FDOT Executive Workshop (4/14/2021)

Design Innovation:
Alternate Designs for Longer-lasting Bridges & Structures

GFRP rebar for deck & substructure of Halls River Bridge (2017-18)

GFRP Secant-Pile Shaft cages for A1A-Flagler Beach seawall (2019)

UHPC-PC H-Pile for CR-339 demonstration (2020)

CFRP-PC FSB's US-1/Cow Key span replacements (2020)

Prepared By: Steven Nolan, P.E. *(Steven.Nolan@dot.state.fl.us) for State Structures Design Office*

Implementing Technology for Longer-Lasting Bridges & Structures

Inspire Innovation

FDOT's History with Innovation and Structures Research…

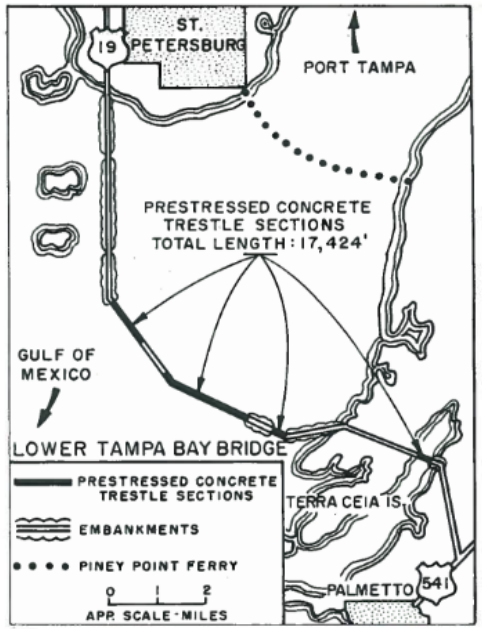


Fig. 21. Location map of Lower Tampa Bay Bridge.

1951 (Ref: PCI Journal, Jul-Aug 1978 Part 2, p51)

William Dean's Influence

During the early construction stages of

known as the Sunshine Skyway. This crossing connects the city of Brandenton to St. Petersburg, Florida (Fig. 21).

This project had laid dormant for several years since bids taken around 1946 exceeded the allocated budget. The proposal was to construct a 17,500 ft (5334 m) trestle bridge calling for precast *reinforced* concrete units (Fig. 22) having spans of 36 ft (11 m) and a total width, out-to-out, of 37 ft 5 in. (11.4 m), including curbs (see next page).

Preload surmised that in using prestressed concrete, the 36 ft (11 m) span could, perhaps, be increased to 48 ft

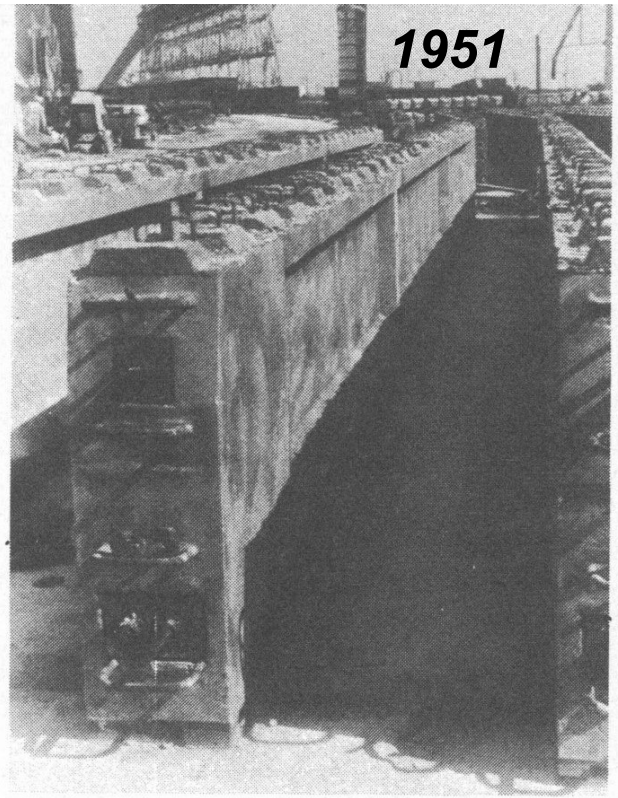
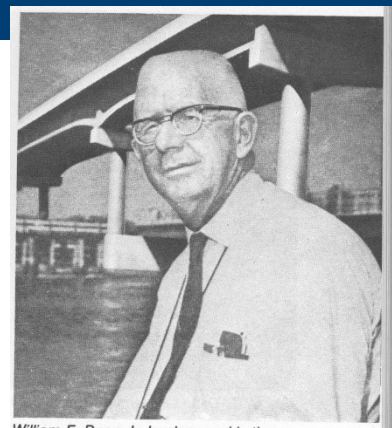


Fig. 26. Typical Tampa Bay beam



William E. Dean. In background is the Sebastian Inlet Bridge for which Dean received a special PCI Award in 1964.

