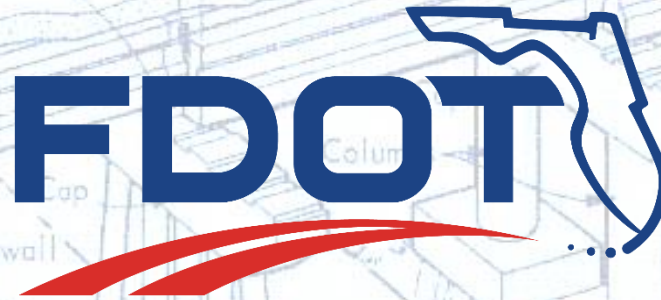


# **Status of FRP Deployment for ACMA-Transportation Structures Council Meeting**



**Structures Design Office**

**(September 29th, 2016)**

**[steven.nolan@dot.state.fl.us](mailto:steven.nolan@dot.state.fl.us)**

**(850) 414-4272**

# Outline:

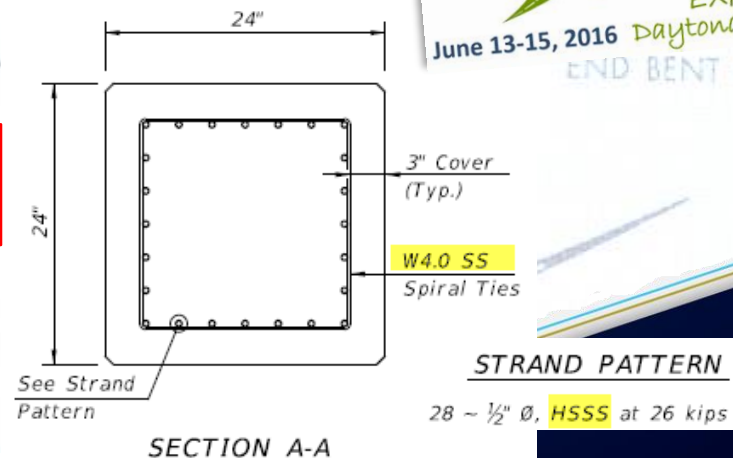
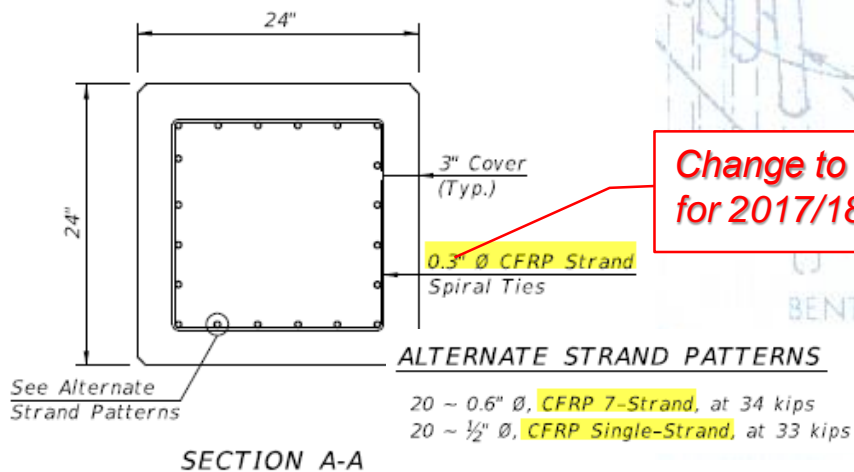
- ◆ *Design Standards*
- ◆ *Developmental Design Standards*
- ◆ Halls River Bridge Replacement Demonstration Project
- ◆ Halls River Bridge FRP Workshop
- ◆ Other Projects
- ◆ Looking Ahead
- ◆ Tech Transfer
- ◆ Research
- ◆ AASHTO-T6



# Design Standards: Prestressed Concrete Piles (with CFRP & SS)

◆ **Indexes 22600, 20601, 22612, 22614, 22618, 22624, & 20630**

- ✓ New corrosion resistant piling for intermediate bridge pile bents in Extremely Aggressive Environments (marine)
  - see Structures Design Bulletin 15-10 for more information and
  - SDG Table 3.5.1-1 for application.
- ✓ Carbon FRP strands (single or 7-strand) & spiral reinforcing or Stainless Steel strand (7-wire) and spiral reinforcing  
(at contractor's/producer's option)

