Third International Workshop on FRP Bars for Concrete Structures (IW-FRPCS3)

Workshop Theme: "Advances in concrete reinforcement"

Date: August 3-4th, 2021

DAY 1 Tuesday, August 3rd

Session 2: Contractors & Practitioners Perspective (10:15 – noon EDT)

(What do contractors really need?)

RoundTable discussion with audience engagement, preceded by 5-minute introduction by panelists.

Moderator: Steven Nolan (FDOT)

i. Contractors - Case Study Project Experience & Risk Perception *(5-minute presentations)*

ii. Design Consultants - Design Code Experience – The Good & the Bad? *(5-minute presentations)*

Panelists:

- Sybille Bayard (Consor)
- Ananda Bergeron/Chris Gamache (Cardno)
- Harry Gleich (Metromont) No Slides
- Brett McMahon (Miller & Long)
- William O'Donnell (DeSimone)
- Robert Sqapi (Stephenson Engineering) No Slides
- Luis Vargas (BPA/Colliers Eng)

THIRD INTERNATIONAL WORKSHOP ON FRP BARS FOR CONCRETE STRUCTURES

"Advances in concrete reinforcement"

August 3-4, 2021 - Virtual

NE 23RD Avenue Bridge over IBIS Waterway

The First Vehicular Bridge in Florida fully reinforced with Glass Fiber Reinforced Polymer (GFRP)

Presented by Sybille Bayard, PE

CONSOR

NE 23RD Avenue Bridge over IBIS Waterway

The First Vehicular Bridge in Florida fully reinforced with Glass Fiber Reinforced Polymer (GFRP)

Existing Bridge Conditions

Built in 1950	**Three-Span Reinforced Concrete T-Beams**	**Concrete bents supported on 30-in circular concrete piles**
Coastal Bridge – extremely aggressive marine environment	**Load Restricted Bridge (29 tons)**	**Age related deterioration evident in substructure/foundation (spalls with some delamination and pile jackets at intermediate bents)**

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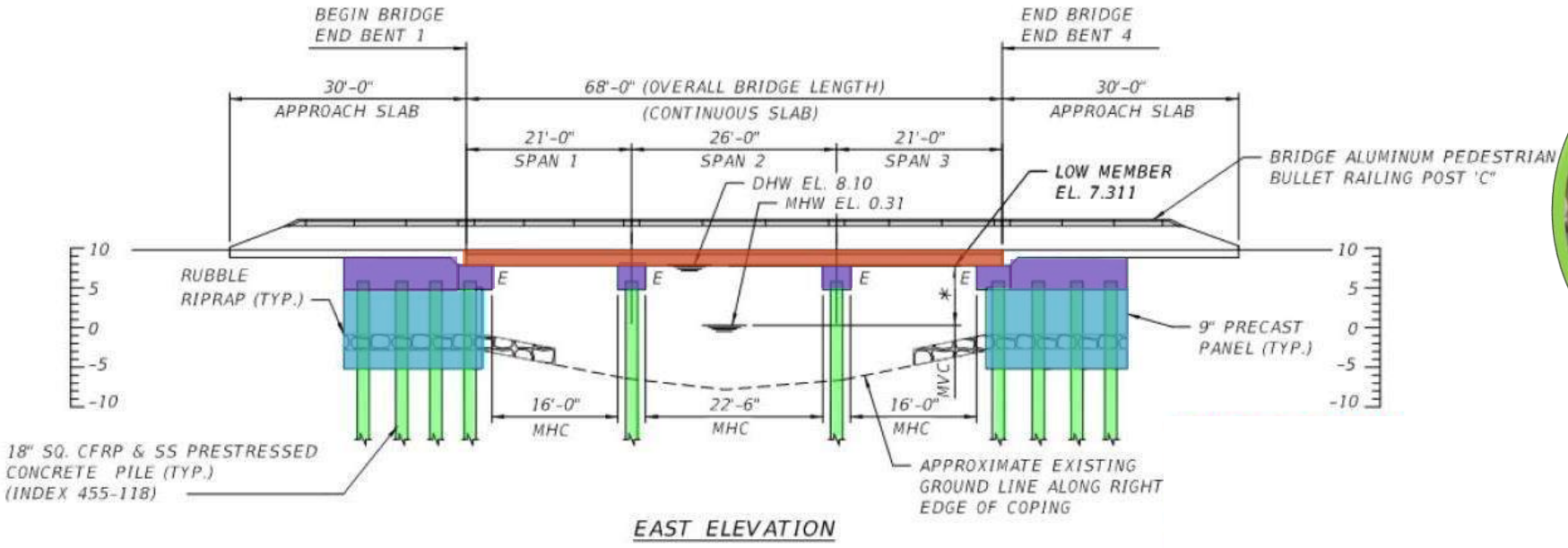
New Bridge GFRP Features



