2017 International Bridge Conference
Technical Workshop W-06: FRP Composites

Halls River Bridge Replacement Project
Corrosion Free Design with FRP Composites

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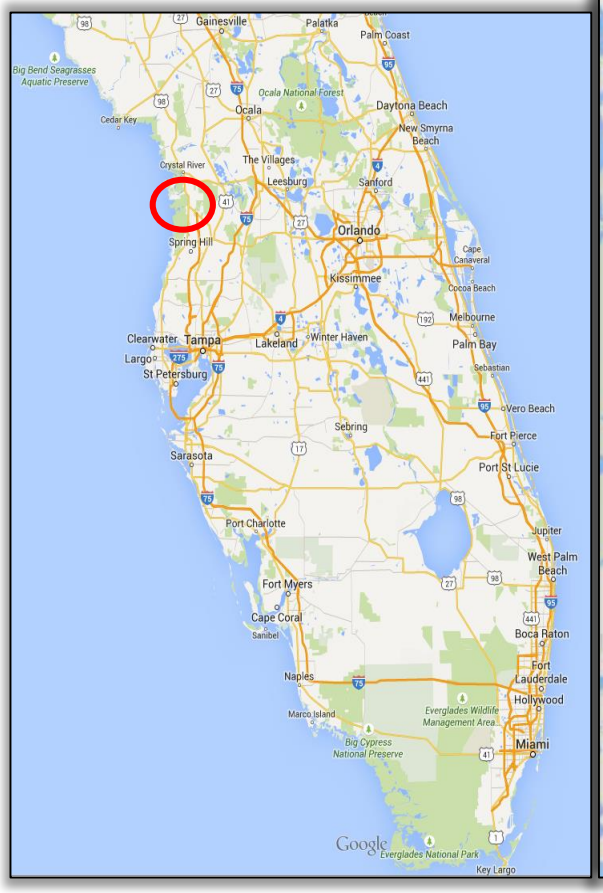
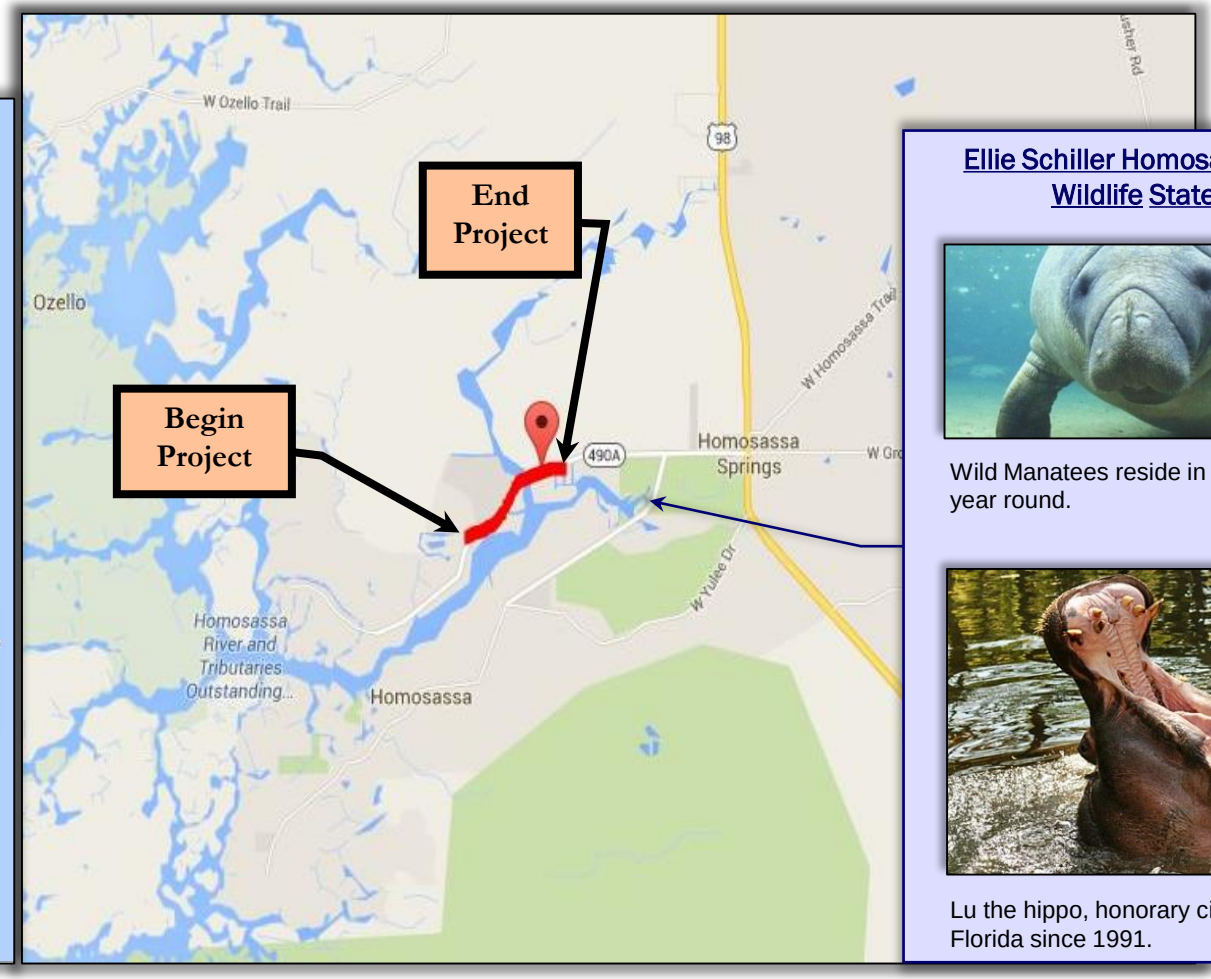
Outline:

1. Project Overview
2. FRP Materials
3. References, Codes and Specifications
4. Challenges
5. Lessons Learned

1. Project Overview

Project Overview





[Ellie Schiller Homosassa Springs Wildlife State Park]

Wild Manatees reside in the park year round.

Lu the hippo, honorary citizen of Florida since 1991.

Project Overview

Designer: FDOT District 7 Structures Design Office

Bridge EOR: Mamunur Siddiqui, P.E.

Bulkhead/Seawall EOR: Richard Hunter, P.E. (ACE)

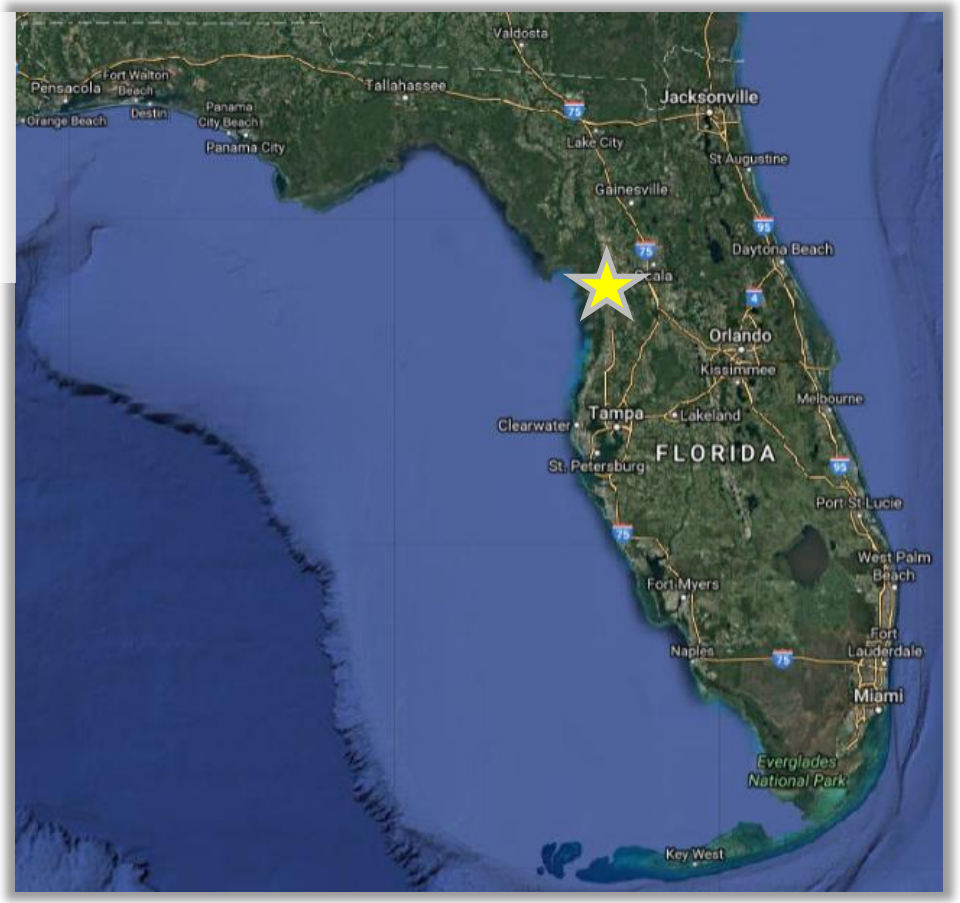
FDOT Developmental Standards EOR: Steven Nolan, P.E.