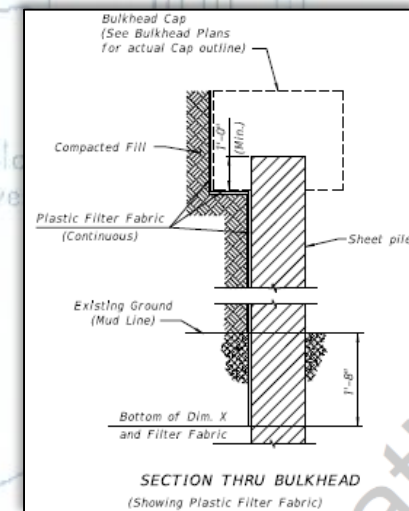
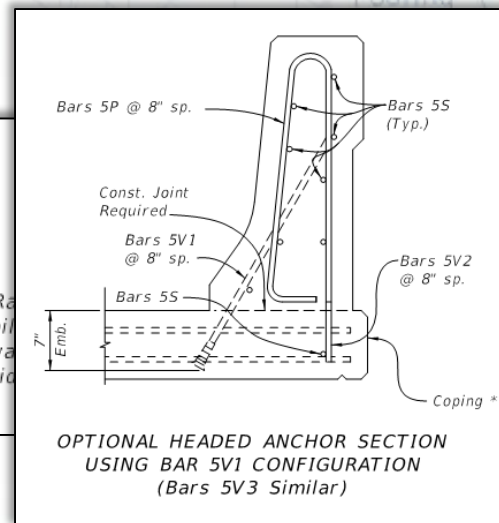
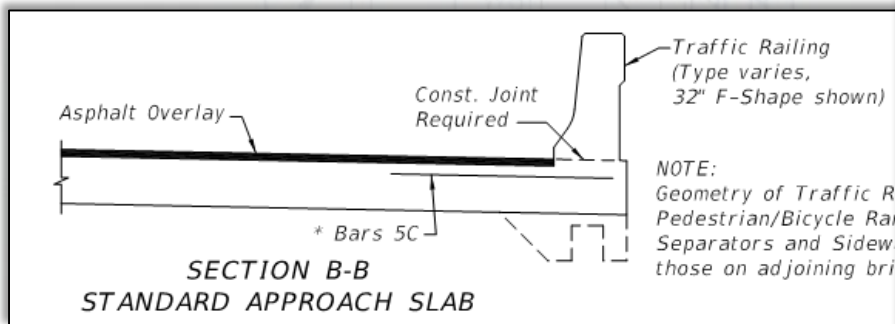
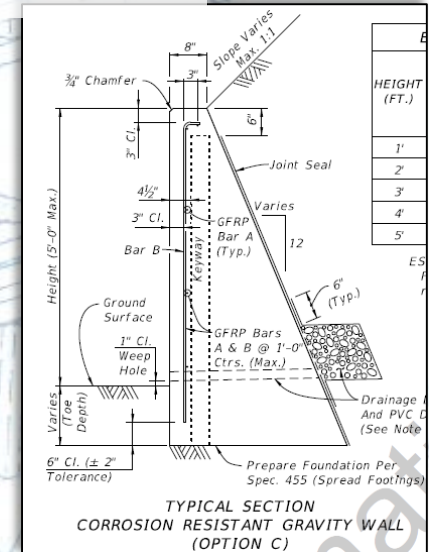


2016 Design Training EXPO  
June 13-15, 2016 Daytona Beach, FL  
END BENT #4

# Recently Published FRP-RC DDS's



- ◆ **Index D6011c**: Gravity Wall – Option C (GFRP Reinforced)
- ◆ **Index D22420 series**: Traffic Railing (32" F Shape – GFRP Reinforced)
- ◆ **Index D22440 series**: Precast Concrete CFRP/GFRP Sheet Pile Wall
- ◆ **Index D22900 series**: Approach Slabs (GFRP Reinforced)



ABUTMENT #1  
With Spread Footing  
(No Piles)

# FRP-RC *DDS*'s to be Revised...



SINGLE BAR BENDING DETAILS

**FRP REBAR HOOK DETAILS**

BAR SIZE	R	180° HOOKS		135° HOOKS		90° HOOKS	
		A/B MIN.	L	E/B MIN.	C/B MIN.		
#2	1 1/2"	3"	3"	3"	3"		
#3	2 1/2"	4 1/2"	4 1/2"	4 1/2"	4 1/2"		
#4	2 1/2"	6"	4 1/2"	6"	6"		
#5	2 1/2"	7 1/2"	4 1/2"	7 1/2"	7 1/2"		
#6	2 1/2"	9"	4 1/2"	9"	9"		
#7	3"	10 1/2"	6"	10 1/2"	10 1/2"		
#8	3"	1'-0"	6"	1'-0"	1'-0"		

**NOTES**

**GENERAL**

For Bar Dimensions See REINFORCING BAR LIST Sheet(s) in Structures Plans.

**SPIRALS (TYPE 3 BARS)**

C = Pitch  
 B = Overall Height  
 θ = Spirals shall be made of GFRP with a minimum Modulus grade of 6.5x10<sup>3</sup> ksi or CFRP with a minimum Modulus grade of 18x10<sup>3</sup> ksi.  
 N = Total number of closed turns at Top and Bottom of columns

Splices may be accomplished by lapping 1.5 turns. Cost of Channel Spacers and Splices shall be included in the Contract Unit Price for Fiber Reinforced Polymer Reinforcing.

**HOOKS**

All dimensions are approximate.

Hook Styles Detailed on this sheet are for Illustration Only.

Actual Hook Style for any particular bar will be shown under A or E Heading on REINFORCING BAR LIST sheet(s) in Structures Plans.

