. This software will analyze the response of a single pile cap connection under cyclical lateral loads. The steel reinforcement and the distance between the top of the steel tube and the bottom of the cap will be adjusted in this process. This design will be adjusted based on results to achieve the most economical design. The results of this study will provide an accurate and economical seismic design methodology for bridge connections. Improving this connection will enhance the overall bridge performance during earthquakes, increasing capacity and service life. The resulting methodology will be used by the SCDOT for future bridge design and can be adopted by other transportation agencies worldwide to develop their own design schemes.

Poster #23

DIGITAL TWIN–BASED FRAMEWORK FOR SAFE SPEED ESTIMATION ON ROAD CURVES

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Rural roadways often include sharp horizontal curves where drivers misjudge safe speeds, resulting in frequent crashes. Traditional design standards, such as the AASHTO method, use simplified equations with conservative assumptions to estimate safe speeds. While useful for general planning, these models cannot capture the wide range of vehicle types, loading conditions, and environmental factors that affect safety. This study addresses that limitation by developing a Digital Twin–based framework to estimate safe curve speeds using a realistic, physics-driven simulation. A real-world rural curve was modeled in Unity using geometric and elevation data, and vehicle speeds were collected with a radar gun under varying weather conditions. The digital twin incorporates a parameterized vehicle model with adjustable mass, acceleration, and center of gravity, allowing simulation of multiple vehicle types and scenarios. By systematically adjusting these parameters, the model identifies the maximum safe speed a vehicle can maintain without losing control. Simulation results showed strong agreement with field data, confirming the model reflects actual driving behavior. This approach demonstrates that digital twins provide more accurate and adaptive assessments of roadway safety than traditional analytical models. By combining virtual testing with real-world validation, the framework supports safer roadway design and the development of connected and autonomous vehicle systems.

Poster #24

Analyzing Microplastic Distributions in Fluvial Flood Sediments from Hurricane Helene, Upper French Broad Subbasin, North Carolina

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Hurricane Helene passed through western North Carolina on September 27th, 2024, depositing nearly 20-30 inches of rain which resulted in nearly 2,000 reported landslides and macroscale displacement of sediment in the French Broad river, the Swannanoa river, and their tributaries. These immediate consequences of the storm were devastating, but long-term consequences of the storm are still developing. One such long-term consequence of Hurricane Helene is microplastic contamination. Due to their small size, microplastics are particularly pervasive in natural environments and have been proven to be transported during major disturbances, including heavy floods and hurricanes. This project aims to characterize microplastic distributions in flood sediments deposited by Hurricane Helene in Asheville, North Carolina, located in the Upper French Broad River Subbasin. Sediment samples from 4 sites were collected in Asheville that are known to have experienced extreme flooding during the hurricane. After sample collection and refrigeration, microplastics were separated from larger sediment particles through density separation in a sodium chloride solution. The resulting density separated solution was then microfiltered to isolate plastics on glass microfiber filters. Suspected microplastics were examined using a Leica S9D dissecting microscope, after which several suspected plastics found in the samples were probed with a fine-tipped soldering iron (350°C), a process referred to as a hot needle test.

Poster #25

A Proposed Model to Assess Hydrodynamic Forcing By Boat-Generated Wakes and Potential Impact to Erosion of Estuarine Shorelines

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Wakes created by boat traffic can influence the hydrodynamic environment of waterways and may have particular impact to shoreline erosion. Shorelines exposed to frequent wake hazard may be more vulnerable to erosion, yet it is challenging to predict where these high-risk areas are. Resource managers therefore have difficulty considering wake hazards in planning bank stabilization projects. A method for evaluating potential wake risk was developed and applied along 2,250 km of estuarine shorelines in eastern Florida. Risk of erosion by boat wake was defined by frequency of wake incidence, estimated by commercial vessel traffic data, and wake magnitude, represented by regulatory speed zones. Wake risk at the shoreline was aggregated across distances of 0 m, 50 m, 100 m, and 200 m from the shoreline. We tested the assumption that areas of high boat traffic are well represented by commercial data through a comparison with recreational boating data in a subset of the study area. We found that 80.1% of high-density areas of commercial and recreational traffic agreed, providing support for our use of commercial traffic data to represent areas of high boat traffic in the study area. The risk model was validated by comparing high risk shoreline against observed shoreline characteristics, including slope, observed shoreline erosion, and modeled wind wave climate. Preliminary validation indicated that the proposed model effectively identified shoreline areas with high wake risk.
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DIGITAL POSTERS

Digital Poster #1

Bacteria-Based Self-Healing Mechanism for Enhancing Interlayer Bond Strength in 3D-Printed Concrete

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The interlayer bond strength of 3D-printed concrete (3DPC) is a critical parameter governing the structural integrity and durability of printed elements. Weak bonding between successive layers often arises from surface moisture loss, rapid setting, and the time gaps between printing passes. These factors result in poor mechanical interlocking and limited chemical adhesion, creating potential planes of weakness that can significantly reduce load-bearing capacity and long-term durability. This study explores the potential of a bacteria-based self-healing mechanism to restore and enhance interlayer adhesion in 3DPC. Calcium-carbonate-precipitating bacteria were incorporated into the printable cementitious matrix to investigate their effect on microcrack sealing and interlayer re-bonding. The experimental program involves two sequential stages. First, interlayer bond strength of printed samples is evaluated through splitting tensile tests to quantify the initial mechanical integrity. Second, specimens subjected to failure are reassembled under controlled moist curing conditions to stimulate bacterial activity and healing at the fractured interfaces. The recovered samples are retested to assess the regained interlayer bond strength, while microstructural and compositional analyses (SEM/EDS) are performed to verify the precipitation of calcite within the interfacial region. Preliminary expectations suggest that bacterial self-healing may partially restore the interfacial bond through calcite bridging, leading to enhanced post-damage strength retention and durability.