3-span continuous CIP 16-in Flat Slab (21'-26'-21')	CIP Concrete Bents & Bulkheads (42-in wide x 36-in deep)	9-in Precast Concrete Panels at abutments & bulkheads	CFRP & SS Prestressed Concrete Piles
➢ 5.5 ksi Concrete ➢ Glass Fiber Reinforced Polymer ➢ 1.5-in cover	➢ 5.5 ksi Concrete ➢ Glass Fiber Reinforced Polymer ➢ 3-in cover	➢ 5.5 ksi Concrete ➢ Glass Fiber Reinforced Polymer ➢ 2-in cover	➢ FDOT Standard 455-101 & 455-118 ➢ 6.0 ksi Concrete ➢ 3-in cover

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Considerations in Design / Detailing

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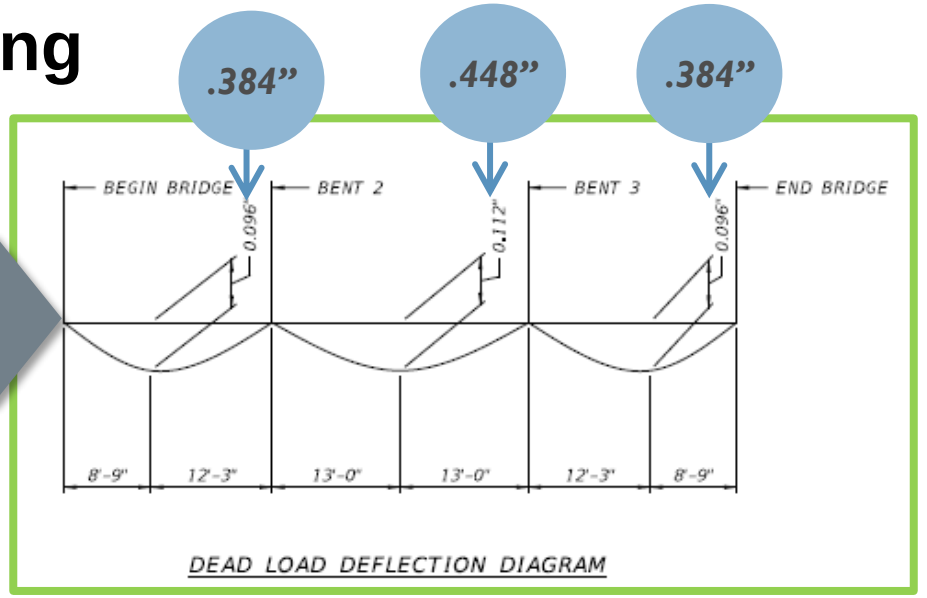
Deflection

Anticipate higher long-term deflection due to lower Modulus of Elasticity



Flexure

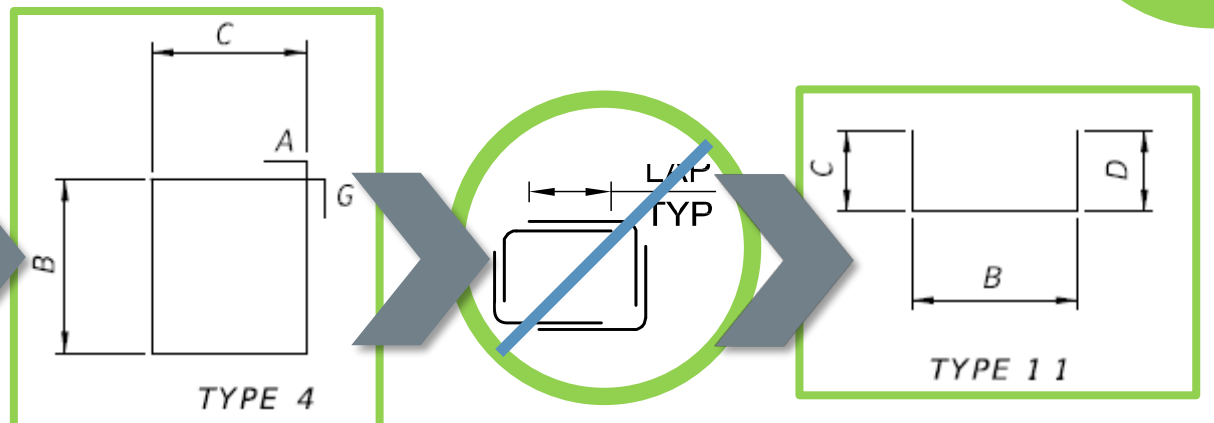
Anticipate more Flexural reinforcement due to non-ductile behavior

Shear

Anticipate lower shear capacity due to anisotropic properties of FRP materials

Bar Bending Details

Limited bar bending due to low-ductility GFRP materials



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GFRP Construction Lesson Learns

Considerations in Delivery & Handling

Damaged Panels

Considerations in Construction Time and Schedule:

- No Field Bending
- GFRP Bars may not be readily available (6-8 weeks manufacturing time)
- May not be available locally (added transportation time)

