CAMX

THE COMPOSITES AND ADVANCED MATERIALS EXPO

September 8 – 11 | 2025

Orlando, FL, USA

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INFRASTRUCTURE PANEL:

Advancing Infrastructure: Real-World Successes & Opportunities with FRP in Florida

Moderator: **Steven Nolan**, PE. - *Lead for Design Innovation and Implementation of FRP in Structural Applications,* (FDOT State Structures Design Office)

Panelists:

Alexander Lewis - Composite Materials Specialist, *Lead for FRP Materials Approvals, Testing, and Auditing,* (FDOT State Materials Office)

Atiq Alvi PE. - Sector Manager/Vice President, *Design lead for I-275 Sunshine Skyway Bridge beam strengthening project (*TY Lin International)

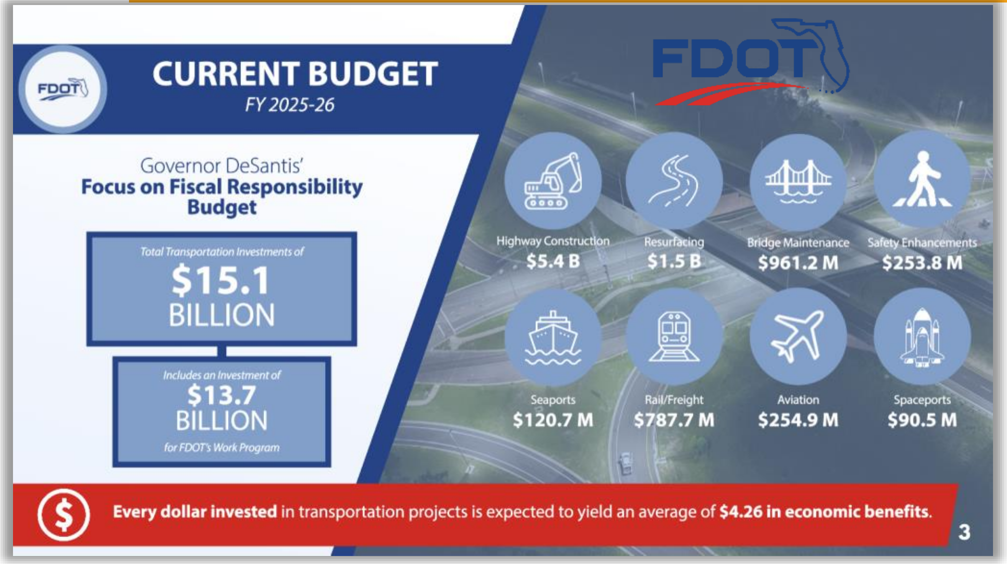
Mohit Soni PE. - Structures Transportation Business Center Practice Leader, *Design lead for US17/Trout River and SR312/Matanzas River Foundation Rehabilitation (*Stantec)

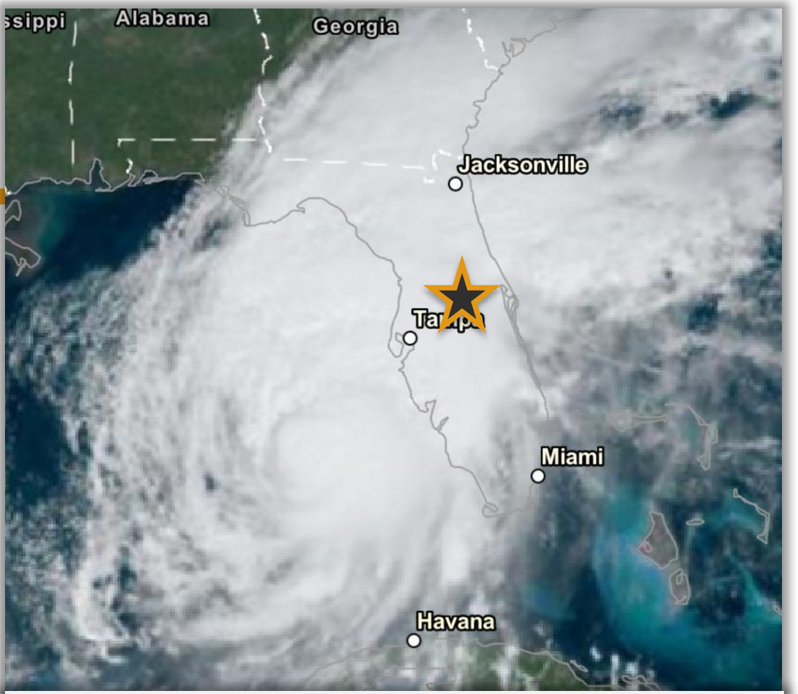
Danielle Kleinhans, PhD, PE. - *Director of Engineering and Business Development (*Mateenbar). FRP Expert and former Steel Industry (CRSI) President and CEO.

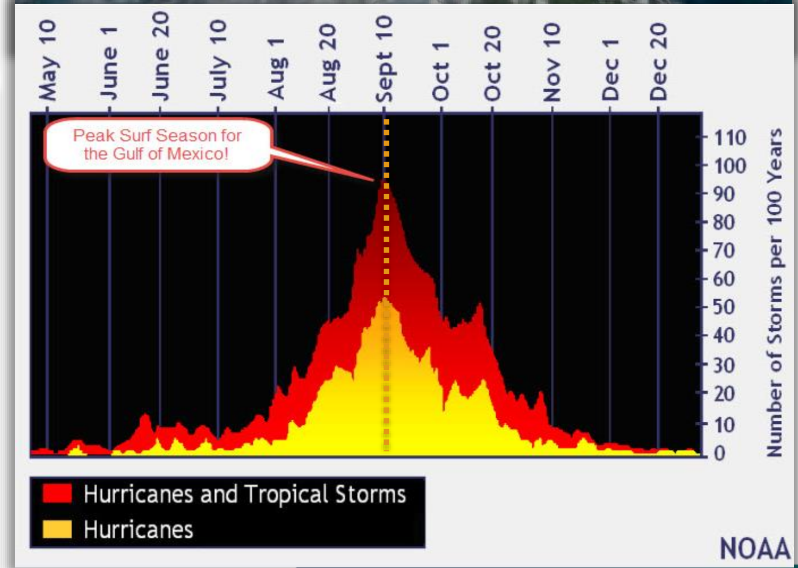
Francisco De Caso, PhD, PE. - *Principal Scientist* at Structures and Materials Laboratory, University of Miami.

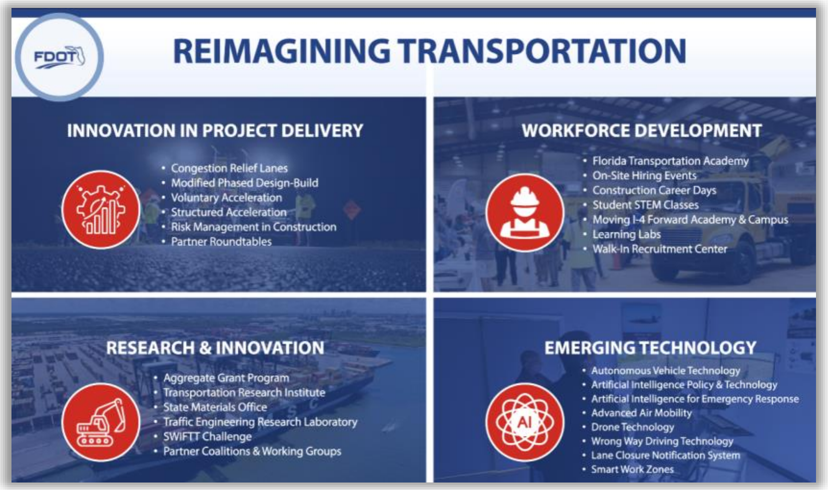
Kelley Severns – *Program Director for X-Bridge project,* FHWA Office of the Assistant Secretary for Research and Technology (OST-R), DARPA-I program.

Welcome to Florida









Description

- This sessions will explore a decade of FRP innovation in Florida’s infrastructure and discover how FRP is revolutionizing Florida’s infrastructure in this expert-led session.
- Kicking off with a visually engaging showcase of cutting-edge projects, the panel will explore FRP’s role in bridge reinforcement and strengthening, precast concrete, pultruded, and navigation protection structures.
- A dynamic discussion will follow, addressing key challenges, strategies, and future opportunities. Don’t miss this deep dive into the future of structural materials.
- Bring your questions and gain firsthand insights from top industry leaders!

Introductions

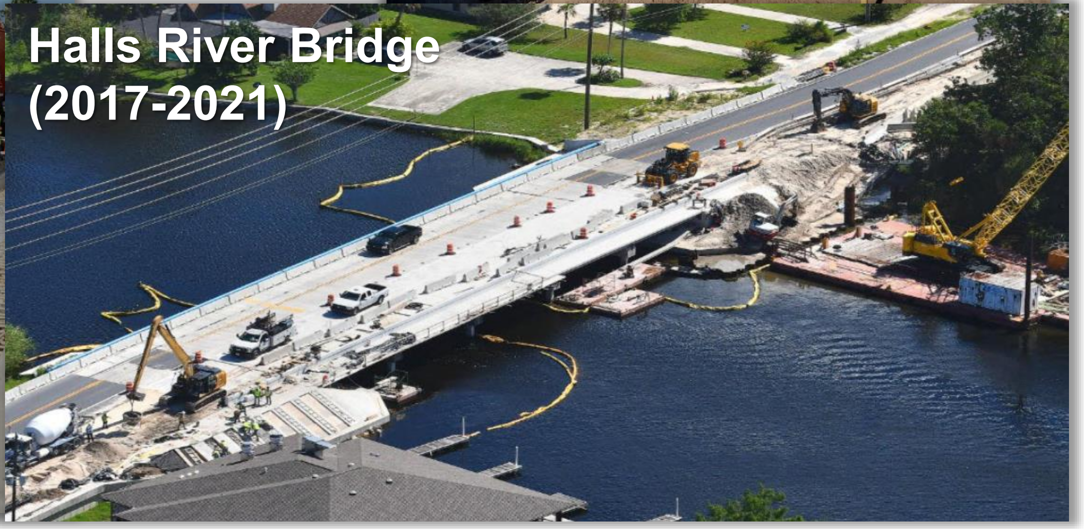
Alexander Lewis | Atiq Alvi | Mohit Soni | Danielle Kleinhans | Francisco DeCaso | Kelley Severns

Session Format

- 25-minute presentation provided from panel experts projects woven together by the moderator, allowing for
- 25-minute curated pre-submitted questions lead by the moderator covering all panelists expertise
- 25-minute audience participation Q & A at the end.

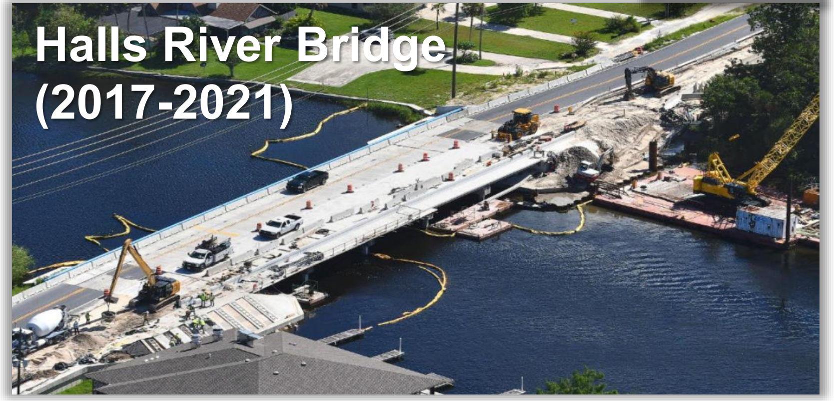
Moderator: Introducing Florida – Part 1a

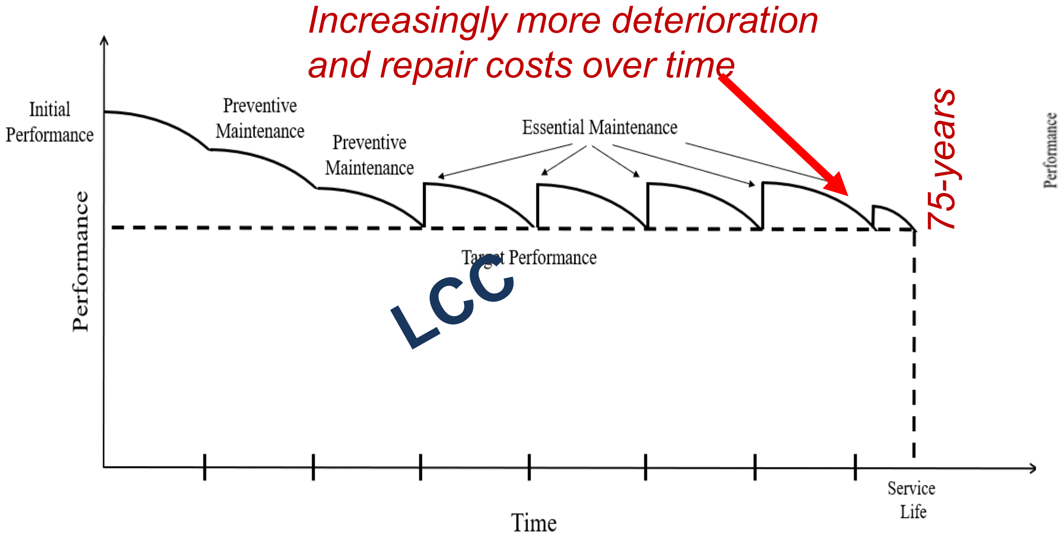
- Feature projects:
  - Halls River Bridge (Homosassa)
  - Volusia/Flagler Beach Secant-Pile Seawalls
  - 17^{th} St East Span Replacements (Vero Beach)
  - 40^{th} Ave NE. over Placido Bayou



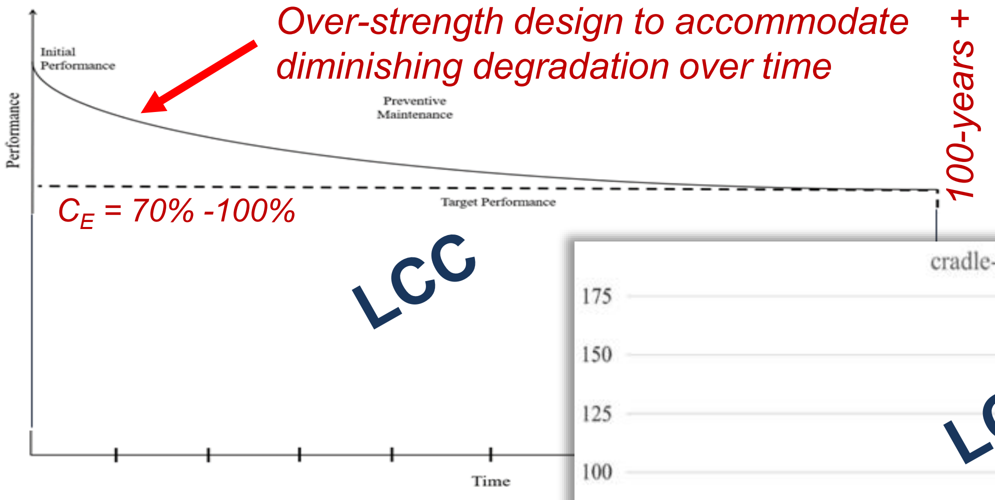
Moderator: Introducing Florida – Part 1a

