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Orlando, FL, USA

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# The Next Decade of FRP Reinforcement inside Florida Bridges and Structures

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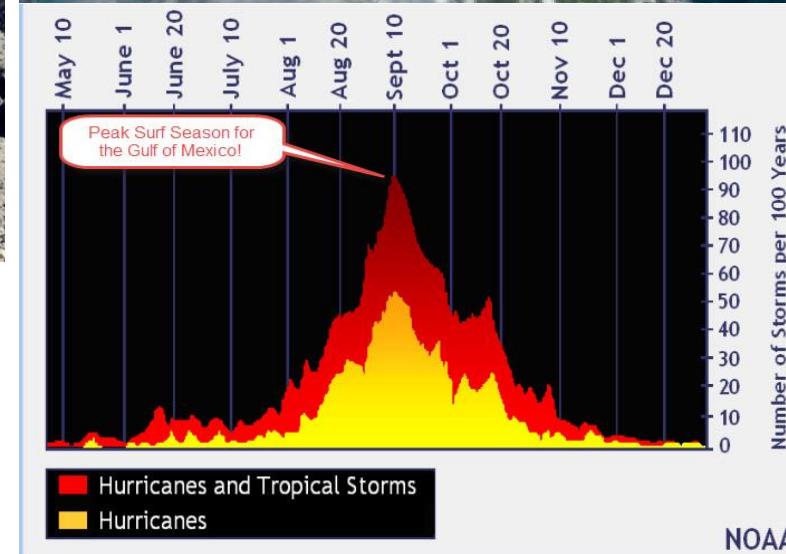
<sup>3</sup> Department of Civil and Architectural Engineering, University of Miami, Coral Gables, FL, 33146, USA

# Steve Nolan, P.E.

- Australian born, Florida resident since 1996
- B.Eng. Civil Engineering, UNSW, Sydney, 1990.
- Experience
  - 3.5 years in Heavy Civil Construction NSW, Leighton Contractors
  - 29 years FDOT, 26 in Structures Design Office
  - CAMX attendee first time 2014.
  - CAMX contributor 2015 to 2020.



I'M FROM THE  
GOVERNMENT,  
I'M HERE  
TO HELP



NOAA



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# Learning Objectives

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- Upon completion, participants will be able to describe the progression of advancement material technologies and standards for FRP reinforcing and prestressing for concrete structures.
- Upon completion, participants will be able to list applications that demonstrate the effective and efficient use of structural FRP materials for infrastructure.
- Upon completion, participants will be able to identify material, design, and construction practice improvements that can increase the efficiency and competitiveness of structural FRP for concrete infrastructure applications.

# Abstract

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After a decade of implementation in Florida's bridges, and maturation of design guidance and specifications that began more than three decades ago, this presentation showcases recent successful projects in Florida and highlights improvements on the horizon with advancements in the state-of-the-practice. FDOT officially introduced guidance for the implementation of internal Fiber-Reinforced Polymer Reinforcement and Prestressed Concrete in 2014 and has since developed a robust program of advocacy and outreach which is publicly accessible on the [\*\*FDOT Design Innovation\*\*](#) website. Many structural applications and advancements have been implemented over the past decade, however the next decade offers the greatest opportunity for leveraging material improvements including potentially bio-inspired and nano-technologies, with sustainable practice, and creative engineering to improve the economic, environmental, and social impacts for transportation infrastructure.

These goals can only be achieved by collaboration with researchers, FRP materials and concrete producers, and other infrastructure owners or custodians. Expanding participation in these collaborations and partnering on outreach and advocacy of standards and codes development and implementation are key activities that need involvement of all stakeholders. Aspirations for future enhancement and emerging design and construction practice under **AASHTO** (American Association of State Highway and Transportation Officials') and **ACI** (American Concrete Institute's) criteria will be presented, with a focus on bridges and structures located in coastal and other demanding environments.

# Outline

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## Needs, Rules & Tools

1. Expanding Range of Reliable FRP Materials & Structural Solutions for Reinforced Concrete
2. Recent Full-Scale Testing and Research on Bridge Beams and Piles
3. Expanded Applications for FRP Rebar in Bridge Foundations
4. Education Tools for Designers, Contractors, & Owners

## Case Studies

5. Recently Completed Coastal Structures
6. Projects Under Construction
7. New Projects in Design
8. Lessons Learned from the Real World
9. Projects of Interest Nationally

# 1. Expanding Range of Reliable FRP Materials & Structural Solutions for Reinforced Concrete

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- i. GFRP rebar & improved properties
- ii. BFRP rebar implementation
- iii. Improving CFRP strand & bar performance and economy
- iv. Hybrid solutions including pultruded or molded structural components

# 1. Expanding Range of Reliable FRP Materials & Structural Solutions for Reinforced Concrete

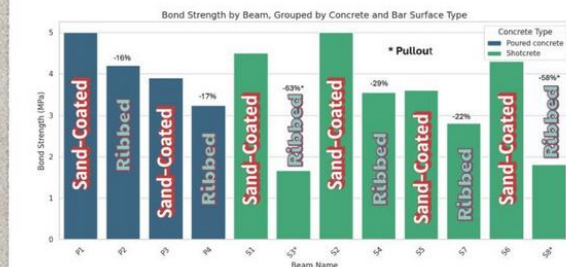
## i. GFRP rebar & improved properties (example E → E-CR glass filaments; bond to concrete)

| Alkali-resistance<br>Comparison of alkali erosion (electrophotography)                                                                                                                                | Acid-resistance<br>Comparison of acid erosion (electrophotograph)                                                                                                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>WizARG™</p> <div> </div> <p>As manufactured      Held at 80°C for 200 hours in saturated cement solution</p> <p>No significant change observed.</p>                    | <p>WizARG™</p> <div> </div> <p>As manufactured      Held at 50°C for 1 hour in 1N-HCl</p> <p>No significant change observed.</p>                    |
| <p>NEG's E Glass Fiber</p> <div> </div> <p>As manufactured      Held at 80°C for 200 hours in saturated cement solution</p> <p>The fibers are completely destroyed.</p> | <p>NEG's E Glass Fiber</p> <div> </div> <p>As manufactured      Held at 50°C for 1 hour in 1N-HCl</p> <p>The fibers are completely destroyed.</p> |

A peer-reviewed study published in the ASCE Journal of Composites for ...more

### BOND AND DEVELOPMENT LENGTH OF GFRP BARS EMBEDDED IN SHOTCRETE

New study in the **ASCE** journal of Composites for Construction



**V-ROD**  
FIBERGLASS REBAR

<https://ascelibrary.org/doi/10.1061/JCCOF2.CCENG-5195>

# 1. Expanding Range of Reliable FRP Materials & Structural Solutions for Reinforced Concrete

- i. GFRP rebar & improved properties
- ii. BFRP rebar implementation

Ying and Zhou (2013)

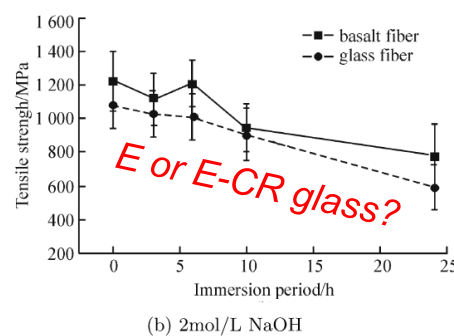
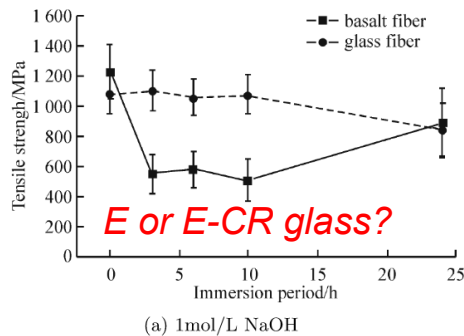


Figure 2.6: Tensile strength of fibers exposed to NaOH solution for 24 h at 100 °C



Figure 2.1: (a) Basalt rock, (b) Fiber, and (c) Rebar

Table 2.1: Mechanical and physical properties of fibers (Singha, 2012)

| Properties            | unit | Fiber Type        |             |             |             |
|-----------------------|------|-------------------|-------------|-------------|-------------|
|                       |      | Continuous Basalt | Carbon      | Glass       |             |
|                       |      |                   |             | E- glass    | S- glass    |
| Breaking Strength     | MPa  | 3000 – 4840       | 3500 – 6000 | 3100 – 3800 | 4020 – 4650 |
| Elastic Modulus       | GPa  | 79.3 – 93.1       | 230 – 600   | 72.5 – 75.5 | 83 – 86     |
| Breaking Extension    | %    | 3.1               | 1.5 – 2.0   | 4.7         | 5.3         |
| Fiber Diameter        | µm   | 6 – 21            | 5 – 15      | 6 – 21      | 6 – 21      |
| Linear Density        | tex  | 60 – 4200         | 60 – 2400   | 40 – 4200   | 40 – 4200   |
| Temperature Withstand | °C   | –260 – 700        | –50 – 700   | –50 – 380   | –50 – 380   |

Final Report

BFRP Rebar Characterization and Performance

Testing Protocol and Material Specifications  
for Basalt Fiber Reinforced Polymer Bars

Contract Number BE694  
FSU Project ID: 042878

Department of Transportation  
er  
Street  
Florida 32399-0450

FDOT

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# 1. Expanding Range of Reliable FRP Materials & Structural Solutions for Reinforced Concrete

- i. GFRP rebar & improved properties
- ii. BFRP rebar implementation
- iii. Improving CFRP strand & bar performance and economy
- iv. Hybrid solutions including pultruded or molded structural components

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🚧 FRP Rebar Market to Surpass \$1.19 Billion by 2030

According to a recent industry article, demand for nonmetallic reinforcement is rapidly accelerating. This growth is driven by infrastructure investment, sustainability goals, and the need for durable, corrosion-resistant materials in harsh environments.