Owner & Maintaining Agency

Design & Bi-Annual Inspection

Collaboration Research

Funding & Oversight



Project Overview

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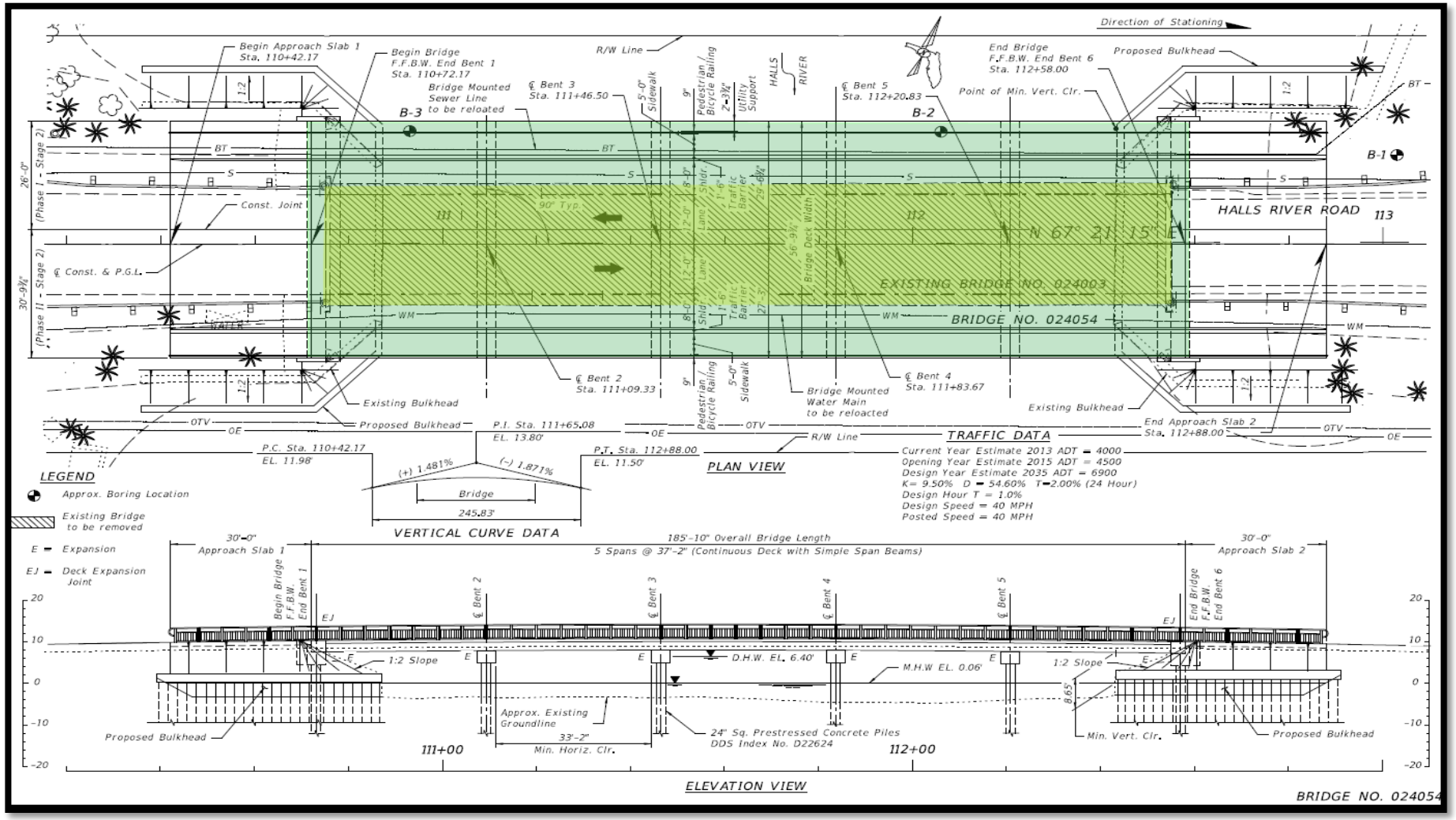
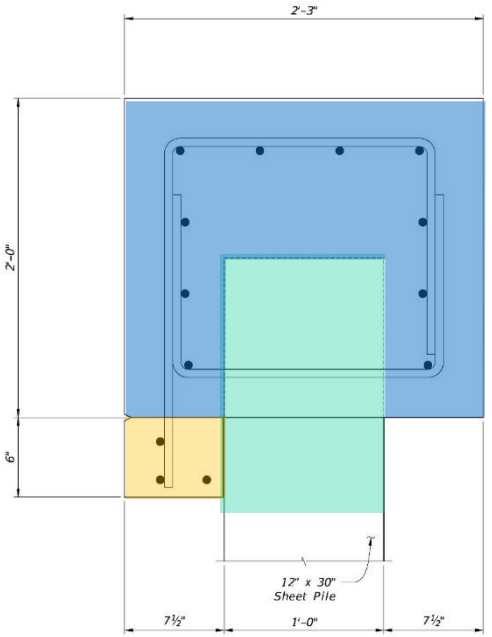