- Life Cycle Cost Accounting (LCCA)
- Life Cycle Assessment (LCA)
- LRFD + Adaptability & Resilience

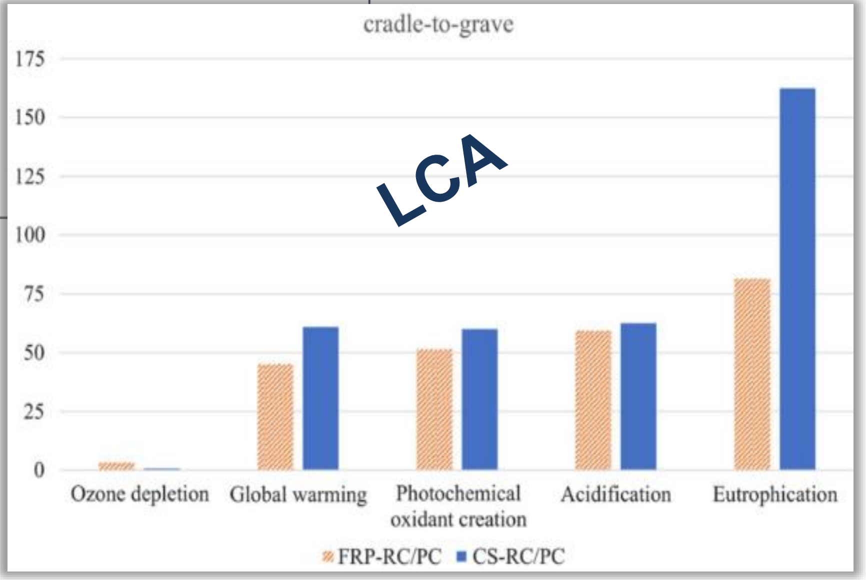




Conventional-RC/PC process



FRP alternatives



Charts: Cadenazzi, T., Dotelli, G., Rossini, M., Nolan, S., and A. Nanni. (2019). Cost and Environmental Analyses of Reinforcement Alternatives for a Concrete Bridge. Structure and Infrastructure Engineering. [*https://doi.org/10.1080/15732479.2019.1662066*](https://doi.org/10.1080/15732479.2019.1662066)

Moderator: Design Criteria (LRFD + R&A)

LOAD

- Structural Loading *(Traffic, Extreme Event – Seismic Collision, Weather)*
- Environmental Loading *(Cl$^-$, SO$_4$, pH, ASR, UV, SLR)*
- Future Use *(Capacity increase, Functional change, Hydraulic change)*
- Justification *(LCC, LCA, Social Benefit & Equity; Cost Benefit comparison)*

RESISTANCE

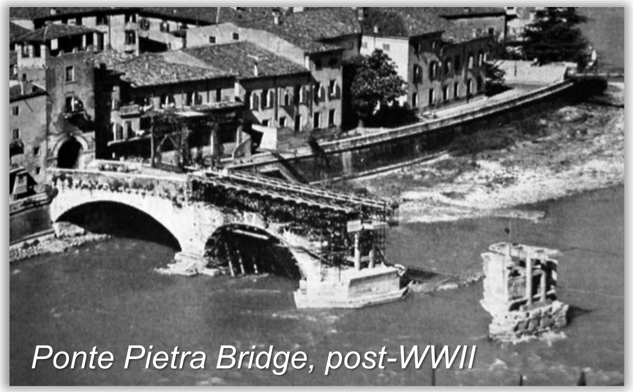
- Structural Capacity *(Mandatory Codes vs. Guide Specifications; ULS vs. SLS)*
- Material Endurance *(Strength, Fatigue; Creep - constant vs. declining threshold limits?; extrapolation validity)*
- Material Durability *(Aging effects; Accelerated testing vs. Durability models)*

The 200-year Bridge: Resilient, Economical, Environmentally & Socially Sustainable

Moderator: Design Criteria (LRFD + R&A)

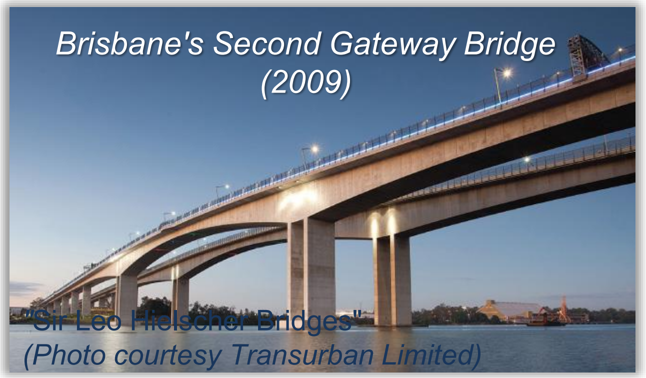
RESILENCE

- Defying Gravity *(Arch-Compressive vs. Flexural Resistance)*
- Inert or Regenerative materials *(Ultra-durable, or Self-healing, or easily replaceable)*
- Rapid Repair &/or Replacement *(component upgrade, periodic replacement)*



Ponte Pietra Bridge, post-WWII

...2016, Born 100 BC (Verona)



Brisbane's Second Gateway Bridge (2009)

"Sir Leo Hielscher Bridges"
(Photo courtesy Transurban Limited)

ADAPTABILITY

- Repurposing *(Roadway - commuting/freight, vs. Transit, vs. Shared-use)*
- Tunable *(Strengthening, Widening, Lengthening, Heightening?)*
- Future Environment *(Hydraulic capacity, Vertical Clearance, Seawater encroachment)*

DOI:10.2749/newyork.2019.1207

Panelist Question – Part 1a

1. What is the driving factor of slower FRP acceptance across the country: if **Life-Cycle Costs** show a significant decrease over the long term, is it the initial cost?
2. Is it the lack of standards/specifications/quality materials audits that inhibit use by state DOTs?
3. The standardized use of GFRP rebar took decades, other more recent technologies such as Maine's "bridge in a backpack" using FRP tubes took over 20 years for development and use by multiple states. How do we reduce this "decades long" implementation process?
4. What are the key points to decreasing initial costs?
5. How can we take what is being done in a few key states – FDOT, Maine, Tennessee (with rural FRP bridge replacements) – and make it appealing to implement throughout the US?

FDOT Composite Materials – Part 1b

Panelist: Alex Lewis, PE.

Composite Materials Specialist
State Materials Office, FDOT
Gainesville, FL.

- Materials Engineering Specialist
- Project Manager for several research projects on FRP and Corrosion
- Technical Committee (voting member) for AASHTO Product Evaluation and Audit Solutions

Panelist: Alexander Lewis – Part 1b

i. **FDOT § 415 Specification change for FY2026-27**

- Effective: July 1, 2026

415-3 Protection of Material.

Store reinforcement above the surface of the ground, upon platforms, skids, or other supports, and protect it from mechanical injury and surface deterioration. Ensure that the reinforcement is free from loose rust, scale, dirt, paint, oil, and other foreign material prior to incorporation into the work. Protect FRP against UV exposure and extreme ambient storage temperatures as required by the FRP manufacturer. If the manufacturer does not provide any requirements, limit FRP sun exposure to 4 months and maximum ambient storage temperature to 120°F.

- Current

415-3 Protection of Material.

415-3.1 Steel Reinforcing: Store steel reinforcement above the surface of the ground, upon platforms, skids, or other supports, and protect it from mechanical injury and surface deterioration. Ensure that the steel reinforcement is free from loose rust, scale, dirt, paint, oil, and other foreign material prior to incorporation into the work.

415-3.2 Fiber Reinforcing Polymer (FRP) Reinforcing: Store FRP reinforcement above the surface of the ground, in boxes or upon platforms, skids, or other supports, and protect it from mechanical injury and direct exposure to UV light. Ensure that the FRP reinforcement is free from dirt, paint, oil, and other foreign material prior to incorporation into the work.

- **Summary of Changes**
  - Simplify language
  - Change FRP Reinforcement Storage Exposure Limits
  - Expand rebar tying options for FRP reinforcement

Panelist: Alexander Lewis – Part 1b

i. FDOT § 415 Specification change for FY2026-27

- Effective: July 1, 2026

415-5.3 Tying: Securely tie all reinforcement together without damage. Use ties of sufficient strength to maintain the reinforcement in its proper position. For stainless steel reinforcement, use stainless steel wire or non-metallic tying materials.

The tying materials should not damage the reinforcement during the construction.

- Current

415-5.3 Tying:

415-5.3.1 Steel Reinforcing: Tie steel reinforcing using pliable steel wire that readily bends and twists without breaking and that provides a tie of sufficient strength to hold the steel reinforcing in its proper position. Tie stainless reinforcing steel using plastic coated pliable steel wire; or stainless steel wire meeting the requirements of ASTM A276, UNS S31600.

Non-metallic fasteners for steel reinforcing may be used in precast concrete products upon approval by the District Materials Office (DMO).

415-5.3.2 Fiber Reinforcing Polymer (FRP) Reinforcing: Tie FRP reinforcing using self-locking plastic straps; or plastic coated pliable steel wire that readily bends and twists without breaking and that provides a tie of sufficient strength to hold the FRP reinforcing in its proper position.

- **Summary of Changes**
  - Simplify language
  - Change FRP Reinforcement Storage Exposure Limits
  - Expand rebar tying options for FRP reinforcement

Panelist: Alexander Lewis – Part 1b

ii. FDOT § 932-4 Specification change for FY2026-27

- Effective: July 1, 2026

932-4.3 Material Acceptance: Submit to the Engineer a certificate of analysis for each production LOT from the producer of the FRP reinforcing bars, confirming compliance with the requirements of this Section.

932-4.3.1 Sampling: The Engineer will identify specimens for the test samples. Contractor will provide the testing samples if the project includes more than 15,000-feet of straight or 10,000-feet of bent or 10,000-feet of spiral or a combined length of more than 20,000-feet of FRP reinforcing bars. One sample of each size of straight, bent, and spiral FRP reinforcing bar must be selected. A straight bar sample includes six specimens of at least 7-foot length. A bent or spiral bar sample includes five specimens of at least 2-foot length. Testing will not be required for bars to be used solely as reinforcement for sheet pile bulkhead cap or pile jackets, but samples will still be selected and retained by the Engineer until final acceptance of the work.

- Current

932-4.3 Material Acceptance: Submit to the Engineer a certificate of analysis for each production LOT from the producer of the FRP reinforcing bars, confirming compliance with the requirements of this Section.

932-4.3.1 Sampling: The Engineer will select a minimum of six straight bars with minimum lengths of 7 feet each and a minimum of five bent bars or spiral bends/revolutions from each shipment, representing a random production LOT, per bar size of FRP reinforcing for testing in accordance with Table 932-9. Testing shall be conducted, at the Contractor's expense, by a Department approved independent laboratory. Each test shall be replicated a minimum of three times per sample. Submit the test results to the Engineer for review and approval prior to installation. Testing will not be required for bars to be used solely as reinforcement for sheet pile bulkheads, but LOT samples will still be selected and retained by the Engineer until final acceptance of the work.

Panelist: Alexander Lewis – Part 1b

ii. FDOT § 932-4 Specification change FY2026-27

- Summary of Changes
  - Change Sampling Frequency: LOT → PLF
  - Remove requirement for approved lab'
    - Requirement for approved lab' will remain for rebar qualification testing.
    - SMO aims to have capability of performing Table 932-9 tests in-house by July 2026.
  - Add CP pile jackets to project level testing exemption list.

Table 932-9
Testing Requirements for Project Material Acceptance of FRP Reinforcing Bars

Property	Test Method	Requirement	Test Required for Straight Bar	Test Required for Bent Bar
Fiber Mass Fraction	ASTM D2584 or ASTM D3171	≥70%	Yes	Yes – bent portion[b]
Short-Term Moisture Absorption	ASTM D570, Procedure 7.1; 24 hours immersion at 122°F	≤0.25%	Yes	Yes – bent portion[b]
Glass Transition Temperature	ASTM D7028 (DMA) or ASTM E1356 (DSC; T_m)/ ASTM D3418 (DSC; T_{mg})	≥230°F ≥212°F	Yes	Yes – bent portion[b]
Degree of Cure	ASTM E2160	≥95% of Total polymerization enthalpy	Yes	Yes – bent portion[b]
Measured Cross-sectional Area		Within the range listed in Table 932-8	Yes	Yes – straight portion
Guaranteed Tensile Load[a]		≥ Value listed in Table 932-8	Yes	No
Tensile Modulus	ASTM D7205	≥6,500 ksi for BFRP and GFRP (Type 0) ≥8, 700 ksi for BFRP and GFRP (Type III) ≥18,000 ksi for CFRP (Type I) Bars ≥22,400 ksi for CFRP (Type II) Strands	Yes	No

a – Guaranteed tensile load shall be defined as the average test result minus three standard deviations.
b – Bent portion specimens shall be extracted from a central location within a 90° bend.

*Effective: July 1, 2026

Panelist: Alexander Lewis – Part 1b

iii. Build America Buy America (BABA)

- Guidance from Office of Management & Budget
- Florida: FRP = Construction Material
- FRP incorporated into a manufactured product…

§ 184.3 Definitions.

Construction materials means articles, materials, or supplies that consist of only one of the items listed in paragraph (1) of this definition, except as provided in paragraph (2) of this definition. To the extent one of the items listed in paragraph (1) contains as inputs other items listed in paragraph (1), it is nonetheless a construction material.

(1) The listed items are:

(i) Non-ferrous metals;

(ii) Plastic and polymer-based products (including polyvinylchloride, composite building materials, and polymers used in fiber optic cables);

(iii) Glass (including optic glass);

(iv) Fiber optic cable (including drop cable);

(v) Optical fiber;

(vi) Lumber;

(vii) Engineered wood; and

(viii) Drywall.

(2) Minor additions of articles, materials, supplies, or binding agents to a construction material do not change the categorization of the construction material.

Manufactured products means:

(1) Articles, materials, or supplies that have been:

(i) Processed into a specific form and shape; or

(ii) Combined with other articles, materials, or supplies to create a product with different properties than the individual articles, materials, or supplies.

(2) If an item is classified as an iron or steel product, a construction material, or a section 70917(c) material under § 184.4(e) and the definitions set forth in this section, then it is not a manufactured product. However, an article, material, or supply classified as a manufactured product under § 184.4(e) and paragraph (1) of this definition may include components that are construction materials, iron or steel products, or section 70917(c) materials.

Produced in the United States means:

(1) In the case of iron or steel products, all manufacturing processes, from the initial melting stage through the application of coatings, occurred in the United States.

