2016 Design Training Expo

HALLS RIVER BRIDGE REPLACEMENT

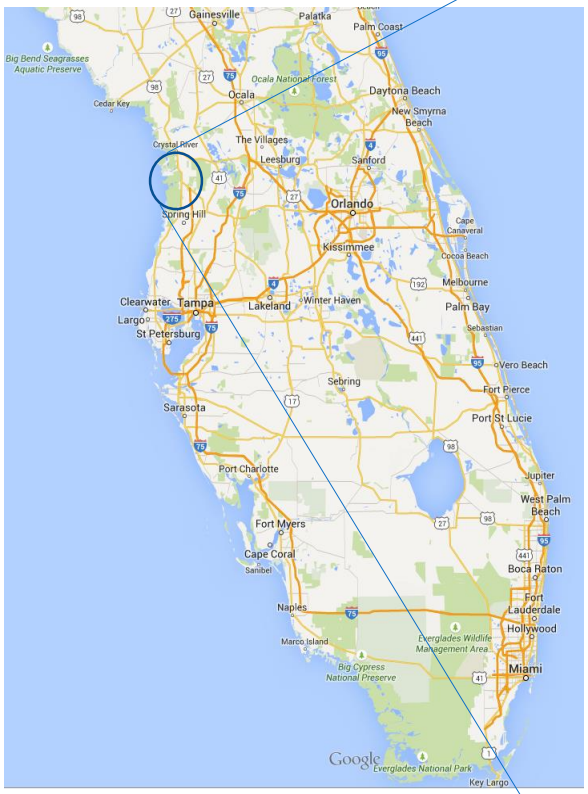
FDOT District 7 Structures Design Office

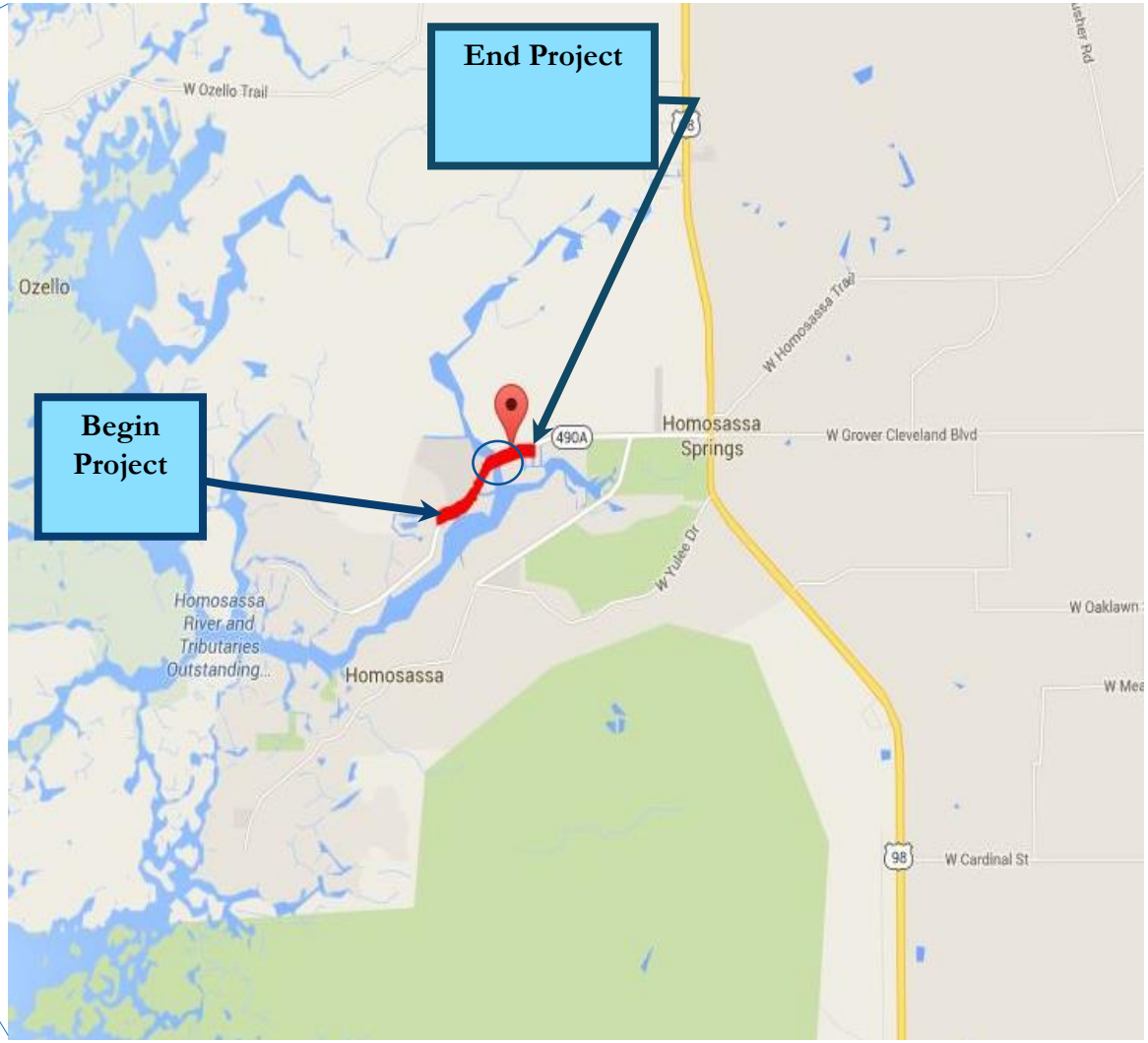
Cristina Kay Suarez	***Structures Designer***
Mamunur Siddiqui, P.E.	***Structures Design Engineer - SEOR***
David Pelham	***Senior Structures Designer & Geotechnical PM***