**REINFORCING LAPS**

l<sub>d</sub> shall be calculated and detailed per ACI 440.1R.

Lap Splice distances shall be ≥ 1.3l<sub>d</sub>

Where bars of unequal sizes are lapped, the greater l<sub>d</sub> value of the lapped bars shall be used.

◆ **Index D21310 series: FRP Bar Bending Details**

- ✓ To be updated to match steel reinf. Bar bending index per agreement at FDR-GFRP Workshop 6/15/16
- ✓ Send to ACMA-RMC ?

*GFRP Rebar Workshop*

**2016 Design Training Post-Expo**

6/15/2016, 10:00pm - 4:00pm

#1808 Orleans Blvd. (Intersect Point)

St Johns Room

FDOT

LAST REVISION 01/01/16	DESCRIPTION:	DEVELOPMENTAL DESIGN STANDARDS	PULTRUDED FRP BAR BENDING DETAILS	INDEX NO. D21310	SHEET NO. 1 of 1
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# Halls River Bridge Replacement Demonstration Project



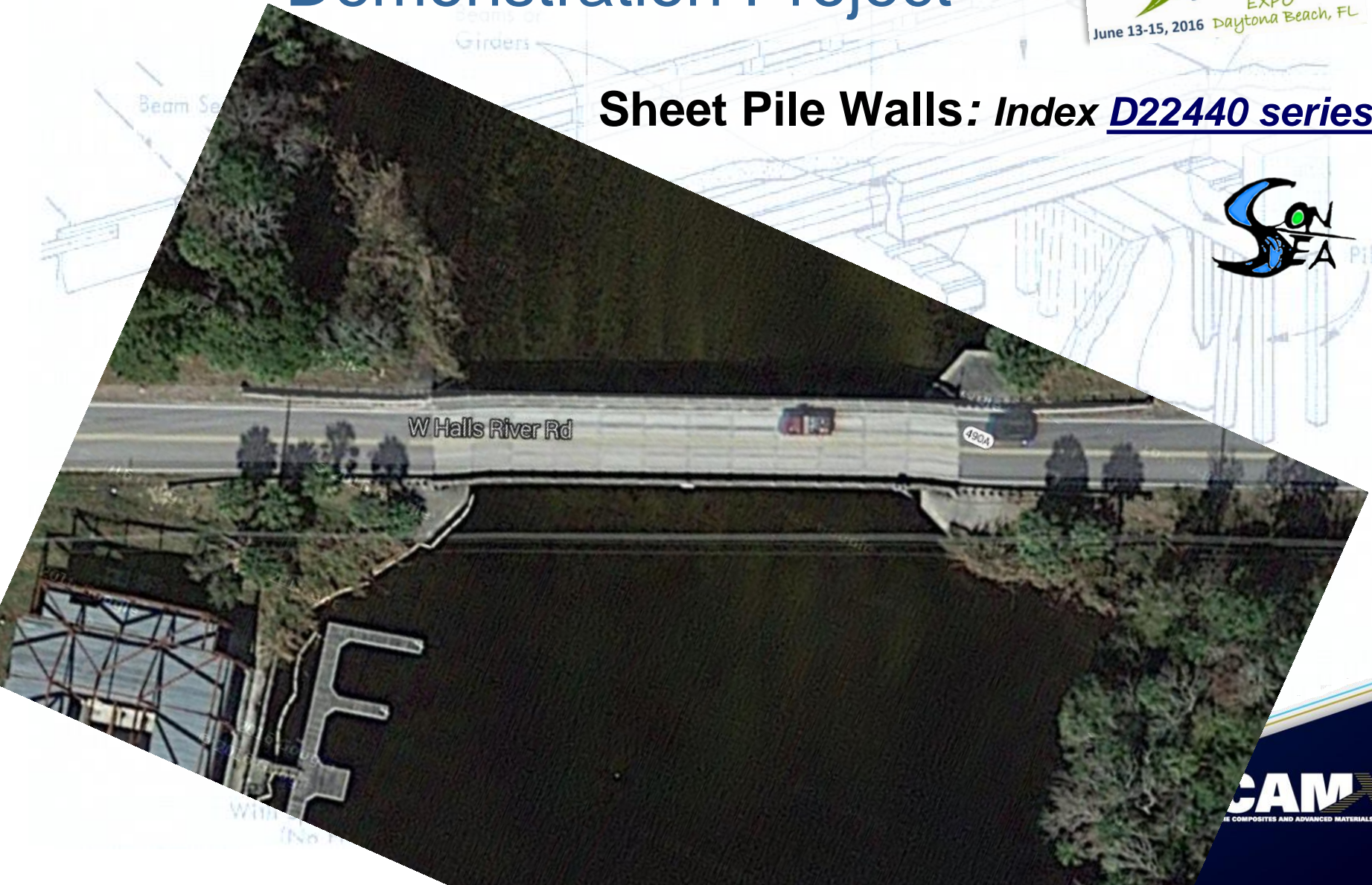
## ***DDS's in this project:***

- ✓ ***Index D21310*** – FRP Bar Bending Details;
- ✓ ***Index D22420*** – GFRP reinforced 32" F-Shape Traffic Railing;
- ✓ ***Index D22440*** – Precast Concrete CFRP/GFRP Sheet Pile Wall:
  - CFRP strands 3.5" cover / GFRP Stirrups 3" cover (Type A).
  - Steel strands 5" cover / GFRP Stirrups 2" cover (Type H).
- ✓ ***Index D22618 series*** – 18" Square CFRP Prestressed Concrete Piles (no HSSS strand option);
- ✓ ***Index D22900*** – GFRP reinforced Approach Slab;
- ◆ Also includes:
  - ✓ Hybrid Composite Beams (superstructure)
  - ✓ GFRP-RC Bridge Deck and Pile Bent Caps

# Halls River Bridge Replacement Demonstration Project



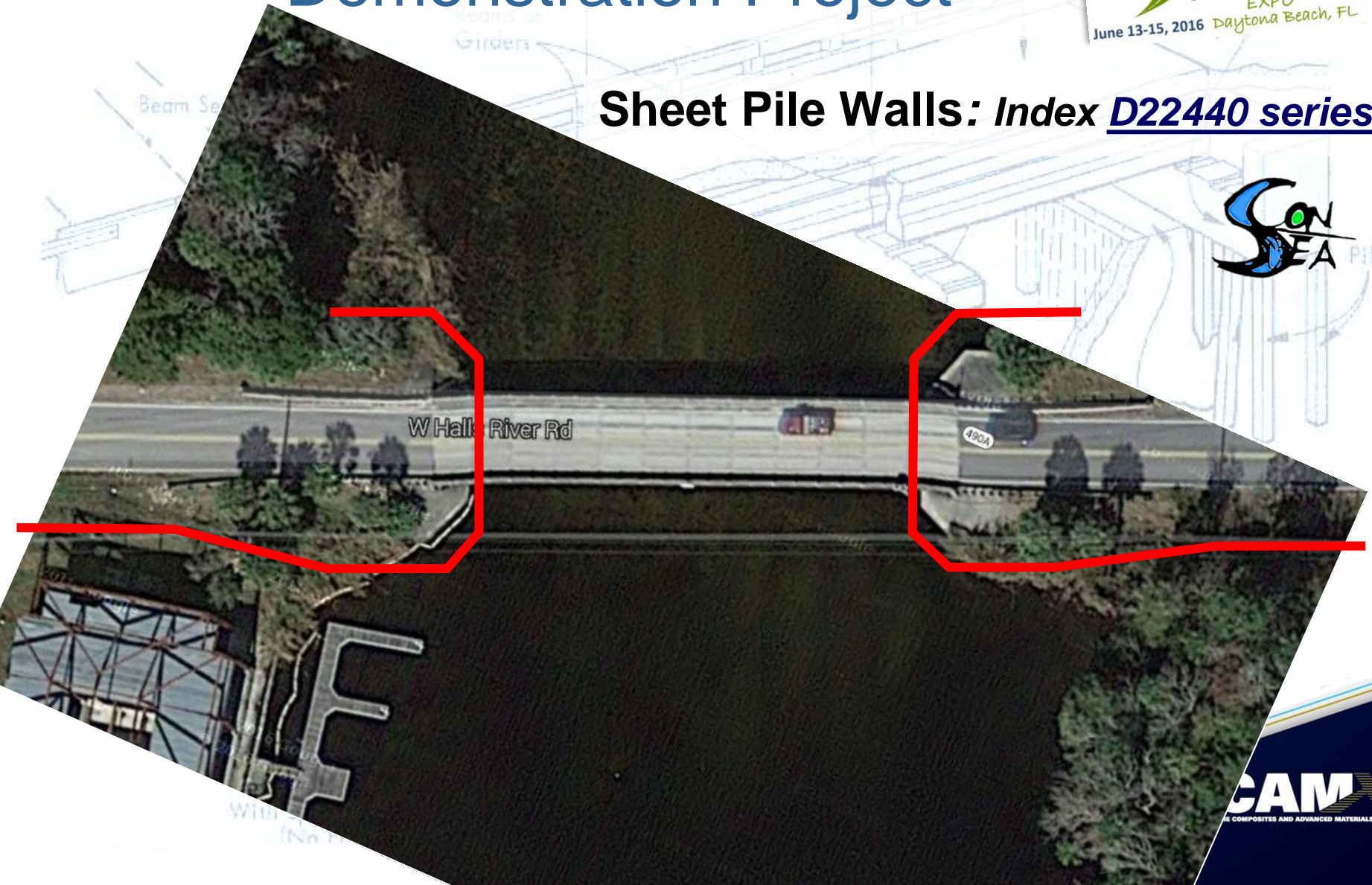
## Sheet Pile Walls: *Index* [D22440 series](#)