(2) In the case of manufactured products:

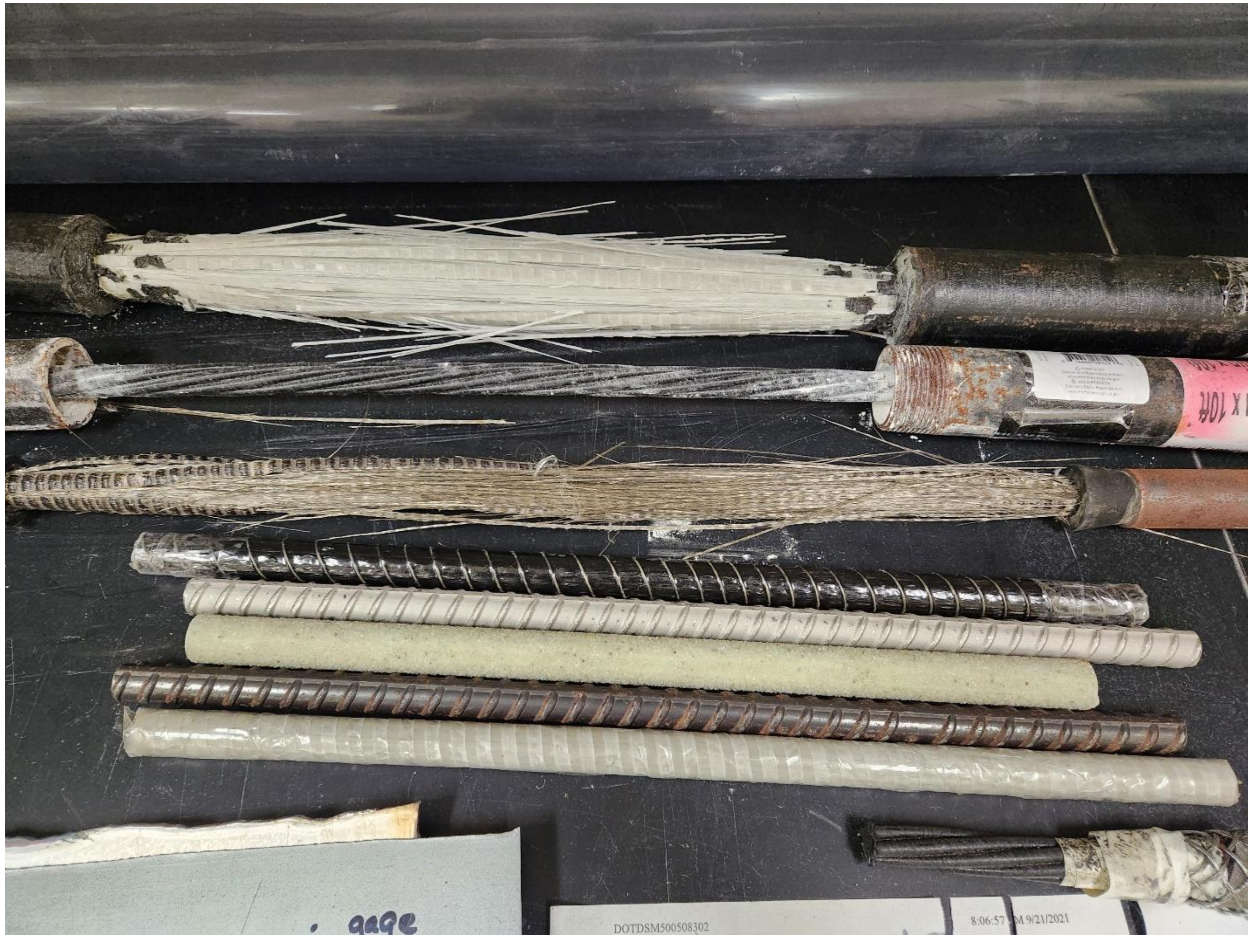
(i) The product was manufactured in the United States; and

(ii) The cost of the components of the manufactured product that are mined, produced, or manufactured in the United States is greater than 55 percent of the total cost of all components of the manufactured product, unless another standard that meets or exceeds this standard has been established under applicable law or regulation for determining the minimum amount of domestic content of the manufactured product. *See* § 184.2(a). The costs of components of a manufactured product are determined according to § 184.5.

(3) In the case of construction materials, all manufacturing processes for the construction material occurred in the United States. *See* § 184.6 for more information on the meaning of "all manufacturing processes" for specific construction materials.

Panelist: Alexander Lewis – Part 1b

iv. FRP Materials Program - Future



Equipment Acquisitions

- Large Horizontal Tensile Test Machine
  - 500kN/2500kN load capacity
  - Tensile test up to #11 bars
- Universal Materials Tester
  - 50kN load capacity
  - Tension, compression capability w/added fixtures for other tests

Keeping up w/industry advancements

- CFRP wraps
- FRP bridge girder
- FRP pedestrian deck

Move away from auditing

- AASHTO PEAS

Panelist: Alexander Lewis – Part 1b

v. Instron 34TM-50kN

Specifications

- 50 kN load capacity in tension and compression
- Additional 0.2kN load cell for greater precision with weaker materials
- 5kN pneumatic plate grips, 50kN wedge grips
- Long Travel Extensometer
  - Calibrated To ASTM E83 Class B1 at 1”, 2” gauge length to 30” travel

Rebar Tests

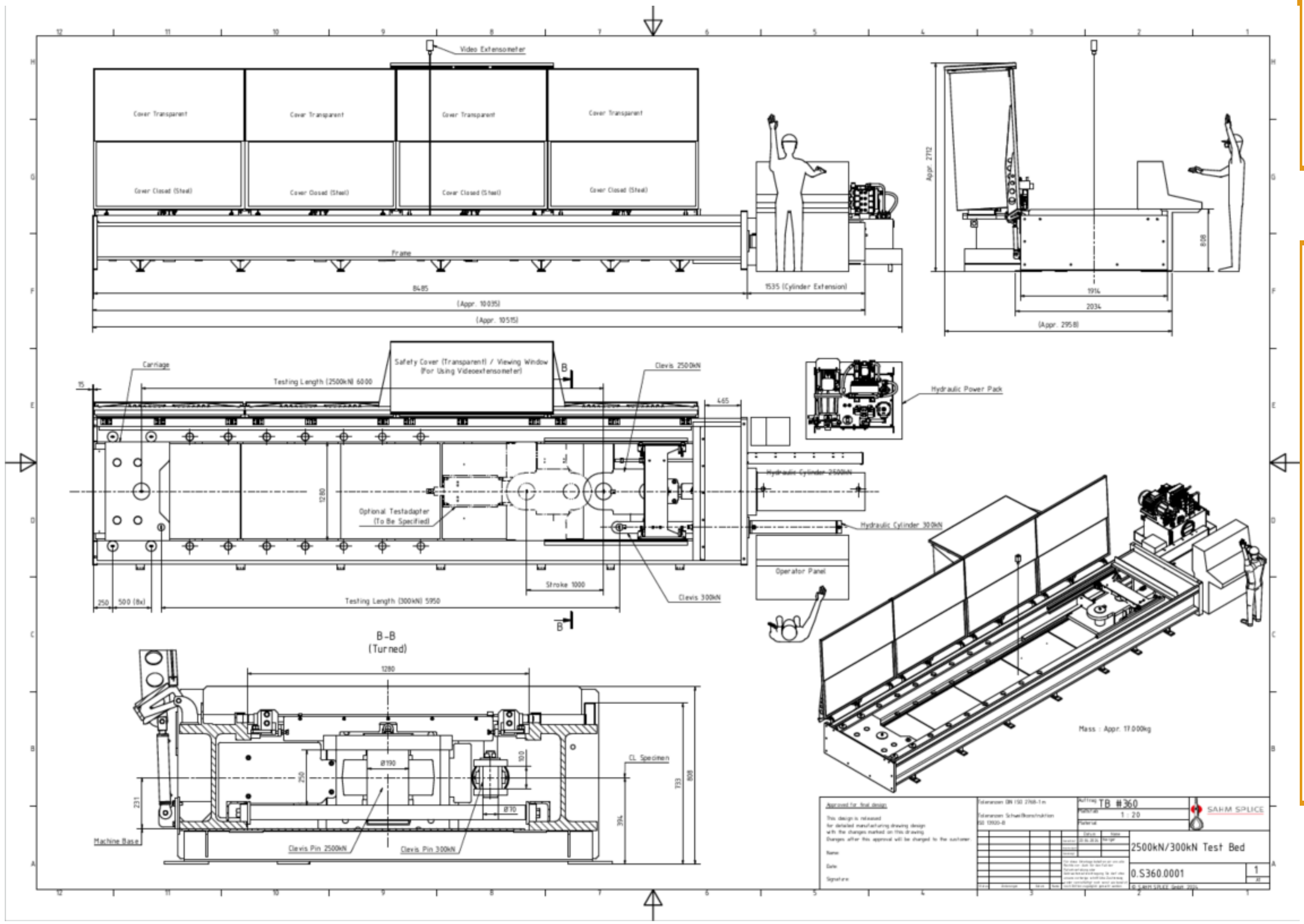
- ASTM D4475
- ASTM D7617

Structural Composites & Plastics

- ASTM D638
- ASTM D3039
- ASTM D7078
- And more…

Panelist: Alexander Lewis – Part 1b

v. Horizontal Tensile Test Machine Procurement



General

- Manufacturer: Sahm Splice
- Delivery timeline: Q1 2026
- Design based on frames produced for and currently used by Tokyo Rope USA

Features & Capability

- 2500/500 kN 2-in-1 test bed
- Test Capability:
  - GFRP/BFRP: #3 - #11
  - CFRP Prestressing Strand: 15mm
  - Steel:
- 5kN pneumatic plate grips, 50kN wedge grips
- Ceiling mounted video extensometer

Panelist: Alexander Lewis – Part 1b

vi. AASHTO Involvement

Composite Concrete Reinforcements (CCR)

- Chair: Steven Nolan, PE.
- Addition of BFRP Bars to Workplan (2025)
- Incorporation of ASTM D8505-23 into audit documents
- CFRP Prestressing Strand Workplan in Development (2026-27)
- FDOT working on how to best incorporate CCR auditing program in its Producer QA/QC program in upcoming years

AASHTO
PRODUCT EVALUATION & AUDIT
SOLUTIONS

Panelist: Alexander Lewis – Part 1b

vii. FDOT Research Update: BEG77…

Table 4. Concrete Mix

Component	Description	% by Mass
Water	Water	7.0%
Cement	Type IL	11.0%
Coarse Aggregate	Crushed Limestone #67	39.0%
Fine Aggregate	Type A Concrete Sand	37%
Class F Fly Ash	Silo #4 DS 3/5-3/27	6.0%

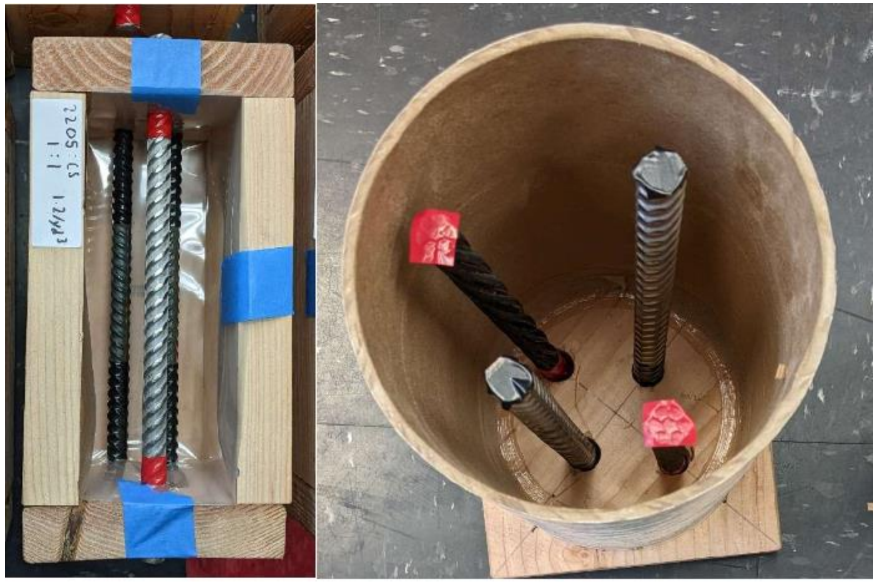


Photo Credit: James Ellor, PE. (KTA Tator Inc.)

Figure 3. Test Samples Prior to Concrete Placement

Title

- ***Determining the Effect of Changing Relative Area on the Galvanic Corrosion Rate of Dissimilar Materials***

Material Combinations

- 316LN SS/Duplex 2205 SS with A615 steel
- CFRP with 316LN SS/Duplex 2205 SS
- Cathode: Anode Area Ratios: 1:1, 1:3, 1:10

Test Conditions

- Simulated Pore Solution
  - pH 13 – formula derived from ASTM C1876
  - pH 11.2 – simulate carbonated & chloride contaminated environment
- Concrete Prisms
  - Chloride Contamination
  - Simulated ponding, partial immersion

Panelist: Alexander Lewis – Part 1b

vii. Research Update: BEG77 – Galvanic Corrosion…

- Status: All tests complete. Pending final report
- Estimated Project Completion Date: **February 2026**

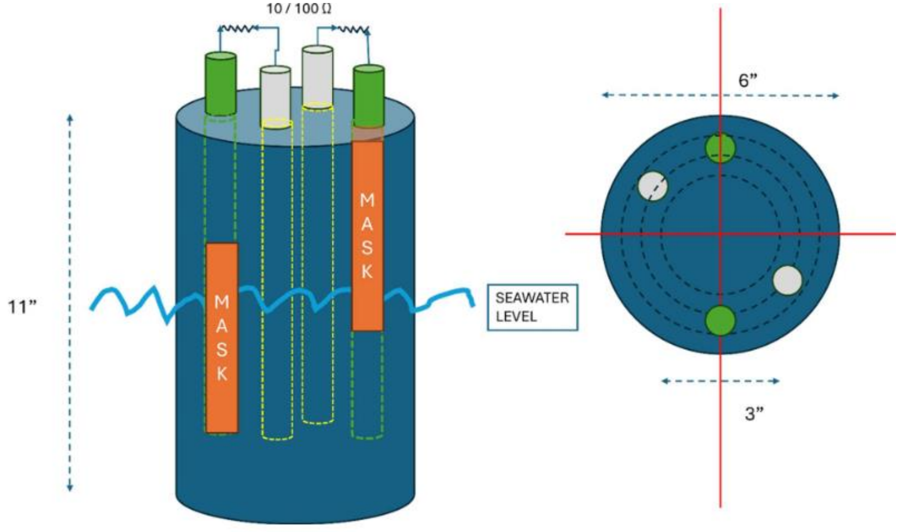


Figure 2. Cylindrical Concrete Prisms, with Partial Seawater Exposure

Photo Credit: James Ellor, PE. (KTA Tator Inc.)

