SUMMARY OF ABSTRACTS SUBMITTED

This in-person workshop will be a regional collaboration promoting holistic RESILIENT and SUSTAINABLE infrastructure solutions with a focus on efficient highway and pedestrian bridges and structures.

The goals of the workshop are increasing RESILIENCE (robust strength, durability, long service-life, and dynamic adaptability) using SUSTAINABLE (dynamic adaption, lower embodied energy and GHG/CO_2 emissions, incorporating recycled, repurposed and upscaled materials) structures, for EFFECTIVE & EFFICIENT (materials, fabrication, hauling, construction and design practices) solutions considering mature and emerging technologies.

This will be achieved through the exchange of information on the latest advancements and practices for bridge design, construction, and maintenance and materials with discussions on the combination of these inputs to minimize life asset life-cycle cost and owner's risk, while simultaneously reducing any environmental impacts.

PRESENTATION ORDER

Part 1 – 10:00am, Icebreaker; Round table discussion of goals and commitments (15-mins)

Part 2 – 10:15am, Technical presentations of State-of-the-Art in Owners and Engineers (90-mins)

10:15-10:30 (AB013): Resiliency & Sustainability in NYSDOT's Bridge Policies, *by Alan Zack, NYSDOT.*

10:30-10:45 (AB027): NCDOT– Harkers Island & Alligator River Coastal Bridges, *by Cabell Garbee, NCDOT.*

.10:45-11:00 (AB030): Evaluation of FRP Pedestrian Truss Bridges with Timber Decks, *by Dr. Hota GangaRao.*

11:00-11:15 (AB028): FDOT-Advancing Reinforced Concrete Design for Resilient & Sustainable Structures, *by Steven Nolan, ACI 440C/CSAO*

11:15-11:30 (AB022): I-Bridge: Innovative Corrosion Free Bridge, *by Dr. Franscisco De Caso, UMiami.*

11:30-11:45 (AB020): Research and Developments on Improving FRP Rebar Sustainability - Manufacturing & Product Development to meet owner's Needs and Market Demand *by Dr. Omar Alajarmeh, USQLD.*

11:45-12:00 (AB011): Potential Applications Artificial Intelligence for Asset Management, *by Dr. Antonio De Luca, Thornton Tomasetti.*

Lunch Break & Lab Tours (60-mins)

Part 3 – 1:00pm, Technical presentations of Materials & Manufacturers (60-minutes)

13:00-13:15 (AB015): Allium Stainless-Clad Rebar for Resilient & Sustainable Reinforced Concrete Structures, *by Dr. Samuel McAlpine, Allium Engineering.*

13:15-13:30 (AB029): Innovative Composite Solutions for Sustainable Concrete Structures, *by Pierre Hofmann, Dextra Group.*

13:30-13:45 (AB021): GFRP Bars for More Resilient & Sustainable Bridges, *by Borna Hajimiragha, MST Bar.*

13:45-14:00 (AB019): Ground-Glass Pozzolan as a Sustainable Supplementary Cementitious Material for Portland Cement Concrete*, by Dr. Prasad Rajarangu, Clemson.*

Part 4a – 2:00pm Technical presentation and/or discussion on Research Gaps & Needs (45-mins)

14:00-14:10 (AB016): Machine Learning for Evaluating In-Service Concrete Bridges*, by Pinar Okumus, University at Buffalo*

14:10-14:20 (AB017): 3-D Printing for Bridge Applications, *by Dr. Ravi Ranade, University at Buffalo*

14:20-14:30 (AB018): Bridges and Tunnels Under Fire Hazard, *by Dr. Negar Elhami-Khorasani, University at Buffalo.*

Coffee break (15 min.)