FRP (Fiber Reinforced Polymer) rebars are emerging as an alternative to steel in bridges, coastal buildings, marine structures, and more. With a projected Compound Annual Growth Rate of 11.5% through 2030, the global market is on track to exceed \$1.19 billion in value.

As an ACI Center of Excellence for Nonmetallic Building Materials, NEX is proud to support this transformation through research, certification, and member collaboration.

🔗 Read the full market outlook:  
<https://lnkd.in/gbwXN-XX>

#GFRP #FRPRebar #Nonmetallics #Infrastructure #ACI #ConcreteInnovation #5



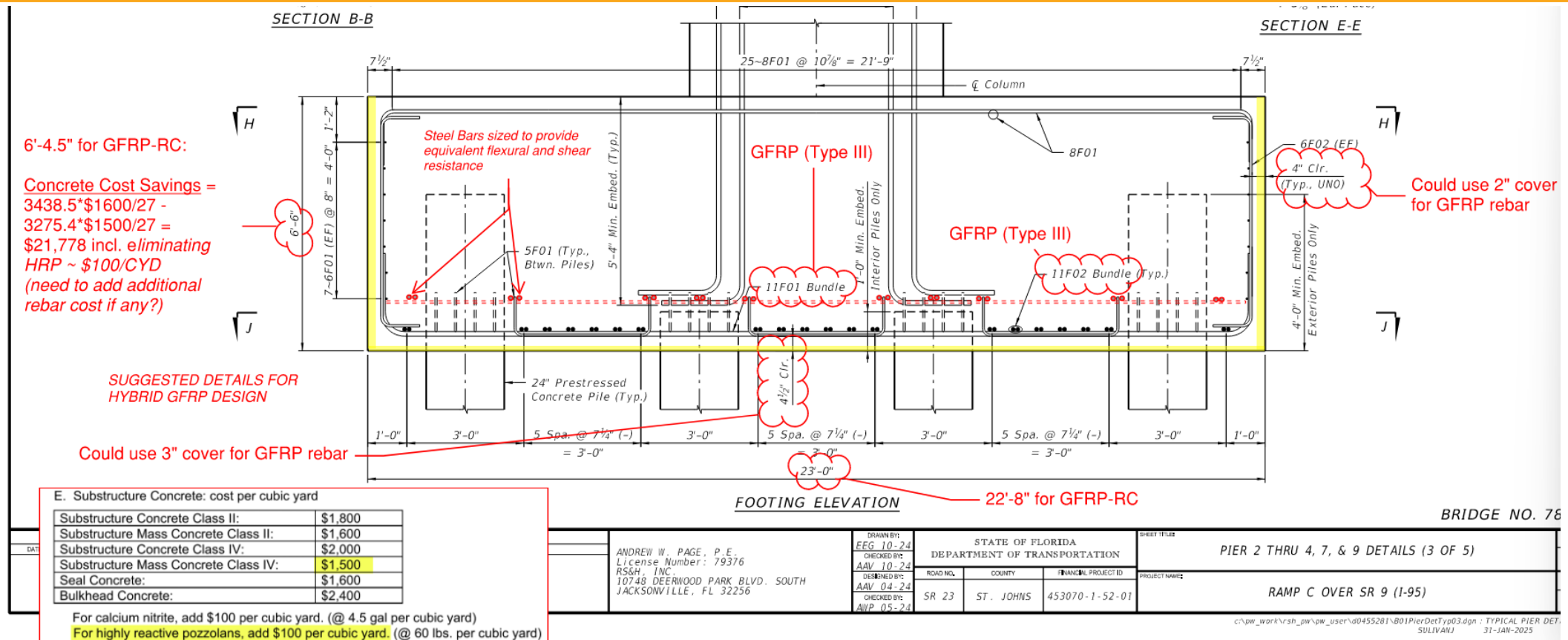
🏭 Chemicals & Materials Industry

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FRP Rebar Market to Reach \$1.19 Billion by 2030, Driven by Growing...

Saurabh Singh

# 1. Expanding Range of Reliable FRP Materials & Structural Solutions for Reinforced Concrete



iv. Hybrid solutions including pultruded or molded structural components

## 2. Recent Full-Scale Testing and Research on Bridge Beams and Piles

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- i. CFRP prestressed beams and piles, with GFRP auxiliary reinforcement.
- ii. NCHRP 12-121 sponsored research finding for transverse and interface shear and confinement reinforcing.
- iii. Durability Sampling and Testing of Halls River Bridge after 6-years in saltwater concrete.

## 2. Recent Full-Scale Testing and Research on Bridge Beams and Piles

### A. FDOT Research - Completed

| Completed  | Title                                                                                                                | Researcher     | Institution | Research No.            |
|------------|----------------------------------------------------------------------------------------------------------------------|----------------|-------------|-------------------------|
| Nov. 2018  | <b>Performance Evaluation</b> of GFRP Reinforcing Bars Embedded in Concrete Under Aggressive Environments            | R. Kampmann    | FAMU-FSU    | BDV30 977-18            |
| April 2019 | <b>Degradation Mechanisms and Service Life Estimation</b> of FRP Concrete Reinforcements                             | A. El Safty    | UNF         | BDV34 977-05            |
| 6/30/2019  | <u>Performance Evaluation of Basalt Fiber Reinforced Polymer (BFRP) Reinforcing Bars Embedded in Concrete</u>        | R. Kampmann    | FAMU-FSU    | BVD30 986-01            |
| April 2022 | <u>Epoxy Dowel Pile Splice Evaluation</u> with FRP Bars                                                              | A. Mehrabi     | FIU         | BDV29 977-52            |
| Dec. 2020  | <u>“Stainless Steel Strands and Lightweight Concrete for Pretensioned Concrete Girders”</u> (w/ GFRP shear stirrups) | M. Roddenberry | FAMU-FSU    | BDV30 977-27 (Report A) |
| 07/30/2022 | <u>Improving Testing Protocol and Material Specifications for Basalt Fiber Reinforced Polymer Bars</u>               | R. Kampmann    | FAMU-FSU    | BE694                   |

## 2. Recent Full-Scale Testing and Research on Bridge Beams and Piles

### B. FDOT Research - Completed and In-progress

| Completion Date | Title                                                                                                                                                    | Researcher     | Institution | Research No.  |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-------------|---------------|
| 08/29/2022      | <u>Development of GFRP Reinforced Single Slope Bridge Rail</u>                                                                                           | G. Consolazio  | UF          | BDV31 977-110 |
| 12/31/2023      | <u>Evaluation of Glass Fiber Reinforced Polymers (GFRP) Spirals in Corrosion Resistant Concrete Piles</u>                                                | S. Jung        | FAMU-FSU    | BDV30 977-27  |
| Feb. 2025       | FSBs With Stainless Steel Strands and GFRP Shear Reinforcement                                                                                           | M. Roddenberry | FAMU-FSU    | BED30 977-09  |
| May 2025        | <i>Waterline Pile Cap Footings for Bridges using Large Diameter FRP Reinforcing – Material Characterization and Design</i>                               | A. Nanni       | UM          | BEE76 977-01  |
| Oct 2025        | <i>HRB Extraction and Physio-Mechanical Testing of FRP Reinforcing Bars from 5-year-old Seawater Concrete Test Blocks on Halls River Bridge Bulkhead</i> | F. De Caso     | UM          | BEE76 977-02  |

### 3. Expanded Applications for FRP Rebar in Bridge Foundations

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- i. Development of #11 Bar specifications
- ii. Development of ASTM specifications and AASHTO Materials Programs for BFRP & GFRP rebar and CFRP strands
- iii. Feasibility Study for Large Bridge Foundation Elements.