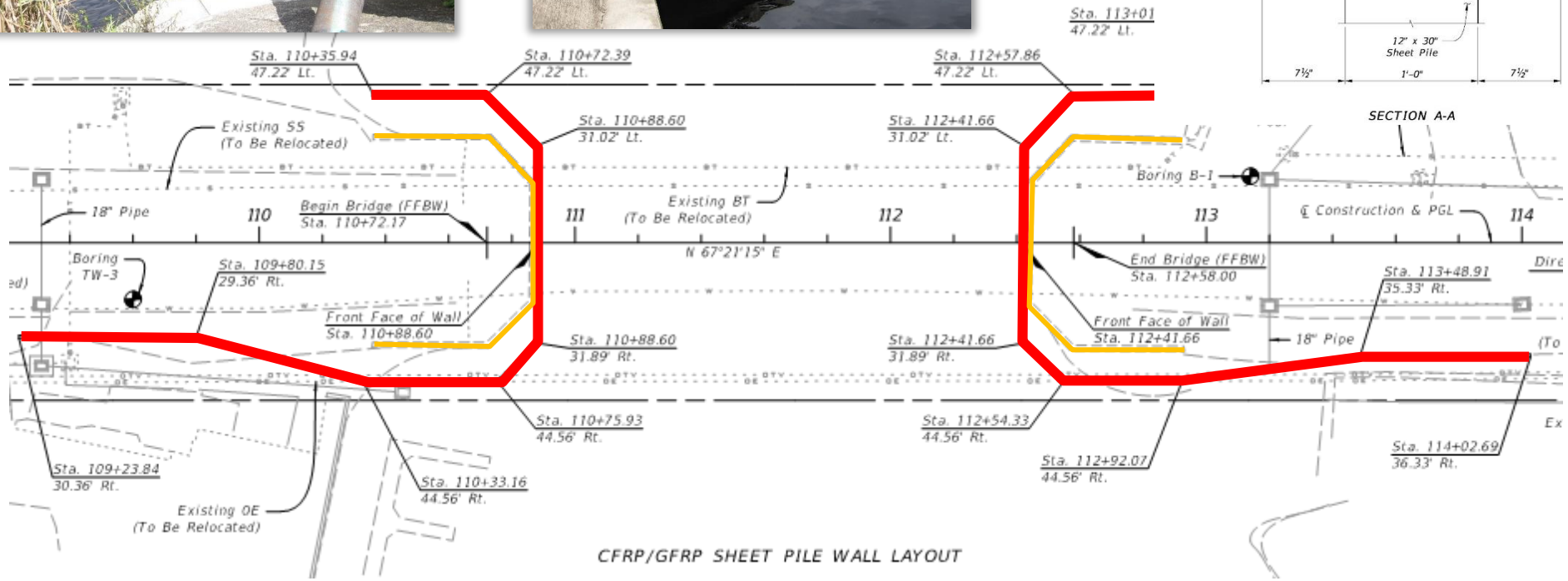
Project Overview



GFRP

CFCC

Test Block

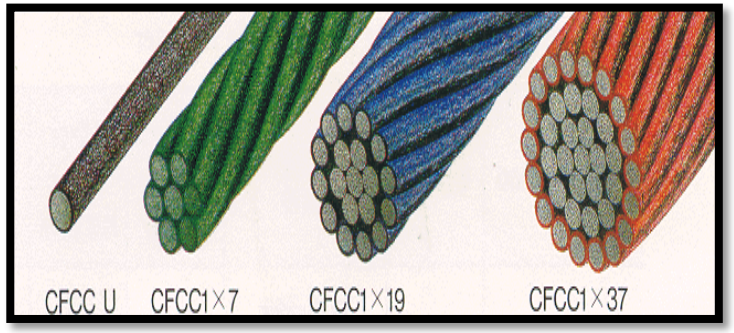


2. FRP Materials

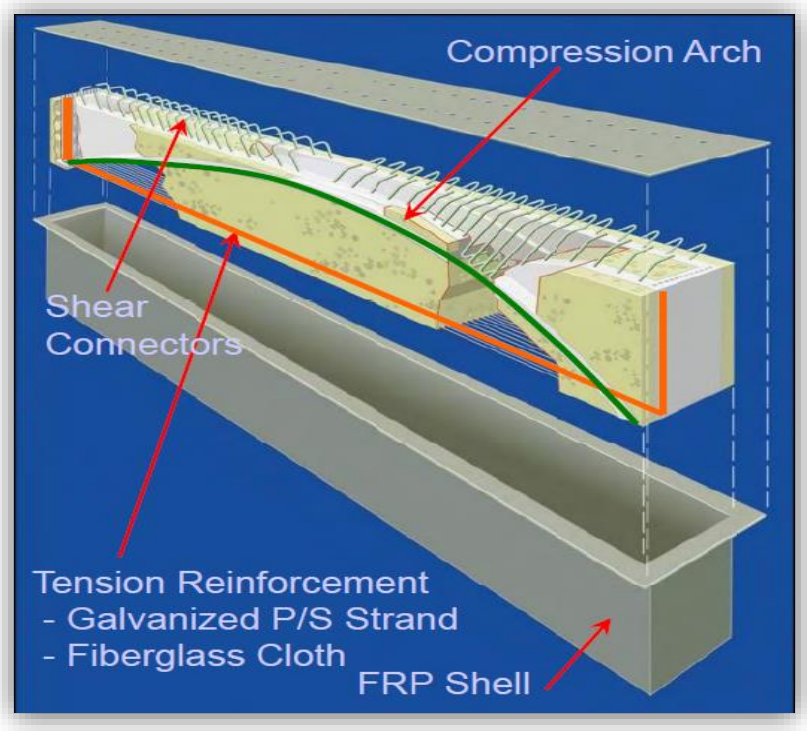
FRP Materials

Glass Fiber Reinforced (GFRP) Bars

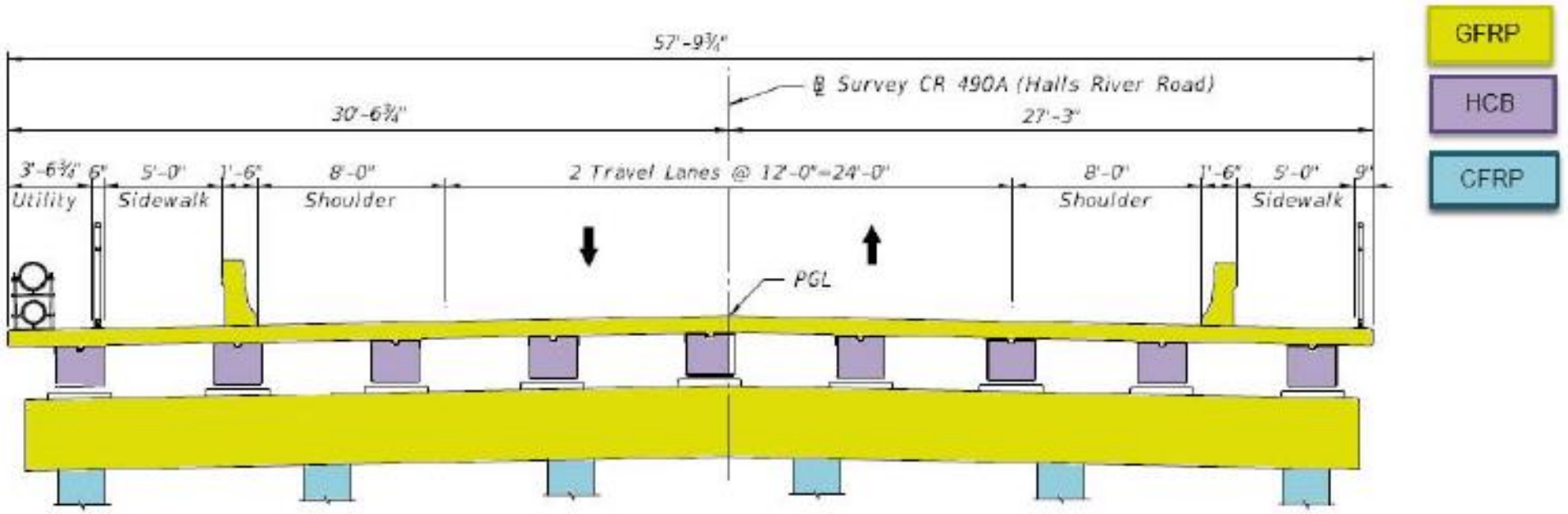
Carbon Fiber Composite Cable (CFCC)



Hybrid Composite Beam (HCB)