Part 4b – 2:45 pm Technical presentation and/or discussion on Research Gaps & Needs (45-mins)

14:45-15:00 (AB014): The Response of Fiber Reinforced Polymer Composite Material Under Fire and Its Mitigation Methods *by Dr. Ray Liang, CICI-WVU*

15:00-15:15 Analyzing Shear Strength of the Lightweight Concrete Reinforced with Glass Fiber Reinforced Polymer (GFRP) Bars, *by Dr. Saeid Haji Ghasemail, SUNY at Canton.*

15:15-15:30 (AB012): (AB031): Life Cycle CO_2 Emissions Assessment for GFRP and Steel Structural Components and Systems*, Md Ala Uddin and Faysal Ahamed.*

15:30-15:45 (AB031): Puncture and Impact Responses of FRP Composite Jacketing for Railway Tank Car*, Dr. Chao Zhang.*

Part 5 – 3:45pm Final Q & A, Wrap Up Summary of Outcomes (15 minutes)

Presenters Email Contact:

ADeLuca@ThorntonTomasetti.com
haji_ghasemali@canton.edu
Alan.Zack@dot.ny.gov
rliang@wvu.edu
sam@alliumeng.com
pinaroku@buffalo.edu
ranade@buffalo.edu
negarkho@buffalo.edu
prangar@clemson.edu
omar.alajarmeh@unisq.edu.au
Borna.h@mstbar.com
fdecaso@miami.edu
cgarbee@ncdot.gov
steve.nolan@dot.state.fl.us
phofmann@dextragroup.com
Hota.Gangarao@mail.wvu.edu
mau00003@mix.wvu.edu
fa00049@mix.wvu.edu
chao.zhang@mail.wvu.edu

LIST OF ABSTRACTS SUBMITTED

#011: Potential Applications Artificial Intelligence for Asset Management, *by Dr. Antonio De Luca, Thornton Tomasetti.*

#012: Analyzing Shear Strength of the Lightweight Concrete Reinforced with Glass Fiber Reinforced Polymer (GFRP) Bars, *by Dr. Saeid Haji Ghasemail, SUNY at Canton.*

#013: Resiliency & Sustainability in NYSDOT's Bridge Policies, *by Alan Zack, NYSDOT.*

#014: The Response of Fiber Reinforced Polymer Composite Material Under Fire and Its Mitigation Methods *by Dr. Ray Liang, CICI-WVU*

#015: Allium Stainless-Clad Rebar for Resilient & Sustainable Reinforced Concrete Structures, *by Dr. Samuel McAlpine, Allium Engineering.*

#016: Machine Learning for Evaluating In-Service Concrete Bridges*, by Pinar Okumus, University at Buffalo*

#017: 3-D Printing for Bridge Applications, *by Dr. Ravi Ranade, University at Buffalo*

#018: Bridges and Tunnels Under Fire Hazard, *by Dr. Negar Elhami-Khorasani, University at Buffalo*

#019: Ground-Glass Pozzolan as a Sustainable Supplementary Cementitious Material for Portland Cement Concrete*, by Dr. Prasad Rajarangu, Clemson.*

#020: Research and Developments on Improving FRP Rebar Sustainability: Manufacturing & Product Development to meet owner's Needs and Market Demand *by Dr. Omar Alajarmeh, USQLD.*

#021: GFRP Bars for More Resilient & Sustainable Bridges, *by Borna Hajimiragha, MST Bar.*

#022: I-Bridge: Innovative Corrosion Free Bridge, *by Dr. Franscisco De Caso, UMiami.*

#027: NCDOT– Harkers Island & Alligator River Coastal Bridges, *by Cabell Garbee, NCDOT.*

#028: Advancing Reinforced Concrete Design for Resilient & Sustainable Structures, *by Steven Nolan, ACI 440C/CSAO & FDOT.*

#029: Innovative Composite Solutions for Sustainable Concrete Structures, *by Pierre Hofmann, Dextra Group.*

#030: Evaluation of FRP Pedestrian Truss Bridges with Timber Decks*, by Dr. Hota GangaRao.*

#031: Life Cycle CO_2 Emissions Assessment for GFRP and Steel Structural Components and Systems*, Md Ala Uddin and Faysal Ahamed.*

#032: Puncture and Impact Responses of FRP Composite Jacketing For Railway Tank Car*, Dr. Chao Zhang.*

Submittal #011:

POTENTIAL APPLICATIONS ARTIFICIAL INTELLIGENCE FOR ASSET MANAGEMENT

Abstract:

Artificial Intelligence (AI) has the potential to improve the way bridge assets are managed and maintained. While AI is not intended to replace humans in the decision-making process, it can add significant value in evaluating both historic inspection data and current, real-time monitoring data. The added value comes from the ability of AI to assist engineers in evaluating larger sets of data better than that an experienced person can. Ultimately, based on the available data and their quality, AI could offer a new insight to predict when an asset element or component may require intervention and appropriately and timely allocate budgets for it. Two potential applications of AI are summarized as follows:

1. *Evaluation of historic data*: AI-based algorithms can mimic the thought processes of the experienced engineer and help analyze large amounts of data. Data must be appropriately tabulated or organized based on human input. This approach would allow reviewing asset-specific data at the element level and would allow to “look back” throughout the entire service life of the bridge. The analyzed data can then be reviewed by the engineer or maintenance team to extrapolate trends and make recommendations to prioritize work and optimize the available maintenance/repair budgets.
2. *Evaluation of real-time monitoring data*: In addition to historic data, AI can assist in post-processing data from continuous monitoring systems. Monitoring data can be fed to an AI-based algorithm that looks for data trends. Based on the monitoring data collected and additional data from structural analysis, environmental conditions and traffic levels etc., the algorithm can be trained to identify warning signs. These warning signs would then be investigated by the engineer or maintenance team making decisions to determine what type of action is needed.

This presentation will discuss pros and cons of the use of AI for asset management and will elaborate on the required workflow to apply AI for the evaluation of historic data and for the evaluation of real-time monitoring data.

Speaker:

Antonio De Luca, Ph.D., P.E., S.E. Thornton Tomasetti Senior Associate

ADeLuca@ThorntonTomasetti.com

Direct +1.954.903.9331

Submittal #012:

ANALYZING SHEAR STRENGTH OF THE LIGHTWEIGHT CONCRETE REINFORCED WITH GLASS FIBER REINFORCED POLYMER (GFRP) BARS

Abstract:

The increasing adoption of Glass Fiber Reinforced Polymer (GFRP) as an internal reinforcement in construction projects presents a compelling alternative to traditional steel bars. GFRP boasts several advantages, including its lightweight nature, resistance to rust, high tensile strength, and superior mechanical performance. A notable advantage of utilizing GFRP bars for reinforcement is their ability to prolong the lifespan of concrete structures while reducing maintenance needs. The combination of lightweight concrete and FRP reinforcement results in building components with impressive strength-to-weight ratios, enabling them to support heavy loads while maintaining a lightweight profile, thereby reducing overall building weight. This study involves fabricating 8 beam specimens: 2 with lightweight concrete (LWC) reinforced with GFRP bars, 2 with normal weight concrete (NWC) reinforced with GFRP bars, 2 with LWC reinforced with steel rebar, and 2 with NWC reinforced with steel rebar. Each beam, measuring 1000 mm (39 in.) in length, 100 mm (4 in.) in width, and 150 mm (6 in.) in height, is reinforced with 2-No. 3 bars uniformly positioned to resist tensile stress. The objective is to determine the shear strength of these beams and subsequently establish a reduction factor for the shear strength of lightweight concrete to address the gap in the American Concrete Institute Code, ACI 440.1R and CODE-440.11-22, which currently exclude the use of GFRP for lightweight concrete due to insufficient research and information.

Speaker:

Saeid Haji Ghasemail, PhD., P.Eng. SUNY at Canton Associate Professor

haji_ghasemali@canton.edu

Office: (315) 386-7024

Submittal #013:

RESILIENCY AND SUSTAINABILITY IN NYSDOT'S BRIDGE POLICIES

Abstract:
Bridge engineers are constantly trying to find new ways to increase the resiliency of our nation's bridges. The goal is to increase resiliency using sustainable structures and details for effective and efficient solutions considering mature and emerging technologies. At the New York State Department of Transportation, we are continuing to develop economical details and policies to achieve long lasting, low maintenance structures. Some example policies and details used at NYSDOT are increasing peak flows by 10%-20% in the hydraulic analysis for replacement bridges, the use of epoxy, galvanized, chromium and stainless steel reinforcement, and incorporating jointless details wherever possible for rehabilitation and replacement bridge projects. For bridge replacement projects jointless details are accomplished with the use of integral or semi-integral abutments. For rehabilitation projects jointless details are accomplished through partial backwall reconstruction or, more recently, with the use of link slabs. In addition to the policies and details above, NYSDOT has developed a pilot program called "SUPERBOX" in preparation for unexpected culvert failures or post hazard response. The SUPERBOX program involved coming up with a series of pre-designed box culvert units that were fabricated and stored at certain facilities across New York State that could be used to expedite culvert repairs or replacements. In January of 2022 the SUPERBOX project was put to the test when a culvert in Hoosick, NY suddenly collapsed.