NE 23RD Avenue Bridge over IBIS Waterway

The First Vehicular Bridge in Florida fully reinforced with Glass Fiber Reinforced Polymer (GFRP)

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GFRP Advantages:

The light weight of GFRP allows for much easier installation (Construction workmanship & time-efficiency)

OTHER BENEFITS

- ***Durability (100+ yrs)***
- ***Resistance to Corrosion***

NE 23RD Avenue Bridge over IBIS Waterway

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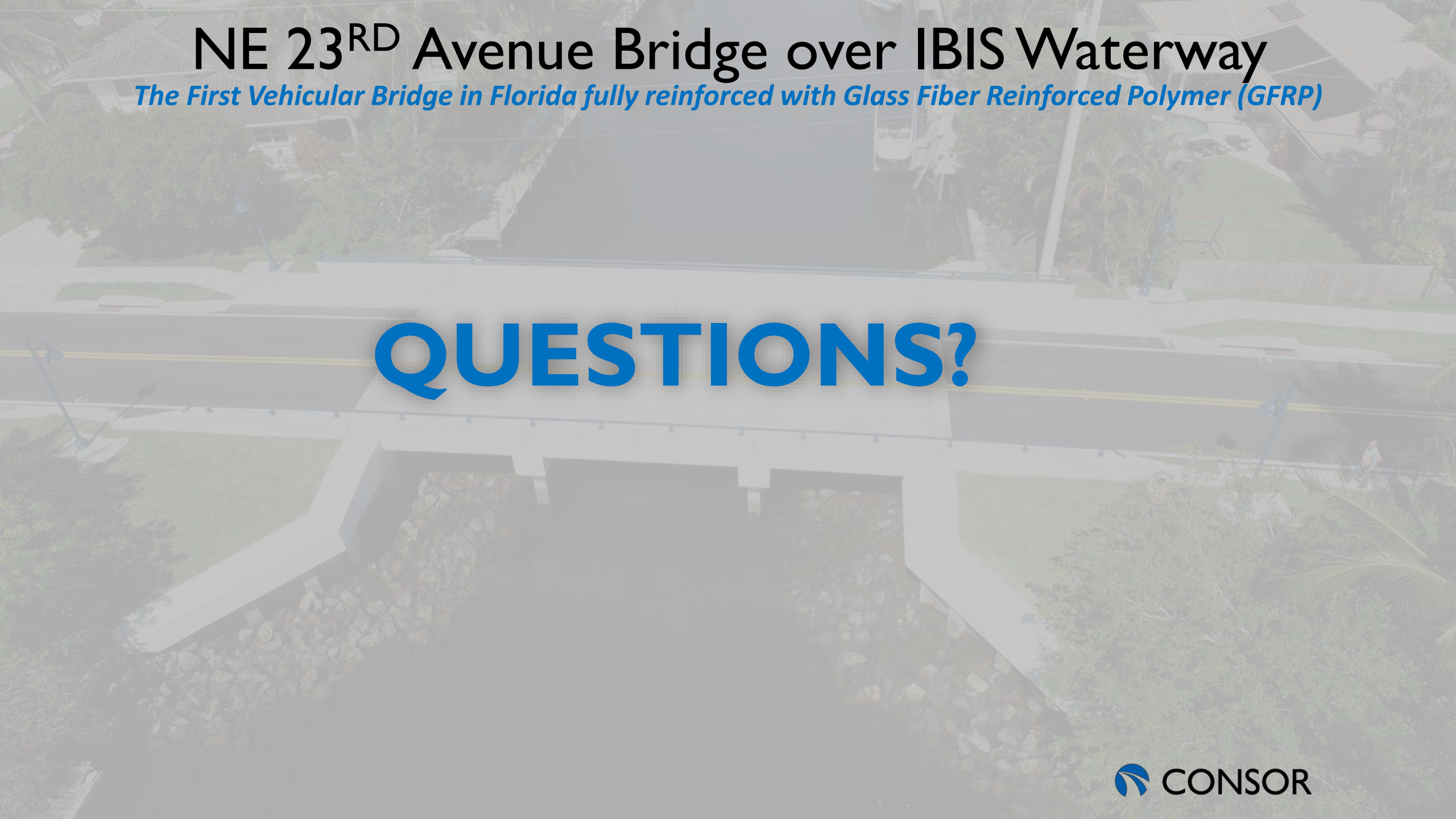

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THIRD INTERNATIONAL WORKSHOP ON FRP BARS FOR CONCRETE STRUCTURS

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Bridge Replacement at 40th Avenue NE over Placido Bayou

Christopher Gamache, P.E., Cardno, U.S.

Ananda Bergeron, P.E., Cardno, U.S.