# Halls River Bridge Replacement Demonstration Project



## Sheet Pile Walls: *Index* D22440 series

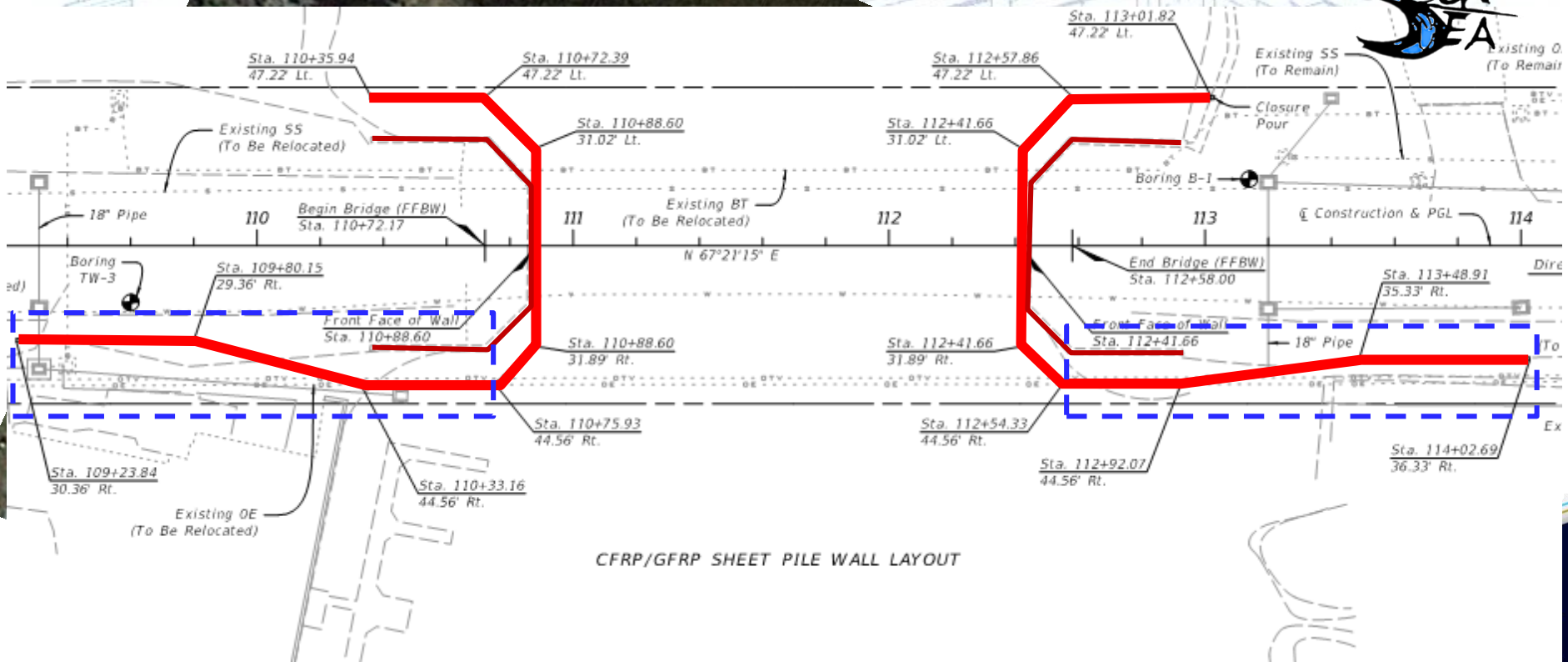




# Halls River Bridge Replacement Demonstration Project



## Sheet Pile Walls: *Index* D22440 series





# Other Projects

## i. Cedar Key SR24 Bulkhead Rehabilitation

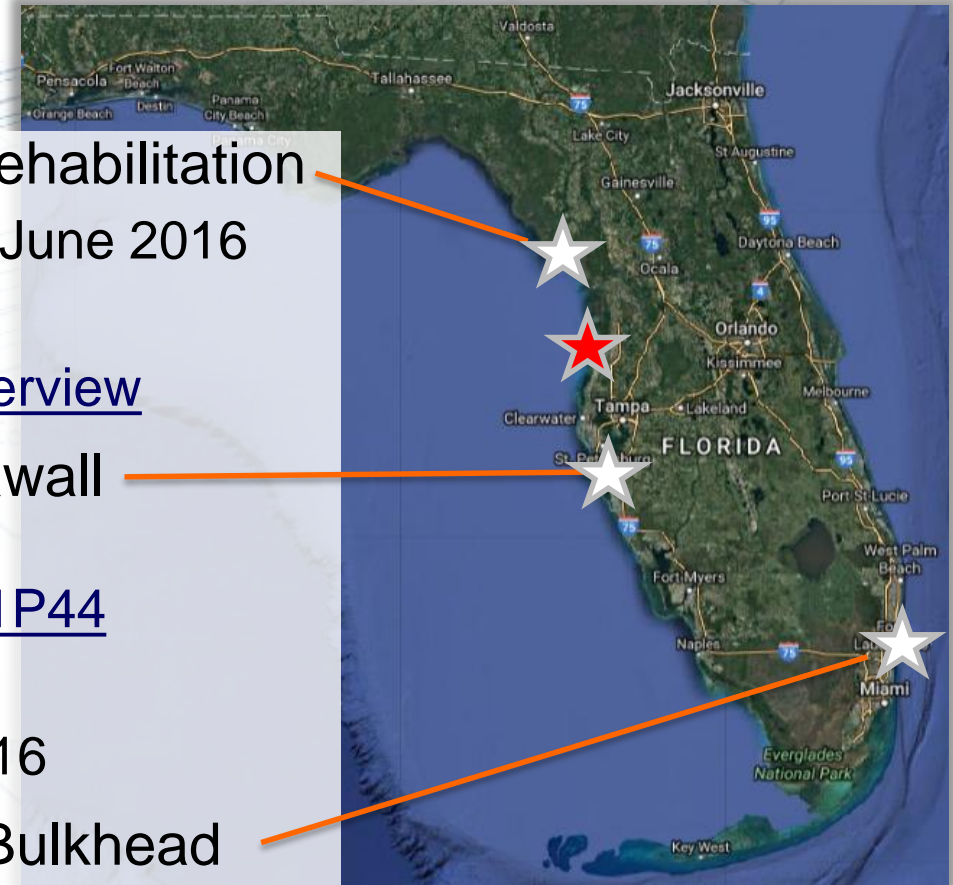
- Construction completed June 2016
- (FPID 432194-1-52-01)
- [Construction Project Overview](#)

## ii. Skyway South Rest Area Seawall Rehabilitation

- Design-Build [contract E1P44](#)
- (FPID 438528-1-52-01)
- Advertisement 04/11/2016

## iii. Bakers Haulover Cut Bridge Bulkhead Rehabilitation

- Letting 6/15/2016
- (FPID 432194-1-52-01)





# Looking Ahead

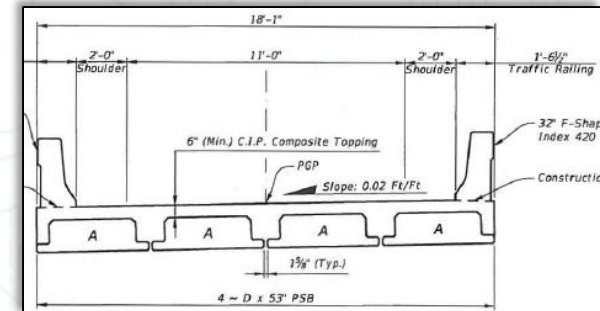