Speaker:

Alan Zack, P.E. New York State DOT Structures Design Bureau
Alan.Zack@dot.ny.gov
O: (716) 847-3489

Submittal #014:

THE RESPONSE OF FIBER REINFORCED POLYMER COMPOSITE MATERIAL UNDER FIRE AND ITS MITIGATION METHODS

Abstract:

The fire performance of fiber reinforced polymer (FRP) composite material is regarded as one of its disadvantages. However, our recent studies revealed that a composite utility structure might survive from an active wildfire front. This presentation will cover the effect of fire exposure on the mechanical properties of FRP composite utility structures (poles and crossarms) and the effective techniques to mitigate fire damage. These techniques are the application of intumescent coatings and the installation of a thin fire protection sleeve around the lower portion of the installed composite pole. The study included samples from four pole manufacturers and six crossarm manufacturers, currently active in North America. The samples were exposed to simulated wildfire damage by using a flame front temperature of ~1000°C with durations of 1, 2 and 3 minutes. Coupon specimens were cut from the post-burn sections for both the pole and crossarm samples and tested for their mechanical properties under three-point bending and short beam shear test methods. This testing was repeated for samples with intumescent coating, and fire protection sleeve shielding. The results were compared to unburned specimens. This research has demonstrated the significant influence of intumescent coatings and other fire mitigation methods on the mechanical properties of composite utility poles and crossarms when exposed to flames of varying durations. Both intumescent coatings and fire protective sleeves can play a crucial role in improving the fire resistance of composite utility poles and crossarms. These fire mitigation methods help preserve the structural integrity of these utility structures when exposed to flames, thus reducing the risk of structure failure during fire events. This research is sponsored by EPRI.

Speaker

Ray Liang, Ph.D., Managing Director, NSF IUCRC Center for Integration of Composites into Infrastructure, West Virginia University, Morgantown, WV 26506, USA.
rliang@wvu.edu
Office: 304 293 9348
http://compositescici.statler.wvu.edu/

Submittal #015:

ALLIUM STAINLESS-CLAD REBAR FOR RESILIENT AND SUSTAINABLE REINFORCED CONCRETE STRUCTURES

Abstract:

The corrosion of carbon steel reinforcement (rebar) is one of the primary lifetime limiting factors for reinforced concrete structures, especially critical transportation infrastructure such as bridges. Rising sea levels and more prolonged and severe storm surges in coastal areas means that this problem will only become more severe in the decades to come. In order to address this problem in a scalable, cost-effective way, Allium Engineering has developed a novel laser deposition manufacturing approach to produce stainless-clad rebar which can achieve corrosion resistance and durability of stainless steel at a much reduced cost. This presentation will focus on the innovative manufacturing process developed by Allium, case studies of construction applications, and an analysis of the embodied carbon reduction potential for this material applied to transportation infrastructure. Performance testing of corrosion resistance, concrete/steel bond strength, and mechanical testing will be presented demonstrating the structural and anti-corrosion benefits of the stainless-clad rebar technology. Finally, connections will be drawn to other technologies being pursued for more sustainable concrete and cementitious materials, particularly low-alkalinity and carbonated cementitious materials. Long-term deployment of these materials can be enabled by stainless-clad rebar technology in order to achieve the durability and resilience required for transportation infrastructure. To enable more sustainable and resilient bridges and infrastructure, innovative advanced materials such as Allium stainless-clad rebar will be needed.