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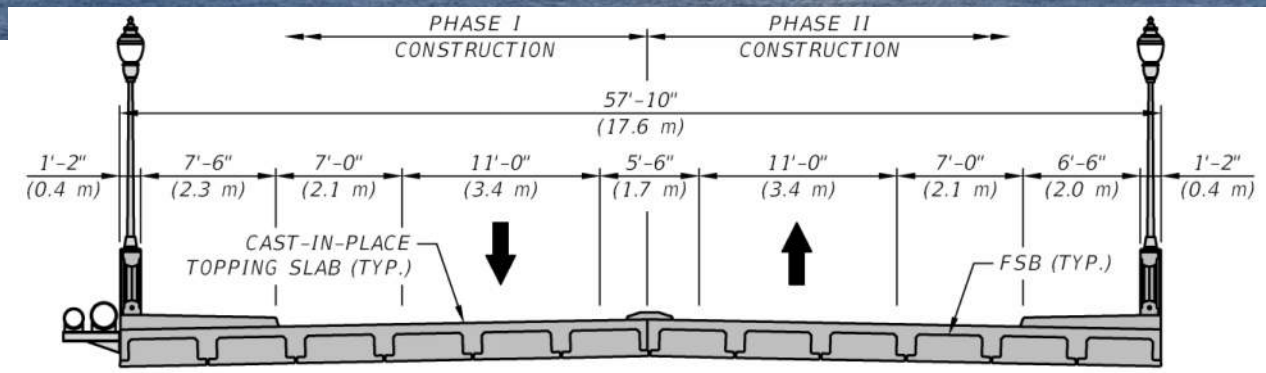
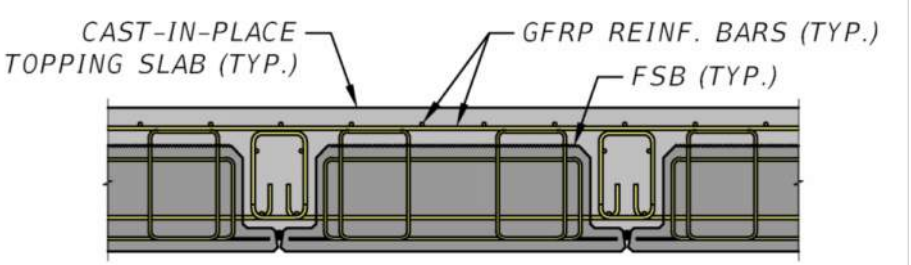
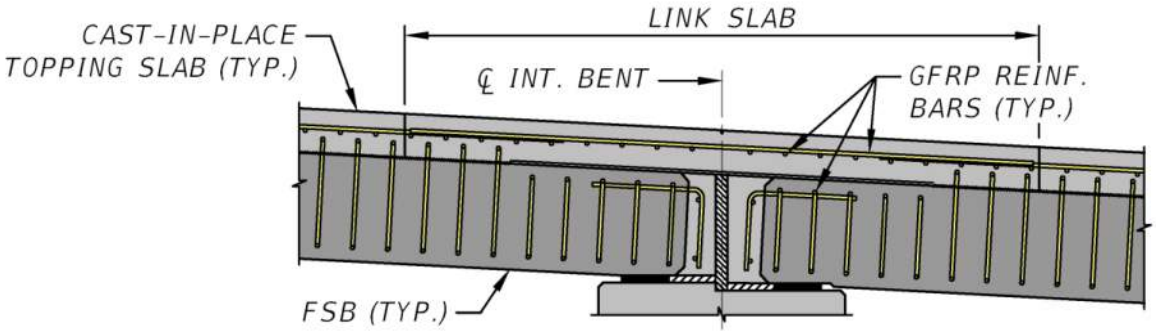
- Proposed Replacement Bridge
  - FRP reinforced structural members with salt water exposure
  - 6-span structure with an overall length of 320.0 ft (97.5 m)
  - 50 ft (15.2 m) and 60 ft (18.3 m) prestressed concrete Florida Slab Beams (FSBs) with a cast-in-place concrete topping slab
  - Pile bents with 24 in (610 mm) square prestressed concrete piles and cast-in-place concrete caps



- Superstructure Design
  - 18 in (457 mm) deep FSBs with GFRP reinforcing bars and CFRP prestressing tendons
  - Composite cast-in-place topping slab with GFRP reinforcing bars
  - Link slabs over interior bents with GFRP reinforcing bars