Digital Poster #2

Setting Behavior of Portland-Limestone Cement Pastes Containing Next-Generation Supplementary Cementitious Materials

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The global shift towards sustainable construction practices has intensified the demand for supplementary cementitious materials (SCMs). SCMs improve concrete sustainability by lowering total carbon emissions and extending structures service life. The most common SCMs are byproducts of industrial processes with fly ash being the most common SCM. However, declining fly ash availability necessitates developing the next generation of SCMs to maintain concrete quality. This study identifies key next-generation SCMs, such as reclaimed fly ash, ground bottom ash, ground glass, natural pozzolans, ground granulated blast furnace slag and nanosilica and investigated how their inclusion at varied replacement levels influences the setting of cement pastes. Both the physical and chemical components of cement paste setting were monitored by vicat setting time (combined effects), ultrasonic pulse velocity (physical), and isothermal calorimetry (chemical). Most SCMs caused the vicat setting time to increase or remain comparable to the control, except for natural pozzolans, which accelerated setting. UPV setting behavior aligned with vicat results, while the isothermal results varied with ground glass, natural pozzolans, and slag showing accelerated set. These findings suggest that physical factors dominate concrete setting behavior while chemical factors are secondary and additionally provide critical insights into setting times and jointing schedules for construction professionals. Acknowledgement: This research was supported by SCDOT Project SPR 774.

Digital Poster #3

Real-World Evaluation of Protocol-Compliant Denial-of-Service Attacks on C-V2X-based Forward Collision Warning Systems

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Cellular Vehicle-to-Everything (C-V2X) technology enables low-latency, reliable communications essential for safety applications such as a Forward Collision Warning (FCW) system. C-V2X deployments operate under strict protocol compliance with the 3rd Generation Partnership Project (3GPP) and the Society of Automotive Engineers Standard (SAE) J2735 specifications to ensure interoperability. This paper presents a real-world testbed evaluation of protocol-compliant Denial-of-Service (DoS) attacks using User Datagram Protocol (UDP) flooding and oversized Basic Safety Message (BSM) attacks that 7 exploit transport- and application-layer vulnerabilities in C-V2X. The attacks presented in this study transmit valid messages over standard PC5 sidelinks, fully adhering to 3GPP and SAE J2735 specifications, but at abnormally high rates and with oversized payloads that overload the receiver resources without breaching any protocol rules such as IEEE 1609. Using a real-world connected vehicle 11 testbed with commercially available On-Board Units (OBUs), we demonstrate that high-rate UDP flooding and oversized payload of BSM flooding can severely degrade FCW performance. Results show that UDP flooding alone reduces packet delivery ratio by up to 87% and increases latency to over 400ms, while oversized BSM floods overload receiver processing resources, delaying or completely suppressing FCW alerts. When UDP and BSM attacks are executed simultaneously, they cause near-total communication failure, preventing FCW warnings entirely.

Digital Poster #4

Application of LiDAR for Bridge Deflection Evaluation: A Case Study on a Retrofit Bridge in Dorchester, South Carolina

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Traditional methods to assess in-situ bridge deflection require significant labor to instrument the bridge and frequently require disruptions to vehicle traffic. To address the challenges associated with traditional bridge assessment, a novel light detection and ranging (LiDAR) system was tested and compared with a traditional BDI cable-string potentiometer system. The goal of this experiment was to compare the accuracy of deflection measures for a short span retrofit concrete bridge. Deflection values for each girder were used to calculate load distribution factors, which help inform the load rating of bridges. Results showed poor alignment when comparing distribution factors, with LiDAR distribution factors only aligning with BDI results for two of five truck paths. An additional goal was to create a 3D mesh to compare the displaced shape for the entire length of the girder, but the rough nature of the concrete made post processing 3D mesh comparison challenging. Despite poor alignment for this bridge, LiDAR has the potential to work well for deflection evaluation on bridges with greater flexibility, and for 3D mesh making for bridges with steel girder, which make creating a smoother model easier. Overall, there is future work in evaluating the usability of LiDAR on bridges that are more flexible, and with smoother girder surfaces. The retrofit bridge in this study was closed to the public, and was partially over water, so the reduced disruption to vehicle traffic was not tested.

DIGITAL POSTERS

Digital Poster #5

Enhancing nutrient management and methane production in an AnMBR-UV system integrated with hydroponic controlled environment agriculture

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Conventionally, agriculture uses water sourced from surface and groundwater, which are sometimes unreliable due to droughts. So, unconventional water sources are being explored and implemented but come with the risk of being higher in salinity or contaminated by pollutants such as pathogens, heavy metals, hydrocarbons, pesticides, PFAS, and microplastics. This research explores using reclaimed municipal wastewater from an anaerobic membrane bioreactor (AnMBR) to grow crops in a hydroponic or similar controlled environment agricultural system, as well as using produced methane to offset the energy costs or help with temperature control.This study used a lab-scale anaerobic membrane bioreactor that was fed with synthetic wastewater that had a COD concentration of 300 mg/L, and then raw and fermented harvest waste was added to increase the concentration to 600 mg/L in a stepwise fashion. During each level of COD addition, various water quality parameters such as nutrient concentration and methane production were measured twice a week. Results showed that AnMBR was able to remove most of the COD from the feed, while increasing ammonia and potassium concentrations in the permeate. Additionally, fermented harvest waste was more efficient at producing methane than raw harvest waste. The results highlight the possibility of using AnMBR permeate to supplement the need for ammonia in a hydroponic system, as well as using the methane produced to produce heat and energy through burning it and converting it into CO2.