Speaker:
Samuel McApline, PhD. Allium Engineering, Inc. Chief Technical Officer
sam@alliumeng.com
Office: (925) 878-1173

Submittal #016:

MACHINE LEARNING FOR EVALUATING IN-SERVICE CONCRETE BRIDGES

Abstract:

This presentation will detail how machine learning can be used to predict the shear strength and load history of prestressed concrete beams. Loads that correspond to crack widths (load history) is considered to be an indicator of beam condition when evaluated relative to shear strength. Beam geometry, material properties, loading type, prestressing amount, and reinforcement details are used as features that can be used to predict shear strength. For predictions of load history, crack width is used as an additional predictive feature. A dataset consisting of 897 slender, normal weight concrete, simply supported beams with prestressing bonded strands is compiled. The available dataset was much smaller for predicting load history corresponding to crack widths, 79 beams with 391 crack width measurements. Three machine learning algorithms are trained with these datasets and validated using k-fold validation. Gaussian process regression led to the least error in predictions compared to other algorithms (ordinary linear regression and support vector regression). Prestress amount was the most influential feature for both strength and load history predictions. The mean absolute error in predictions of shear strength was 14%, while the error in predictions of load history was 10%. For comparison, the error in shear strength predictions of AASHTO LRFD Bridge Design Specifications (2020) is 33%. It is noted that the higher error of AASHTO LRFD predictions is partially due to intentional conservatism. Additional data is needed on load history and crack widths for more reliable predictions.

Speaker:

Pinar Okumus University at Buffalo Associate Professor

pinaroku@buffalo.edu

Office: (716) 645 4356

Submittal #17:

3D-PRINTED DUCTILE CONCRETE COVERS FOR IMPROVING DURABILITY OF PRESTRESSED CONCRETE BRIDGE GIRDERS

Abstract:

Prestressed concrete bridge girders, especially deep bulb-tee girders, are known to crack at their ends which can negatively affect their long-term durability. Researchers have explored various structural approaches to tackle this problem with varying degrees of success. This research investigates the feasibility of a materials-based approach of addressing this problem with a jacketing shell made of ductile concrete for limiting the openings of surface cracks at girder ends. Furthermore, the ductile concrete shell is envisioned to be 3D-printed for accommodating a variety of girder shapes and sizes. The research completed to date has involved numerical simulations for determining the target mechanical properties for ductile concrete, development of a new 3D-printable ductile concrete, and preliminary printing of shells for lab-scale beams. This presentation will include the highlights and challenges in each of the above tasks and a roadmap for concluding this feasibility study. If this proof-of-concept project is successful, future research will seek to scale up the novel idea to large-scale girders, which could significantly enhance the durability and service life of the precast-prestressed concrete bridge girders.

Speaker:

Ravi Ranade | University at Buffalo | Associate Professor

ranade@buffalo.edu

Office: (716) 645 5150

Submittal #18:

POST-FIRE ASSESSMENT AND RESILIENCE DESIGN OF REINFORCED CONCRETE BRIDGES

Abstract:

Bridges are crucial elements of transportation networks, and their closure can lead to major economic losses. Fires are a notable and frequent hazard to bridge infrastructure. Examples of recent incidents include the 2017 bridge fire on I-85 in Atlanta, the 2023 bridge fire on I-95 in Pennsylvania, and the 2024 bridge fire near downtown Los Angeles in California, leading to the collapse or major damage to the bridges. This presentation focuses on the post-fire assessment of reinforced concrete structures. During a fire, distinct temperature gradients develop in reinforced concrete sections due to the low thermal conductivity of concrete. It is proposed to use advanced modeling to simulate the distribution of temperatures within sections, provided that the information on the fire scenario during the event is available. Thus, post-fire damage classifications and the associated repair categories can be defined not only based on observations, non-destructive testing, and using the results of advanced modeling. Temperature thresholds for damage states are proposed considering the reduction in post-fire material properties (concrete and steel rebar) and bond strength (between rebar and concrete) to assist with damage diagnosis. The importance of considering the cooling phase of a fire is also discussed. Finally, the proposed approach can be used to predict the level of damage, associated downtime, and costs for pre-defined fire scenarios during the design phase. This enables adjustments to the design to meet resilience goals effectively.