## 4. Education Tools for Designers, Contractors, & Owners

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- i. FRP Designer Training
- ii. Structural Design Software
- iii. Technology Transfer Opportunities

# 4. Education Tools for Designers, Contractors, & Owners

## FOURTH INTERNATIONAL WORKSHOP ON FRP BARS FOR CONCRETE STRUCTURES

*"Advances in concrete reinforcement"*

### C. FDOT Structures Manual



### FDOT Design Criteria for FRP:

#### Vol. 1 – SDG

- Bearing Piles – 3.5
- Fender Systems – 3.14
- Structural FRC – 3.17
- BDR Cost Estimating – 9.2
  - Bearing Piles
  - Sheet Pile

#### Vol. 2 – SDM

- Fender Systems – 24

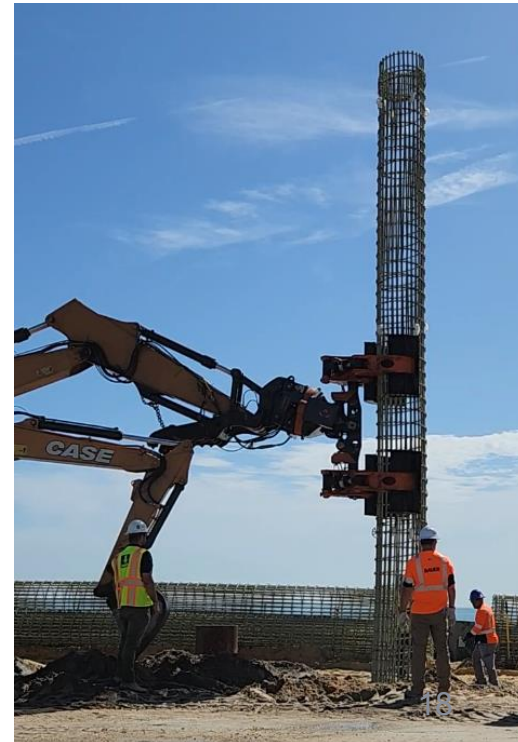
#### Vol. 4 – FRPG

- Reinforcing Bars – 2
- Strands – 3
- Strengthening – 4
- Pultruded Shapes – 5
- VIP Shapes – 6
- Thermoplastic Shapes – 7

## 5. Recently Completed Coastal Structures

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- Bridge Superstructures (NE 40<sup>th</sup> Ave,)
- Bridge Foundations (Bimini Drive, Barracuda Blvd, 4<sup>th</sup> St over Big Island Gap)
- Seawalls (A1A-Flagler/Volusia Seawalls 2 & 3)



# 5. Recently Completed Coastal Structures

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## 6. Interesting Projects Under Construction

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- Bridge Superstructures (17<sup>th</sup> St East End, CR30A over Western Lake, Little Pine Island, US-1 over Sebastian River, US-1 over Earman River)
- Bridge Foundations Rehabilitation (US90 over Aucilla River)
- Pedestrian and Pier Structures (Jupiter Federal & North Causeway)
- Seawalls (Sanibel Island Causeway)

## 6. Interesting Projects Under Construction

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## 7. New Projects in Design

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- Prestressed Bridges (CR 372/Surf Road over Otter Creek Rise)
- Bridge Foundations (Caxambas Ct/Roberts Bay, SR105/Hecksher Dr over Browns Ck)
- Seawalls (St Augustine-A1A & Avenida Menendez waterfront, Tampa Westbay Interchange)

# 7. New Projects in Design

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# 8. Lessons Learned from the Real World

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- Designer Issues
- Material & Testing Issues
- Constructability Issue

# 8. Lessons Learned from the Real World

## A. Reinforcing Bars

### Cost Comparison (Installed Price)

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

## 9. Projects of Interest Nationally

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- AASHTO Committee on Bridges & Structures
- Update NCHRP Domestic Scan (2013)
- ACI 440 Technical Committees on FRP
- ASTM D30.10 – CFRP Rebar & Strand, FRP Mesh
- CSA S6:2030 Revision Cycle
- FHWA ARAP-I / UMaine – X-Bridge project
- NCDOT - Alligator River Bridge Replacement
- Virginia DOT – Hampton Roads Trestle Approaches to Tunnel.
- Nano-material Inclusions and Bio-based Resins

# 9. Projects of Interest Nationally

- NCHRP Project 22-41: Recommendations in 2023

## NCHRP 22-41 [Final]

### Proposed Modification to AASHTO LRFD Bridge Design Specifications, Section 13—Railing

| Project Data                   |                                         |
|--------------------------------|-----------------------------------------|
| <b>Funds:</b>                  | \$230,000                               |
| <b>Research Agency:</b>        | Modjeski & Masters                      |
| <b>Principal Investigator:</b> | Mr. John M. Holt                        |
| <b>Effective Date:</b>         | 6/6/2019                                |
| <b>Completion Date:</b>        | 8/31/2023                               |
| <b>Comments:</b>               | Published as NCHRP Research Report 1109 |

## Future Research

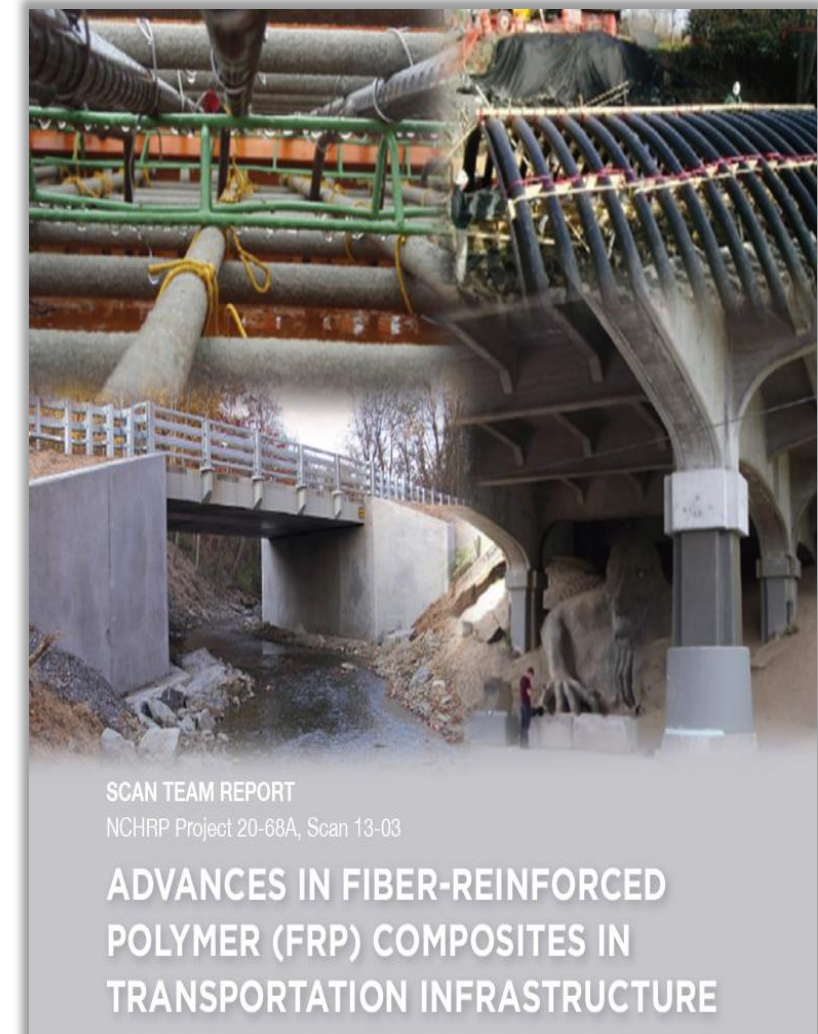
The literature review identified a number of knowledge gaps warranting future research. A partial topic list includes static equivalent impact loads for design, effects of mass activation, design requirements for ground-mounted railing supports, GFRP-reinforced bridge decks, alternate railing design methodologies, and protection or shielding for superstructure elements behind and extending above traffic railings.

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# 9. Projects of Interest Nationally

## Updating NCHRP Report on FRP for Bridges

- NCHRP Study commissioned in 2013 and report completed in 2015
  - New construction
  - Refurbishment
- IACMI Working group at the annual meeting in June 2025 recommended an update to this report
  - Steve Nolan            Florida DOT
  - Joe Stilwell            Maine DOT
  - Shaun Beamish        CMSI
- String of endorsements including Cabell Garbee (*formerly NCDOT Manufactured Products Engineer*) at the recent Peer Exchange Workshop at NC State:
  - “You have to do it”