PRESENTATION OUTLINE

- Project Overview
- Design
- Materials
- Details
- Construction
- Monitoring

PROJECT OVERVIEW





BRIDGE LOCATION

2016 Design Training Expo

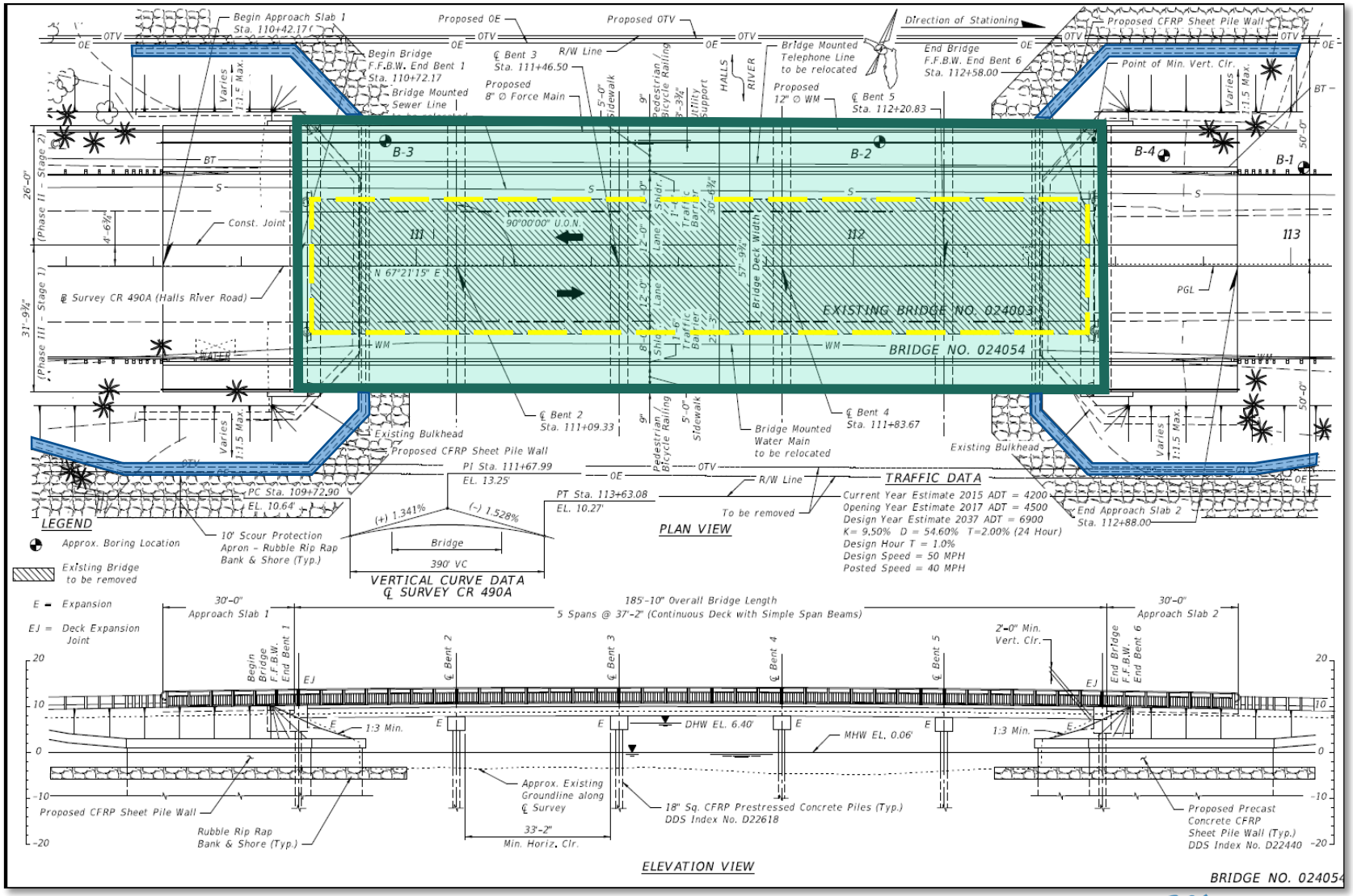
PROJECT OVERVIEW

Design & Bi-Annual Inspection

Owner & Maintaining Agency

Funding & Monitoring

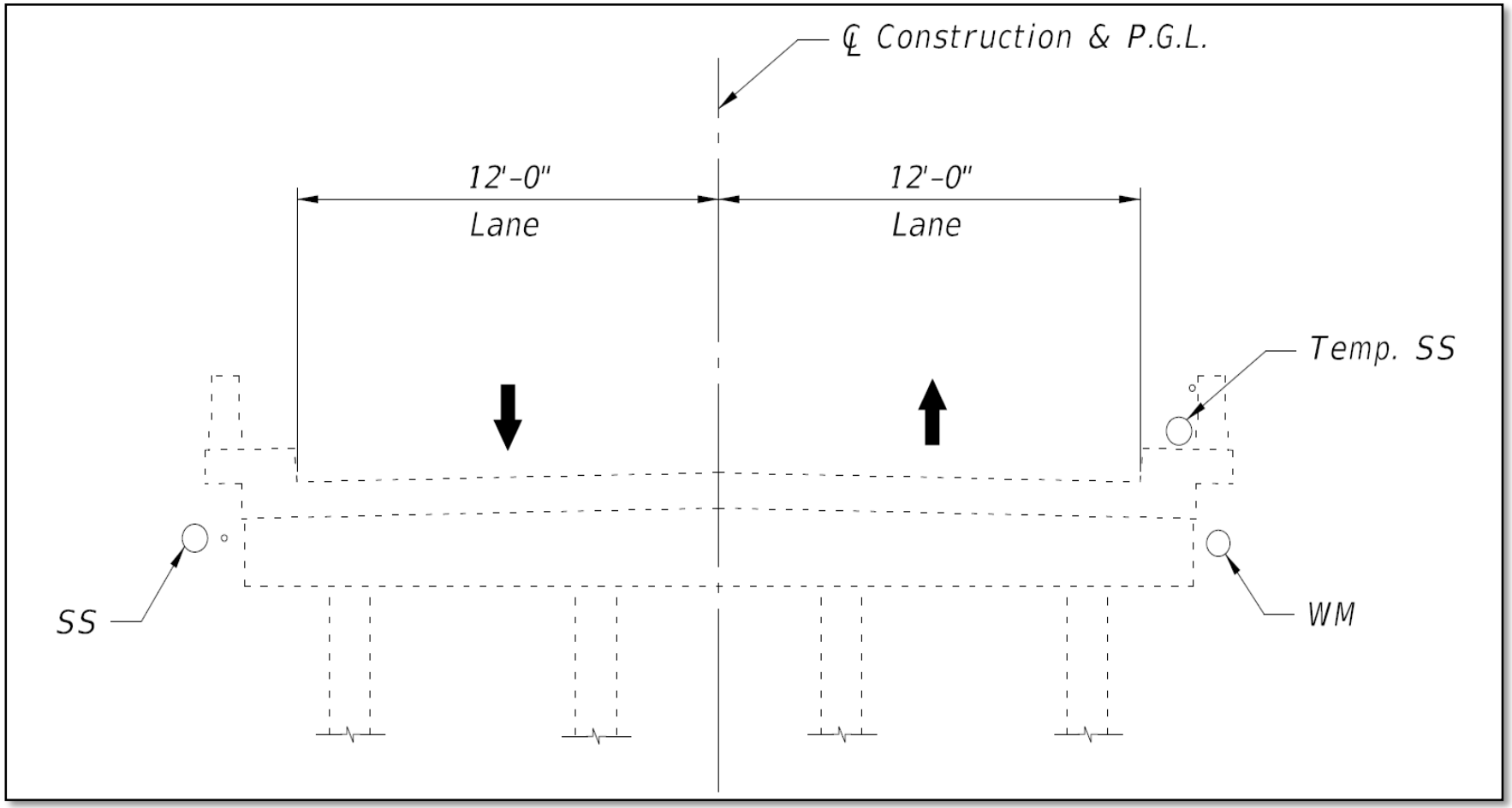
PROJECT OVERVIEW



Existing and Proposed Layout

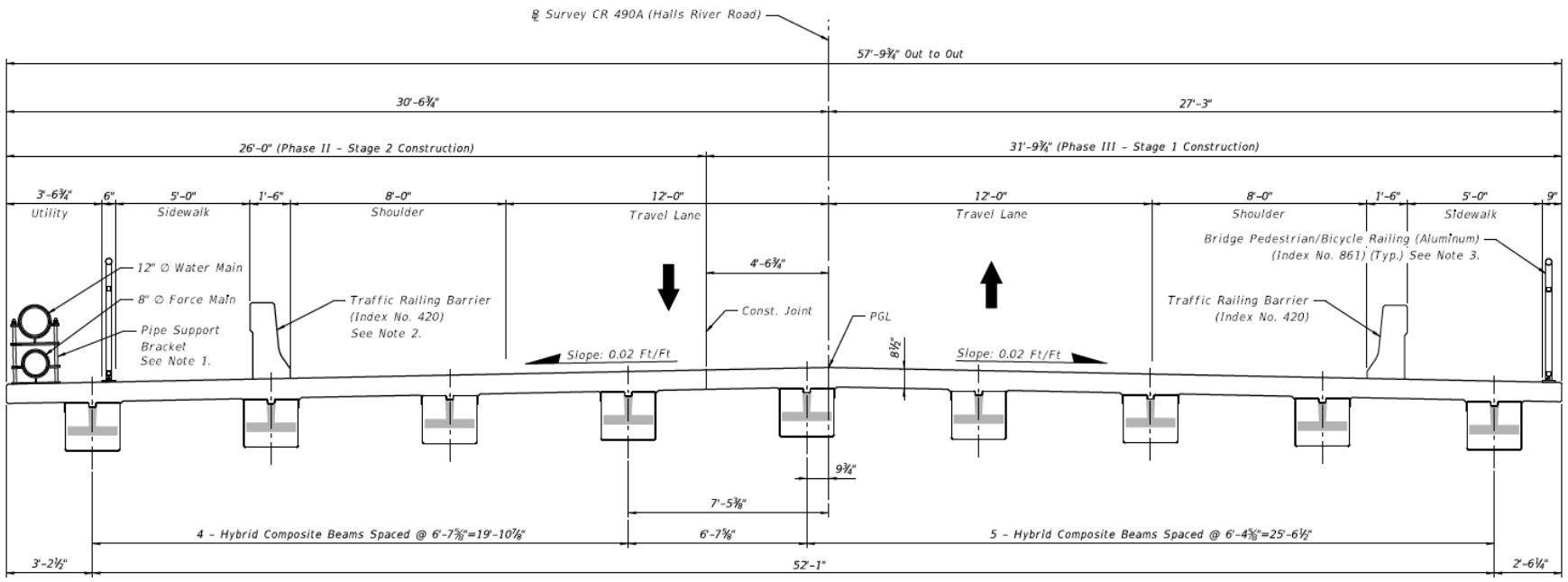
2016 Design Training Expo

PROJECT OVERVIEW



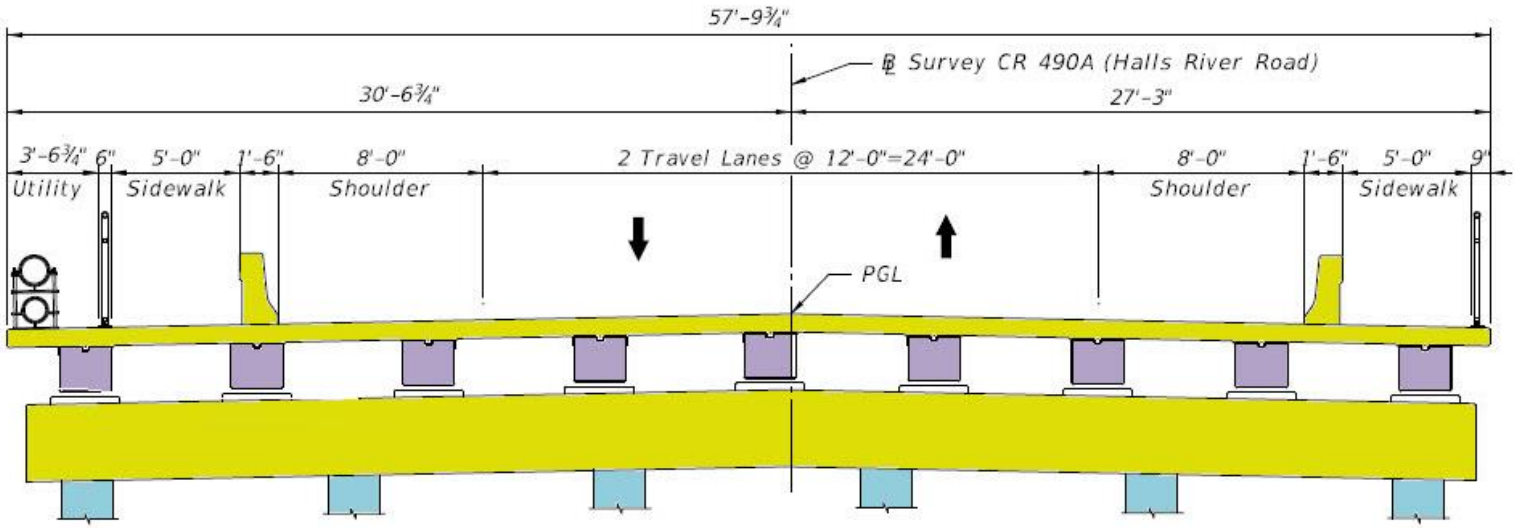