Speaker:

Negar Elhami-Khorasani University at Buffalo Associate Professor
negarkho@buffalo.edu
Office: (716) 645 3019

Submittal #019:

GROUND-GLASS POZZOLAN AS A SUSTAINABLE SUPPLEMENTARY CEMENTITIOUS MATERIAL FOR PORTLAND CEMENT CONCRETE

Abstract:

Concrete construction sector is continually seeking new sources of supplementary cementitious materials (SCMs) to augment the Portland cement, fly ash, slag cement, and silica fume used in modern concrete mixtures, to not only improve the mechanical and durability performance of concrete, but also to reduce the carbon footprint of concrete construction. As the availability of traditional SCMs is becoming increasingly scarce in some regions, extensive research and testing has shown that ground glass can perform as an effective pozzolan in structural concrete. Supported by the results from past research studies and field experience, ASTM Subcommittee C09.24, on Supplementary Cementitious Materials, has authored ASTM C1866/C1866M-20, "Standard Specification for Ground Glass Pozzolan for Use in Concrete" This presentation will provide the background information on glass-based pozzolans in terms of their role in the performance on fresh and hardened properties of concrete and the future of ground-glass pozzolans as viable SCMs in the concrete industry.

Speaker:

Prasad Rangaraju, PhD, PE, FACI   Clemson University   Prof. & Director of SMaRT Lab

Email: prangar@clemson.edu

Tel:

Submittal #020:

RESEARCH AND DEVELOPMENTS ON IMPROVING FRP REBAR SUSTAINABILITY: MANUFACTURING & PRODUCT DEVELOPMENT TO MEET OWNER'S NEEDS AND MARKET DEMAND

Abstract:

Research and development of advanced fiber-reinforced polymer (FRP) rebar represents a significant opportunity. By focusing on innovative manufacturing processes and product development, companies can address key industry challenges and asset owners' demands, lowering costs and reducing supply lead times. Incorporating bio-resins and recycled materials can not only reduce production costs but also appeals to the growing demand for sustainable materials and construction practices. This shift can lead to the creation of high-performance, durable FRP rebar that meets the stringent requirements of modern infrastructure projects. Moreover, enhancing the local production capabilities of FRP rebar can reduce costs and boosting supply chain efficiency. As a result, government procurement policies and businesses investing in these advancements can enable superior, cost-effective solutions that meet both environmental and structural demands, supporting construction markets increasingly oriented towards sustainability and resilience.

Speaker:
Dr Omar Alajarmeh
Senior Lecturer
University of Southern Queensland
omar.alajarmeh@unisq.edu.au
M: +61497394088

Submittal #021:

GFRP BARS FOR MORE RESILIENT AND SUSTAINABLE BRIDGES

Abstract:

Glass Fiber Reinforced Polymer (GFRP) rebar represents a significant advancement in the field of civil engineering, offering enhanced resilience and sustainability for infrastructure projects. This presentation will explore the benefits of GFRP rebar, focusing on its environmental impact, durability, and performance under various conditions including high alkaline and high UV exposure. Key topics include the analysis of Environmental Product Declarations (EPDs) to assess the lifecycle environmental impacts of GFRP rebar, and best practices for the repair and maintenance of bridge barriers utilizing GFRP. By addressing these aspects, the presentation aims to highlight how GFRP rebar contributes to the longevity and sustainability of modern infrastructure.

Speaker:

Borna Hajimiragha MST Rebar, Inc CEO

Borna.h@mstbar.com

M: (416) 618-4848

Submittal #022:

I-BRIDGE: INNOVATIVE CORROSION FREE BRIDGE

Abstract:

Corrosion in RC structures affects our society, causing degradation and damage, resulting In significant costs. Reconsidering the material systems used today to construct new infrastructure is critical; technologies and solutions must suitably withstand the environmental and natural stresses to which structures are predicted to be exposed. To this end, the University of Miami deliberately chose to construct the 'iBridge' or innovation bridge; a pedestrian passage spanning over a canal using concrete elements solely reinforced and prestressed with fiber-reinforced polymer (FRP) composites. In addition to showcasing concrete reinforcing bars made of basalt and glass FRP and tendons made of carbon FRP, this bridge is the first of its kind. It features unique basalt FRP forms such as continuous close stirrups used in the pier-caps and curbs; as well as prefabricated basalt FRP cages for the auger-cast piles. The elements of the bridge were instrumented with vibrating-wire gages to monitor the structural performance over time, and load tests conducted on one of the prestressed concrete girders at the precast yard and a at the completion of the project. This presentation discusses the material technologies used to reinforce the iBridge, as well as the unique design features and construction methods, while providing load test data to support the design methodologies. The iBridge sets a course for the new construction of robust, durable corrosion free infrastructure.