# 9. Projects of Interest Nationally

## A Lot Has Happened Since 2015 !!



*Halls River Bridge, Florida DOT 2019*



*Rouge River Bridge, Michigan DOT 2019*



*Column strengthening  
with CFRP wraps*

**“Proven but under  
utilized”**



*Grist Mill Bridge, Maine DOT 2021*



*Harkers Island Bridge, NCDOT 2021*

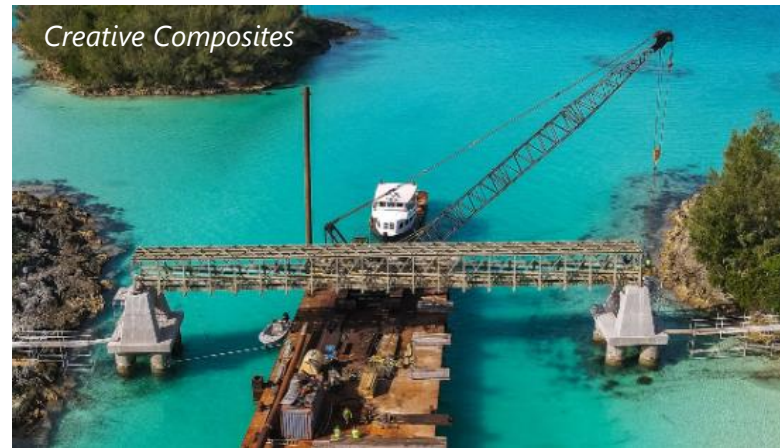


*Morgan County Bridge, Tennessee 2021*

# 9. Projects of Interest Nationally

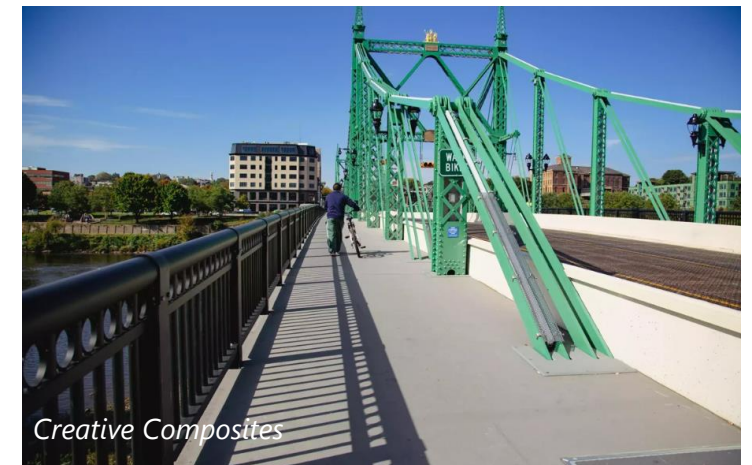
## Other Important (and Recent) Applications of FRP in Bridges

- Pedestrian bridges



**“Proven but under utilized”**

- Cantilever walkways for multi-modal transportation
  - Lightweight addition to existing structures



**Updating the NCHRP report will increase awareness and drive further adoption of FRP**

# 9. Projects of Interest Nationally

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## Updating the NCHRP Report on FRP for Bridges

- *Key Deliverables:* A **state-of-the-art report** and a **communication plan** intended to dramatically increase the use of FRP in bridges by state DOTs
  - Many diverse case studies from across the nation
    - Highway bridges
    - Rural bridges
    - Pedestrian bridges
    - Multimodal bridges
  - Emphasis on longevity and reduced need for maintenance
  - Success stories and best practices

## 9. Projects of Interest Nationally

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### Updating the NCHRP Report on FRP for Bridges

- **ACMA** (John Busel) is interested in collaborating with IACMI on this project
  - Expands the scope/reach
    - More companies = non-IACMI members
    - More state DOTs = AASHTO Specialized Structures committee
- A **steering committee** would be formed, comprised of state DOT reps

# 9. Projects of Interest Nationally

## US Army Corps of Engineers



### WHY COMPOSITES IN USACE?



#### ■ Problem

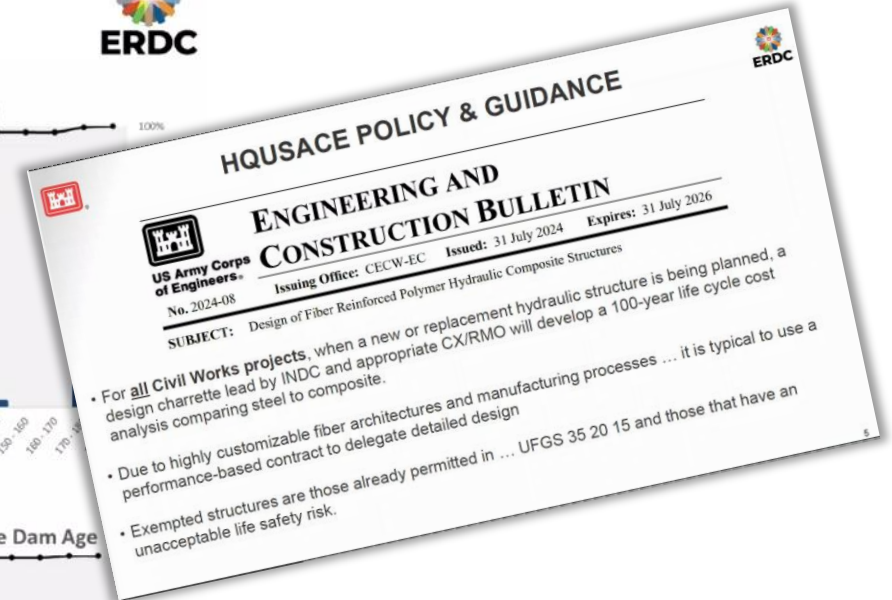
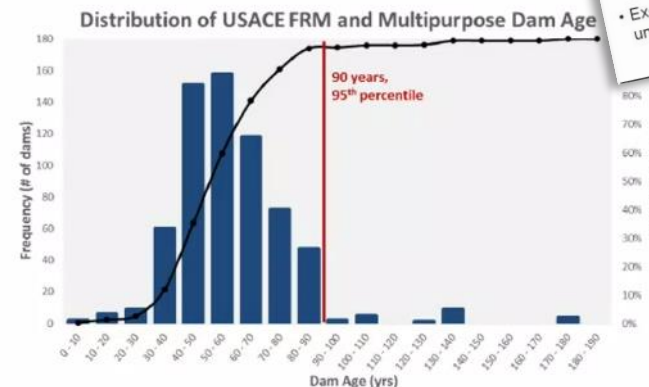
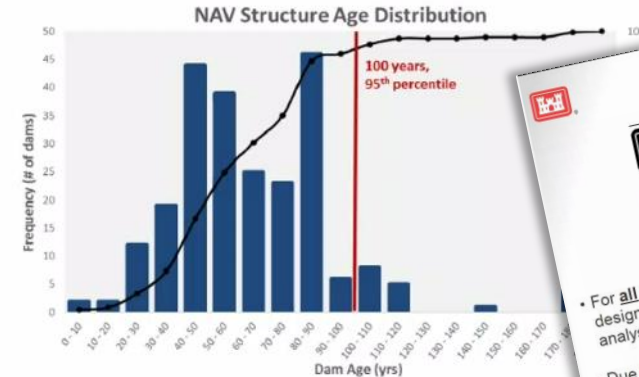
- Steel structures require reoccurring & costly maintenance
- ~ 13,000 steel structures within navigation and FRM portfolios.
  - ▶ Currently ~70% *exceeding* 50-year design life
  - ▶ However, maintenance cost nearing replacement costs

#### ■ Solution

- Similar first cost; steel to FRP
- Faster design; similar to design-build process
- Faster fabrication; similar to precast concrete manufacturing
- **Significant Life Cycle Cost Avoidance - Ranges up to 10:1**

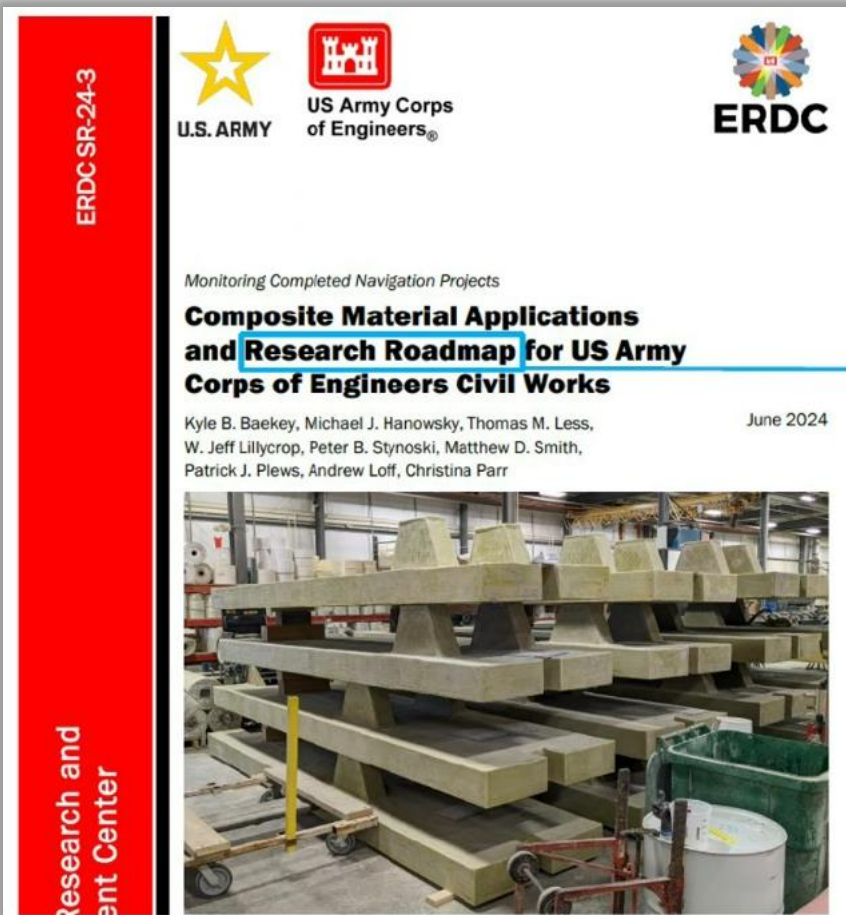
#### ■ National Academies Study: Innovative Materials