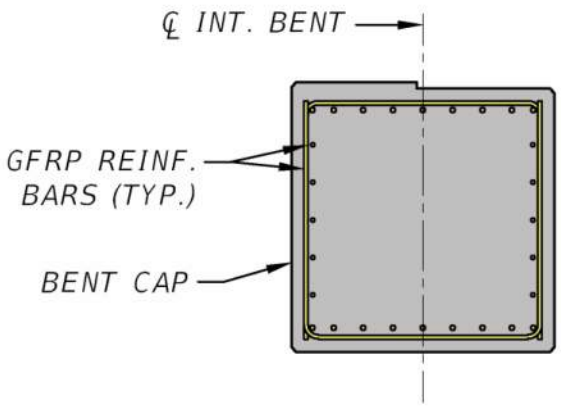


Transverse Superstructure Section

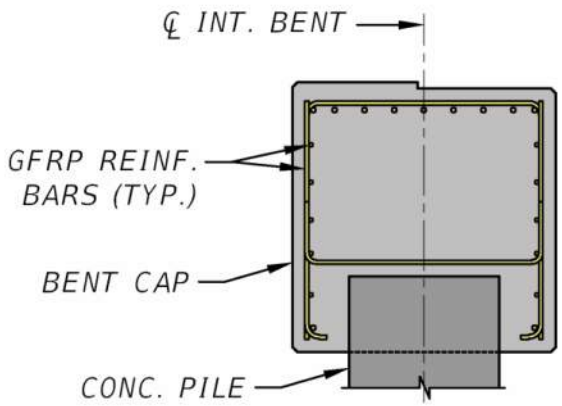


Longitudinal Superstructure Section

- Substructure Design
  - Cast-in-place bent caps with GFRP reinforcement
  - Phased construction splice made with stainless steel threaded coupler
  - Contractor had option to use concrete piles with either CFRP or stainless steel prestressing strands & reinforcement



Intermediate Bent Typical Section



Intermediate Bent Section at Pile

- Challenges to Date
  - Phased construction joints with limited room for splicing
  - Shear design capacity
  - Bend geometry limitations
  - GFRP reinforcing bar sampling and testing

Current Construction Progress

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Use of FRP Rebar in Buildings

Brett McMahon, Miller & Long Co., Inc., USA

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Miller&Long
CONCRETE CONSTRUCTION

Case study:

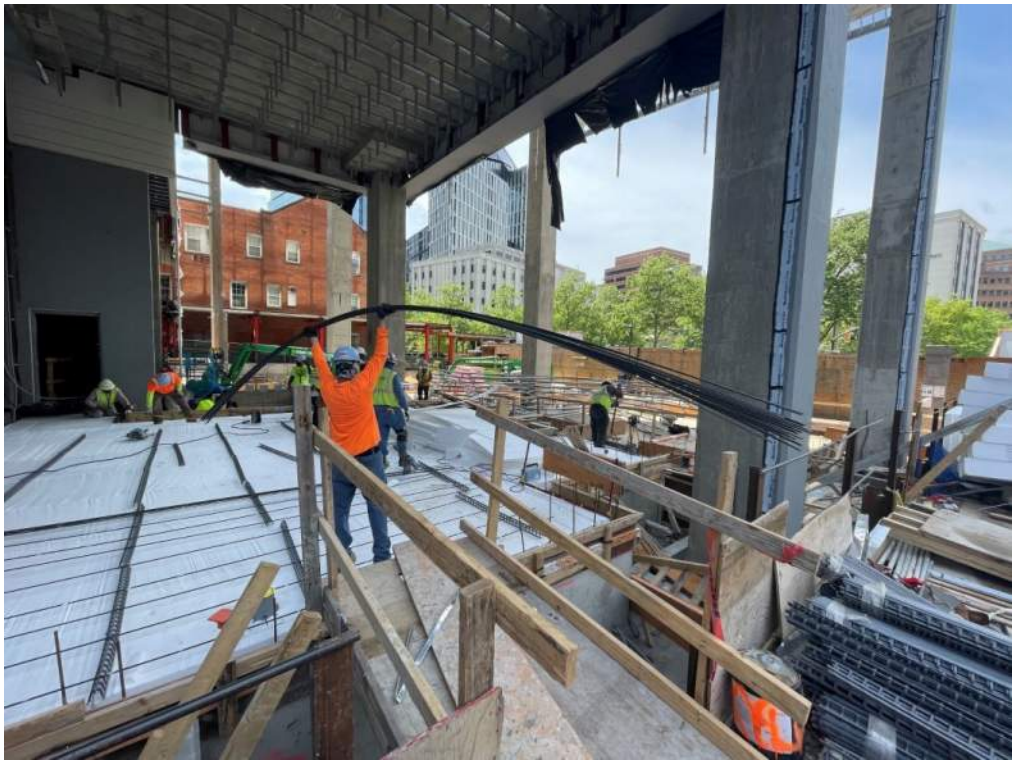
Avocet Tower, Bethesda, Maryland

Pallet of Basalt Mesh

Miller&Long
CONCRETE CONSTRUCTION

Case study:

Avocet Tower, Bethesda, Maryland



Carrying Basalt Bars

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- 55 Countries
- 44 States in the U.S.