Panelist: Alexander Lewis – Part 1b

viii. Research Update: BEE76-977-02, "HRB 7-year Durability Investigation in Seawater Concrete"

- Status: All extraction and testing completed. pending Final Report from UM.
- See Dr. De Caso's slides (Part 1f)

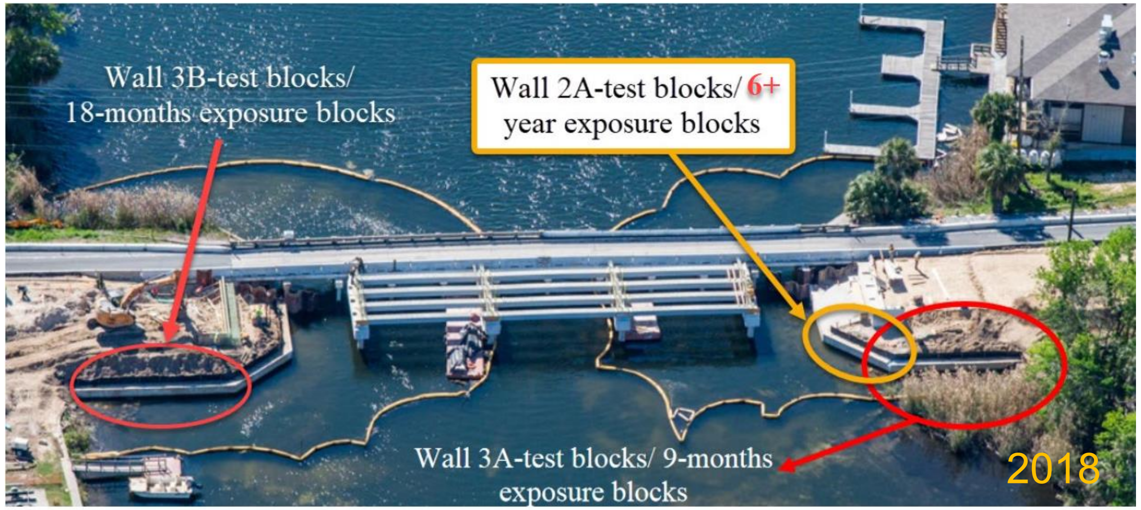


Figure 5. Aerial photo of Halls River Bridge during construction with previous and current test-block extraction sites labeled

Materialist Question – Part 1b

1. What is the driving factor of slower FRP acceptance across the country: if **Life-Cycle Costs** show a significant decrease over the long term, is it the initial cost?
2. Is it the lack of **Standards/Specifications/Quality Materials Audits** that inhibit use by state DOTs?
3. The standardized use of GFRP rebar took decades, other more recent technologies such as Maine's "bridge in a backpack" using FRP tubes took over 20 years for development and use by multiple states. How do we reduce this "decades long" implementation process?
4. What are the key points to decreasing initial costs?
5. How can we take what is being done in a few key states – FDOT, Maine, Tennessee (with rural FRP bridge replacements) – and make it appealing to implement throughout the US?

CFRP Rehabilitation Opportunities – Part 1c

Panelist: Atiq Alvi, PE.

Vice President / Florida Bridge Sector

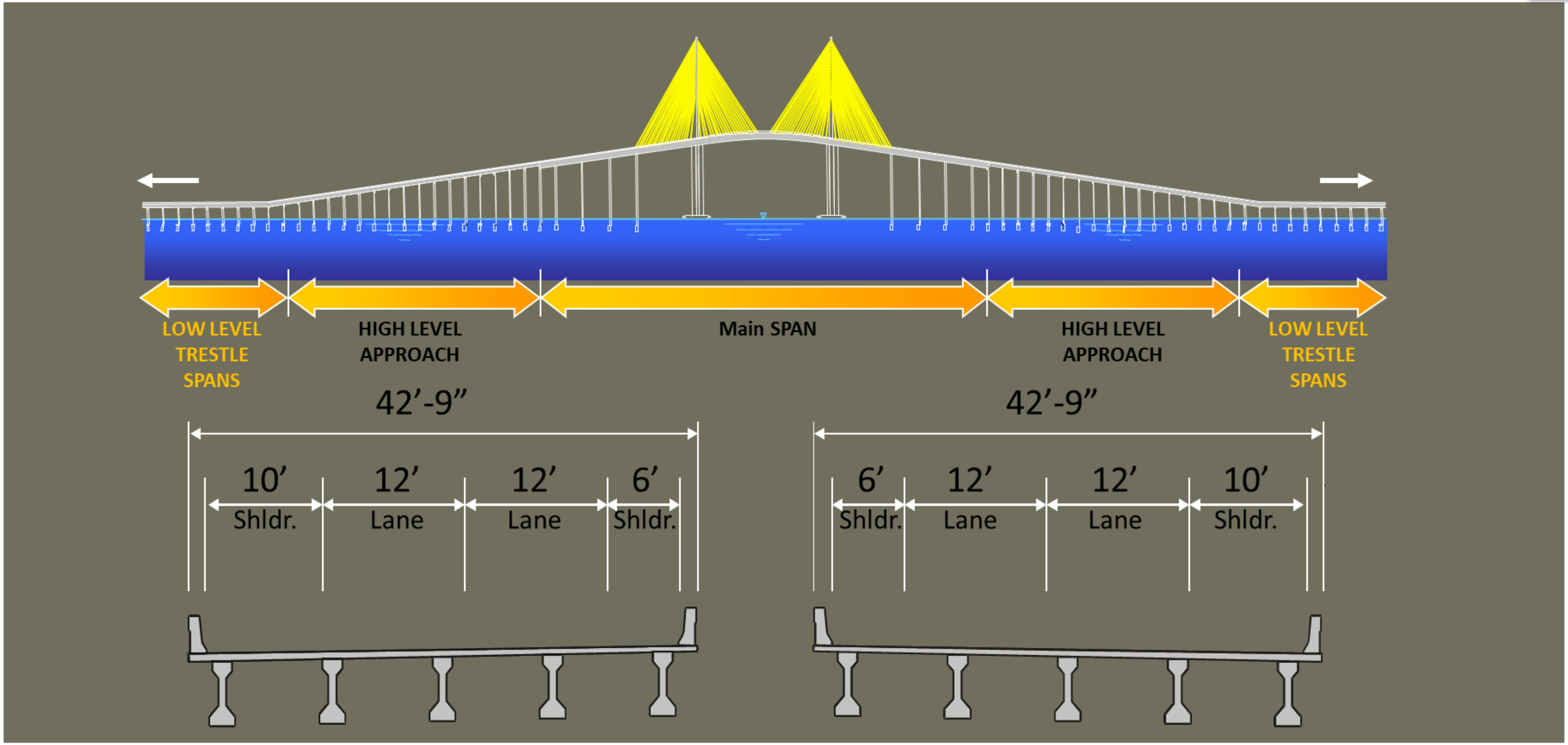
Manager / National Lead for Bridge Rehabilitation Practice

TYLin

- Engineer of Record for 3rd CFRP Strengthening Project 2019
- Project Manager for Pilot CFRP Project 2007
- Project Manager for Skyway Trestle Span Beam Study 2006
- Former FDOT District Seven Structures Maintenance Engineer
- PM/Engineer of Record for 50+ rehab projects, including movable and complex bridges
- Transportation Research Board Bridge Structural FRP Committee (Member and Friend) since 2003

34 Years Bridge Engineering Experience

CFRP Featured Project: Sunshine Skyway – Part 1c



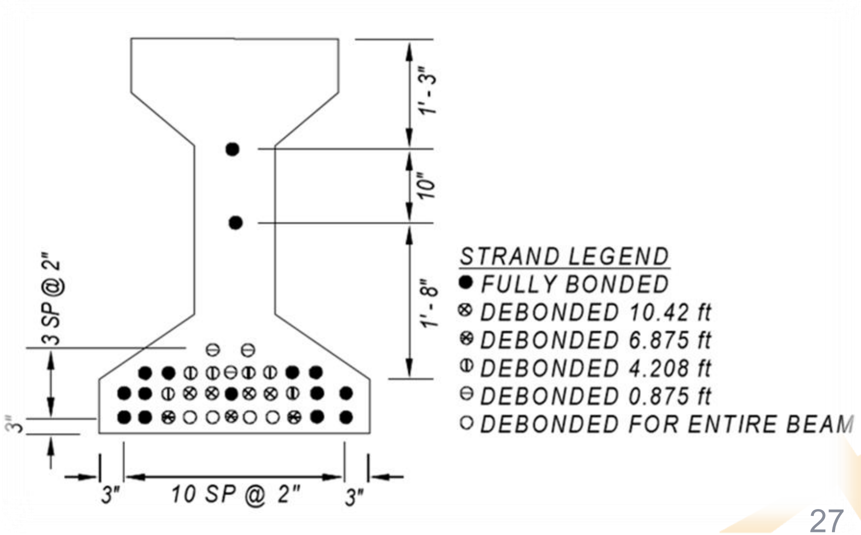
Trestle Spans Length: 13,000 feet

CFRP Featured Project: Sunshine Skyway– Part 1c

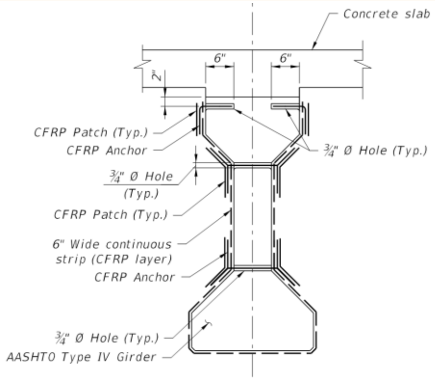
Bridge	Girders			Girders w/Cracking				
	Total Girders	Exterior Girders	Interior Girders	Exterior Girders	Exterior %Cracked	Interior Girders	Interior %Cracked	Total %Cracked
Northbound	650	260	390	254	97.7%	4	1.0%	39.7%
Southbound	650	260	390	242	93.1%	5	1.3%	38.0%

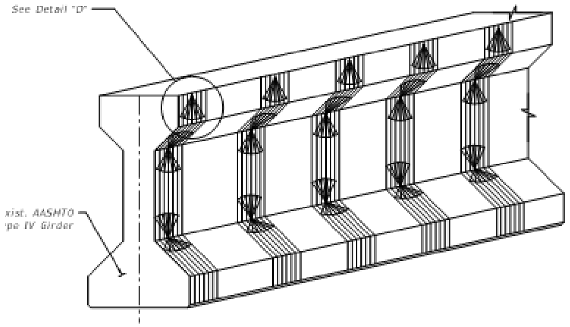
* Majority of Diagonal Cracks in Exterior Faces of External Girders

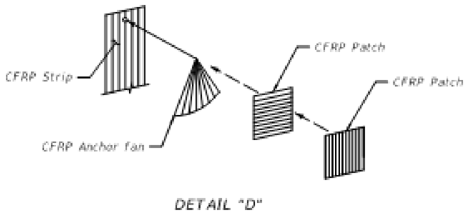
- Excessive Debonding due to Change Made in Construction
- 33 Strands in Bottom Flange
- 20 (61%) Debonded
- 13 (39) Fully Bonded
- Current FDOT Codes Allow 25% Debonding, not to exceed 30%



CFRP Sunshine Skyway Featured Project – Part 1c







Description	Year	CFRP Wrap (LF)
Pilot Project	2009	975
Pilot for Mechanical Anchoring	2013	365
Self-Adhesive CFRP Wrap	2019	7,225

CFRP Sunshine Skyway Featured Project – Part 1c

- Challenges for rehabilitation design & construction
- Coupling of FRP rehab with Corrosion Mitigation (Cathodic Protection, etc.)
- Vessel Impact, Fendering & Dolphin Systems

Bridge Design, Construction, & Rehab. – Part 1d

Panelist: Mohit Soni, PE.

Senior Principal

Bridge Lead for US Gulf and Texas

Stantec

- Engineer of Record for 100 bridge design or rehabilitations.
- Former Building Industry Designer.
- AASHTO/NSBA TG 11 Steel Design.

25 Years Bridge Engineering Experience

Bridge Design, Construction, & Rehab. – Part 1d

- Challenges for new construction design and rehabilitation
- Potential applications for new bridge and structures design
- Feature projects:
  - SR 312 over Matanzas River Rehab.
  - US 17 over Trout River Rehab.
  - Brickell Key Bridge Rehab.
  - Atlantic Isles Lagoon Replacement

Bridge Design, Construction, & Rehab. – Part 1d

FRP – Design Innovation

Fast Facts:

Glass Fiber Reinforced Polymer & Basalt Reinforcing Mesh

FDOT

Project Location:	FDOT District Two St. Johns County St. Augustine, Florida
Agency:	Florida Department of Transportation
URL:	http://www.fdot.gov/structures/innovation/FRP.shtm
Project Name:	SR-312 Over Matanzas River Bridge No. 780089 FPID: 428229-1
Project Description:	Bridge Substructure Rehabilitation
Project Purpose & Need:	Bridge Inspection Reports identified concrete deterioration in the substructure. Work activities included removal of existing multi-column pier jackets and installation of new jackets on the multi-column pier. New jackets were installed at the specific multi-column piers. Pier Footing Jackets with Impressed Current Cathodic Protection (ICCP) were installed. Ribbon anodes were installed between the piles on the pier footing. GFRP dowels and Basalt Reinforcing Mesh were used in select locations.

SR-312 over Matanzas River (ST. AUGUSTINE)

What was unique about this project?

Pier 15, Pier 19, Pier 20, Pier 21, Pier 22, Pier 23, Pier 26, Pier 29, Pier 30, and Pier 31 were rehabbed as follows:

Columns: No. 4 L-shape GFRP dowel bars with epoxy were embedded into the columns to attach the 150mm x 150mm x 4mm Basalt Reinforcing Mesh to protect the Titanium Anode Mesh.

Struts: No. 4 L-shape GFRP dowel bars with epoxy were embedded into the strut to attach the No. 4 GFRP bars in longitudinal and No. 3 GFRP bars in transverse direction to protect the Titanium Anode Mesh. Dowel spacing was 6-in and GFRP bars were spaced at 1-ft in both direction alongside of strut.

Footing: This is among the first projects to implement Ribbon Anodes.

Shotcrete: Pneumatically applied concrete was used in the Column and Strut to form the Jacket. However, due to problems with concrete quality issues, the shotcrete was removed from a few piers and was applied again. This provided an opportunity to explore removal of concrete from the Basalt Mesh and GFRP bars.

Below is the list of innovations unique to this project:

- Use of GFRP in conjunction with Shotcrete
- GFRP bar use in the marine environment
- Use of Basalt Mesh in conjunction with GFRP
- Use of Ribbon Anode in Footings

Bridge Design, Construction, & Rehab. – Part 1d

FRP – Design Innovation

Fast Facts:

Glass Fiber Reinforced Polymer

Project Location:	FDOT District Two Duval County Jacksonville, Florida
Agency:	Florida Department of Transportation
URL:	http://www.fdot.gov/structures/innovation/FRP.shtm
Project Name:	US-17 (SR-5) Over Trout River Bridge No. 720011 FPID: 426169-1
Project Description:	Bridge Substructure Rehabilitation
Project Purpose & Need:	Bridge Inspection Reports identified concrete deterioration in the substructure. Work activities included removal of existing Pile Jackets and installation of new Pile Jackets and Pier Footing Jackets with Impressed Current Cathodic Protection (ICCP). Glass Fiber Reinforced Polymer (GFRP) dowels and reinforcement were used in select locations.