FRP Materials



COMPLETED STRUCTURE

FRP Materials

HCB Components

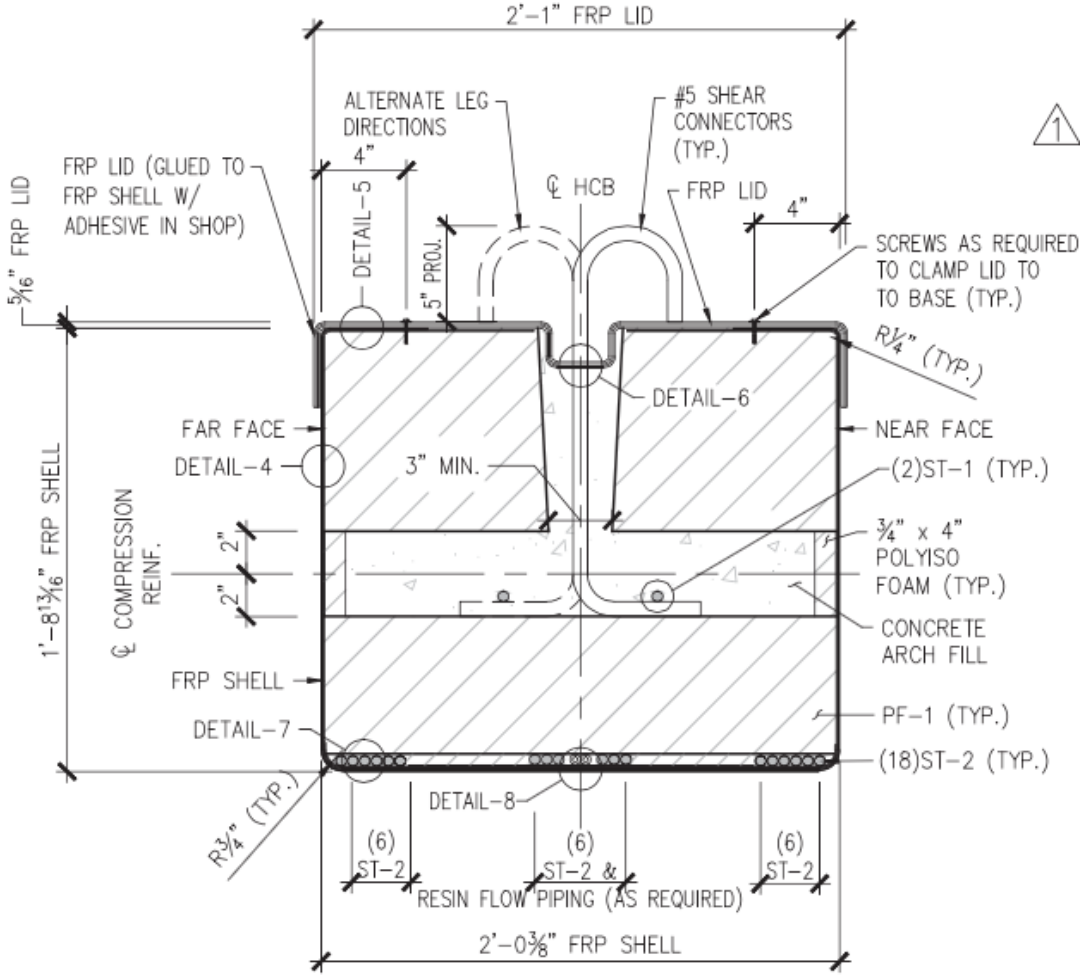
i. Wings vs. No Wings

ii. Concrete Compression Arch

iii. Shell

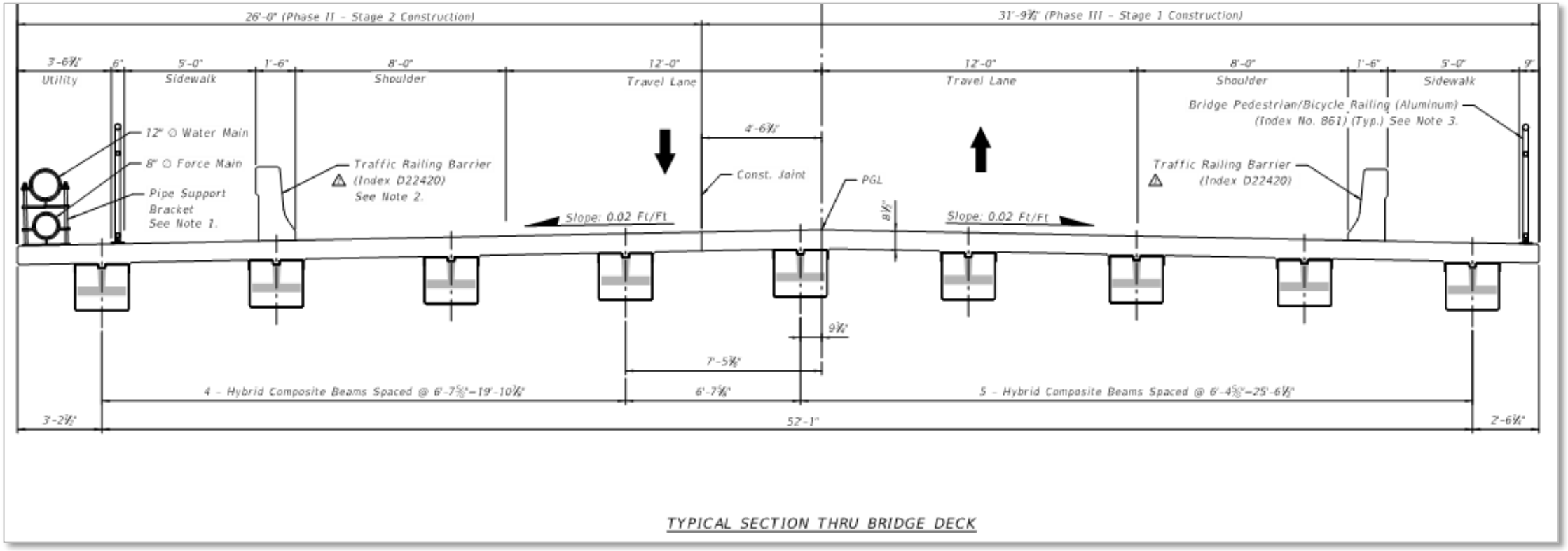
iv. Strands

v. Shear connectors



FRP Materials

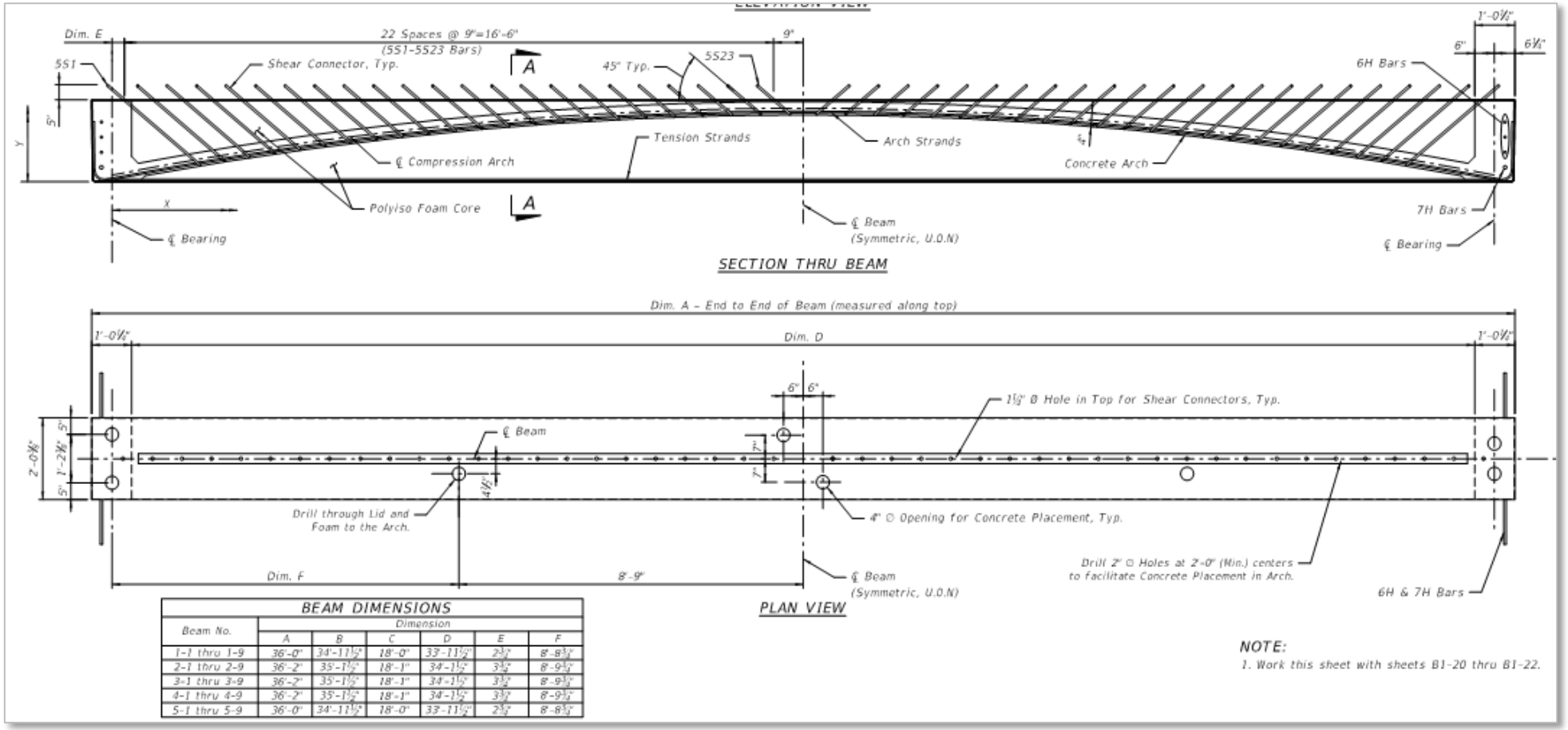
HCB Plan details:



TYPICAL SECTION THRU BRIDGE DECK

FRP Materials

HCB Plan details (cont.):



BEAM DIMENSIONS

Beam No.	Dimension					
	A	B	C	D	E	F
1-1 thru 1-9	36'-0"	34'-11½"	18'-0"	33'-11½"	2½"	8'-8¾"
2-1 thru 2-9	36'-2"	35'-1½"	18'-1"	34'-1½"	3¾"	8'-9¾"
3-1 thru 3-9	36'-2"	35'-1½"	18'-1"	34'-1½"	3¾"	8'-9¾"
4-1 thru 4-9	36'-2"	35'-1½"	18'-1"	34'-1½"	3¾"	8'-9¾"
5-1 thru 5-9	36'-0"	34'-11½"	18'-0"	33'-11½"	2½"	8'-8¾"

NOTE:

1. Work this sheet with sheets B1-20 thru B1-22.

FRP Materials

FRP Materials

Projects with HCB

Source: HCB, Inc.

FRP Materials

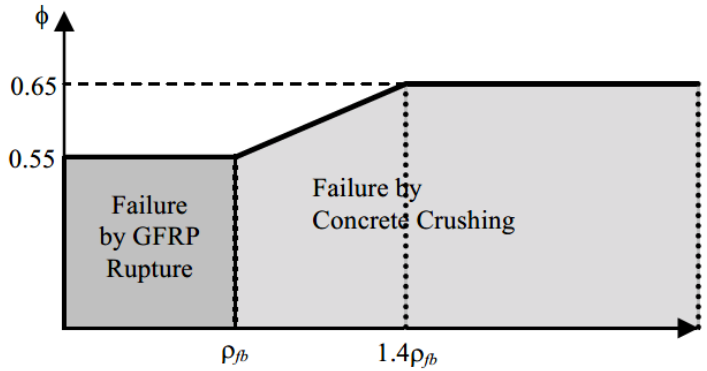
Design – Glass Fiber Reinforced Polymer Rebar:

i. General

a. Modulus of elasticity: E_f = 6500 ksi

b. Resistance factors:

- Flexure and Tension: ϕ_f = 0.55 to 0.65
- Shear and Torsion: ϕ_v = 0.75



ii. Principles

a. Equilibrium, Compatibility of Strains, Stress-Strain characteristics.

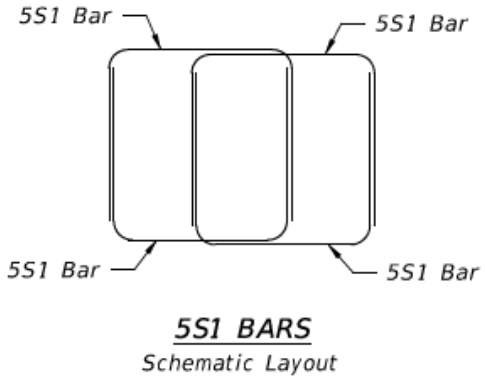
b. Crack width, Bond factor, Minimum reinforcement.

FRP Materials

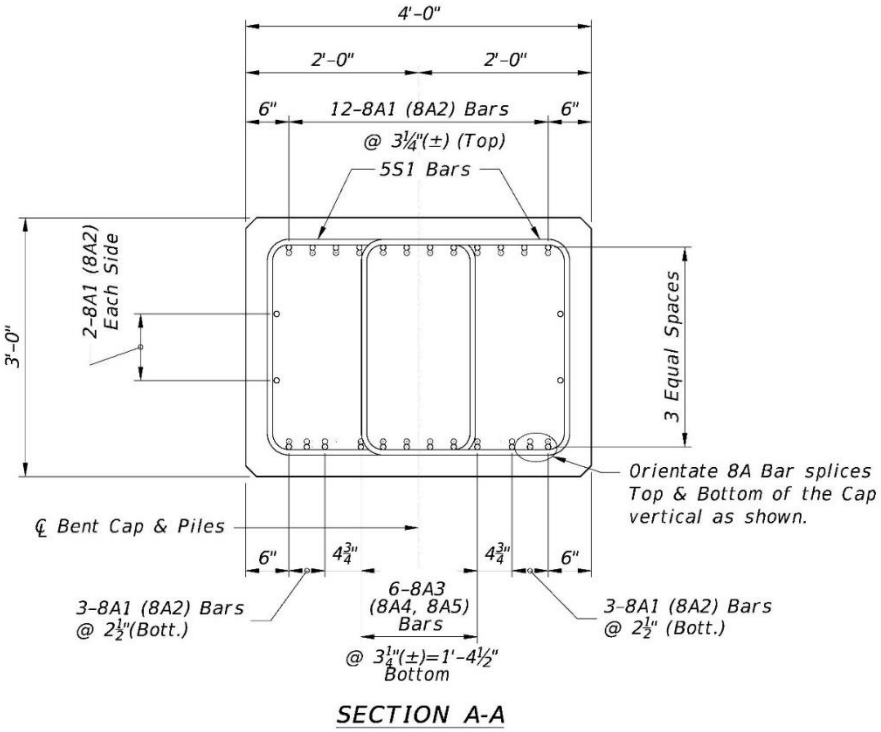
Design – Glass Fiber Reinforced Polymer Rebar (cont.):

iii. Failure Mode
   a. Catastrophic Failure.
   b. Margin of Safety.

iv. Challenges
   a. Crack Control.
   b. Deck Shear.
   c. Traffic Railing.
   d. Bar Detailing.