- <https://www.nationalacademies.org/our-work/study-on-furthering-the-development-and-use-of-innovative-materials-in-water-resources-infrastructure>



# 9. Projects of Interest Nationally

## US Army Corps of Engineers



### ERDC R&D ROADMAP



ERDC Special Report SR-24-3 published June 2024  
<http://dx.doi.org/10.21079/11681/48755>

- FRP is a mature commercial technology
- Does not require additional research for most USACE applications

#### Key Points:

- FRP is applicable to most hydraulic structures
- Select Commercial Off-The-Shelf items available for immediate use
- Point-loaded bearing components may struggle in design

#### Applicable Structures

The following component types are recommended for FRP consideration during design charrettes:

- |                               |                                      |
|-------------------------------|--------------------------------------|
| • Tainter Gate/Spillway Gate  | • Panels                             |
| • Lift Gate                   | • Floating Mooring Bitts             |
| • Roller Gate                 | • Bridge Substructure/Superstructure |
| • Miter Gate                  | • Mooring Pier                       |
| • Sector Gate                 | • Embedded Quoin Section             |
| • Bulkhead                    | • Trash Boom, Trash Racks            |
| • Filling and Emptying Valves | • Bearing Supports                   |
| • Contact Blocks              | • Trestles                           |
| • Foundation Piles            | • Mooring Buoy                       |
| • Embedded Frame and Guide    | • Floating Caisson                   |
| • Wickets                     | • Needle Beam                        |
| • Outlet Gates                | • Sluice Gate                        |
| • Emergency Gate              | • Slide Gate                         |
| • Levee Closure               |                                      |

#### Commercial Off-The-Shelf

The following component types are available as COTS products and are highly recommended for immediate consideration and use:

- |                              |                               |
|------------------------------|-------------------------------|
| • Decking/Grating            | • Drains                      |
| • Railings                   | • Culverts                    |
| • Roof Panels                | • Seepage Cutoff (sheet pile) |
| • Wicket Gates               | • Docks                       |
| • Piping                     | • Cover Plates                |
| • Ladders                    | • Fuel Tanks                  |
| • Doors                      | • Cable Trays                 |
| • Signage                    | • Septic Field/Mounds         |
| • Trusses                    | • Fender Supports             |
| • Stairways                  | • Manholes                    |
| • Platforms                  | • Holding Tanks               |
| • Mooring Cells (sheet pile) |                               |

# 9. Projects of Interest Nationally

## US Army Corps of Engineers



$$SC = K_E K_R K_I K_{RD}$$

### THE ALGORITHM

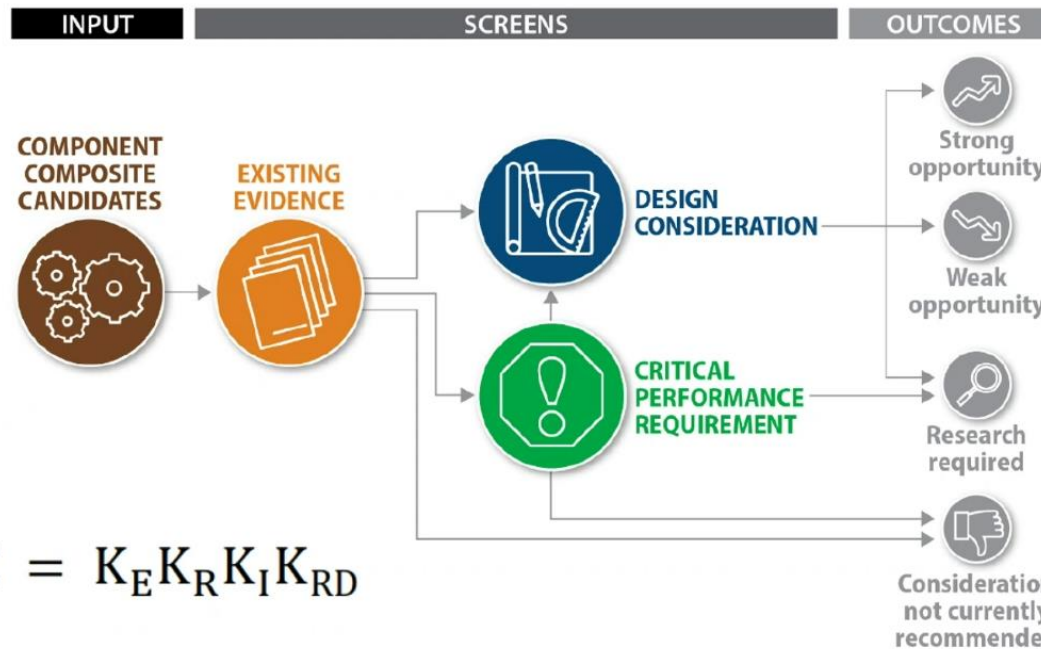


Table B-4. Component score.

| Component                        | Economic                      |                   | Risk, $K_R$ | Importance, $K_I$ | RDT&E, $K_{RD}$ | Combined Component Score, SC |            |
|----------------------------------|-------------------------------|-------------------|-------------|-------------------|-----------------|------------------------------|------------|
|                                  | $N \times C \times F / 3,000$ | Rank Order, $K_E$ |             |                   |                 | Raw                          | Normalized |
| Trash Racks                      | 3,320                         | 51                | 1.20        | 0.37              | 1.00            | 22.34                        | 1.63       |
| Decking/Grating                  | 11,060                        | 63                | 0.01        | 0.46              | 0.25            | 0.07                         | 0.01       |
| Strut Arm                        | 87,933                        | 77                | 1.20        | 0.76              | 1.00            | 69.76                        | 5.08       |
| Railing                          | 3,076                         | 49                | 0.01        | 0.46              | 0.25            | 0.06                         | 0.00       |
| Roofing                          | 30,440                        | 72                | 0.01        | 0.17              | 0.25            | 0.03                         | 0.00       |
| Tainter/Spillway Gate            | 6,940,000                     | 84                | 1.77        | 0.93              | 1.00            | 137.27                       | 10.00      |
| Vertical Lift Gate               | 4,200,000                     | 82                | 1.77        | 0.93              | 1.00            | 134.00                       | 9.76       |
| Wicket Gate                      | 3,100                         | 50                | 0.27        | 0.58              | 0.25            | 1.92                         | 0.14       |
| Roller Gate                      | 39,000                        | 74                | 1.77        | 0.93              | 1.00            | 120.93                       | 8.81       |
| Hinge Crest Gate                 | (14,000)                      | 1                 | 1.77        | 0.93              | 1.00            | 1.63                         | 0.12       |
| Miter Gate                       | 6,504,000                     | 83                | 0.77        | 0.93              | 1.00            | 58.86                        | 4.29       |
| Sector Gate                      | 553,333                       | 80                | 1.77        | 0.93              | 1.00            | 130.73                       | 9.52       |
| Trunnion Rod                     | 599                           | 36                | 1.20        | 0.37              | 1.00            | 15.77                        | 1.15       |
| Bulkhead                         | 5,117                         | 56                | 1.20        | 0.37              | 1.00            | 24.53                        | 1.79       |
| Filling and Emptying Valves      | 35,287                        | 73                | 1.13        | 0.54              | 1.00            | 44.68                        | 3.25       |
| Piping                           | 3,800                         | 54                | 0.17        | 0.48              | 0.25            | 1.07                         | 0.08       |
| Contact Blocks (miter and quoin) | 78,667                        | 76                | 0.70        | 0.89              | 1.00            | 47.08                        | 3.43       |
| Foundation Piles                 | 242,533                       | 79                | 0.70        | 0.89              | 1.00            | 48.94                        | 3.57       |
| Ladder                           | 913                           | 40                | 0.01        | 0.46              | 0.25            | 0.05                         | 0.00       |
| Chain                            | 169                           | 24                | 0.01        | 0.46              | 0.25            | 0.03                         | 0.00       |