Existing Section

PROJECT OVERVIEW



Proposed Section

PROJECT OVERVIEW

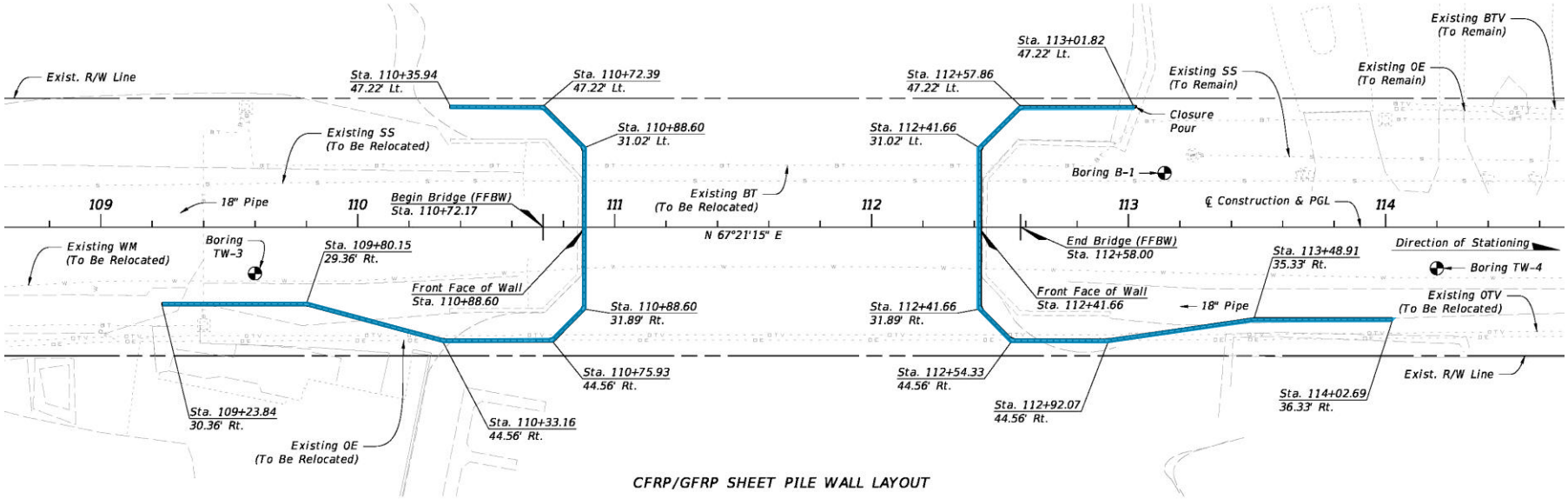


COMPLETED STRUCTURE

PROJECT OVERVIEW

CFRP/GFRP Sheet Pile Walls

Total: 575 LF

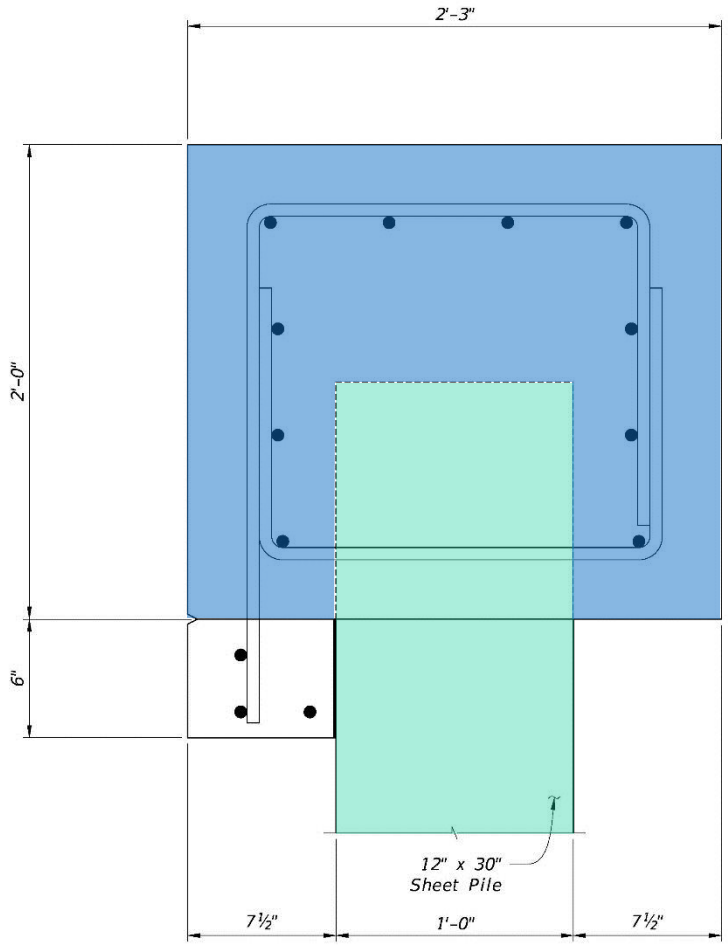


CFRP/GFRP SHEET PILE WALL LAYOUT

2016 Design Training Expo

PROJECT OVERVIEW

CFRP/GFRP Sheet Pile Walls



SECTION A-A

GFRP

CFRP

PROJECT OVERVIEW

Relevant Information

- Demonstration Project - First of its kind in Florida
- Category II Structure - D7 Structures In-house Design