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- Chicago
- Houston
- Las Vegas
- Miami
- New Haven
- New York (Headquarters)
- Plainville
- San Francisco

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- Bjarke Ingels

Art Gallery of Alberta
Alberta, Canada

Centra at Metropark
Iselin, New Jersey, US

One Thousand Museum
Miami, Florida, US

Paramount Residences
Miami, Florida, US

Turnberry Beach Club Tower
Sunny Isles Beach, Florida, US

Panorama Tower
Miami, Florida, US

Grove at Grand Bay
Coconut Grove, Florida, US

Taubman Museum of Art
Roanoke, Virginia, US

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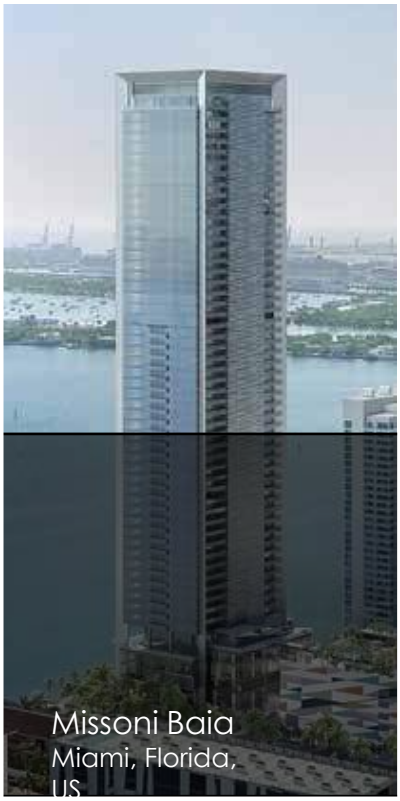
Seminole Hard Rock Hotel & Casino Hollywood
Hollywood, Florida, US