FDOT

US-17 over Trout River (JACKSONVILLE)

Overall Budget/Cost Estimate: $2,759,262.00 (Construction Contract)

What was unique about this project?

No. 4 GFRP bars with epoxy were embedded into existing Pier Footings 9 and 10 to attach the new Footing Jacket to the existing Pier Footer. The Pier 10 Footing Jacket included No. 6 GFRP reinforcement.

Shotcrete (pneumatically applied concrete), was used to apply concrete to Pier 9 and Pier 10 Footings to form the Pier Jacket. However, due to problems with concrete quality issues, the shotcrete was removed from the Pier 10 footing and the process of forming the jacket and pouring concrete was used. This provided an opportunity to explore removal of concrete from FRP bars. Below are the list of pilot projects incorporated:

- GFRP bars used in conjunction with Shotcrete
- GFRP bars used in the splash zone
- GFRP bars used with traditional pour in place construction methods

Describe Traditional Approach: Traditional approach includes installation of grade 60 steel rebar in conjunction with cast-in-place concrete.

Describe New Approach: Utilization of GFRP bars in lieu of traditional grade 60 steel rebar in a variety of settings, including in conjunction with Shotcrete; in the splash zone; with traditional pour in place construction methods; and removal of concrete from GFRP bars.

Top Innovations Employed: Utilization of GFRP bars within the splash zone/marine environment

Primary Benefits Realized/Expected: Lifted the restrictions on use of GFRP bars within the splash zone/marine environment. The restriction was in place due to reaction of GFRP bar resin with chlorides

Project Start Date/Substantial Completion Date: 5/4/2014 – 3/26/2016

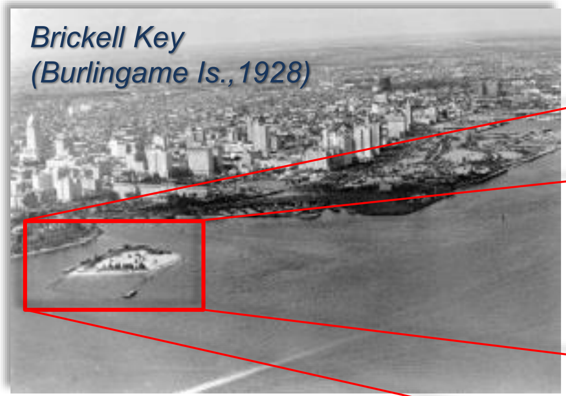
Affiliations:	PE Consultant: Construction Contractor: Construction Engineering Inspection:	Stantec Consulting Services Inc. Coastal Gunite Construction Company JEA Construction Engineering Services
Project Contact:	Engineer of Record:	Mohit D. Soni, P.E. Stantec Consulting Services Inc. Mohit.Soni@stantec.com
	FDOT Project Manager:	Jeff Bailey FDOT District Two Jeff.Bailey@dot.state.fl.us
	FDOT State Materials Office:	Chase C. Knight, Ph.D. FDOT Composites Material Specialist Chase.Knight@dot.state.fl.us

FDOT

http://www.fdot.gov/structures/innovation/FRP.shtm

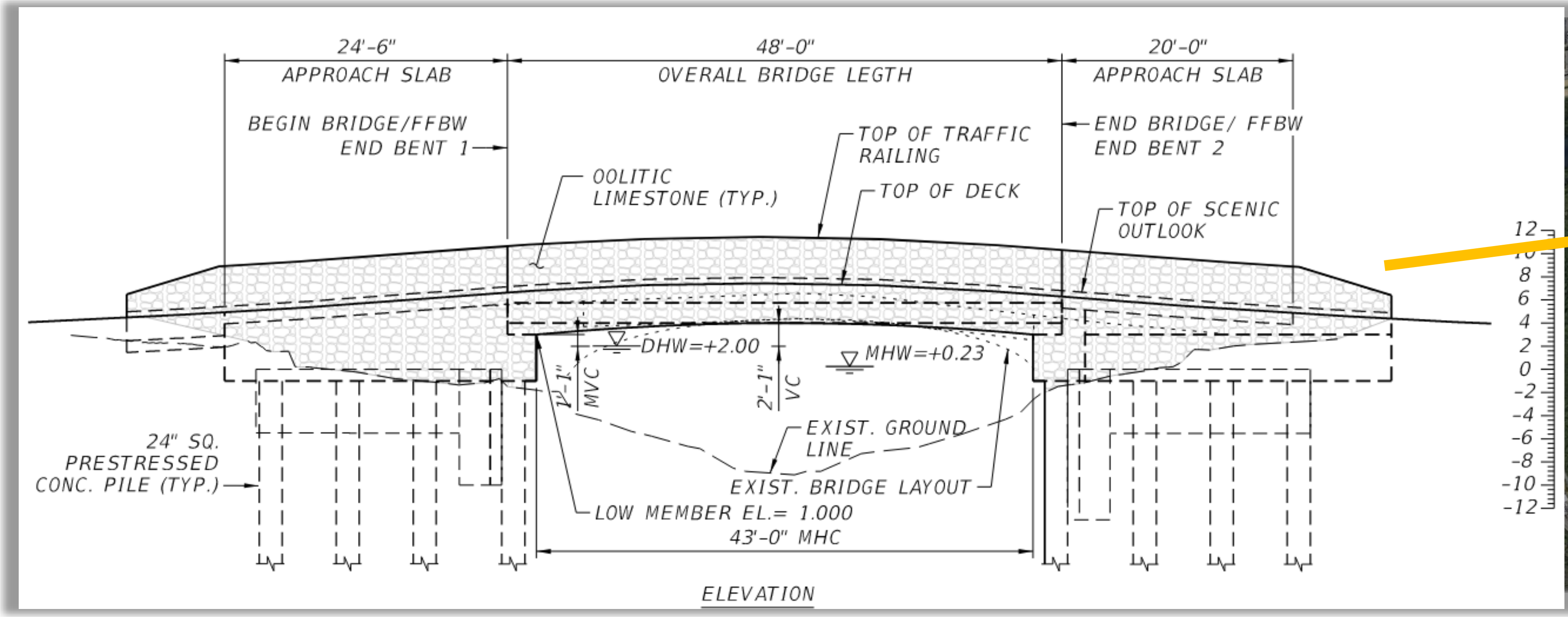
Bridge Design, Construction, & Rehab. – Part 1d

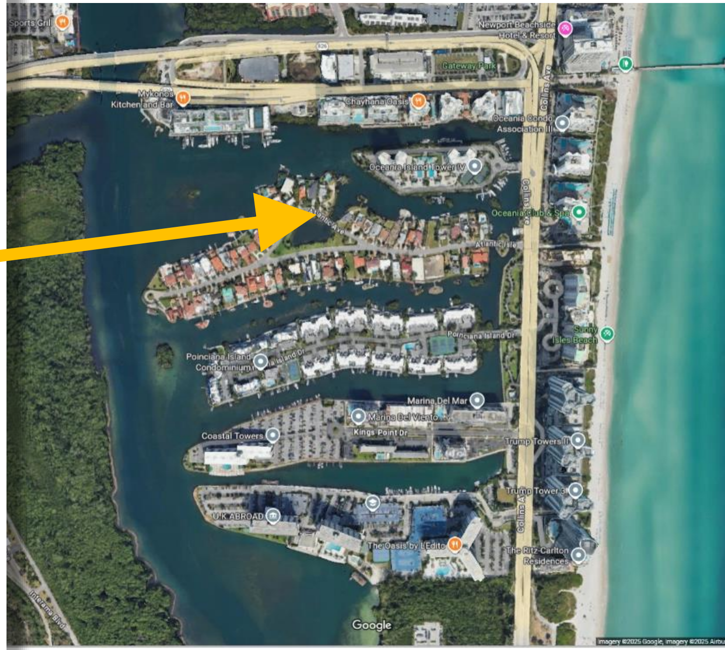
Brickell Key Bridge (MIAMI)



Bridge Design, Construction, & Rehab. **– Part 1d**

Atlantic Isle Lagoon (CITY OF SUNNY ISLES BEACH)





Atlantic Isle Lagoon Historic Bridge Replacement (430029-2),
Local Assistance Project – FRP-RC/PC end bents & arched FSB's, upper drilled shaft connection $2M, Letting 12/22/2027

Practitioner's Question – Part 1c & 1d

1. What is the driving factor of slower FRP acceptance across the country – if lifecycle costs show a significant decrease over the long term, is it the initial cost?
2. Is it the lack of standards/specifications/quality materials audits that inhibit use by state DOTs?
3. The standardized use of **FRP Externally Bonded Repairs** and **FRP Rebar** took decades, other more recent technologies such as Maine's "bridge in a backpack" using **FRP tubes** took over 20 years for development and use by multiple states. How do we reduce this "decades long" implementation process?
4. What are the key points to decreasing initial costs?
5. How can we take what is being done in a few key states – FDOT, Maine, Tennessee (with rural FRP bridge replacements) – and make it appealing to implement throughout the US?

Challenges for Producers – Part 1e

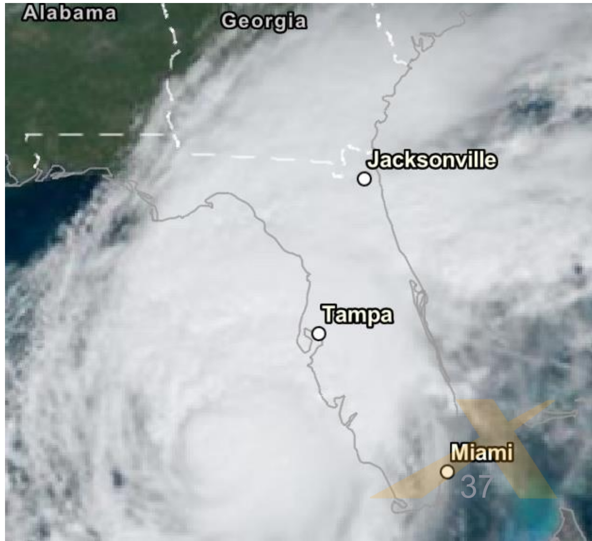
Panelist: Danielle Kleinhans, Ph.D, PE.

Director of Engineering and Business Development

mateenbar

- PhD from University of Missouri-Rolla under Dr. Antonio Nanni and Dr. John J. Myers
- Former President and CEO of CRSI
- Technical Committee (Member/Friend) ACI 440, ASTM, TRB, AASHTO

25 Years Bridge Engineering Experience



Challenges for producers entering the market – Part 1e

- Understand the material specifications
- Understand the market potential
- Establish manufacturing capabilities
- Navigating the approval process
- Multiple rounds of testing and audits
- Product recognition
- Name recognition

Challenges for producers servicing contractors – Part 1e

- Take-off support
- Project management capabilities
- Logistics
- Distribution partners
- Contracts and cashflow

Opportunities for expansion – Part 1e

- Eliminate duplication of efforts
- Educate design community
- Educate contractor community
- Clearer guidance on best use scenarios
- Industry capacity exists, ready to add facilities

Featured Project: Harker's Island – Part 1e

- World's largest bridge built without steel reinforcement
- Located in the Outer Banks of NC
- 3,200-ft-long, 28-span structure
- 1.57 million feet of Mateenbar60™ used
- 100-year corrosion-free design
- Winner of two 2025 PCI Design Awards

Producer's Question – Part 1e

1. What is the … country – if … long term, is …
2. Is it the lack … that inhibit u…
3. The standar… **FRP Rebar** … Maine's "bri… years for de… reduce this "…

A. Reinforcing Bars

Cost Comparison (Installed Price)

Bar Size	Nominal Diameter	Average Unit Costs HRB (3-bids) / **		FDOT Structures Manual for BDR Cost Estimating / **	
		GFRP Bars 2016	GFRP Bars 2023	Grade 60 Steel	Stainless-Steel
#4	0.500"	$1.18 / LF	$1.90 / LF	$~~0.60~~ 1.11 / LF	$~~2.72~~ 5.25 / LF
#5	0.625"	$1.37 / LF	$2.29/ LF	$~~0.94~~ 1.74 / LF	$~~4.19~~ 8.09 / LF
#6	0.750"	$1.55 / LF	$2.71/ LF	$~~1.35~~ 2.51 / LF	$~~5.98~~ 11.54 / LF
#8	1.000"	$2.54 / LF	$4.04/ LF	$~~2.40~~ 4.45 / LF	$~~10.74~~ 20.73 / LF

Note: There is not 1:1 substitution of FRP for steel bars.
Black steel bar based on $1.67** ~~$0.90~~ / lb for all bar sizes.
Stainless steel bar based on $7.72** ~~$4.00~~ / lb for all bar sizes.

** 2023 FDOT Bid Avg.

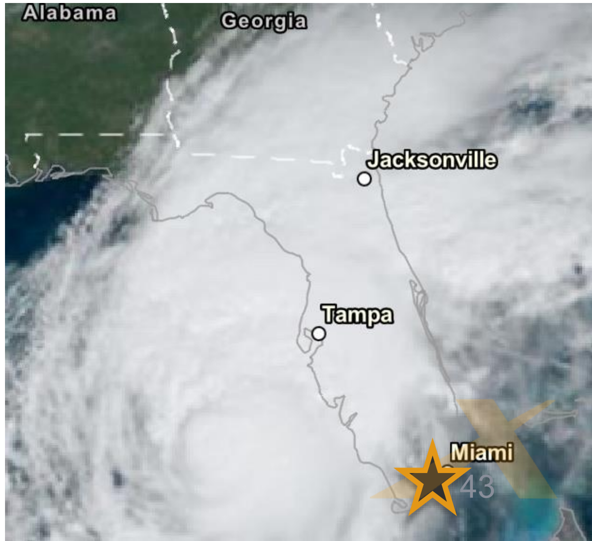
4. What are the key points to decreasing initial costs?
5. How can we take what is being done in a few key states – FDOT, Maine, Tennessee (with rural FRP bridge replacements) – and make it appealing to implement throughout the US?

FRP Research, Standards and Specifications – Part 1f

Panelist: Francisco De Caso, Ph.D, PE.

Principal Scientist
Structures and Materials Laboratory, CAE
University of Miami

- Francisco De Caso, UM, Managing Director of the NSF Center for Integration of Composites into Infrastructure (CICI).
- Manager ISO17025-accredited Structures and Materials Laboratory (SML), and ISO 17020-accredited inspection body.
- Chair of ASTM D30.10: Composites for Civil Structures.



FRP Research for Standards and Specifications – Part 1f

Halls River Bridge:
A Concrete Bridge with Zero Steel

A 'living lab' for testing FRP, recycled aggregates and seawater concrete

- Francisco De Caso, Ph.D., P.E.
- *Principal Scientist, University of Miami*

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Featured Project: Halls River Bridge – Part 1f

- Completed in 2017, Halls River Bridge is FDOT's first major marine demonstration of FRP reinforcement, seawater-mixed concrete, and recycled materials.
  - Number of spans: 5
  - Total length: 56.7 m (187')
  - Width: 17.6 m (58')

Halls River Bridge Research Team – Part 1f

Francisco De Caso

Osama Omar

Juan Manuel Palacios

Roger Solis

Alvaro Ruiz Emparanza

Alexander Lewis

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Featured Project: Halls River Bridge – Part 1f

i. Incorporates GFRP, BFRP, and CFRP bars across different structural elements.

ii. Serves as a *living lab* for ongoing monitoring and performance evaluation of innovative materials in marine environments.