## ***Future standards under consideration:***

- ✓ ***Index D20700 series*** – Precast Intermediate Bent Cap;
  - GFRP Option in Mathcad Design Program



- ✓ ***Index D20450G series*** – FSB's with GFRP Stirrups:
  - Option 1 – 2.5" minimum cover to steel strands
  - Option 2 – 3.5" Minimum cover to steel strands
  - Option 3 – CFRP/SS strands 2.5" cover



- ✓ ***Index D22440 series*** – Non-Prestressed Concrete Sheet Piles – GFRP Reinforced (under analysis).

ABUTMENT #1  
With Spread Footing  
(No Piles)

# Technology Transfer (T<sup>2</sup>)



## **NCHRP Report 768** (2014):

10 key components provide practitioners with a “roadmap” through a guided T<sup>2</sup> process:

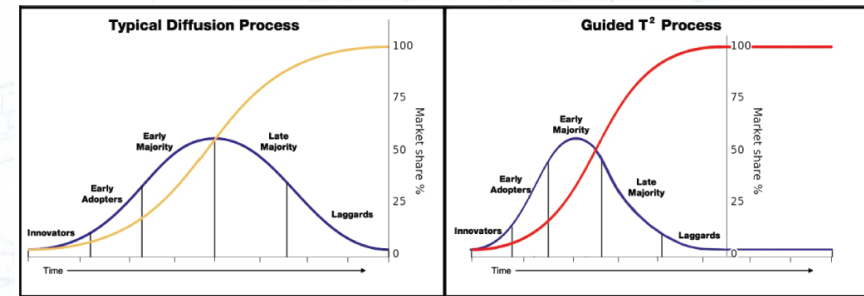
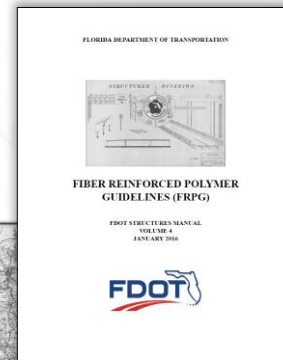


Figure 1-2. Conceptual representation of the intent of guided T<sup>2</sup>.