# 9. Projects of Interest Nationally



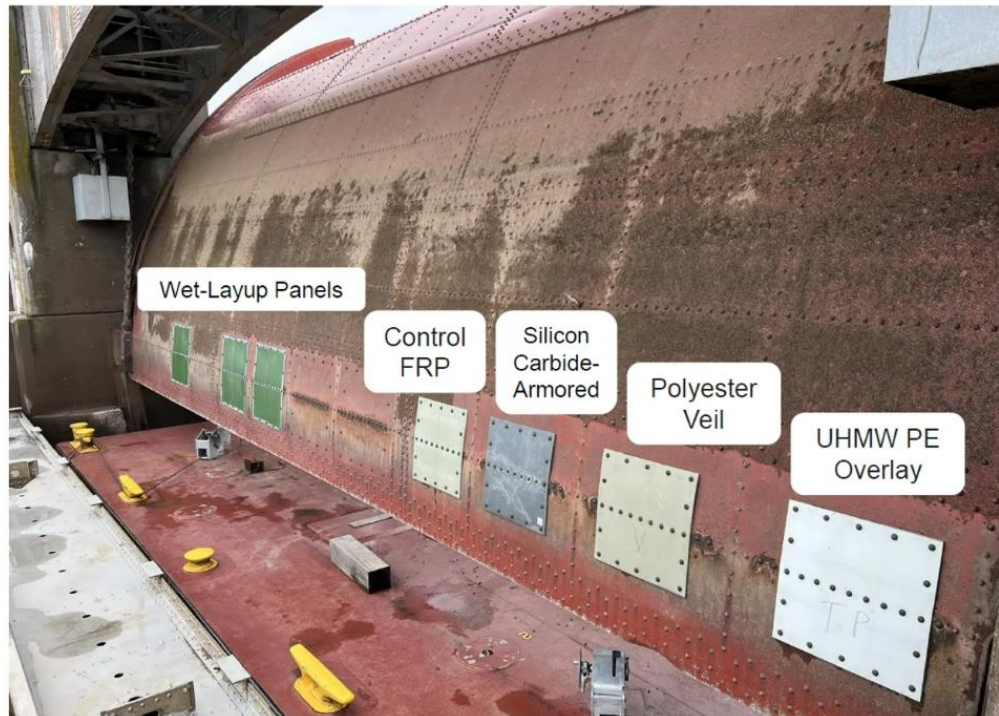
## Updating the NCHRP Report on FRP for Bridges



### FIELD STUDY – WEARING PANELS (AB-1)



- Rock Island District, INDC, and ERDC utilized Lock 12 Tainter Gate Retrofit to aid R&D efforts on fiber-reinforced polymer (FRP) composites
- Objective: Evaluate how different kinds of FRP wear due to sediment, ice, and debris impacts



$$SC = K_E K_R K_I K_{RD}$$

Table 2. Ranked research and development topics.

| ID     | Project Name                                | SCP<br>(Comp.) | S <sub>R</sub><br>(Research) | S <sub>UA</sub><br>(Unique) | Total Score |
|--------|---------------------------------------------|----------------|------------------------------|-----------------------------|-------------|
| AB-1   | FRP Abrasion and Wear                       | 4.2            | 4+                           | 3                           | 8.40        |
| IG-1   | FRP Inspection Manual and Training          | 5.0            | 2                            | 3                           | 7.50        |
| LEG-1  | FRP Techno-Economic Analysis                | 4.9            | 2                            | 3                           | 7.35        |
| CLCF-1 | FRP Bearing and Concentrated Loads          | 4.5            | 2                            | 3                           | 6.75        |
| DG-1   | FRP LRFD Design Manual                      | 5.0            | 4+                           | 2                           | 6.67        |
| MFC-1  | Bolt Group Effects for FRP                  | 4.2            | 2                            | 3                           | 6.30        |
| CLCF-5 | FRP Manufacturing Stds for High-Load Areas  | 4.4            | 4+                           | 2                           | 5.87        |
| MFC-2  | Environmental Effects on Bolt Groups in FRP | 4.2            | 4+                           | 2                           | 5.60        |
| CLCF-4 | FRP Failure Modes                           | 4.7            | 3                            | 2                           | 5.48        |
| IL-1   | FRP Nondestructive Testing                  | 3.5            | 2                            | 3                           | 5.25        |
| IG-2   | Standardized Impact Loads                   | 4.5            | 3                            | 2                           | 5.25        |
| FCS-1  | FRP Fatigue and Creep Curves                | 3.9            | 4+                           | 2                           | 5.20        |
| FCS-2  | Environ. Effects on FRP Fatigue and Creep   | 3.9            | 4+                           | 2                           | 5.20        |
| FCS-3  | Creep and Fatigue for FRP Shape and Size    | 3.9            | 4+                           | 2                           | 5.20        |
| IL-2   | Material Influence on Impact Loads          | 3.5            | 4+                           | 2                           | 4.67        |
| MS-2   | Hybrid Fiber Layout Applications            | 4.0            | 3                            | 2                           | 4.67        |
| FCS-4  | Fatigue Prone Details in FRP                | 3.9            | 3                            | 2                           | 4.55        |

# 9. Projects of Interest Nationally

## NEx Research for FRP

### REQUESTS FOR PROPOSALS 2026

NEx is excited to announce the availability of funding and sponsorship opportunities for 2026. We invite proposals for a range of projects. Please click the link below for more details on the issued Requests for Proposals (RFPs).

[Click here for RFPs](#)

#### RESEARCH AND DEVELOPMENT RFPs

- RD26.14 Evaluate the Connection Mechanisms for Pultruded Structural Members and Facades.
- RD26.15 Roadway Continuously Reinforced Concrete Whitetopping with GFRP Reinforcement.

#### STANDARDS AND GUIDELINES RFPs

- SG26.08 Performance-Based Guidance for Resin Selection in Infrastructure Applications.
- SG26.09 Reinforcement Guidance for Environmental Concrete Structures.
- SG26.13 Guidance for Nonmetallic Reinforcement (GFRP Rebar and Fibers) in Cryogenic Applications.
- SG26.44 Polymer Concrete Railroad Tie Standard Including Recycled Polymers.

Please submit your proposals by October 10, 2025.

<https://www.nonmetallic.org/requests-for-proposals>

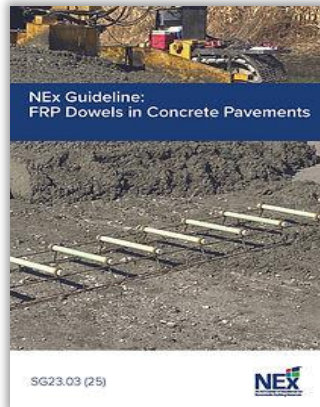
### Relevant Recent Publications



[NEx SG-01\(24\)  
Design and  
Selection  
Guidelines for  
FRP Pultruded  
Structures](#)



[NEx RD23.06  
\(24\) State of  
the Art: Fire  
Performance  
of Concrete  
with FRP  
Reinforcement](#)



[NEx SG23.03  
\(25\) Guideline:  
FRP Dowels in  
Concrete  
Pavements](#)



[ACI/NEx MNL-6\(23\)  
Recommended  
Practice Guidelines  
for FRP Bars in Pre-  
Engineered Projects](#)

# Thank you for your attention



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## Questions?

# Supporting information for Case Studies – D1

(LEGEND: GREY = COMPLETE; BLACK = ONGOING; RED = CURRENT STATUS)

1. Skyway Rest Area (Design-Build: [437635-1](#), [437973-1](#) & [438528-1](#)), [E1P44](#), [Fast-Facts](#): bulkhead cap replacement; xCR-sheet pile wall extension & traffic railings – complete.
2. US41 over Morning Star & Sunset Waterways ([435390-1](#)), [T1742](#), [Fast-Facts](#): Link-slab details (GFRP & BFRP) – 2/27/19 letting, ([Bid Tabs](#)) – status: completed 10/30/20.
3. US41 over North Creek ([433550-3](#)), [T1747](#), [Fast-Facts](#): piles (HSSS-PC), wall panels, flat-slab, traffic railings, 8/28/19 letting ([Bid Tabs](#)) – status: **completed 7/7/21**.
4. I-275 Skyway South Approach Wave Attenuation, Manatee County ([438528-2](#)) E1U62 Design-Build [RFP](#): RC wave attenuation device (WAD) to be either FRP or SS reinforced, [Advertised](#) 1/10/22, Executed 4/20/22. **status**: Only using FRC to be used in precast WAD units.
5. Harborview Rd, Charlotte Harbor ([434965-2](#)) [GoMap](#), 3 CIP Box Culverts under consideration–11/14/2025 Production, no letting date - **status**: Phase III Plans due 4/25/2025.
6. [Caxambas Ct/Roberts Bay, Marco Island](#) xCR low-level bridge. PD&E under [445460-1](#) Letting date 8/27/2026 - **status**: Preliminary BDR 11/22/2024.
7. East Periwinkle Bridge Replacement (City of Sanibel) ([452819-1](#)) \$0.75M PEG [G2W66](#), \$2.5M const. Low-level bridge replacement. **status**: Preliminary design
8. Sanibel Island Causeway Restoration ([452819-1](#)) \$6.6M CG H1719 S2870 GFRP-RC Bulkhead Seawall Caps **status**: Under construction
9. [Little Pine Island Bridge Replacement](#) ([451937-2](#)), H1I24 D-B, EOR: RS&H, FRP-PC Piles & FSB's, GFRP-RC Bent Caps, GFRP Bulkhead Cap, letting 9/29/2023 – **status**: FSB delivery in early March

# Supporting information for Case Studies – D2

(LEGEND: GREY = COMPLETE; BLACK = ONGOING; RED = CURRENT STATUS)