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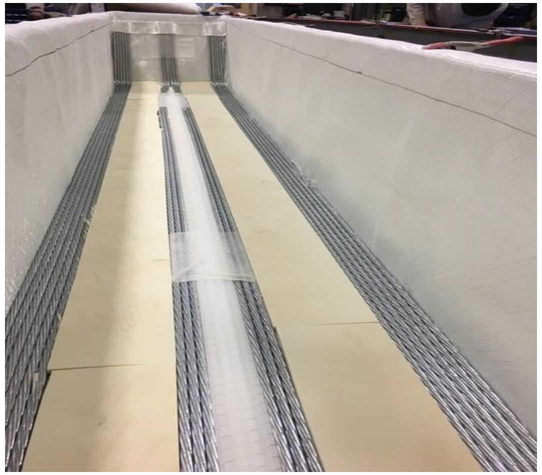
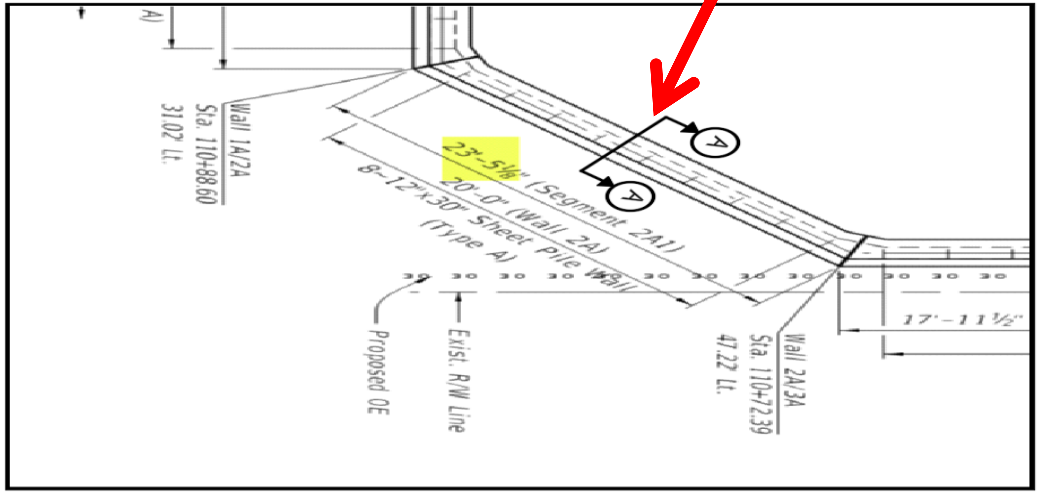
Featured Project: Halls River Bridge – Part 1f

iii. Latest testing campaign (Year 7) assesses durability of FRP bars and concrete; results are nearing completion.





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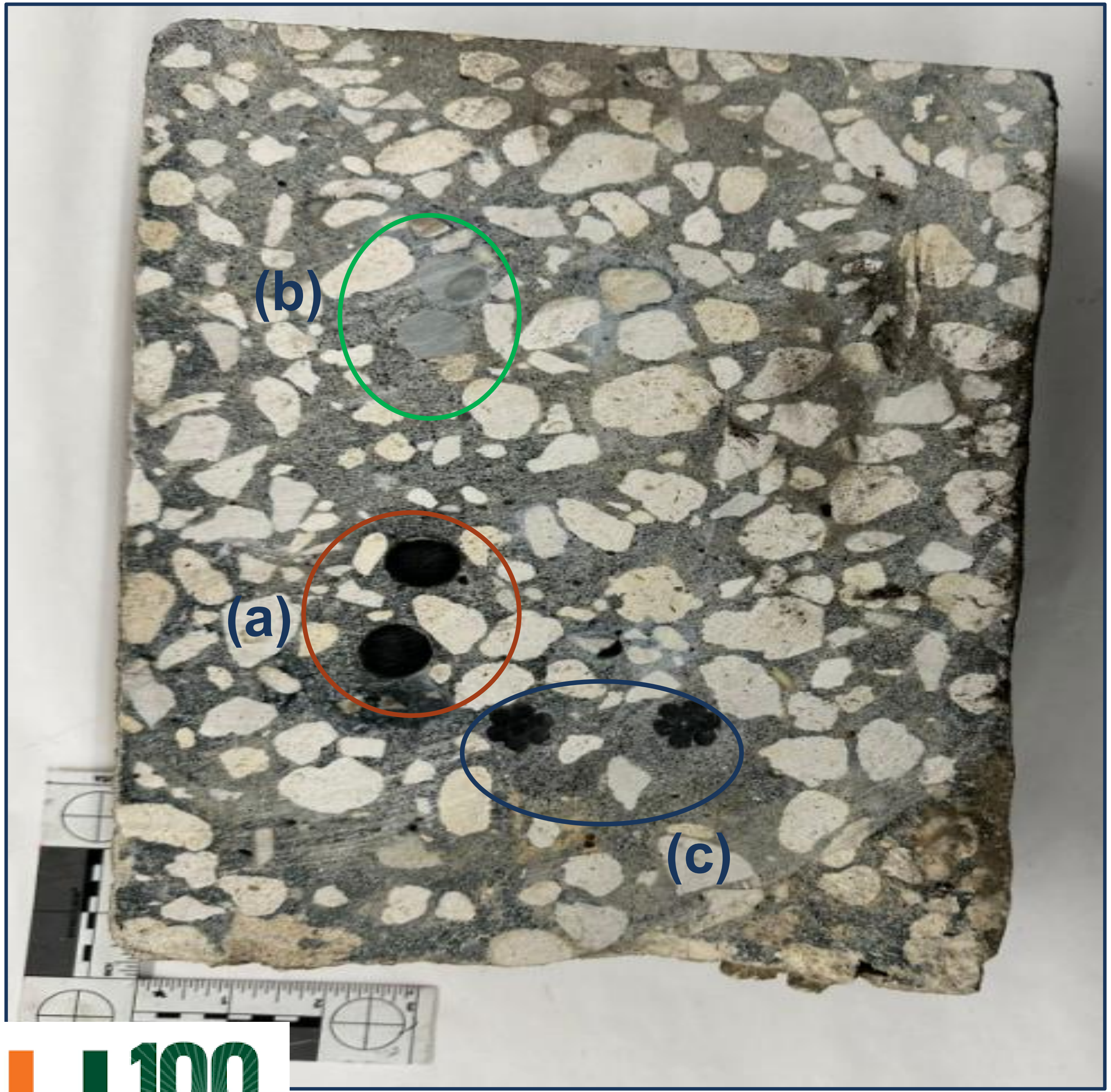


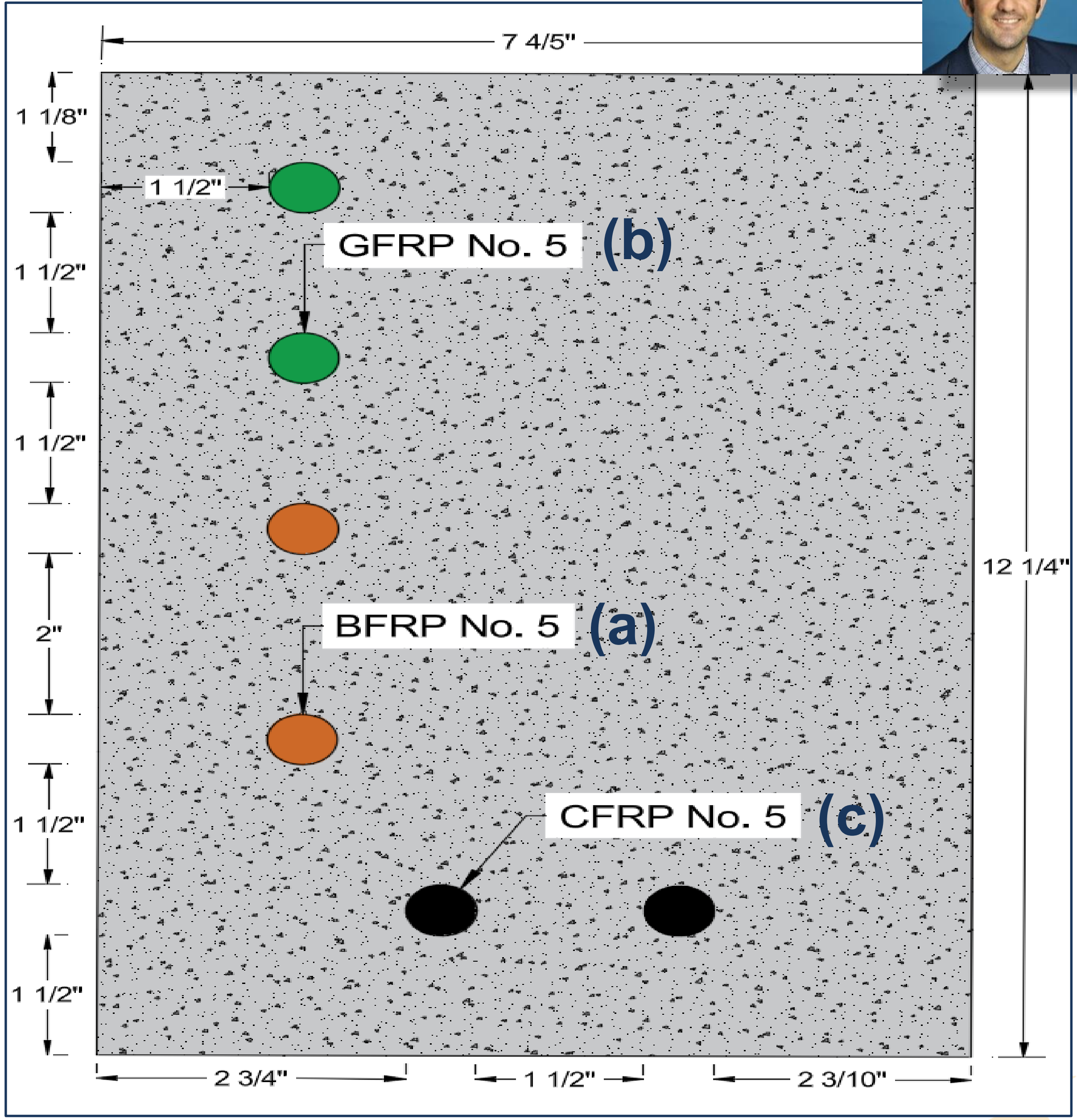
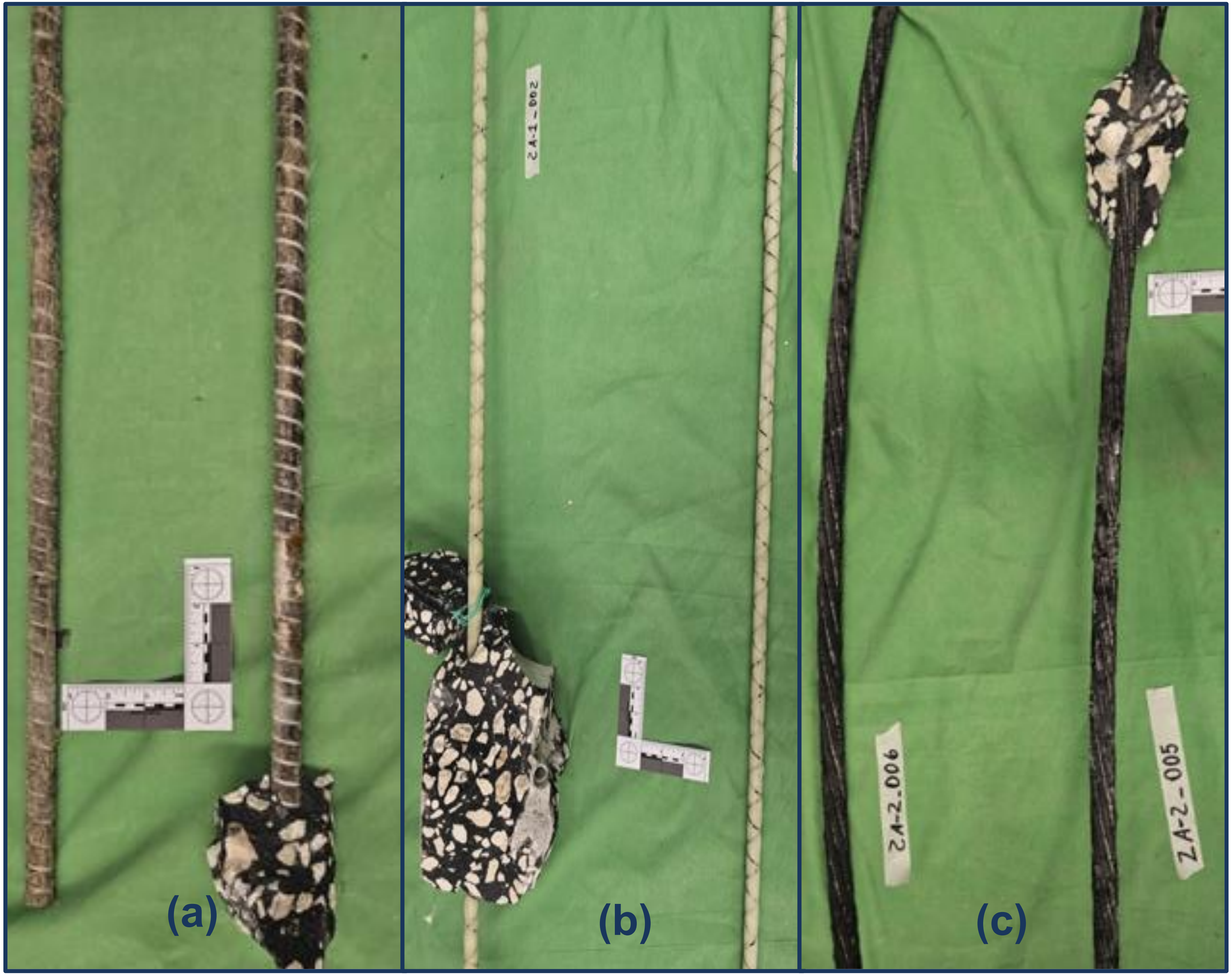
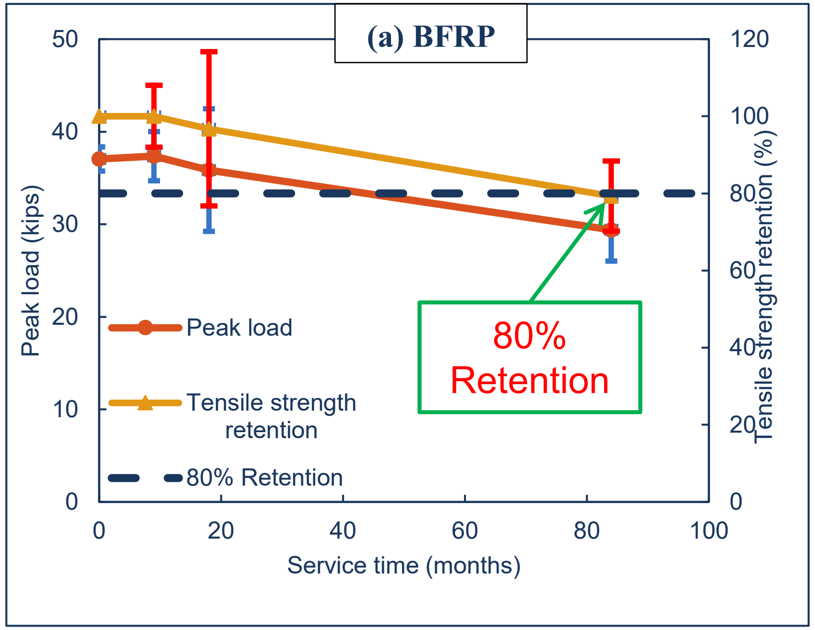