Speaker:

Franscisco De Caso, PhD., LEED A.P., Principal Scientist
University of Miami, College of Engineering Structures and Materials Lab
fdecaso@miami.edu
O: (305) 284 6150, M: (305) 450-9291

Submittal #027:

NCDOT– HARKERS ISLAND & ALLIGATOR RIVER COASTAL BRIDGES

Abstract:

Resiliency of bridges, especially those in coastal areas or that are subject to corrosion from de-icing salts is a major concern for both owning Agencies and Taxpayers. This presentation highlights the use of Fiber Reinforced Polymers in Concrete to construct coastal bridges with a design service life of one hundred years. It will include a summary of projects that illustrate the acceptance process and project design progression for the use of a new material by a NCDOT. It will feature the design, testing, and construction of the Harkers Island Bridge Project consisting of a 3,000-foot long bridge utilizing 100% FRP reinforced concrete and the proposed 3-mile long Alligator River bridge.

Speaker:

W. Cabell Garbee, II, PE. NCDOT Manufactured Products Engineer Materials & Tests Unit
E: cgarbee@ncdot.gov

C: 919-906-6294

Submittal #028:

ADVANCING REINFORCED CONCRETE DESIGN FOR RESILIENT AND SUSTAINABLE STRUCTURES

Abstract:

Recent publication and further development of several design and construction specifications are helping to advance the durability and sustainability of reinforced concrete structures. ACI CODE-440.11-22 now provides a model code for international adoption in design of reinforced concrete structures. ASTM Committee D30.10 has been actively developing FRP internal reinforcement testing and materials specifications with Glass and Basalt FRP reinforcing specifications under D7957-22 and ASTM D8505-23, with several new specifications under development for Carbon FRP and grid/mesh products. ACI Committees 239 and 243 are also developing guide documents for UHPC and Seawater Concrete, respectively. While Committee 323 recently released the Model Code for low-carbon concrete. In combination these specifications and guides provide engineers with valuable tools for design and construction of buildings, bridges, and waterfront structures with improved resilience and sustainability.

Speaker:
Steven Nolan, P.E.   ACI 440C/CSAO & FDOT   Senior Structures Design Eng.
E: steven.nolan@dot.state.fl.us
O: (850) 414-4272

Submittal #029:

INNOVATIVE COMPOSITE SOLUTIONS FOR SUSTAINABLE CONCRETE STRUCTURES

Abstract:

Adoption of GFRP rebars as reinforcement in concrete structures is a well-know solution, yet several recent innovations allow advantageous design & construction methods:

- GFRP carpets, used to cover large areas of slab-on-grade in a minimum amount of time.
- Splicing couplers, offering an alternative to the traditional lap-splices, necessary in concrete roads repair projects.
- GFRP reinforcement in tunnels, allowing huge reduction in concrete consumption.

This presentation will showcase the remarkable benefits of GFRP solutions through case studies. We will explore comparative analyses of material usage, cost-effectiveness, and productivity enhancements. More importantly, the reduction in embodied carbon will be quantified through CO2 emissions metrics and backed by recently published Environmental Product Declarations (EPD).

Speaker:
Pierre HOFMANN Dextra Group General Manager - Geotechnical
phofmann@dextragroup.com
M: +66 655 174 965

Submittal #030:

EVALUATION OF FRP PEDESTRIAN TRUSS BRIDGES WITH TIMBER DECKS

Abstract:

Fiber-reinforced polymer composites find very wide structural applications due to their magnificent thermo-mechanical properties, which are attributed to their corrosion resistance, long service life, and high strength-to-weight and stiffness-to-weight ratios that eventually make them cost-effective. In this work, the two different-sized FRP truss bridges based on the specifications of AASHTO under static and dynamic loads were modeled and analyzed. The tests on individual members are done in order to relate their contribution to the overall structural response. The study reported the bridges' responses against both vertical static and pseudo-static wind loads and gave recommendations for design. Axial compression tests conducted on FRP bridge components demonstrated crushing, local buckling, and lateral torsional buckling failures based on span-to-depth and stiffness-to-stress ratios. Manufacturing process stress concentrations were evaluated, and safety factors were provided for a range of structural shapes to connect the behavior of the individual components with system responses. This research has been sponsored by Bedford Reinforced Plastics (BRP) Inc.