10. Cedar Key: SR24/Channel 3 ([432194-1](#)) [E2T70](#), [Fast-Facts](#): Test Blocks 1-yr baseline (Knight), Letting 7-15-2015 – benchmarking complete. Waiting for next sampling date (2022?)
11. SR117 (Norwood Ave) over Moncrief Ck (437438-1), T2810, letting 5/26/21. [Bid Tabs](#): CFRP-PC 24" piles casting at Gate – **status**: Pile type changed to conventional steel strands and silica fume in concrete. NTP: 8/12/21 Time Began: 11/08/21. Project is 88% paid with 96% time utilized. Project Completion: Spring 2023.
12. SR-A1A/Myrtle & Simpson Creeks ([434041-1](#) & [434042-1](#)), [T2772](#), [Fast-Facts](#), GFRP-RC link slabs 5/20/20 letting ([Bid Tabs](#)) – **status**: completed 2023.
13. SR5A/King St from SR-A1A to Baywall ([430897-1](#)), [E20T7](#), GFRP-RC Bulkhead Cap (#6 bars) on steel king pile sheet pile wall. 9/14/2022 Letting ([Bid Tabs](#)) – **status**: Completed 3/1/2024
14. Various Bridges over Sante Fe & Suwanee Rivers ([437442-1](#)), [E20W3](#), [GoogleMap-260006](#), [310007](#), [370023](#) & [370030](#): Pile Jackets with GFRP rebar (Tuf-N-Lite) (8,715 LF), 6/8/2022 letting, [Bid Tabs](#) – **status**: Completed 1/26/24.
15. SR5 over Oyster Creek ([433843-2](#)), [T2819](#), [GoMap](#): weir/bulkhead rebar (D2-PD&E-Rito Rodriguez/IEI), 10/27/21 letting, [Bid Tabs](#) – **status**: Project expanded. 81% completed. Weir/bulkhead completed 2024.
16. [US1/King St over San Sebastian River](#) (437428-1) [GoMap](#): Using GFRP-RC overlay for FSBs, bent caps and xCR-piles, [4/30/25 new letting](#), [BSN](#) - **status**: Bids received.
17. [CR 357 over Shired Creek](#) (437402-1) [GoMap](#): xCR-FSB Topping, Piling, FRP Caps, letting 3/26/25 - **status**: Bids received and rejected.
18. [SR105\(Hecksher Dr\) over Browns Ck](#) (448825-1) [GoMap](#): xCR-Piles, FIB36, Deck, B/GFRP Caps, letting 10/25/26 - **status**: 60% plans due 9/19/24.
19. [St. Augustine A1A/Avenida Menendez Seawall replacement](#) (428271-2). \$45M. (Videos: [Constr.Sequence](#), 1/23/24 [Public Meeting](#), 9/24/25 letting. **Status**: Phase IV 04/30/2025 in review.
20. [SR13/San Jose Blvd over New Rose Ck](#) (448853-1) [GoMap](#): xCR-Piles, Bents & FSB-15 candidate, letting 03/31/27 – **Status**: 60% Plans due 5/20/25.
21. US90 over Aucilla River Crutch Bents ([447346-1](#)), T2984. Crutch Bents on 2,3, & 4) with 40~#11 GFRP rebar/cap CSI proposal (MSTbar) (~6000 LF), 02/28/24 letting, [Bid Tabs](#) – **status**: Proposal under review.

# Supporting information for Case Studies – D3

(LEGEND: GREY = COMPLETE; BLACK = ONGOING; RED = CURRENT STATUS)

- 22. **St Joe Bay Inlet** ([435815-1](#)), [T3632](#), [Fast-Facts](#) bulkhead sheet piles – 10/30/19 letting [Bid Tabs](#); Began 1/23/2020 – **status:** bulkhead cap installation complete.
- 23. **Pensacola Beach Ped. Tunnels** (City), 3-sided culverts GFRP-RC (Alan Jayroe/Volkert) – **status:** [Not currently funded](#), 100% Plans on shelf.
- 24. **CR30A/Western Lake** ([443331-1](#)) [GoMap](#), xCR-FSBs & xCR-PC Piles & Bulkheads; GFRP-RC Caps, [letting 8/30/23](#) – **status:** under construction.
- 25. **CR30B/Indian Lagoon** ([441185-2](#)) [GoMap](#), Design now by County's consultant (Dewberry FPN [441185-1](#)). xCR-FSBs & xCR-PC Piles; GFRP-RC Caps, letting 11/11/25 – **status:** 100% Plans Review 4/4/2024.
- 26. **CR 372/Surf Road over Otter Creek Rise** ([442951-1 LAP](#)), [GoMap](#), xCR-FSBs & xCR-PC Piles & Bulkheads; GFRP-RC Caps, letting 10/29/25 – **status:** 100% Plans.
- 27. **Victoria Ave over Tidal Branch (Port St Joe)** ([441179-1](#)), [GoMap](#), GFRP Box Culvert to replace railroad flatcar bridge; letting 2/25/26 – **status:** 100% Plans 12/30/2024.
- 28. **SR 30 (US 98) from S Franklin St to Carrabelle River Bridge** [445761-1](#): GFRP-Box Culvert, Letting 6/1/2025 – **status:** Final Plans 4/4/2025.
- 29. **CR2302/Bridge St over Fanning Bayou** ([442917-1](#)) [GoMap](#), SDO/SMO recommended xCR-FSBs or CIP-Flat-Slab with xCR-PC Piles & Bulkheads; GFRP-RC Caps, letting 7/28/27 – **status:** 90% Plans 1/17/25.
- 30. **Rocky Comfort Creek** ([454309-1](#)) (PGA-M.Lauckner) Structural Pile Jackets with GFRP rebar, letting 8/14/25 – **status:** Production 4/11/25.
- 31. **SR 390 EB Bridge over Mill Bayou** ([421225-2](#)) (STV-B.Goble) xCR-FIB36 & xCR-PC Piles & Bulkheads; GFRP-RC Caps, letting TBA – **status:** 60% Plans, BDR, BHR 4/14/25.

# Supporting information for Case Studies – D4

(LEGEND: GREY = COMPLETE; BLACK = ONGOING; RED = CURRENT STATUS)

32. NE 23<sup>rd</sup> Ave/Ibis Waterway ([434359-1](#)) [T4500](#) (LAP), [Fast-Facts](#): GFRP-RC Flat-Slab (Bayard) – 02/27/19 letting ([Bid Tabs](#)) – Began 11/04/19 – **status**: Construction completed 4/26/21. NDT vibration monitoring testing completed by UM/FIU on 5/1/21.
33. [US 1/Jupiter Federal Observation Platform](#) ([428400-2](#)) [T4564](#) – 06/9/21 letting, [Bid Tabs](#), HSSS/CFRP-PC(?) FSB's LF, xCR-18" Piles, (H&H/Nolan), <https://www.fdot.gov/projects/jupiterus1bridge/construction-updates> – **status**: 81% construction.
34. [SR-A1A North Causeway Bridge Observation Platform](#) ([429936-2](#)) [T4583](#) – 1/12/22 letting, [Bid Tabs](#), HSSS/CFRP-PC FSB's(?)=1421'; CFRP-18" piles=1676'+1079' (@CDS); HSSS-24" piles=120'; CFRP-10"x30" Sheet Piles = 621', (H&H/Nolan), [D4 Construction webpage](#) = **status**: 48% construction.
35. SR-A1A over Sebastian Inlet ([445618-1](#)) - Observation Walks as part of bridge replacement - Letting 10/29/25 – **status**: Phase I Plans 9/05/23, [Public Meeting](#) 7/17/24, 60% Plans Review June-July.
36. [SR 5/US 1 over Earman River](#) ([442891-1](#)) [T4714](#) – FSB's, Bent Caps & piling – 09/25/24 letting, [BSN](#), [BidTabs](#) (pending) - **status**: Under construction
37. 17<sup>th</sup> St/Indian River, East End-Vero ([446106-2](#)) - Replace east end spans with xCR-Beams (1-span)+CFRP/GFRP-FSB's (7-spans), SSRC overlay, CS-Barrier, xCR-piling, (GFRP-Bent Caps w/ SS-couplers) – 3/3/23 letting - **status**: Under construction.
38. I-95 NB Off-Ramp at Indiantown Rd ([439758-1](#)) [E4W59](#) – xCR-Piling 18"x18" (1277 LF) – 5/5/2023 letting- **status**: Contract executed 6/23/23.
39. SE Martin County Line Bridge Replacement (DRMP) [maplink](#) – FRP-PC/RC foundation and superstructure - **status**: 60% Plans due March 2023.
40. SR-A1A over Big Mud Creek & Blind Creek ([449179-1](#)) – xCR-FIB/FSB's, - Bents, Piles, and deck. 03/25/26 letting - **status**: D4 in-house. BDR review due 9/3/2024.
41. NE 36<sup>th</sup> St/Sample Road over Cap Knight Bayou Waterway (LAP-City Lighthouse Point) ([453177-1](#)) – \$1M [Congressional CPFR](#): Candidate xCR-FSB - **status**: Consultants short listed in March 2024.
42. NE 31<sup>st</sup> Court over Heron WW (LAP-City Lighthouse Point) ([453176-1](#)) – \$1M [Congressional CPFR](#): Candidate xCR-FSB - **status**: Consultants short listed in March 2024.
43. Seawall & Pump Station Resiliency Project ([448576-1](#), 448577-1, 448574-1) – Letting 9/25/24 - **status**: TBA

# Supporting information for Case Studies – D5

(LEGEND: GREY = COMPLETE; BLACK = ONGOING; RED = CURRENT STATUS)