Sole Source Items

- ✓ Hybrid Composite Beam (HCB) - *HC Bridge Company*
- ✓ Carbon Fiber Composite Cable (CFCC) - *Tokyo Rope Mfg. Company Ltd.*

Estimate - Approximately **$6.1 Million** (Overall Project Cost)

- **$3.7 Million – Structures** (Bridge $2.5M / Sheet Pile Walls $1.2M)
- $2.4 Million - Roadway

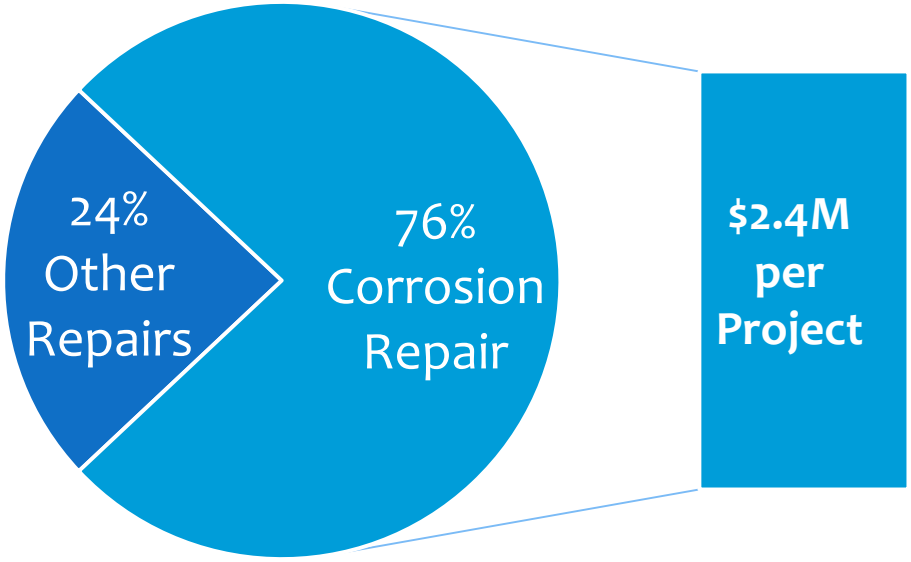
Funding - FHWA

Letting Date: **June 15, 2016**

PROJECT OVERVIEW

Purpose: Why choose an FRP Bridge?

- **Repair Cost of Bridges in District 7 (FY 02/03 to Present)**
- **54 Bridge Projects studied (20 Steel Bridges and 34 Concrete Bridges)**



Source: FDOT D7 District Structures Maintenance Office (DSMO) & T.Y. Lin

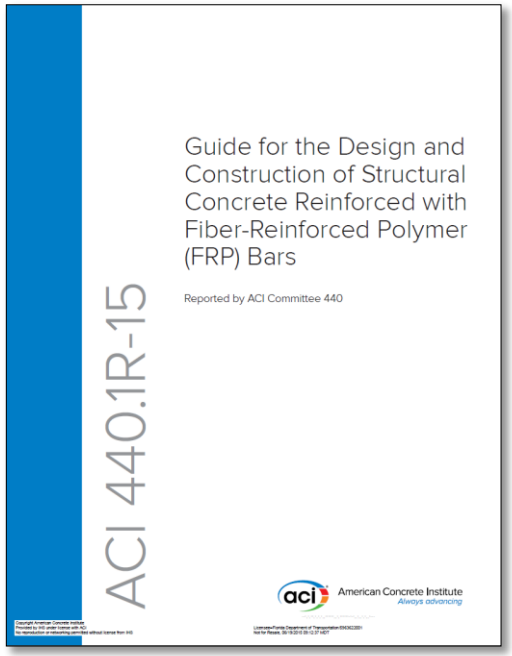
PROJECT OVERVIEW

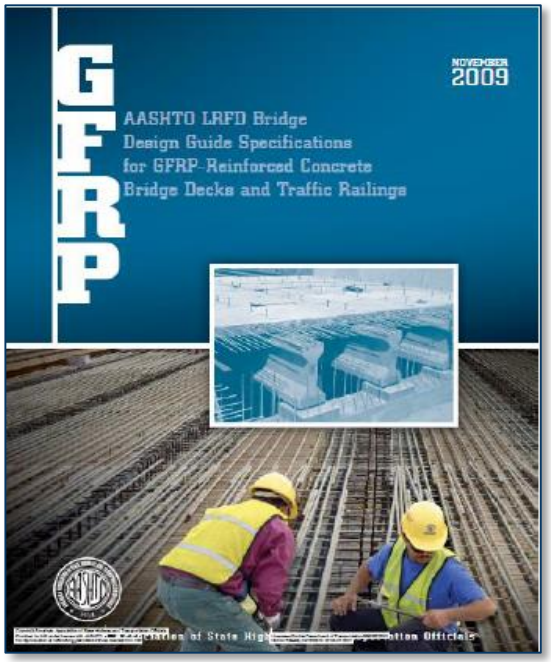
Corrosion Prevention

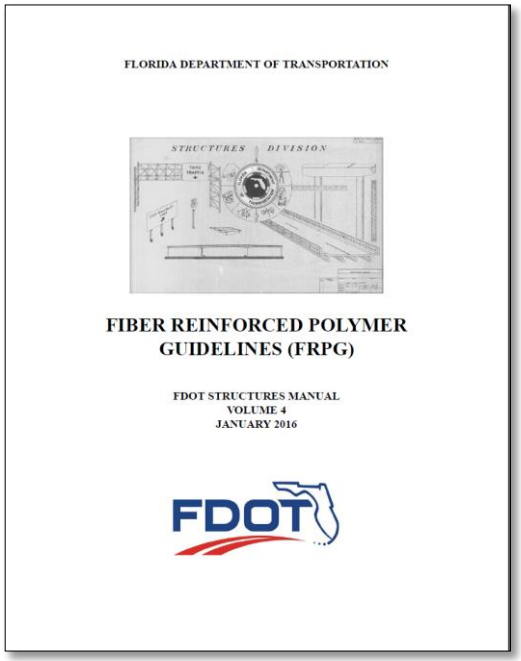
- ✓ Adequate Cover
- ✓ Concrete Quality
- • Alternative Reinforcements →
  - • Glass Fiber Reinforced Polymer (GFRP)
  - • Carbon Fiber Reinforced Polymer (CFRP)
- ✓ Corrosion Inhibiting Admixtures
- • Corrosion Protection of Bridge members
  - • New Construction →
    - • Hybrid Composite Beam (HCB)
  - ✓ Existing Bridge
    - ▪ Pile Jacket
    - ▪ FRP Wrap
    - ▪ Cathodic Protection