1. Address societal and legal issues;
2. Have an effective champion; (Rick Vallier-Structures / Chase Knight-Materials)
3. Engage decision makers;
  - [FDOT-FHWA Corrosion-Resistant Rebar Seminar – 07/17/12;](#)
  - [FRP Rebar Industry-FDOT Workshop – 06/15/16;](#)
  - [ACMA-Transportation Structures Council - CAMX 9/29/16;](#)
4. Develop a T<sup>2</sup> plan; (Developmental Design Standards Reports, Roadmap for FRP Deployment...)
5. Identify, inform, and engage stakeholders; ([Invitation to Innovation](#), FDOT-SRC Research Update webinars, FDOT Design Training Expo, ...)
6. Identify and secure resources; ([FRPG](#), Developmental Specs. & [DDS](#))
7. Conduct demonstrations/showcases; (Halls River Bridge, Haulover Cut Rehab. - 2017)
8. Educate, inform, and provide technical assistance;
  - [FTBA/FDOT Construction Conference - Feb. 2017;](#)
  - [Halls River Workshop – May 2017;](#)
  - [FDOT Design Expo – June 2017;](#)
9. Evaluate progress; ([SEACON](#), FDOT Monitoring Project 430021-1-62-03)
10. Reach [**wider**] deployment decision;



# Technology Transfer Opportunities



Start Over



**Florida Transportation Builder Association 2017 Construction Conference**

**February 2-3, 2017**

Hyatt Regency Orlando  
9801 International Drive  
Orlando, FL 32819  
Telephone: (407) 284-1234

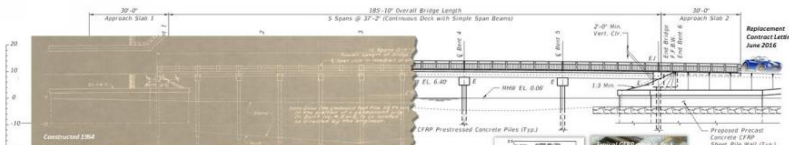
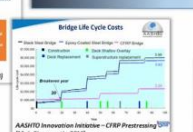

**Design Expo 2017 – June 5-7, 2017**

**Caribe Royale in Orlando**






**FDOT – Halls River Bridge FRP Workshop Outline (Draft)**

**Date:** May 3<sup>rd</sup> - 4<sup>th</sup> 2017  
**Location:** [FDOT - District 7 HQ, Auditorium](#)  
11201 North Malcom McKinley Drive  
Tampa, Florida 33612

**Halls River Bridge Replacement**  
FRP Deployment Demonstration – *Next Generation Infrastructure*  
“...eliminating the threat of concrete cancer”

HOME OUR TEAM SEACON FORUM TECH TRANSFER MORE...


**SEACON FORUM AND HALLS RIVER BRIDGE FRP WORKSHOP**

May 3 - 4, 2017  
Tampa, Florida

[Register](#)

<http://seacon.um-sml.com/seacon-forum.html>

SEACON Forum  
Wednesday, May 3, 2017 8:00 AM to noon  
Holiday Inn & Suites Tampa North  
11310 North 30th Street, Tampa, Florida 33612



# FDOT FRP-RC Research

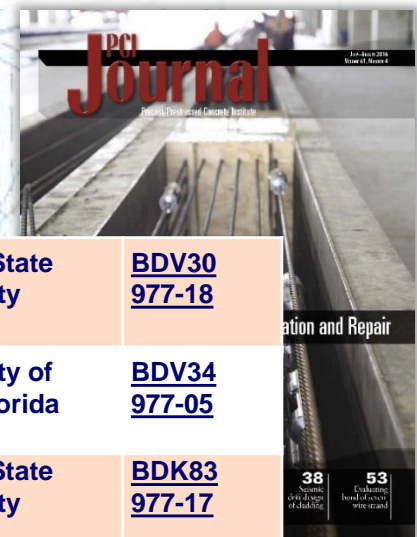
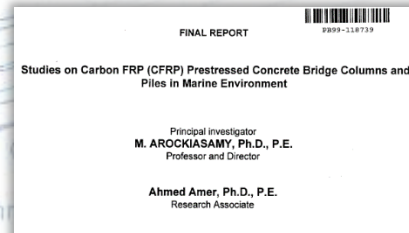
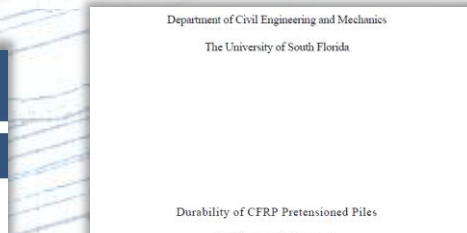


## ◆ Service Life Enhancement thru Durability:

- ✓ The composites research at the SRC has been constant since the late 80's early 90's. Large focus initially was on repair and retrofit, and continues, but attention is now shifting towards new construction (see examples below).