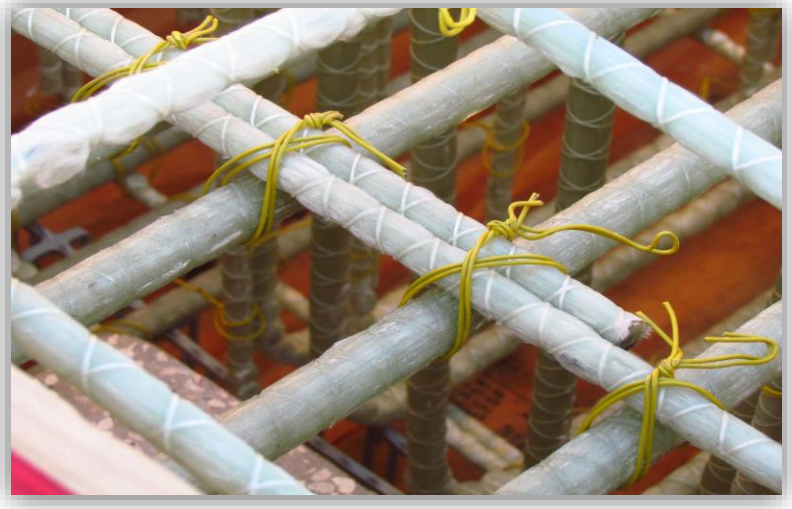
5S1 BARS
Schematic Layout



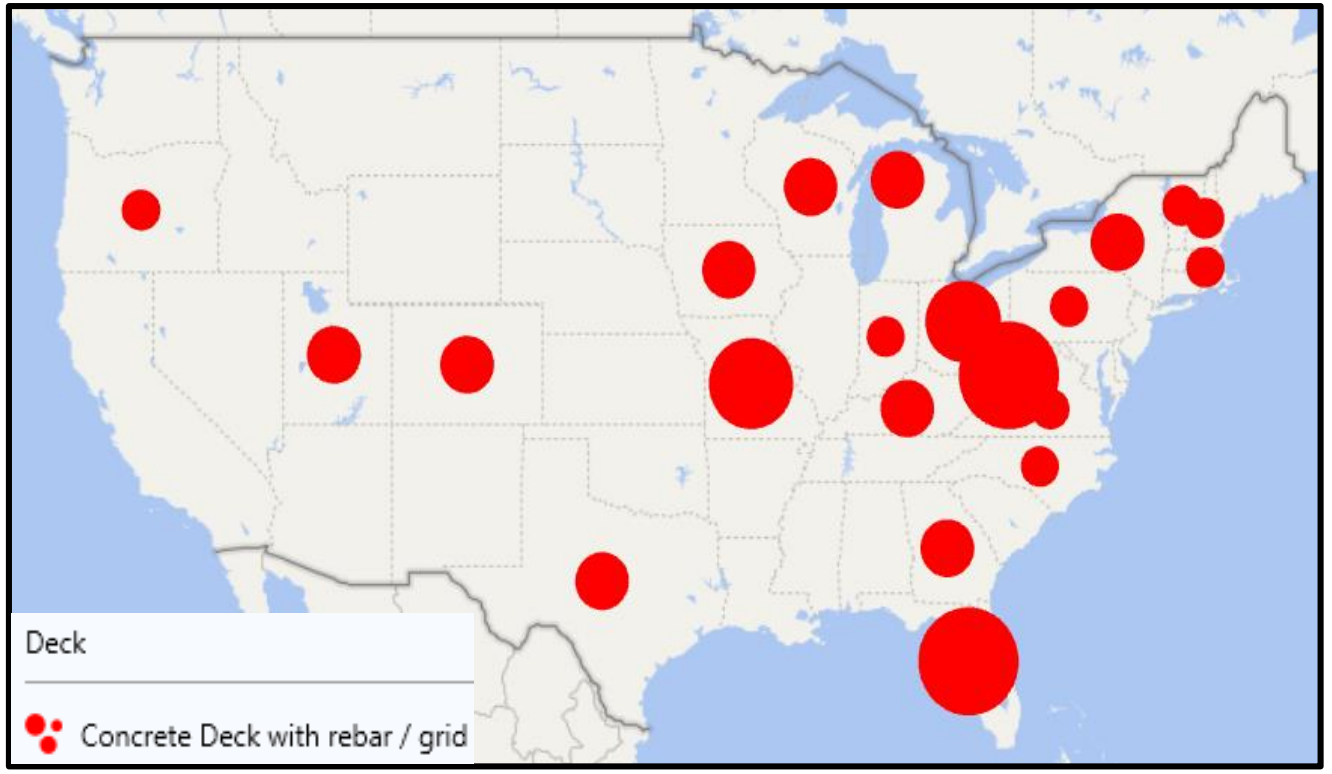
SECTION A-A

Bent Cap Plan Sheet Details:

FRP Materials



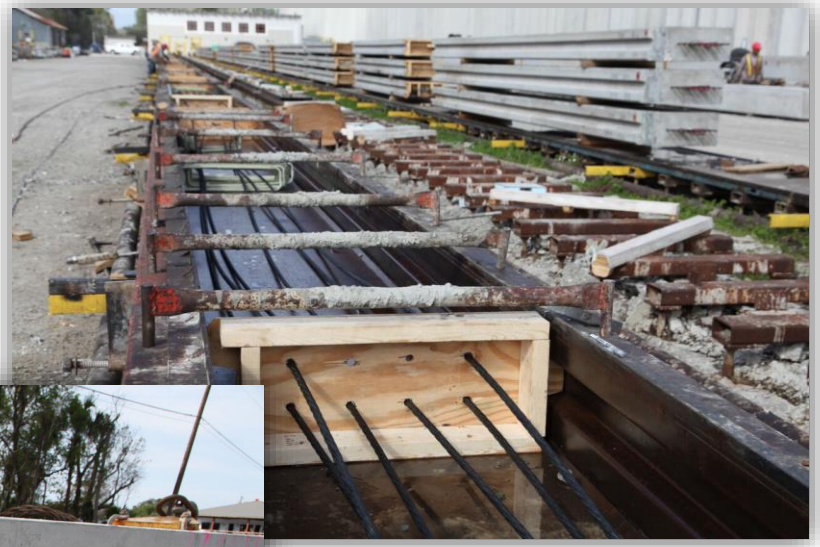
FRP Materials



Source: University of Miami

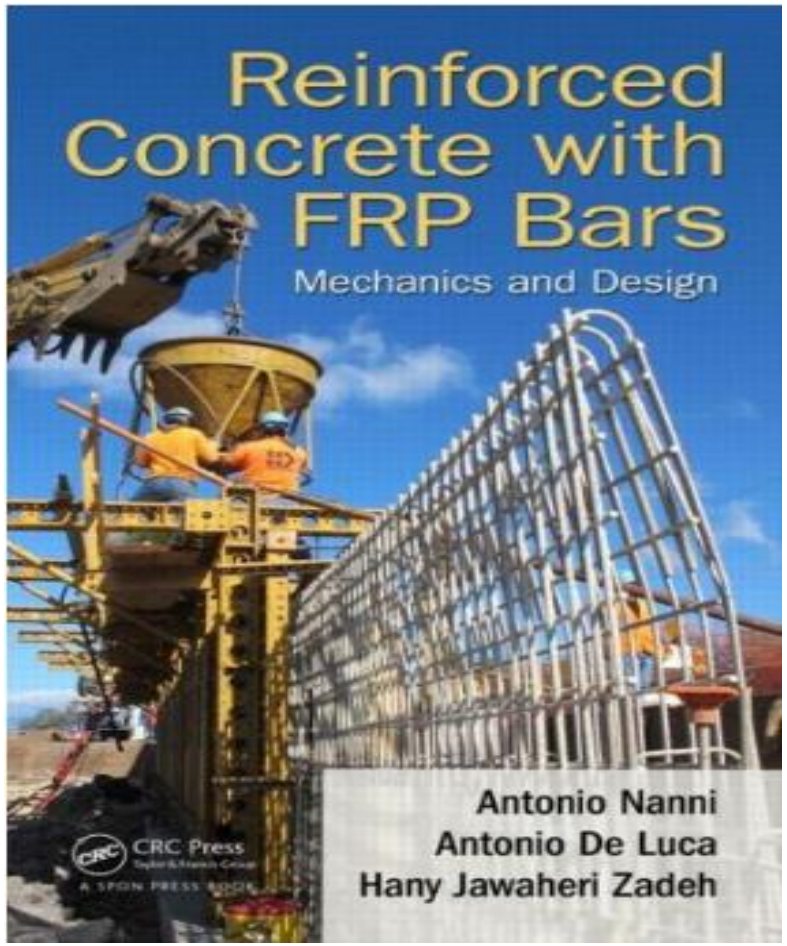
Projects with GFRP Reinforcement

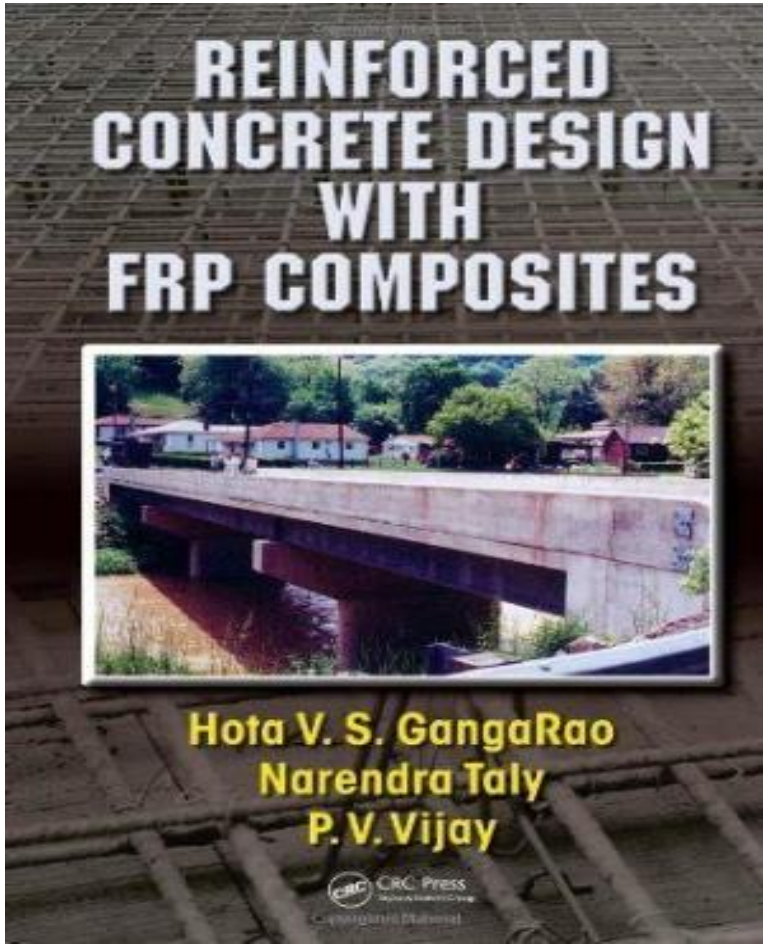
FRP Materials

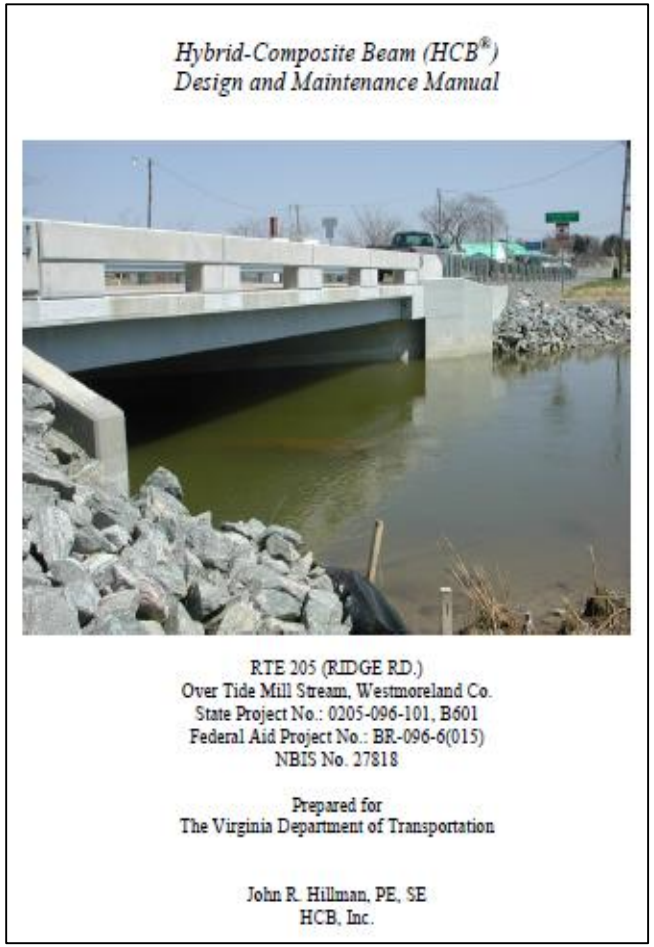


3. References, Codes and Specifications

References, Codes and Specifications







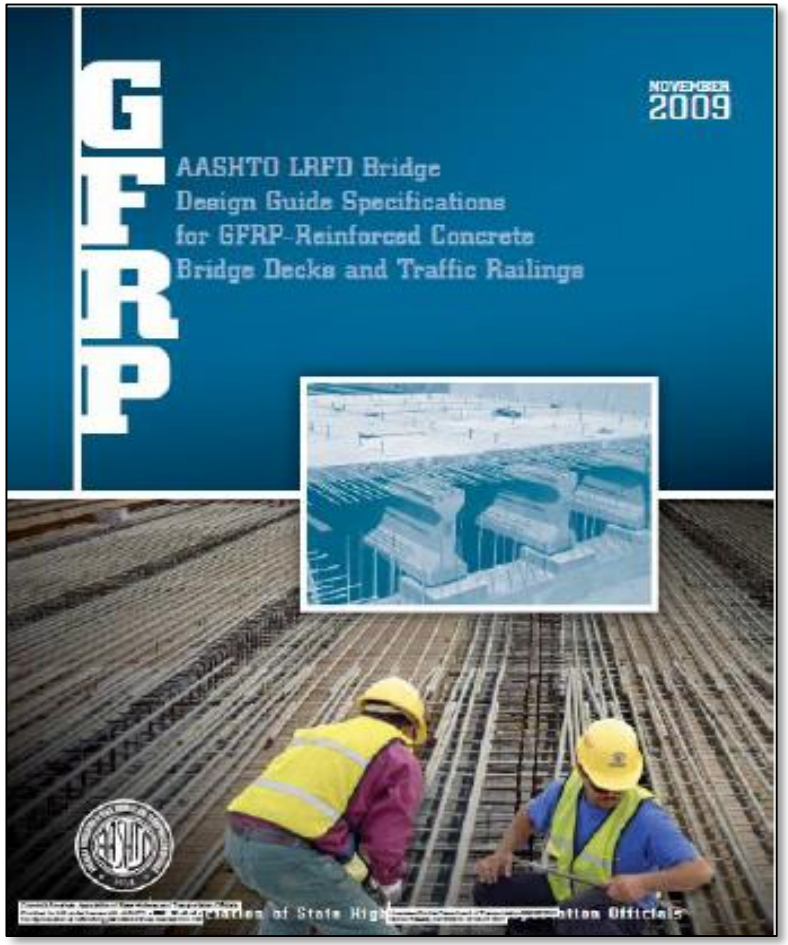
Hybrid-Composite Beam (HCB®)
Design and Maintenance Manual

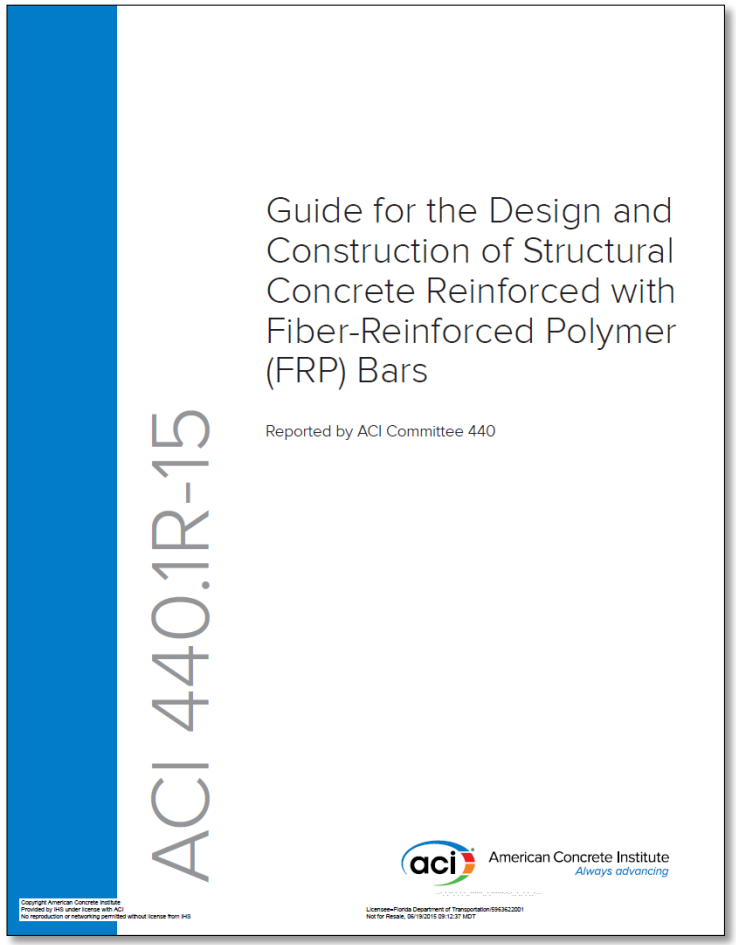
RTE 205 (RIDGE RD.)
Over Tide Mill Stream, Westmoreland Co.
State Project No.: 0205-096-101, B601
Federal Aid Project No.: BR-096-6(015)
NBIS No. 27818