Atlantis
Paradise Island, The Bahamas

Una Residences
Miami, Florida, US



Missoni Baia
Miami, Florida, US

Aston Martin Residences
Miami, Florida, US

Brickell Flatiron
Miami, Florida, US

Resorts World Las Vegas
Las Vegas, Nevada, US

Yas Mall
Abu Dhabi, UAE

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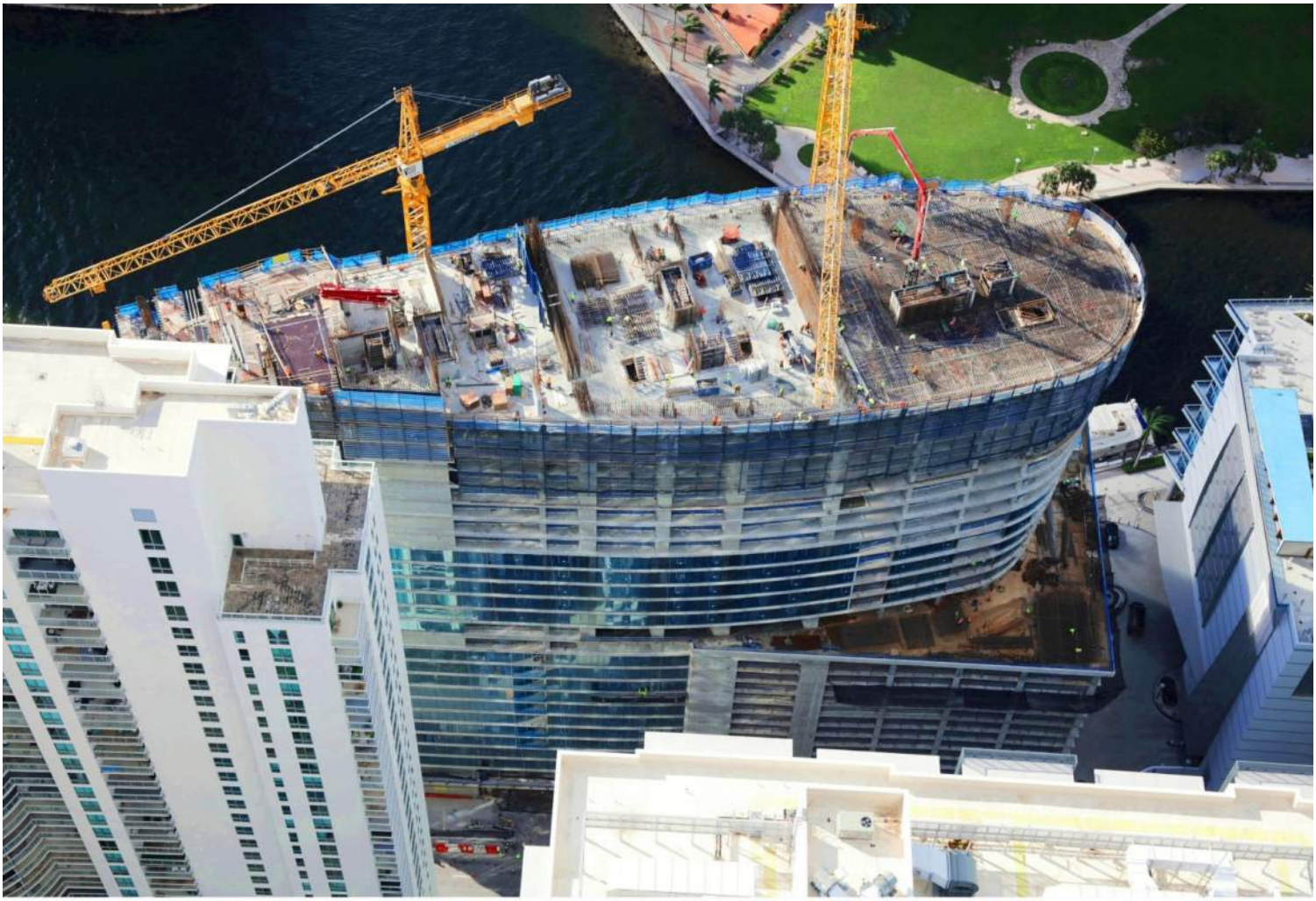
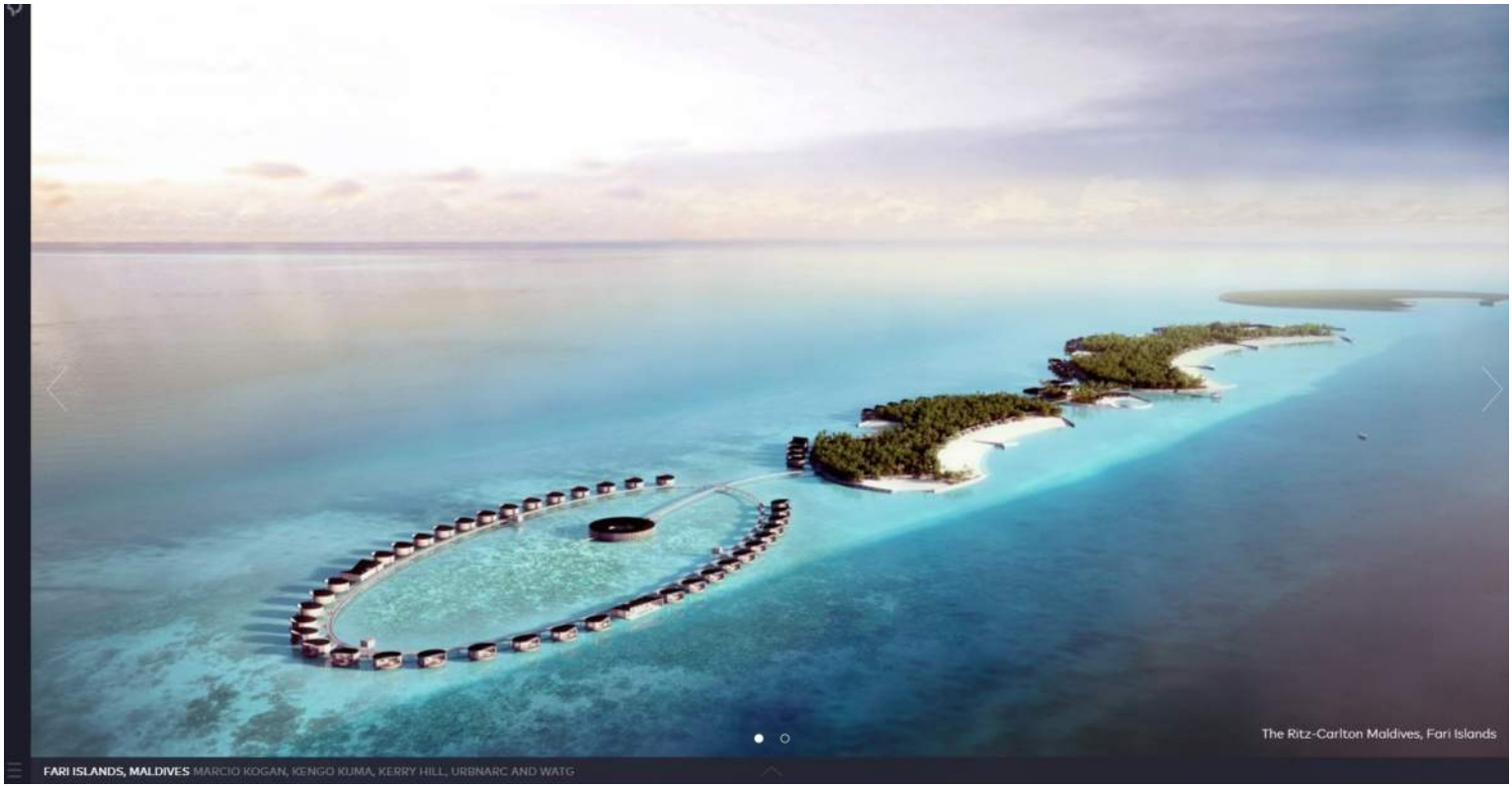


Coastal CONSTRUCTION

Aston Martin Residences

SMITH AERIAL PHOTOS 10-09-20


The Ritz-Carlton Maldives, Fari Islands
FARI ISLANDS, MALDIVES MARCIO KOGAN, KENGO KUMA, KERRY HILL, URBNARC AND WATG