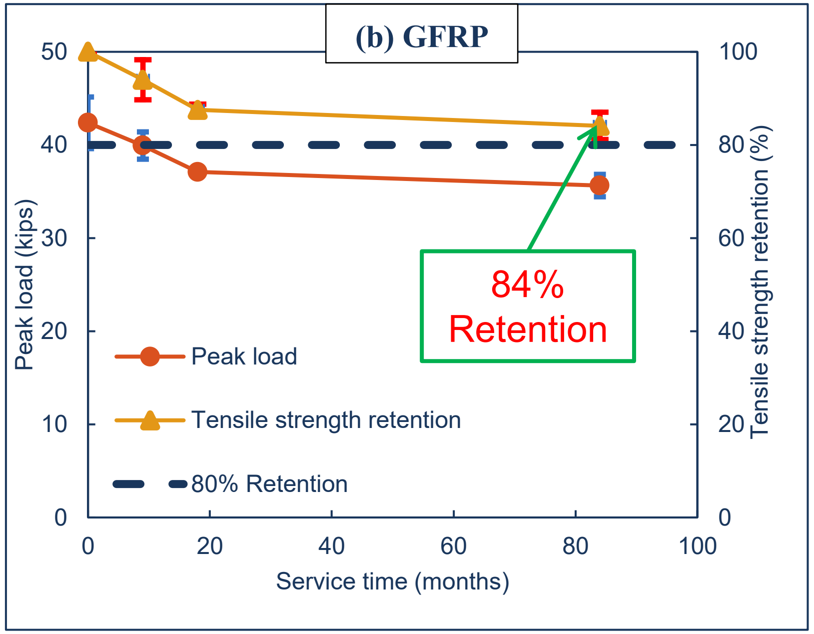
Photo: (a) BFRP, (b) GFRP, and (c) CFRP.

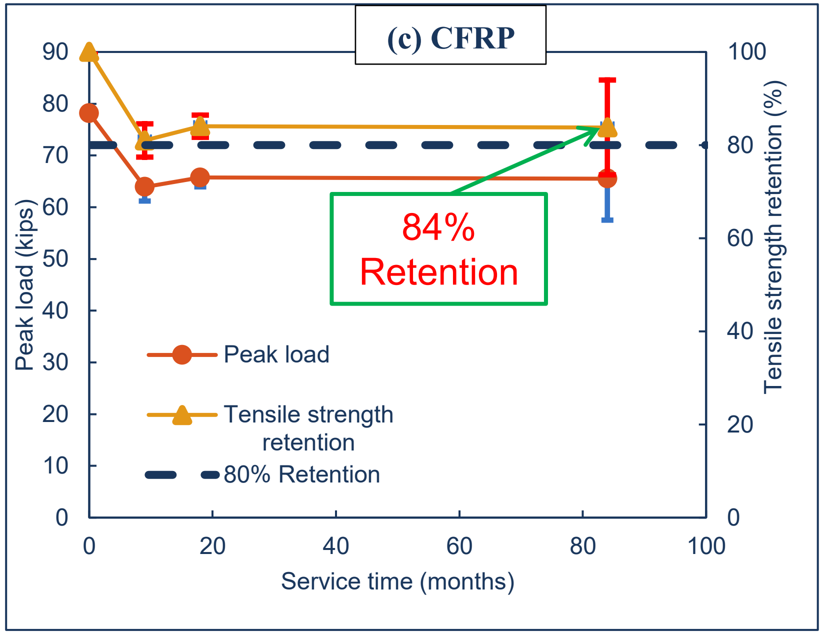
Photos:
(a) BFRP,
(b) GFRP,
(c) CFRP.



FRP Tensile Strength Durability after 7 Years – Part 1f







Charts and Photos: Tensile strength development and failure mode after 7 years of embedment in seawater concrete for (a) BFRP, (b) GFRP, and (c) CFRP.

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Seawater Concrete Compressive Strength under Marine Exposure – Part 1f

iv. Cylinders at all time points (28 days, 9 months, 18 months) exceeded the concrete design strength (5500 psi).

v. Cores extracted at 9 months and 7 years both remained above the ACI 318 acceptance limit (85% of design strength).

vi. These results validate the long-term structural adequacy of seawater-mixed concrete in marine environments where freshwater access is constrained.

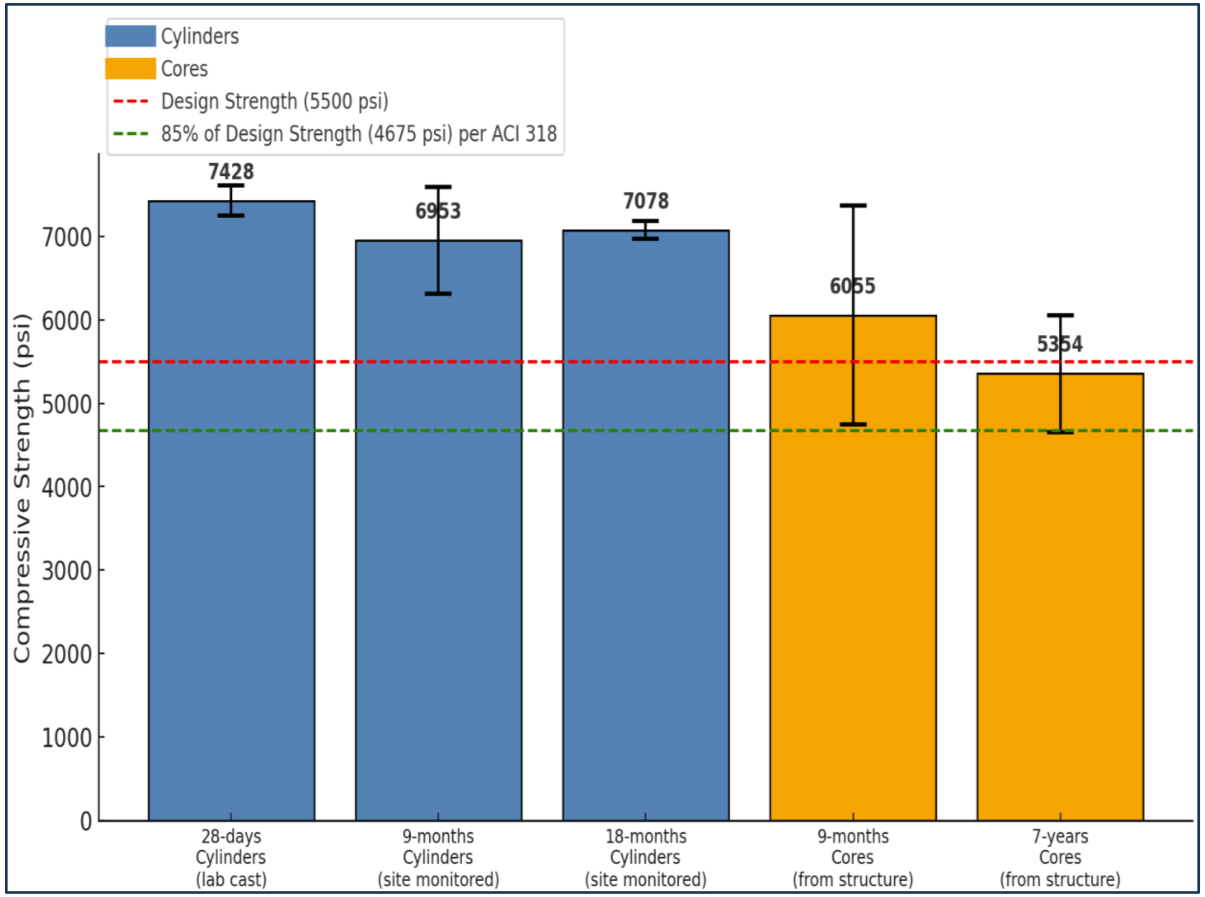

Chart: Compressive strength of cylinders and cores at various ages with ACI 318 acceptance threshold

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Featured Project: Conclusions – Part 1f

viii. **Halls River Bridge** served as FDOT's first large-scale marine FRP pilot and a *living lab* to monitor long-term performance of emerging materials.

ix. **FRP bars** retained >80% tensile strength after 7 years in seawater concrete, confirming long-term durability under field conditions.

x. Findings are based on FRP products manufactured over 7 years ago; **newer generations may perform better**, reinforcing the need for product-specific validation.

xi. **Concrete core strength** remained above ACI 318 limits, supporting the viability of seawater concrete in marine environments

Researcher's Question – Part 1f

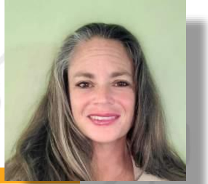
1. What is the driving factor of slower FRP acceptance across the country – if lifecycle costs show a significant decrease over the long term, is it the initial cost?
2. Is it the lack of standards/specifications/quality materials audits that inhibit use by state DOTs?
3. The standardized use of **Externally Bonded Repairs** and **GFRP Rebar** took decades, other more recent technologies such as Maine's "bridge in a backpack" using FRP tubes took over 20 years for development and use by multiple states. How do we reduce this "decades long" implementation process?
4. What are the key points to decreasing initial costs?
5. How can we take what is being done in a few key states – FDOT, Maine, Tennessee (with rural FRP bridge replacements) – and make it appealing to implement throughout the US?

Seeking Expertise

Kelley Severns, PE, PMP
X-BRIDGE Program Director

ARPA-I
ADVANCED RESEARCH PROJECTS AGENCY • INFRASTRUCTURE
DEPARTMENT OF TRANSPORTATION UNITED STATES OF AMERICA
1865 THE UNIVERSITY OF MAINE
ADVANCED STRUCTURES & composites center

Kelley Severns – Part 1g



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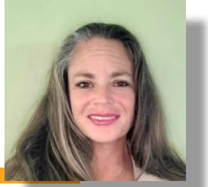
TIDC Transportation Infrastructure Durability Center AT THE UNIVERSITY OF MAINE

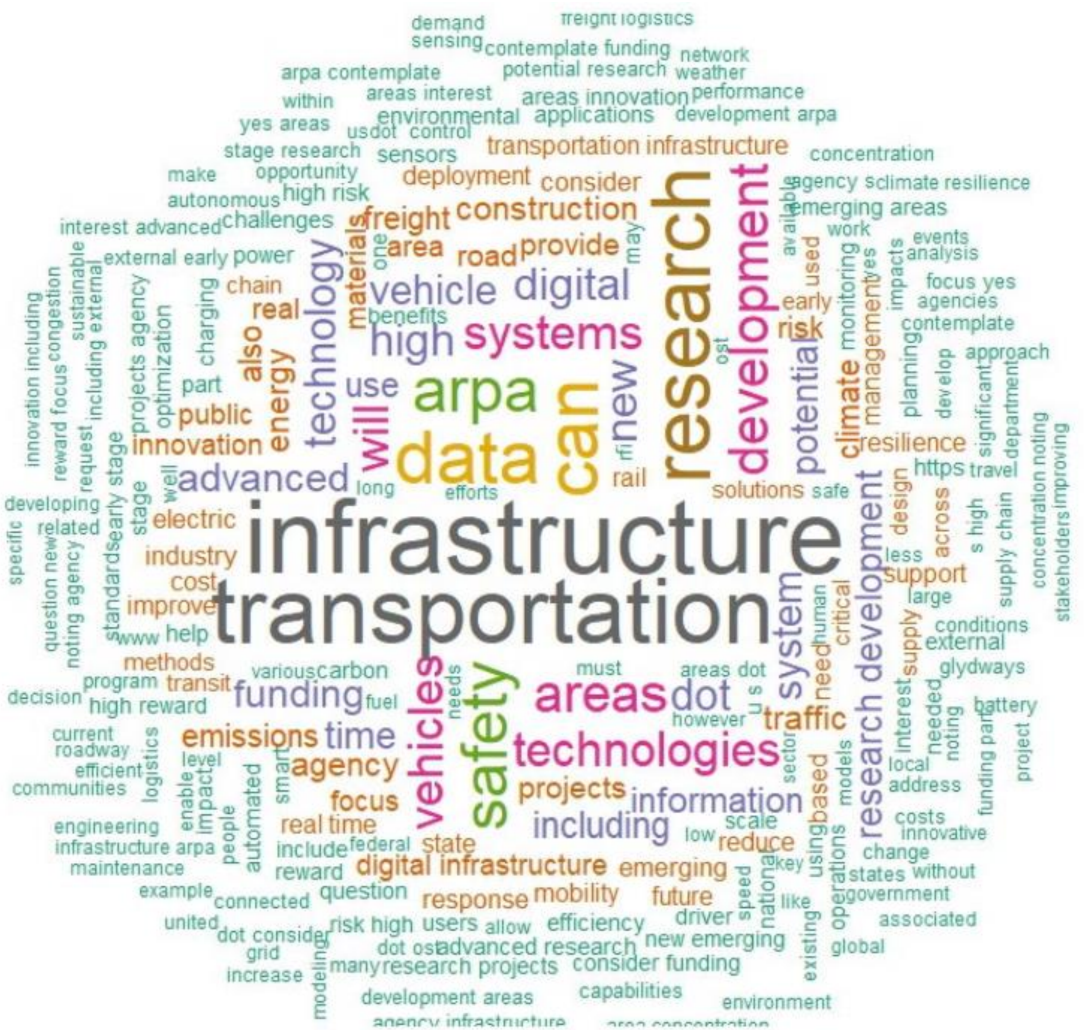
X-BRIDGE

eXceptional BRidges through Innovative Design and Groundbreaking Engineering

i. What is ARPA?

Kelley Severns – Part 1g





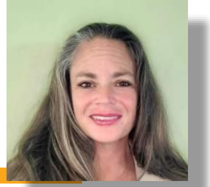
Based on highly successful DARPA Program - U.S. Department of Transportation is accelerating the future of America's transportation by launching the **Advanced Research Projects Agency - Infrastructure (ARPA-I)**. ARPA-I will:

- Fund High-risk, high-reward next-generation transportation technologies
- Bold investments in advanced and emerging materials, structures, components, systems that can radically transform transportation
- What is "THE BIG PROBLEM" and how can we radically make a difference?

ARPA·I

ii. The Differentiator

Kelley Severns – Part 1g



ARPA-I will be a problems focused organization.