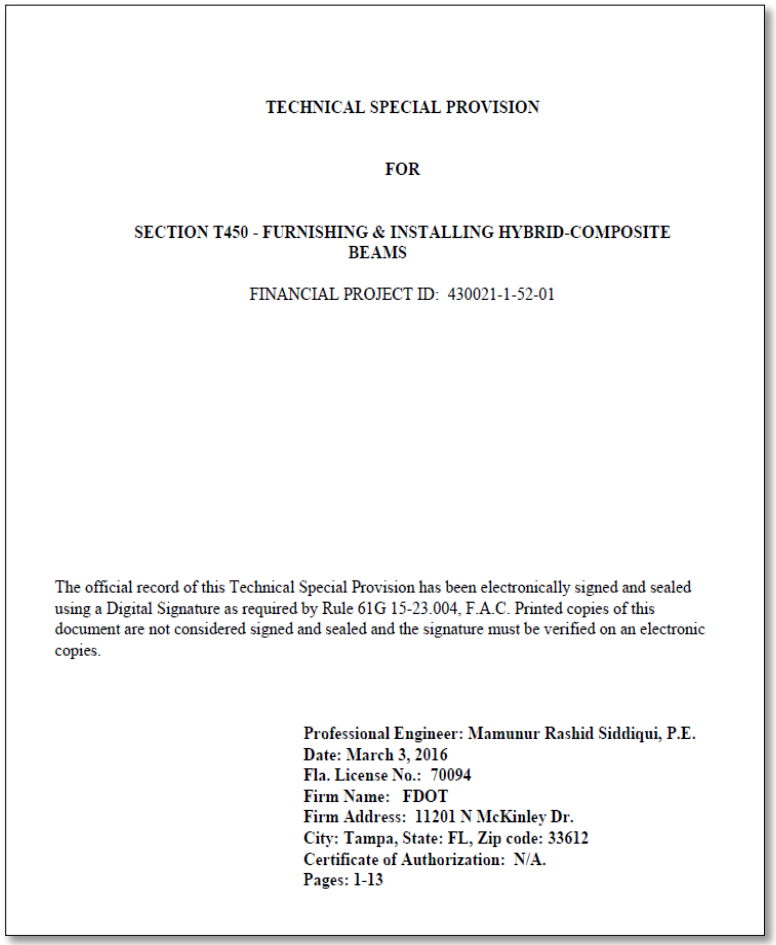
Prepared for
The Virginia Department of Transportation

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

References, Codes and Specifications







TECHNICAL SPECIAL PROVISION

FOR

SECTION T450 - FURNISHING & INSTALLING HYBRID-COMPOSITE BEAMS

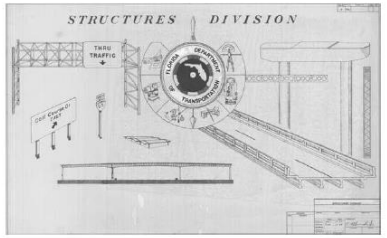
FINANCIAL PROJECT ID: 430021-1-52-01

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

References, Codes and Specifications

FLORIDA DEPARTMENT OF TRANSPORTATION



FIBER REINFORCED POLYMER GUIDELINES (FRPG)

FDOT STRUCTURES MANUAL
VOLUME 4
JANUARY 2016

FDOT

Specifications and Estimates/Specifications/

Materials Manual Section 12.1, Volume II

FIBER REINFORCED POLYMER COMPOSITES

Section 12.1, Volume II

2016

FDOT

Design Standards

For Construction and Maintenance Operations on the State Highway System

Topic No. 625-010-003

State of Florida Department of Transportation
Office of Design
Mail Station 32
605 Suwannee Street
Tallahassee, Florida 32399-0450

* FIBER REINFORCED POLYMER BAR BENDING DETAILS *					
D21310 Certification Statement	FRP Bar Bending Details Permitted Projects FPID No(s): 430021-1, 432194-1-52-01	Steve Nolan	IDDS-D21310	--	Dev932FRP
* FRP REINFORCED PILES *					
D22440 Certification Statement	Precast Concrete CFRP/GFRP Sheet Pile Wall Permitted Projects FPID No(s): 430021-1-52-01, 432194-1	Steve Nolan	IDDS-D22440	CEL-D22440-CSPSA CEL-D22440-CSPDA CEL-D22440-CSPC	
D22600 Certification Statement	Notes and Details For Square CFRP Prestressed Concrete Piles Permitted Projects FPID No(s): 430021-1-52-01	Steve Nolan	IDDS-D22600	CEL-20600	Dev400FRP, Dev415FRP, Dev450FRP, Dev932FRP, Dev933FRP
D22601 Certification Statement	Square CFRP Prestressed Concrete Pile Splices Permitted Projects FPID No(s): 430021-1-52-01				
D22614 Certification Statement	14" Square CFRP Prestressed Concrete Pile Permitted Projects FPID No(s): 430021-1-52-01				
D22624 Certification Statement	24" Square CFRP Prestressed Concrete Pile Permitted Projects FPID No(s): 430021-1-52-01				

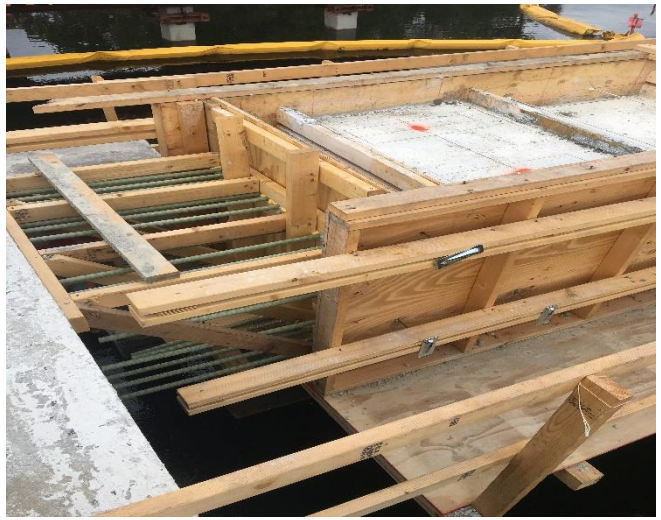
4. Challenges

Challenges

A. **HCB**
   i. Proprietary product
   ii. Design Criteria
   iii. Inspection for closed system
   iv. Durability verification
   v. Fabrication QA/QC

B. **GFRP Reinforced Concrete**
   i. Lap Splice: deck, cap, and diaphragm
   ii. Rebar unit price
   iii. Reinforcing Bar List

C. **Funding and Costs**
   i. FHWA and County



REINFORCING BAR LAPS	
SIZE	LENGTH
4	1'-10"
5	1'-10"
6	2'-3"
8	2'-6"

5. Lessons Learned

Lessons Learned

- Standard details and specifications
- Rebar arrangement – no mechanical coupler
- Lead time, Sole source of CFCC (Tokyo Rope)
- HCB QA/QC plan
- Sheet pile wall driving
- Pile capacity

Summary

Experimental Project with Innovative Materials – First in Florida

- Superstructure: Hybrid Composite Beams; GFRP Bars: Deck, Barriers & Approach Slabs
- Substructure: CFRP Pre-stressed Piles; Bent Caps: GFRP Bars
- Sheet Pile Walls: CFRP Sheet Piles; Wall Cap: GFRP Bars

Contractor Bid Cost - $6.016 Million (Structures = $4.06 Million)

- Bridge Cost = **$218 / sq. ft.**

  (Conventional Construction = **$166 / sq. ft.**)

Accelerated Construction

- Lighter Materials – Beams and Rebar
- Faster Transportation and Delivery – reduced construction time

Questions ?


Gainesville
Cape San Blas
Cross City
Ocala
Tampa
Clearwater
Bradenton
Sarasota
Venice
GREETINGS
FROM
Florida
THE SUNSHINE STATE