1950 (Ref : PCI Journal, Nov-Dec 1978, Part 3, p22)

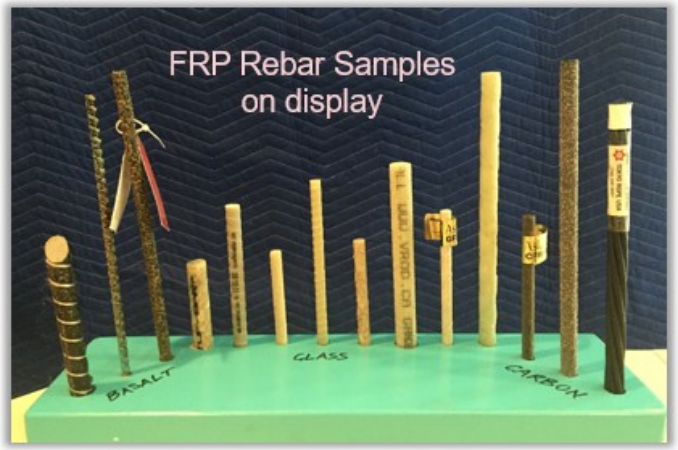
Fig. 25. Demonstration test cf 100-ft (30.5 m) long prestressed channel slab at R. H. Wright & Son, Fort Lauderdale, Florida.

Implementing Technology for Longer-Lasting Bridges & Structures

Recall from 2020:

FDOT Executive Workshop
January 15, 2020

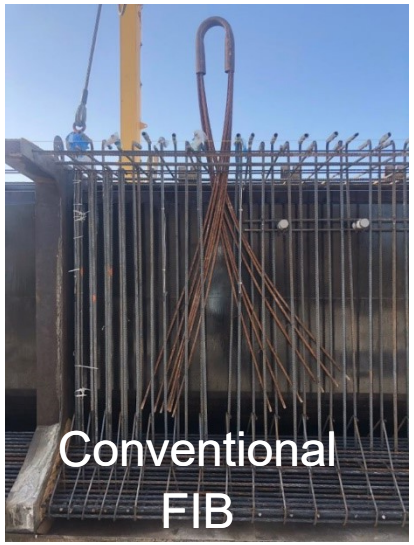
Fiber-Reinforced Polymer Deployment for Corrosion-Free Bridges



Steven Nolan, P.E. (Steven.Nolan@dot.state.fl.us)
State Structures Design Office

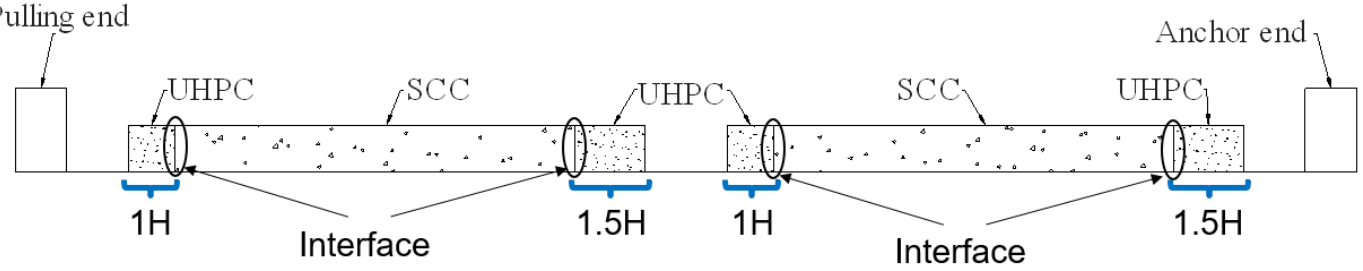
https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/structures/innovation/frp/fdot-exws-frp-nolan.pdf

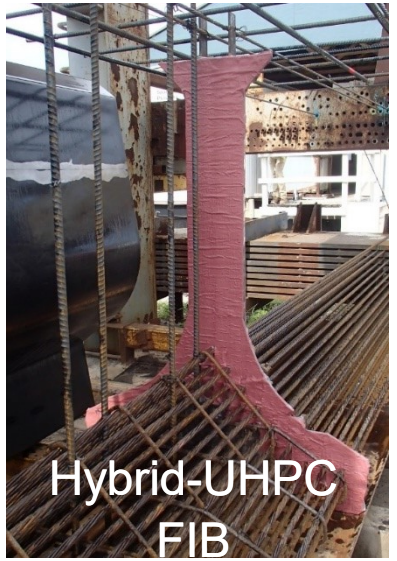
Ultra-High-Performance Concrete (UHPC) Innovation



Hybrid Prestressed Concrete Girder with UHPC

- Evaluated the effectiveness of UHPC to contribute to the structural performance of prestressed girders
- Reduce or eliminate visible end-region cracking
- This will help end girder span length and allow more prestressing force.