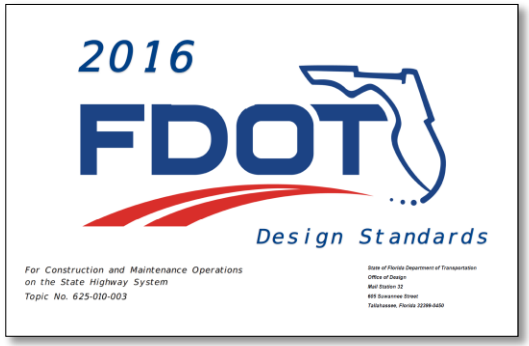
DESIGN

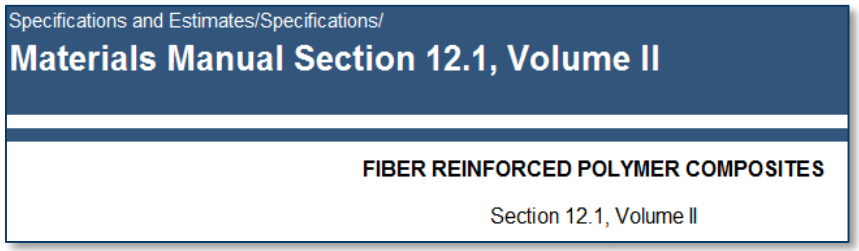
Codes, Standards and References







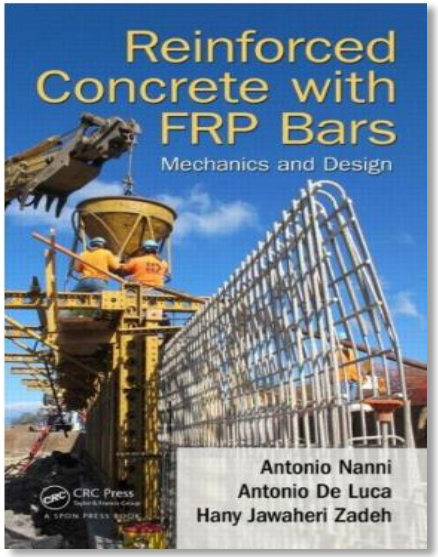




2016 Design Training Expo

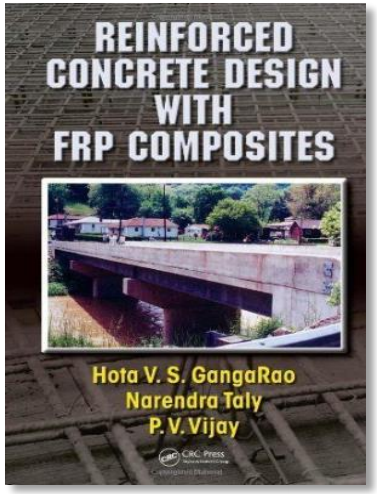
DESIGN

Codes, Standards and References (cont'd)



FDOT Developmental Standards:

- Pultruded FRP Bar Bending Details (D21310)
- 18" CFRP Prestressed Piles (D22618)
- CFRP Prestressed Piles Splices (D22601)
- CFRP/GFRP Sheet Piles Walls (D22440)
- Traffic Railing - GFRP Reinforced (D22420)
- Approach Slab – GFRP Reinforced (D22900)



DESIGN

Hybrid Composite Beam (HCB) – Manuals and References

Hybrid-Composite Beam (HCB®)
Design and Maintenance Manual

RTE 205 (RIDGE RD.)
Over Tide Mill Stream, Westmoreland Co.
State Project No.: 0205-096-101, B601
Federal Aid Project No.: BR-096-6(015)
NBIS No. 27818

Prepared for
The Virginia Department of Transportation

John R. Hillman, PE, SE
HCB, Inc.

TECHNICAL SPECIAL PROVISION

FOR

SECTION T450 - FURNISHING & INSTALLING HYBRID-COMPOSITE BEAMS

FINANCIAL PROJECT ID: 430021-1-52-01

The official record of this Technical Special Provision has been electronically signed and sealed using a Digital Signature as required by Rule 61G 15-23.004, F.A.C. Printed copies of this document are not considered signed and sealed and the signature must be verified on an electronic copies.

Professional Engineer: Mamunur Rashid Siddiqui, P.E.
Date: March 3, 2016
Fla. License No.: 70094
Firm Name: FDOT
Firm Address: 11201 N McKinley Dr.
City: Tampa, State: FL, Zip code: 33612
Certificate of Authorization: N/A.
Pages: 1-13

2016 Design Training Expo

MATERIALS

Hybrid Composite Beam (HCB)

MATERIALS

Fiber Reinforced Polymer (FRP) Reinforcing

So how does it work?

FRP Rebar are made of Fibers embedded in Polymeric Resin

- ✓ Fibers provide strength and durability
- ✓ Resin holds fibers together, transfers load between fibers and protects from abrasion/environment

MATERIALS

Fiber Reinforced Polymer (FRP) Reinforcing

Pros:

- Corrosion Resistance
- High Strength
- Lightweight
- Fatigue Endurance

Cons:

- High Initial Cost
- Brittle Failure

MATERIALS

Cost Comparison

#6 Steel Rebar : **$ 1.40 / ft**

#6 GFRP Rebar : **$ 1.60 / ft**

Steel Bars

GFRP Bars

MATERIALS

Cost Comparison

Precast Prestressed Concrete Piles

- 18” Steel Reinforced : **$ 80 / ft**
- 18” CFRP Reinforced : **$ 122 / ft**

Prestressed Concrete Piles

Precast Prestressed Sheet Piles

- 12”x30” Steel Reinforced : **$ 120 / ft**
- 12”x30” CFRP Reinforced : **$ 144 / ft**