- ARPA-I will **fund actively managed, metrics driven programs**
- **No internal research labs**
- Generally **fund outcome-based contracts,** not grants; accelerated award timelines
- Authorities allow flexibility to assemble the **best private and public sector teams** to develop and operationalize high-impact technologies

Lean and nimble management structure with autonomy in decision-making

ARPA-I Director **reports directly to DOT Secretary**

Term limits bring urgency and idea flow

Flexibility in hiring allows ARPA-I to recruit at levels competitive with industry

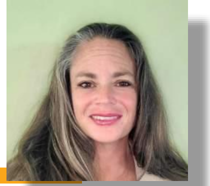
Program Directors will have autonomy to make decisions quickly

They will **actively manage** performers to achieve results

Like DARPA, **ARPA-I** has unique structures and legal authorities to **act quickly and decisively to develop and transition transformational technologies.**

ARPA·I

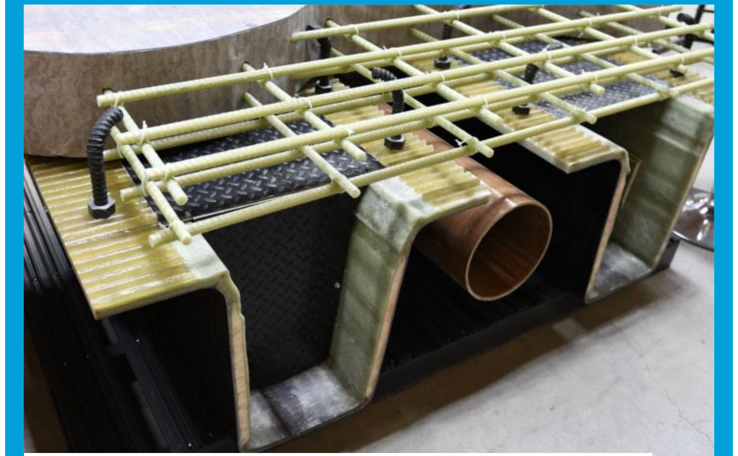
iii. The X-BRIDGE Approach



Delivering bridges at half the cost, in half the time with twice the lifespan

- Thermoset and Thermoplastic innovative manufacturing to save labor and cost
- Lighter, corrosion-free, and stronger than traditional construction – easier transport, faster erection
- Life Span of 150 years
- Nearly Maintenance Free


FRP Composite Tub Girder


FRP Rebar, Deck Connectors, & Girders

(Credit: UMaine ASCC)

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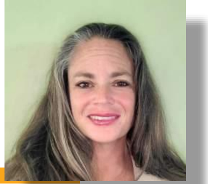
iv. What Is the X-BRIDGE Project?

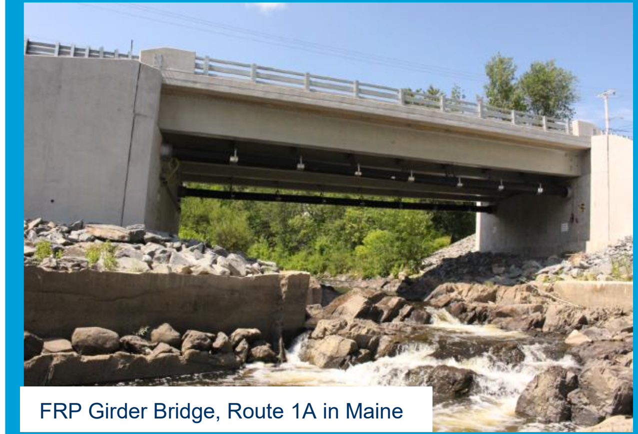


The University of Maine, in collaboration with the U.S. DOT ARPA-I Program, Project research includes:

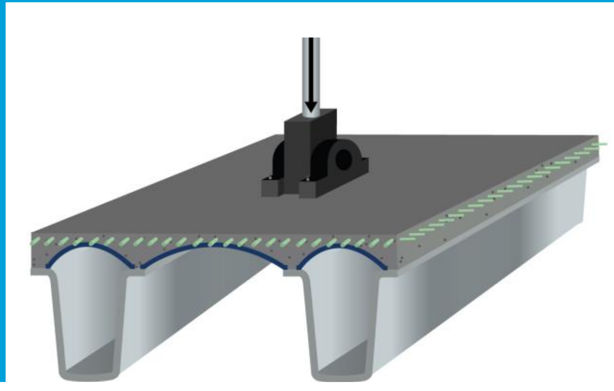
- Developing new fiber reinforced polymer (FRP) composite materials and designs. Such as:
    - Barrel Arch Deck design
    - Stay-in-place FRP formwork
    - Basalt fiber deck reinforcing
    - Thermoplastic, field bendable rebar
- Advancing novel manufacturing and construction practices to save labor and time
- Updating current bridge and material guidelines and specifications.
- Incorporating these new advances in a demonstration bridge project.

Loading of 22” Girders for Transport to Site

Erection of 42” Girders



FRP Girder Bridge, Route 1A in Maine



Barrel Arch Stay-in-place Formwork-Composite Bridge System

(Credit: UMaine ASCC)

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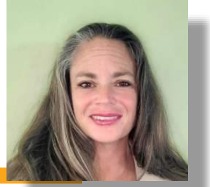
v. What's New? Advanced Concepts



(Credit: AIT Composites, 2019)

(Credit: UMaine ASCC)

Goal: Reduce manufacturing costs

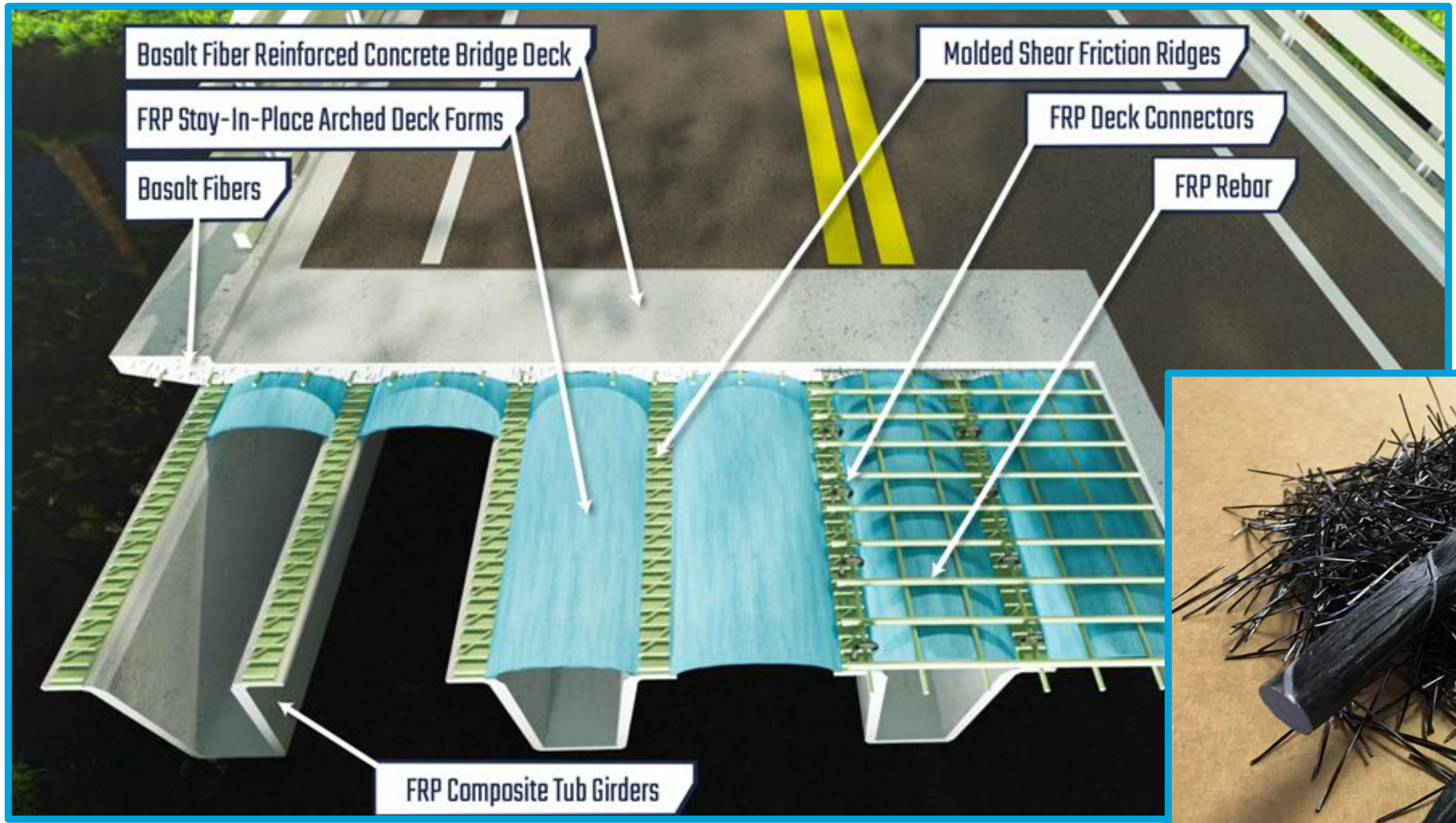
Rapid-Impact Advancements to Current Processes *(Semi-automated fabric placement, optimize material combinations)*

Continuous Production Methods *(Pultrusion, Multicomponent pultrusion, Pull-forming, Hybrid methods, other)*

Continuous Forming Machine- Thermoplastics

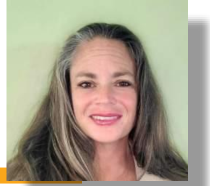
ARPA-I

vi. Out of the Box – Corrosion Free Deck

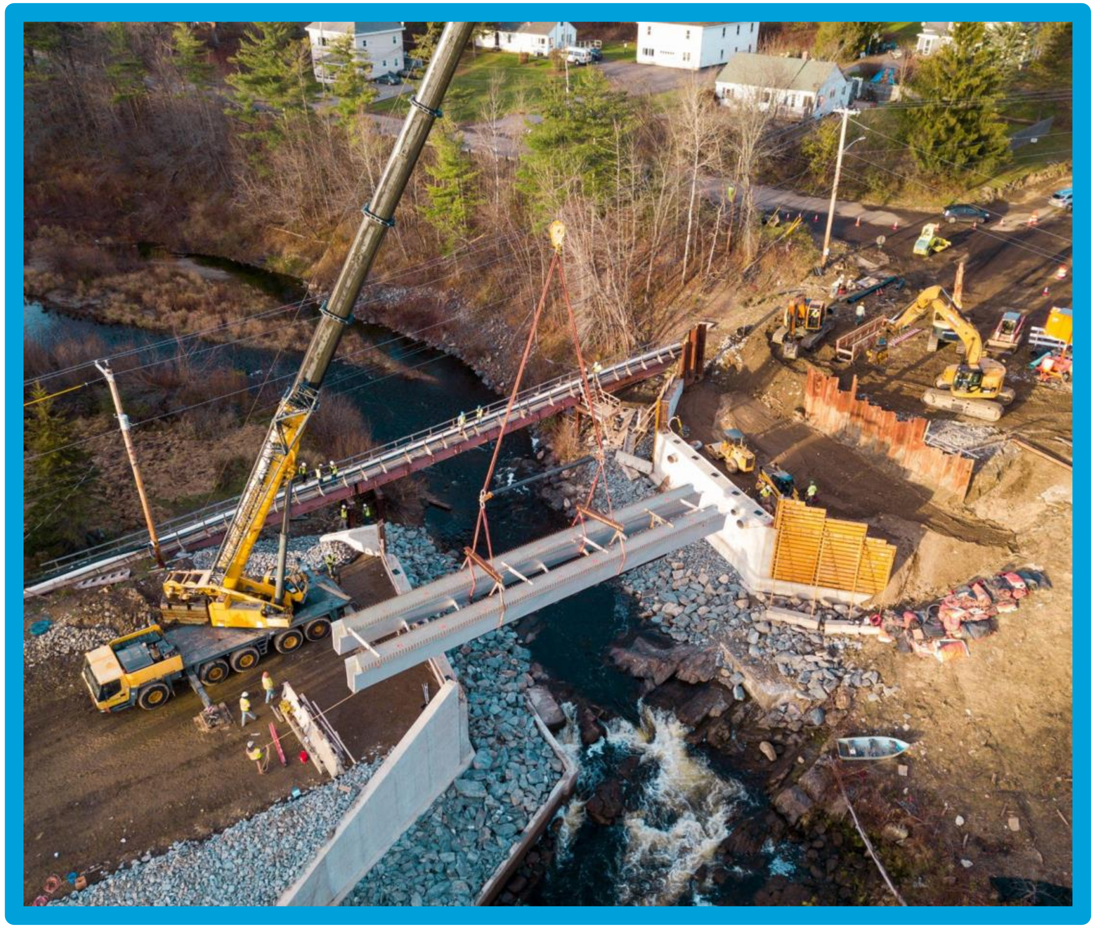


(Credit: UMaine ASCC)

vii. X-BRIDGE Delivers



- Optimal Composite Girder and Corrosion Free Deck Designs
- Efficient, scalable manufacturing processes using less labor and reducing costs for composite bridge elements
- Partner with Maine DOT to build a single span (up to 100ft) bridge prototype in Maine
- Develop specifications and guidelines through organizations like AASHTO, ASTM, and state DOTs to move technology forward throughout the county



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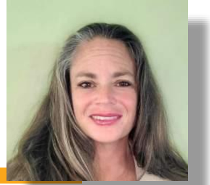

Round Table Q & A – Part 2

1. What is the driving factor of slower FRP acceptance across the country – if lifecycle costs show a significant decrease over the long term, is it the initial cost?
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Audience Q & A – Part 3

- Please use the microphone when you ask your questions

1. How can Florida DOT continue to share their experience with other state departments of transportation leading to increased adoption?
2. How can the design community help to lead the change?
3. How can manufacturers support these efforts?

Closing Remarks

Thank you for participating,

Follow up with questions to the contact information below,

Enjoy the rest of your conference,

Travel safe and always drive responsibly!

Contact Information:

Steven Nolan, P.E.
State Structures Design Office
Florida Department of Transportation
Email: *steven.nolan@dot.state.fl.us*
Website: *https://www.fdot.gov/design/Innovation/*


BEFORE
AFTER
HURRICANE IAN
2022
HURRICANE NICOLE
2022
FDOT
SAFETY
RESILIENCY
SUPPLY CHAIN
TECHNOLOGY
WORKFORCE DEVELOPMENT
COMMUNITIES
HURRICANE IDALIA
2023
TALLAHASSEE TORNADOES
2024
FDOT


BEFORE
AFTER
HURRICANE DEBBY
2024
HURRICANE HELENE
2024
BEFORE
AFTER
14
FDOT
SAFETY
RESILIENCY
SUPPLY CHAIN
TECHNOLOGY
WORKFORCE DEVELOPMENT
COMMUNITIES
WELCOME TO
THE FREE STATE OF
FLORIDA
THE SUNSHINE STATE
Governor Ron DeSantis
HURRICANE MILTON
2024
15
WINTER STORM ENZO
2025
FDOT
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