- 44. **A1A Seawall - Segment 3** ([440557-7](#)) [T5641](#), [Fast-Facts](#): Secant wall for revetment – *complete*. **status:** *Hurricanes Ian & Nicole exposed wall face approx. 10-feet height.*
- 45. **SR 520 over Indian River** ([440969-1](#)) [E5Z68](#), [Fast-Facts](#): Bulkhead Cap Replacement - 3/5/19 letting ([Bid Tabs](#)) – *no issues with the GFRP in the bulkheads that made it back to the EOR (complete).*
- 46. **SR 404 /Indian & Banana Rivers** ([439275-1](#)) [E5Z32](#), Bulkhead Rehab xCR-Sheet piles only – 2/26/18 letting (*complete*).
- 47. **SR 528 /Indian & Banana Rivers** ([441166-1](#)) [E5Z96](#), Bulkhead Rehab CR-Sheet piles only – 12/3/19 letting ([Bid Tabs](#)), complete 5/25/21.
- 48. **Barracuda Blvd New Smyrna** ([437935-1](#)) **T5743**, *Bent Caps, CFRP-18" Piles=1508'+224' (@CDS); 73~CFRP-12"x30" Sheet piles=2269', 8~corner piles, [BSN](#), [Bid Tabs](#), Letting 2/23/2022. 4 new sheet pile walls added ~\$1.5M to address existing wall damage (Phase 2).* **Status:** *completed.*
- 49. **5th Street over Yacht Club Cut** ([437936-1](#)) (LAP-DRMP) [Map](#) – 24" Sq. xCR-Piles optional CFRP or HSSS. **Status:** *completed.*
- 50. **A1A Seawall – Segment 3 & 4** ([452443-1](#) & [452444-1](#)) [H5461](#), [Fast-Facts](#): GFRP-RC [Secant Pile wall](#) for protection, Hurricanes Ian & Nicole permanent repairs. *Construction [Video](#) (5/31/24) - **Status:** *Completed.**
- 51. **SR 404 over Indian & Banana Rivers** ([445395-1](#)) **E55A2**, CP Pile Jackets with GFRP bars, 5/3/22 letting [BidTabs](#) - **Status:** *Estimated completion 11-27-23. The contractor is proposing substitution of GFRP Bars for Steel bars in Pile Jackets.*
- 52. **SR5/US1 NB Over Turnbull Creek** ([447117-1](#)), Bridge Replacement, xCR-Piles, Superstructure TBA, Letting 8/28/24, [BSN](#). **Status:** *Advertised for bid.*
- 53. **N. Banana Rv Dr. Merritt Island** (LAP-Atkins) [Map](#) – 18" Sq. xCR-Piles optional CFRP or HSSS, xCR-FSB's or GFRP-RC Flat-Slab & Soldier Pile Walls. **Status:** *Preliminary Cost study.*
- 54. **US1 over Pellicer Ck** ([447118-1](#)); *Potential xCR bridge in splash zone; letting 3/25/2026. **Status:** 60% Plans due 8/3/23.*
- 55. **SR44 Sth Cswy- over Indian Rv** ([450561-1](#)) Bulkhead Rehab ([Map](#)), GFRP rebar in cap and 62' xCR Sheet Piles, Letting 5/7/2024, [BSN](#). **Status:** *Advertised.*

# Supporting information for Case Studies – D6

(LEGEND: GREY = COMPLETE; BLACK = ONGOING; RED = CURRENT STATUS)

- 56. Bakers Haulover Cut ([433378-1](#)), [Fast-Facts](#): bulkhead – completed.
- 57. Cow Key ([441740-1](#)), [E6L95](#), [Fast-Facts](#): 6 spans (3 per bridge) replacement (*Luis Vargas/BPA*) – 10/31/19 letting ([BidTabs](#)) – **status**: complete (Nov 2020).
- 58. SR-112/I-195 Westshore waterway ([441967-1](#)) [E6M50](#), [Fast-Facts](#) - bridge rehab: piles, bent cap & bulkhead cap repairs – 11/19/2020 letting [BSN](#) - **status**: complete 8/30/22.
- 59. SRA1A/Indian Creek Drive Drainage Mitigation ([439228-2](#)) AS343-City of Miami Beach. GFRP-RC Pump Station Pile Cap and Bulkhead Caps. **status**: No updates.
- 60. US1 over Channel 5 ([436523-1](#)) E6K61 - Precast/PT Pier rehab, Letting 8/27/2020. BSN. **status**: Under construction, FRP-RC repair proposed (Revision 3).
- 61. Long Key Bridge Replacement ([448206-1](#)) – XCR substructure considerations, letting 2035. **status**: PD&E underway - [Public Kickoff Meeting 2/16/2023](#), [Alternatives Meeting 9/12/2023](#).
- 62. Seven Mile Bridge Replacement ([448207-1](#)) - XCR substructure considerations, letting 03/11/2040 – **status**: PD&E. [Public Kickoff Meeting 5/16/2024](#), 30% Plans 5/6/2026.
- 63. 117<sup>th</sup> St/Vaca Channel #2 ([448208-1](#)) LAP – XCR substructure consideration. Design with grant to City of Marathon, letting Nov. 2024. **status**: 100% Plans due 5/24/24.
- 64. FKOHT over Bow Channel Old Bridge Rehab. for SUNTRAIL ([440909-2](#) & [3](#)) – Grant to FDEP \$0.6M design, \$10M construction in 2027/28. **status**: Kickoff meeting 12/6/2024.
- 65. Snake Creek Bridge PD&E Study ([442670-2](#)) New high-level bridge to replace Bascule. XCR foundations will be required. **status**: PD&E Kickoff 2/3/2026. Construction 2035.
- 66. SR 907/Alton Rd ([430444-2](#)) Raising Road and adding pump stations. \$60M with \$18M PROTECT Grant. Structures should be GFRP-RC due to saltwater. Production 9/26/2026 – **status**: 90% Plans 7/28/2024.
- 67. Atlantic Isle Lagoon Historic Bridge Replacement ([430029-2](#)), LAP – xCR end bents & arched FSB's, upper drilled shaft connection? \$2M, Letting 12/22/2027 – **status**: 60% Plans 6/4/2025.

# Supporting information for Case Studies – D7

(LEGEND: GREY = COMPLETE; BLACK = ONGOING; RED = CURRENT STATUS)

67. Halls River Replacement ([430021-1](#)) [T7386](#), [Fast-Facts](#): Bulkhead cap (D7-Nolan) – **status: +5-year Durability FRP-RC Bulkhead Beam Extraction and Testing pending (UM) Winter 2024/25.**
68. Bayway Structure E Seawalls - ([427143-2](#)) **E7R20**, (Hunter), Design-Build: GFRP-RC Cap and Deadman for anchored Steel Sheet pile wall. [drone footage](#) – **status: Completed 1/30/2023.**
69. 4<sup>th</sup> St at Big Island Gap – ([430500-1](#)) **E7O03**, letting 7/21/21 (Siddiqui) – Bent caps are GFRP (Piles are SS-PC), [Bid Tabs](#) – **status: Completed 11/21/2023.**
70. 40<sup>th</sup> Ave. NE/Placido Bayou, City of St Pete ([443600-1](#)), [Fast-Facts](#) (Siddiqui/Cardno) 9/15/20 letting: full bridge – **status: Completed.**
71. **I-275 over Big Island Gap** - Bridge Substructures – xCR piling and caps; Bridge Superstructure 1 (LHS) – xCR beams and deck for SUP; Bridge Superstructure 2 (RHS) – Conventional materials; Bulkhead Extensions – Use xCR Sheetpiles and Caps. **status: construction completed.**

# Supporting information for Case Studies – Local

(LEGEND: GREY = COMPLETE; BLACK = ONGOING; RED = CURRENT STATUS)

- 72. City of Key West Bight Ferry Dock Extension ([412194-1](#) LAP Grant), [Fast-Facts](#): CFRP-PC Piles (*Nolan*) – completed.
- 73. I-dock (University of Miami) - [Fast-Facts](#): GFRP-RC PBES (*Nanni*) – complete.
- 74. North Miami Beach reef – SEAHIVE units with GFRP- **status**: *Placed in service Mar 2023.*
- 75. Bimini Drive at Duck Key – (Monroe County) letting 11/24/20 (*Nolan*), Fast-Facts, xCR-piles, GFRP-RC bulkhead cap – **status**: *construction completed.*
- 76. Wahoo Bay (Palm Beach County) – SEAHIVE units with GFRP- **status**: *placed some units March, but additional mudline preparation required for anchoring toe units for April.*  
<https://news.miami.edu/stories/2023/08/a-way-to-protect-coastlines-and-restore-marine-ecosystems.html>
- 77. [Okaloosa Coastal Artificial Reef](#) – **status**: *25 ~ 3DCP SEAHIVE clusters deployed at 9 locations in Gulf of Mexico on 2/26/2024 (Video), FWC Artificial Reef Program fish survey monitoring (pending).*
- 78. Village of North Bay, (Miami) GFRP-RC Caps & Seacrete™; 100 ft length of bulkhead cap raising – **status**: *SEAHIVE placement in permitting.*