Prestressed Sheet Piles

MATERIALS

Cost Comparison

Prestressed Slab Beams

$ 300 / ft

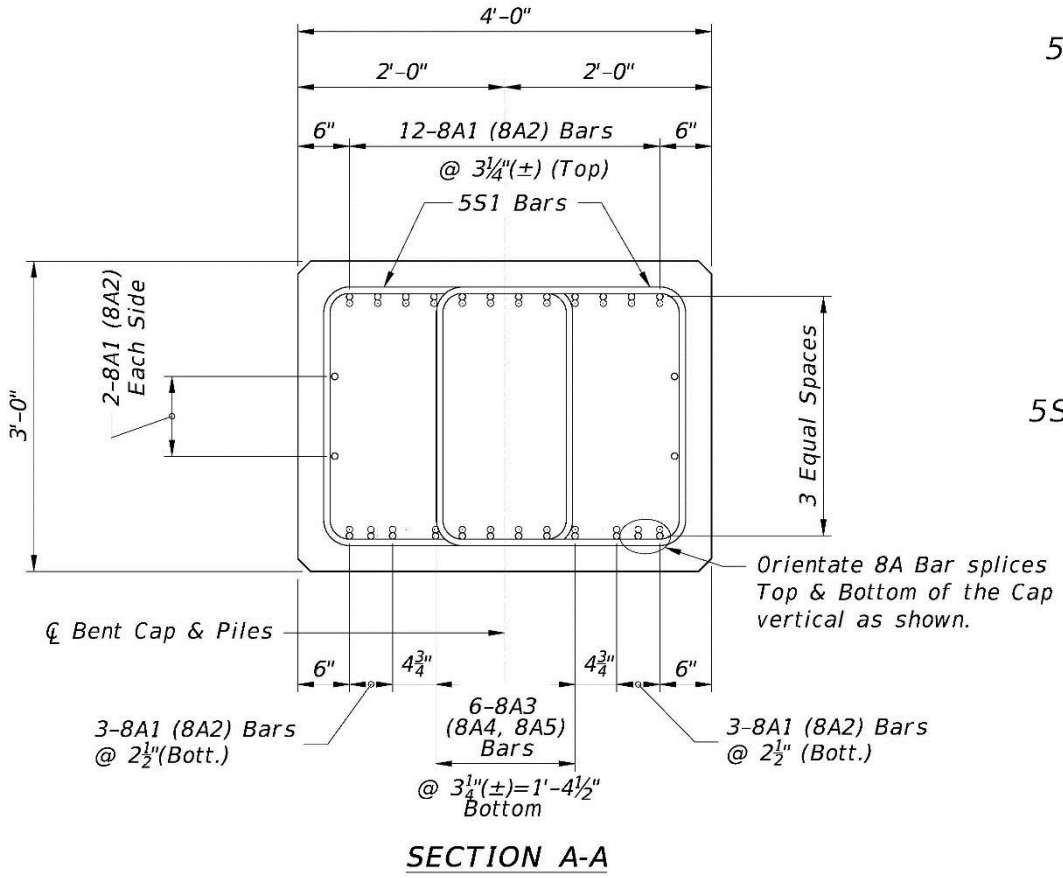
Hybrid Composite Beams

$ 428 / ft

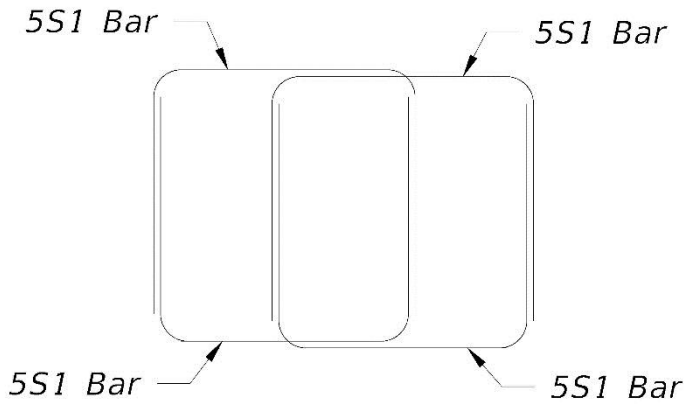
DETAILS

GFRP Bar Detailing Tips

- Bar Splices – no mechanical coupling
- U-Shape Stirrups – no closed stirrups



SECTION A-A



5S1 BARS

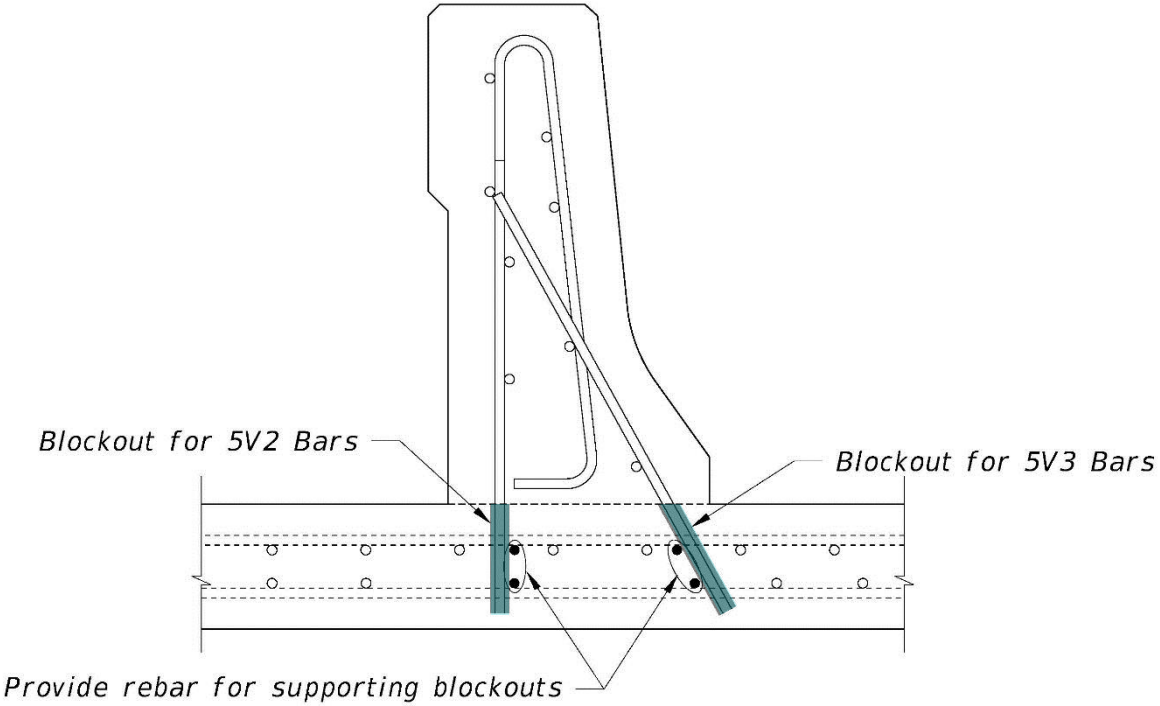
Schematic Layout

2016 Design Training Expo

DETAILS

GFRP Barrier Reinforcement

Post Installed for Phase Construction



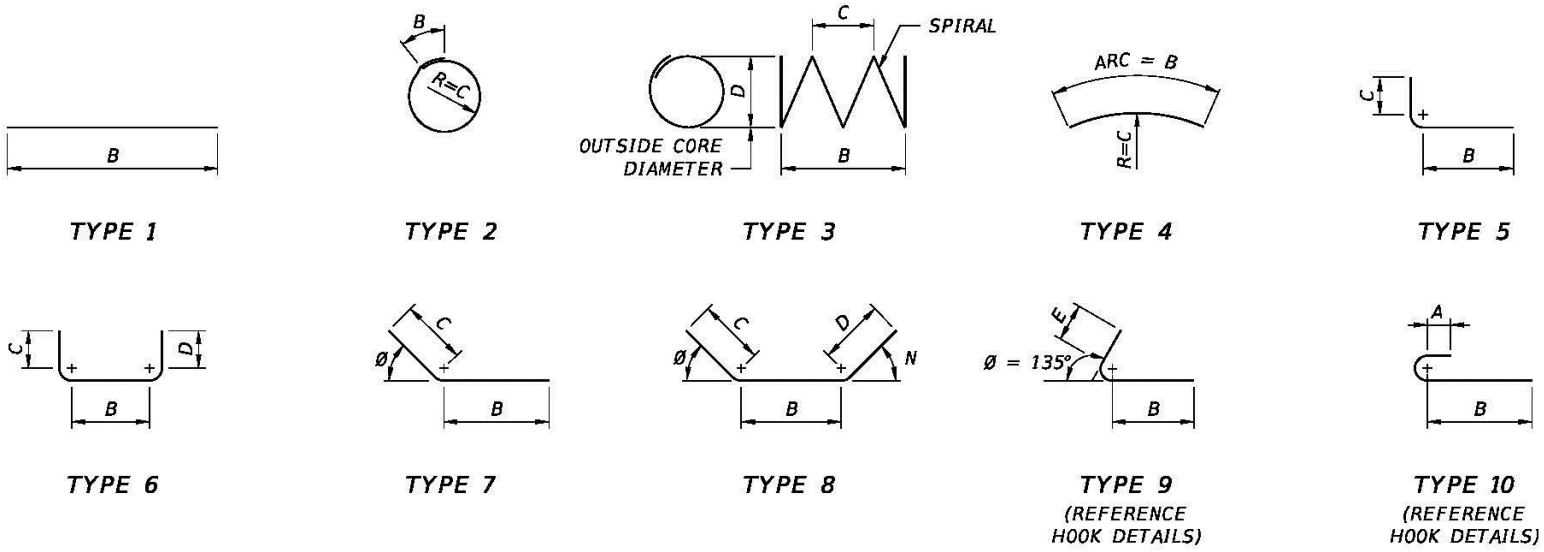
TYPICAL SECTION THRU TRAFFIC RAILING
PHASE II CONSTRUCTION

DETAILS

Developmental Standard D21310 – Pultruded FRP Bar Bending Details

Industry Standards

- Tangent Lengths
- Limited Shapes



SINGLE BAR BENDING DETAILS