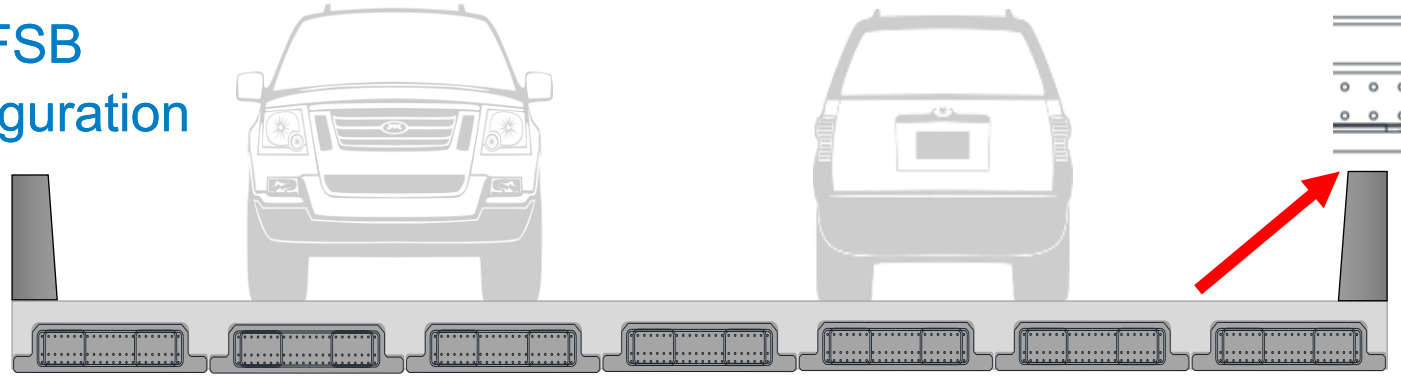


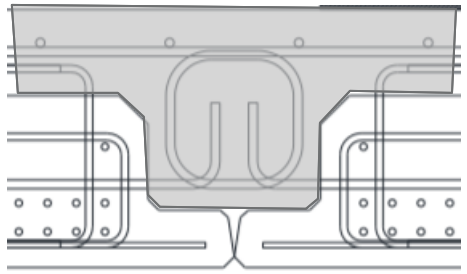


Innovative Structural Research & Demonstration projects by the Florida DOT (2021)

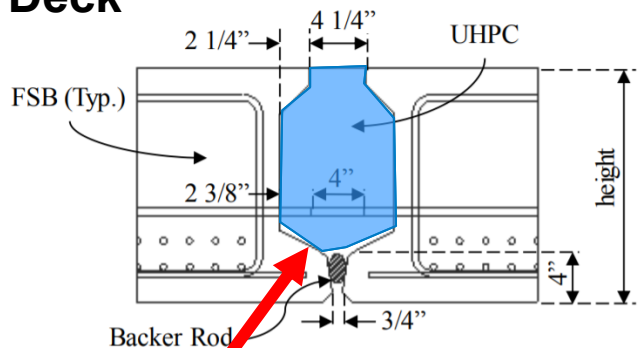
Ultra-High-Performance Concrete (UHPC) Innovation