### Structures Research Center

SRC Home Active Research



6/30/2018	<a href="#"><u>Performance Evaluation of GFRP Reinforcing Bars Embedded in Concrete Under Aggressive Environments</u></a>	R. Kampmann	Florida State University	<a href="#"><u>BDV30 977-18</u></a>
3/31/2018	<a href="#"><u>Degradation Mechanisms and Service Life Estimation of FRP Concrete Reinforcements</u></a>	A. El Safty	University of North Florida	<a href="#"><u>BDV34 977-05</u></a>
4/16/2014	<a href="#"><u>Investigation of Carbon Fiber Composite Cables (CFCC) in Prestressed Concrete Piles</u></a>	M. Roddenberry, P. Mtenga	Florida State University	<a href="#"><u>BDK83 977-17</u></a>
11/30/1998	<a href="#"><u>Studies on Carbon FRP (CFRP) Prestressed Concrete Bridge Columns and Piles in Marine Environment</u></a>	M Arockiasamy	Florida Atlantic University	B-9076
8/1/1995	<a href="#"><u>Durability of CFRP Pretensioned Piles in Marine Environment Volume II</u></a>	R. Sen	University of South Florida	0510642

### State Materials Office

State Materials Office / Structural Material Systems  
**Structural Material Systems**



**CAM**  
 THE COMPOSITES AND ADVANCED MATERIALS EXPO

# AASHTO-SCOBS T6 subcommittee



## ◆ Update of GFRP Guide Specification

- ✓ White Paper circulated by Dr. Nanni

## ◆ T-6 is currently working on a strategic plan (the primary objective is to support the overall AASHTO SCOBS strategic plan)

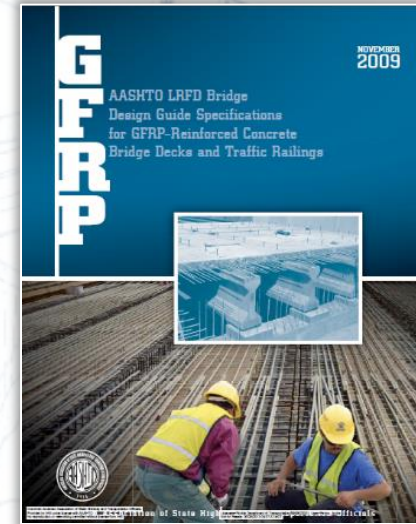
## ◆ Discussion that the CFRP pretensioning will be getting ready for ballot as a separate Guide Specification.

## ◆ NCHRP Research

- ✓ NCHRP 20-68A Domestic Scan 13-03 – Best Practices in FRP Composites (O'Connor, University of Buffalo) *should be published very soon.*
- ✓ NCHRP 47-12 (Synthesis) – Use of FRP in Transportation Infrastructure (Dr. Kim, University of Colorado)
- ✓ NCHRP 12-97 – Guide Specification for the Design of Concrete Bridge Beams Prestressed with CFRP Systems (Dr. Belarbi – University of Houston)

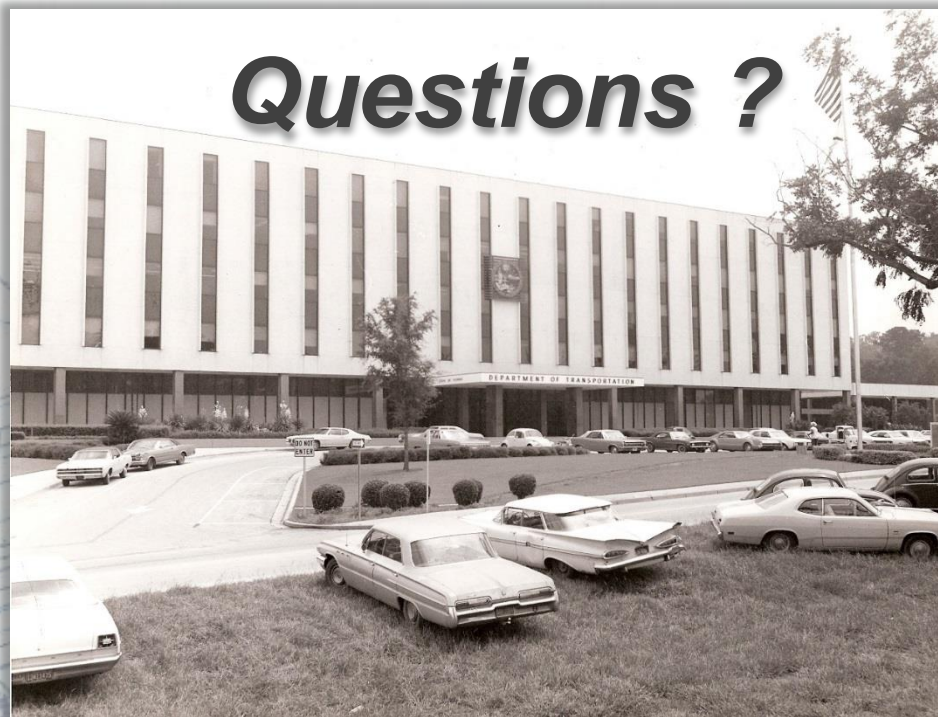
## ◆ AASHTO Innovative Initiative (A.I.I.)

- ✓ Method of Promoting Innovation/Usage (CFRP pre- and post-tensioning currently listed)





# Questions ?



## Structures Design Office:

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[Chase.Knight@dot.state.fl.us](mailto:Chase.Knight@dot.state.fl.us)