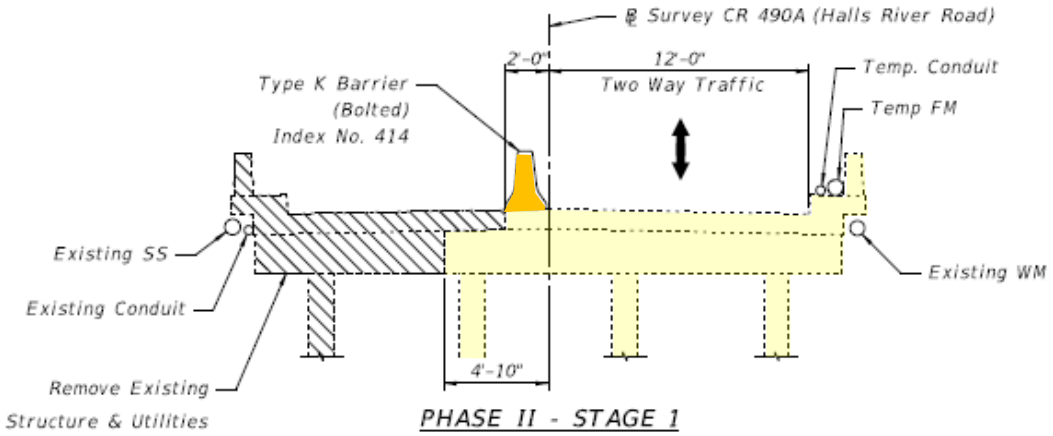
DETAILS

FRP Reinforcing Pay Items & Quantities

- Pay Item for each size of FRP Reinforcement
- Units: Linear Feet

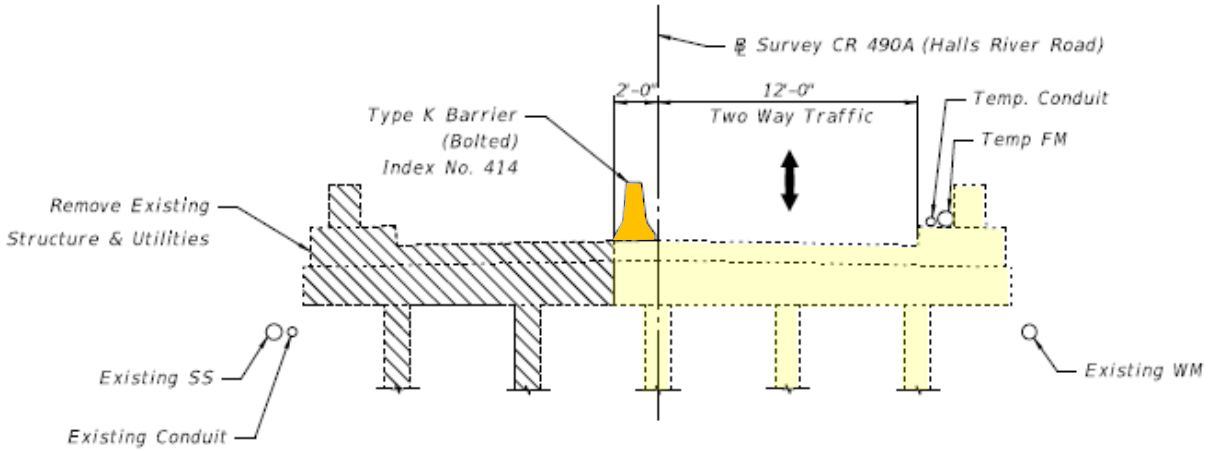
SUBSTRUCTURE	914 415 104	Fiber Reinforced Polymer Reinforcing (#4 GFRP Bar)
	914 415 105	Fiber Reinforced Polymer Reinforcing (#5 GFRP Bar)
	914 415 106	Fiber Reinforced Polymer Reinforcing (#6 GFRP Bar)
	914 415 108	Fiber Reinforced Polymer Reinforcing (#8 GFRP Bar)

CONSTRUCTION



PHASE II - STAGE 1

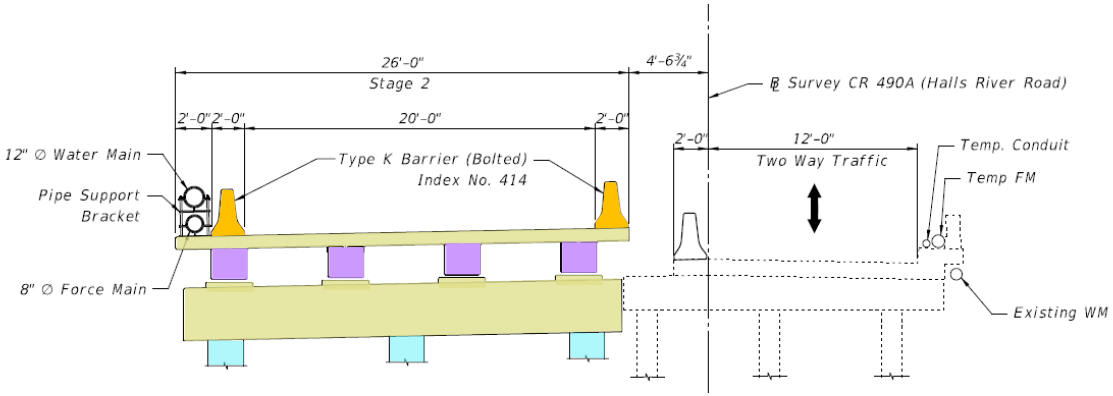
EXISTING STRUCTURE REMOVAL (INTERMEDIATE BENTS)



PHASE II - STAGE 1

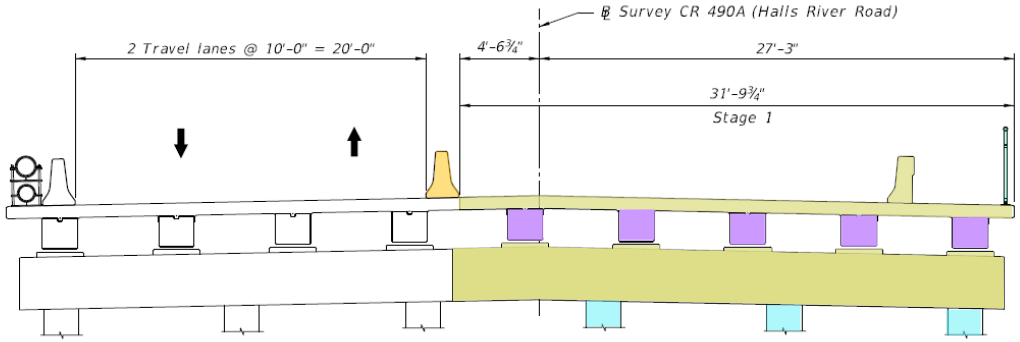
2016 Design Training Expo

CONSTRUCTION



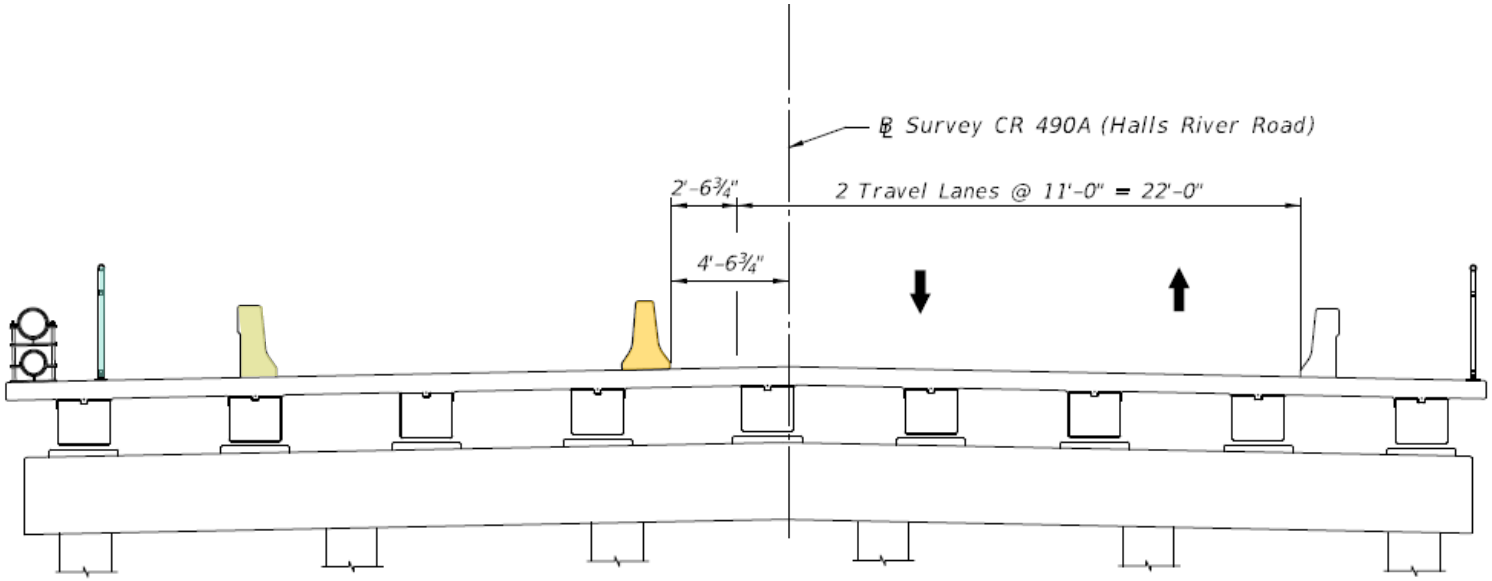
PHASE II - STAGE 2

(Intermediate Bent Shown, End Bent Similar)