Adoption of FRP Reinforcing in Concrete Buildings

- Need ample data and historical use to provide engineers, contractors, and owners with a comfort level
  - Full scale
- Codify use of FRP – ACI Manual coming in 2022
- Supply and demand – what is the manufacturing capacity
- Price comparisons

Coastal Construction

- Florida coastal residential buildings
- Extreme exposure for balconies, open-air garages, and pool decks
- Corrosion prevention measures
- Galvanic corrosion issues in restoration work
- Caribbean projects with substandard concrete - private and government
- Remote projects with no natural potable water supply

Green Buildings

- Embodied carbon
- LC3 cement – Limestone Calcined Clay Cement
  - 40% reduction in CO_2 emission
  - Use of FRP needed with lower pH levels

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Case Study:
US-1 Over Cow Key Channel Span Replacement

Luis M. Vargas, PhD, PE, SE

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Colliers Engineering and Design, USA

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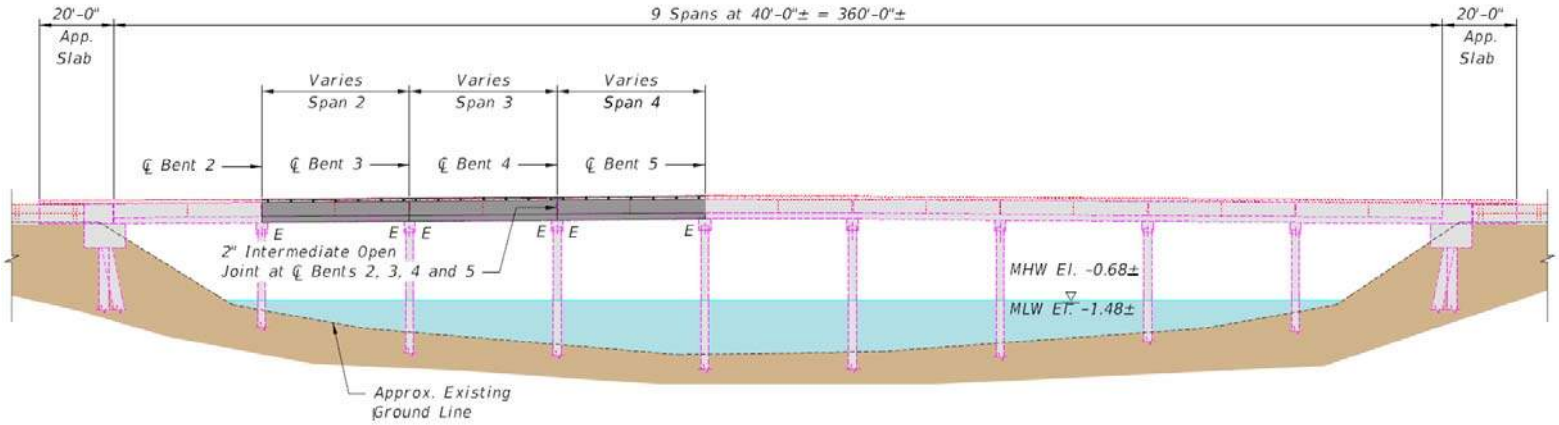
US-1 Over Cow Key Channel Span Replacement



- US-1 over Cow Key Channel Bridges (NB-900086 & SB-900125) located in Florida Keys - Aggressive Environment
- Unique rehabilitation project: In a very complex setting
- Scope was to replace 3-40 ft spans in each bridge
- Maintain the same substructure
- Challenge: use of a shallow and light superstructure, simple to fabricate, light to transport and erect; extend service life
- Opportunity: use of a new FDOT system (FSB 12)- light structural member; GFRP rebar and CFRP strands – extend service life
- Construction time drove the cost of project

- Design Experience:
  - Learning curve for understanding FRP behavior – a different paradigm
  - Project started in 2017 where there were limited tools for **Design,** draft design specs were available
  - Dr Nanni's PhD students help clarifying some concepts
  - Design was confirmed with the 1st Ed of Guide Specifications and FDOT software (preliminary version)
  - Support from FDOT was crucial – Steve Nolan and SMO
- Precasters participation:
  - During design we approached 3 precasters (Tampa, Orlando and Jacksonville) – only one had limited FRP experience
  - All precaster pointed out issues with handling the FRP
  - We needed to confirm we had a reasonable cost estimate that would make the proposed system viable

- Construction Experience:
  - During procurement of materials, we had several interesting RFIs related to casting the FSB
  - Shop drawings-- Bending bar diagrams available (stirrups) had issues fitting the standard FDOT strand pattern – we re-arranged strand pattern timely
  - We had some issues with minor cracking on the anchorage zone, we rearranged stirrups to mitigate cracking at beam ends
  - We reduced the force at anchorages by debonding more strands
  - No issues with delivery of precast panels
  - Fortunate to have an excellent Precaster and Contractor