Speaker

Prof. Hota V. S. GangaRao, Ph.D., P.E., F. ASCE, F.SEI
Maurice A. & JoAnn Wadsworth Distinguished Professor of CEE
Director, National Science Foundation’s Center for Integration of Composites into Infrastructure
Director, Constructed Facilities Center
E: Hota.Gangarao@mail.wvu.edu
W: http://compositescici.statler.wvu.edu/

Submittal #031:

LIFE CYCLE CO_2 EMISSIONS ASSESSMENT FOR GFRP AND STEEL STRUCTURAL COMPONENTS AND SYSTEMS

Abstract:

Global warming demands urgent and systemic action, especially within the construction industry, a significant source of greenhouse gas emissions. Adopting environmentally friendly materials is crucial in this context. Fiber-reinforced polymer (FRP) reinforcements, such as Glass Fiber-Reinforced Polymer (GFRP), are promising alternatives to conventional steel and concrete materials due to their non-corrosive nature, high tensile strength, lightweight properties, and superior thermo-mechanical performance, particularly in harsh environmental conditions. However, a comprehensive assessment of the life cycle CO_2 emissions of GFRP compared to traditional materials like steel, both at the component and system levels, remains unexplored. This research aims to conduct a detailed comparative analysis of the CO_2 emissions associated with GFRP and steel in various structural components and systems, focusing on their environmental impacts and unit-level performance. A sensitivity analysis evaluates the unit life-cycle CO_2 performance under both best-case and worst-case scenarios for steel to determine long-term sustainability. The study quantifies and compares the CO_2 emissions of GFRP and steel in different structural contexts, translating these findings into unit life-cycle performance measures. Results indicate that GFRP significantly reduces CO_2 emissions compared to steel, offering substantial environmental benefits in both the short and long term. However, in specific scenarios where shear or torsion governs failure, steel may demonstrate better performance. This research provides valuable insights for designers and engineers, supporting informed decision-making and highlighting the potential of innovative materials to enhance infrastructure sustainability. This work is sponsored by American Composites Manufacturers Association (ACMA).

Speaker

1. Md Ala Uddin, Graduate Research Assistant, Civil and Environmental Engineering, West Virginia University, Email: mau00003@mix.wvu.edu, Cell: 304 943 8339
2. Faysal Ahamed, Graduate Research Assistant, Civil and Environmental Engineering, West Virginia University, Email: fa00049@mix.wvu.edu, Cell: 304 376 483

Submittal #032:

PUNCTURE AND IMPACT RESPONSES OF FRP COMPOSITE JACKETING FOR RAILWAY TANK CAR

Abstract:

This study, sponsored by USDOT- PHMSA, is to improve the safety and efficiency of transport of hazardous materials by rail tankers through fiber-reinforced polymer composite jackets. In view of the heightened security measures, WVU-CFC has developed an economic alternative to USDOT regulations in response for a transport system of hazardous goods.

A DOT-117 or DOT-117R car body designed according to the USDOT design specifications requires a thicker steel body with increased thermal protection and other safety features to offer improved safety at the expense of added vehicle weight and reduced payload capacity. A multifunctional composite jacket was developed by WVU-CFC with sacrificial FRP layers and intumescent coatings to retrofit existing tank cars for this purpose.

The energy-absorbing composite jacket is lightweight and improves safety through fire and puncture-resistant strategies. WVU-CFC manufactured, tested, and characterized FRP composites with fabric layups and wide core material selections using vacuum infusion processes. Application of ASTM standard tests optimized fabric and VIP configurations. Comparisons to traditional DOT-117 railroad tank cars showed the composite jackets exceeded desired safety performance objectives. The impact-specific energy absorption for the composite jacket was 1.9 times that of the DOT-117 steel shell via the multiplication of the effect during the test with multi-layer fabrics/foam and the steel substrate, according to data for the finite element model.

Speaker
Chao Zhang, PhD.,
Engineering Scientist
West Virginia University
chao.zhang@mail.wvu.edu
Office: 304 293 9983
http://compositescici.statler.wvu.edu/