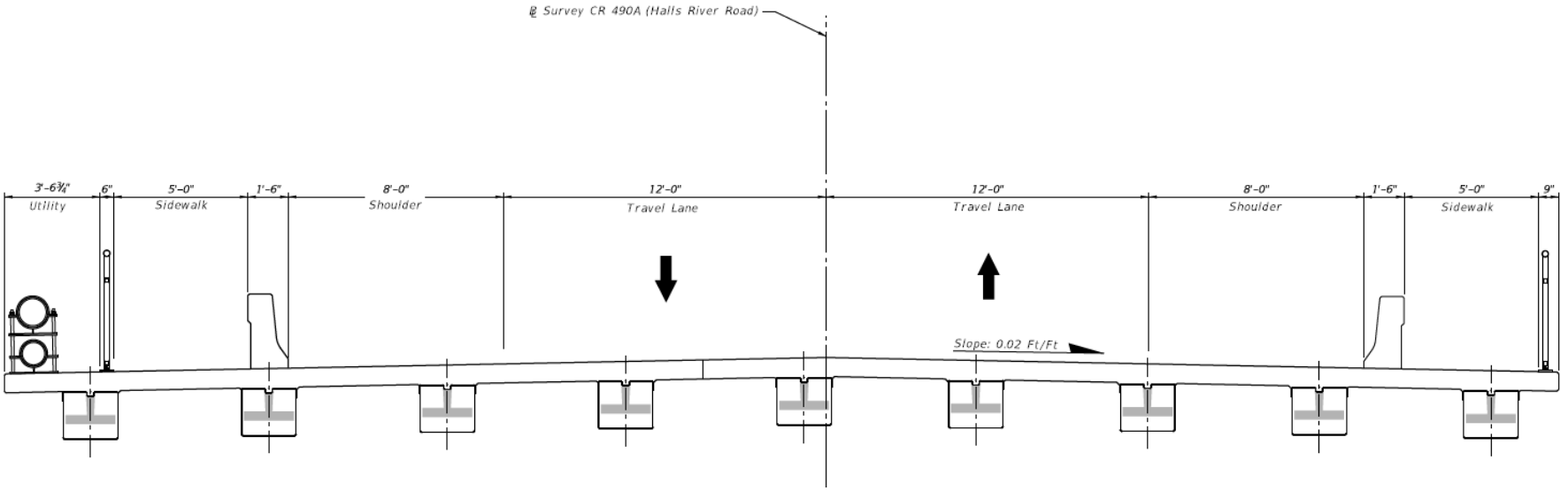
PHASE III - STAGE 1

CONSTRUCTION



PHASE III - STAGE 2

CONSTRUCTION



COMPLETED BRIDGE SECTION

2016 Design Training Expo

CONSTRUCTION

Hybrid Composite Beam – *Fabrication*

HYBRID COMPOSITE BEAMS

STANDARD CONCRETE BEAMS

CONSTRUCTION

Hybrid Composite Beam – *Handling and Storage*

HYBRID COMPOSITE BEAMS

STANDARD CONCRETE BEAMS

CONSTRUCTION

Hybrid Composite Beam – *Transportation*

HYBRID COMPOSITE BEAMS
Union St., Maine
(4 - 70 ft. beams @ 9 kips = 36 kips total)

PRESTRESSED SLAB BEAMS
Gospel Island, Florida
(2 – 39 ft. beams @ 25 kips = 50 kips total)

CONSTRUCTION

Hybrid Composite Beam – *Installation*

HYBRID COMPOSITE BEAMS

PRESTRESSED SLAB BEAMS

CONSTRUCTION

FRP Rebar

FRP Bars are vulnerable to surface damage

Checklist: Handling and Storage of FRP Rebars	
☑	Store bars in a clean environment
	Protect bars against:
☑	- UV radiation
☑	- High temperature
☑	- Damaging chemicals
☑	Lift bundles of bars with care
☑	Do not shear bars when cutting
SAFETY*	Work gloves should be worn at all times

* In addition to typical safety precautions and procedures

CONSTRUCTION

CFRP Prestressed Piles

- FDOT Research
  - Lab Testing
  - Field Testing
- Production
  - Similar to Conventional Piles
  - Handling of CFRP
- Installation
  - Diving Method and Behavior similar to Conventional Piles
- Performance
  - Strength and Capacity similar to Conventional Piles

MONITORING

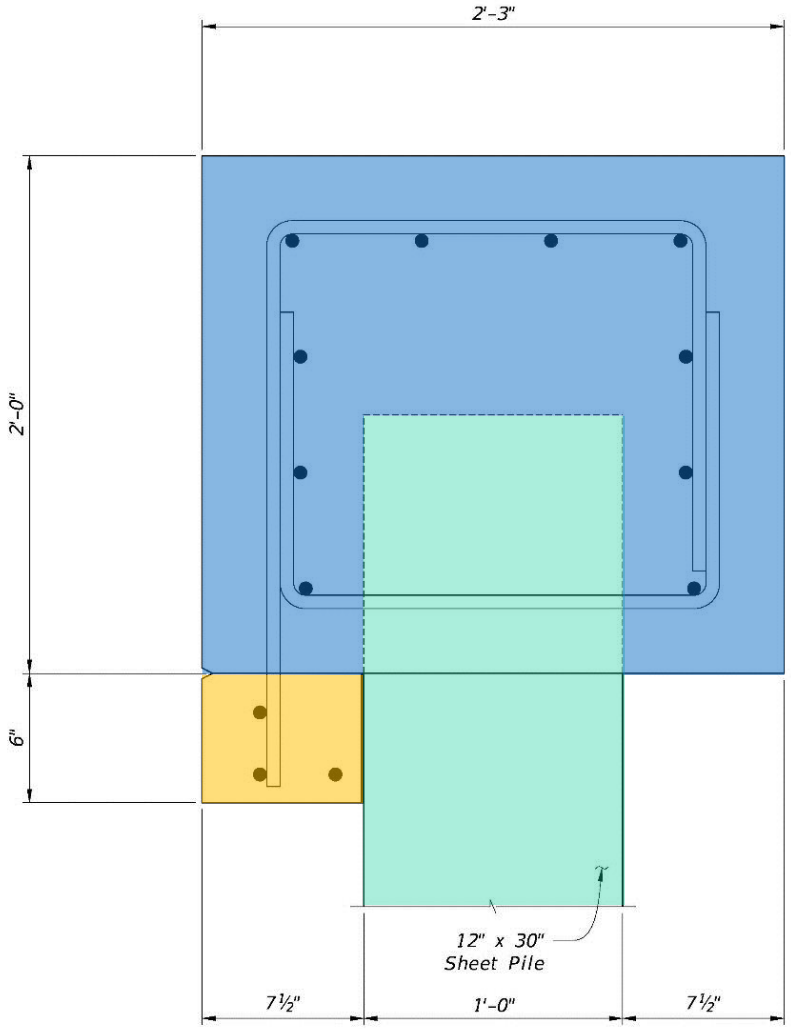
- **3rd Party Monitoring**
  - HCB Beams
  - CFRP & GFRP Reinforcement
- **Monitoring Phases**
  - Fabrication
  - Construction
  - Performance (6 months, 1 & 2 Years - Post Construction)
- **Test Blocks**
  - Sheet Pile Wall Cap
  - 3 Composite Materials
- **Load Test**

MONITORING

Test Blocks

Materials

- CFRP
- GFRP
- Basalt



SECTION A-A

GFRP

CFRP

Test Block

SUMMARY

- **Demonstration Project with Innovative Materials –** First in Florida
  - ✓Superstructure: Hybrid Composite Beams; GFRP Bars: Deck, Barriers & Approach Slabs
  - ✓Substructure: CFRP Prestressed Piles; Bent Caps: GFRP Bars
  - ✓Sheet Pile Walls: CFRP/GFRP Sheet Piles; Wall Cap: GFRP Bars
- **Estimated Project Cost - $6.1 Million (Structures = $3.7 Million)**
  - Bridge Cost = **$221 / sq. ft.**
    (Conventional Construction = **$166 / sq. ft.**)
- **Accelerated Construction**
  - Lighter Materials – Beams and Rebar
  - Faster Transportation and Delivery – reduced construction time

QUESTIONS