Conventional FSB Configuration

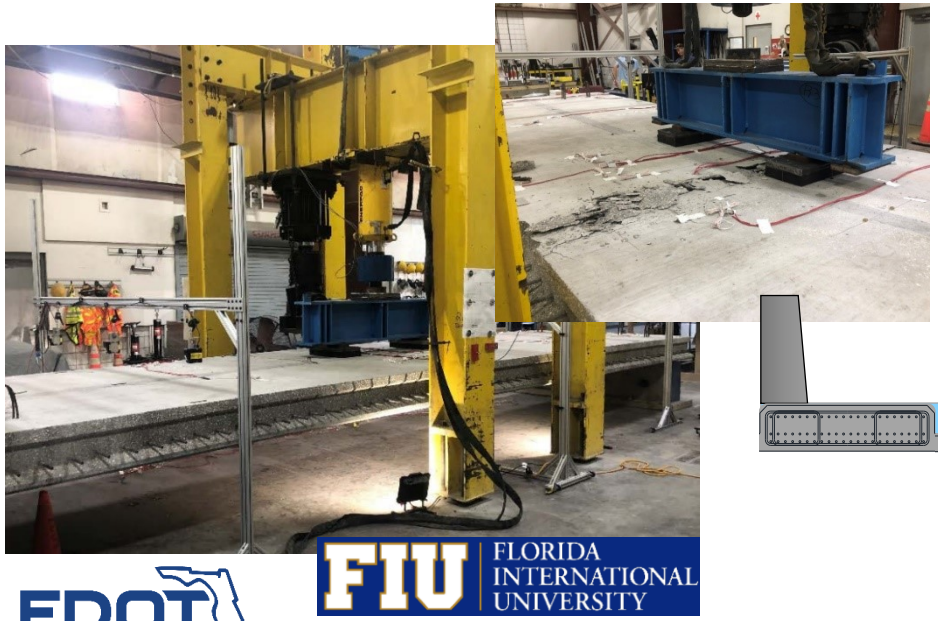


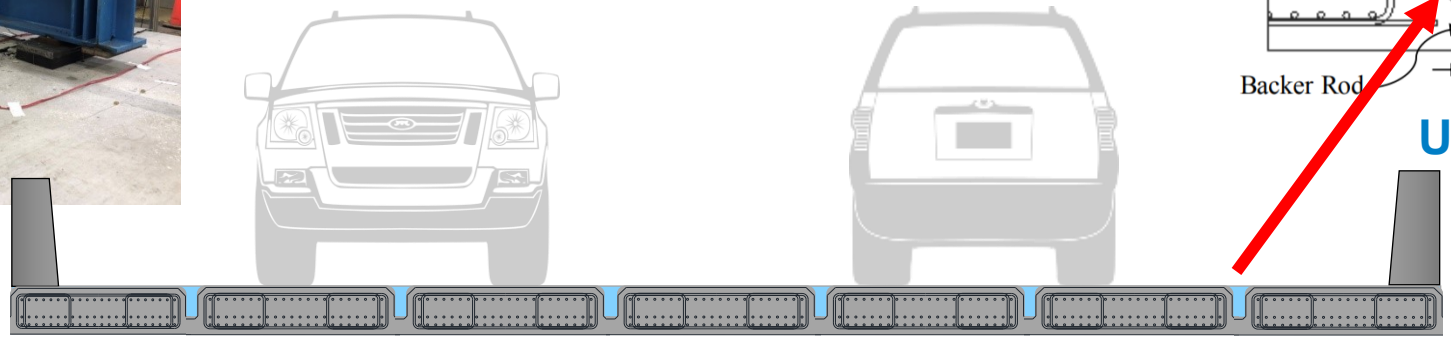


Florida Slab Beam with **6” Concrete Deck**



UHPC Closure Pour





Florida Slab Beam w/ UHPC Joints

FDOT

FIU FLORIDA INTERNATIONAL UNIVERSITY

Corrosion-Resistant Strands (SS & FRP) Innovations

High-Strength Stainless Steel (HSSS) Prestressing
- Concrete Girders -

FDOT FAMU-FSU Engineering

Implementing Technology for Longer-Lasting Bridges & Structures

How to encourage more District participation for implementation?

1. **Schedule** is always a challenge – *seems its always "too early" or "too late".*
2. **Construction** is not the ideal time to propose innovative material alternates, but often that is what industry must default too thru the **CSI** process – *engineering cost and schedule risk is passed on to the contractor.*
3. **Implementation** at the beginning of the consultant's Design Contract not working → 3-*5 years before construction complete.*

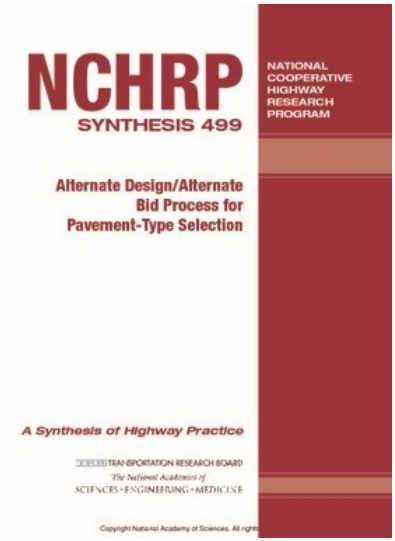
→ *We need a more **agile** and **equitable** process!*

Implementing Technology for Longer-Lasting Bridges & Structures

Inspire Innovation

What would a more agile and equitable process look like?

- **Agile** – *allow HCR alternate designs post-BDR & during procurement of contractor.*
- **Equitable** – *(1) Pay for the design of HCR alternate (**invitation-to-innovation**) in addition to conventional design (**~ADAB**) = "Low-Bid" (**A**);*
  *– (2) Bid alternates recognize the life-cycle cost benefits = "Best Value Bid" (**A+D**)*
- **Incentivize** – ***ATP**** ≠ *Cost Savings Initiative (**CSI**) proposals using select HCR materials (**invitation-to-innovation**) → give up cost share savings to FDOT.*
- **Empower other Stakeholders** – *cost adjustment and schedule extensions until institutionalized.*

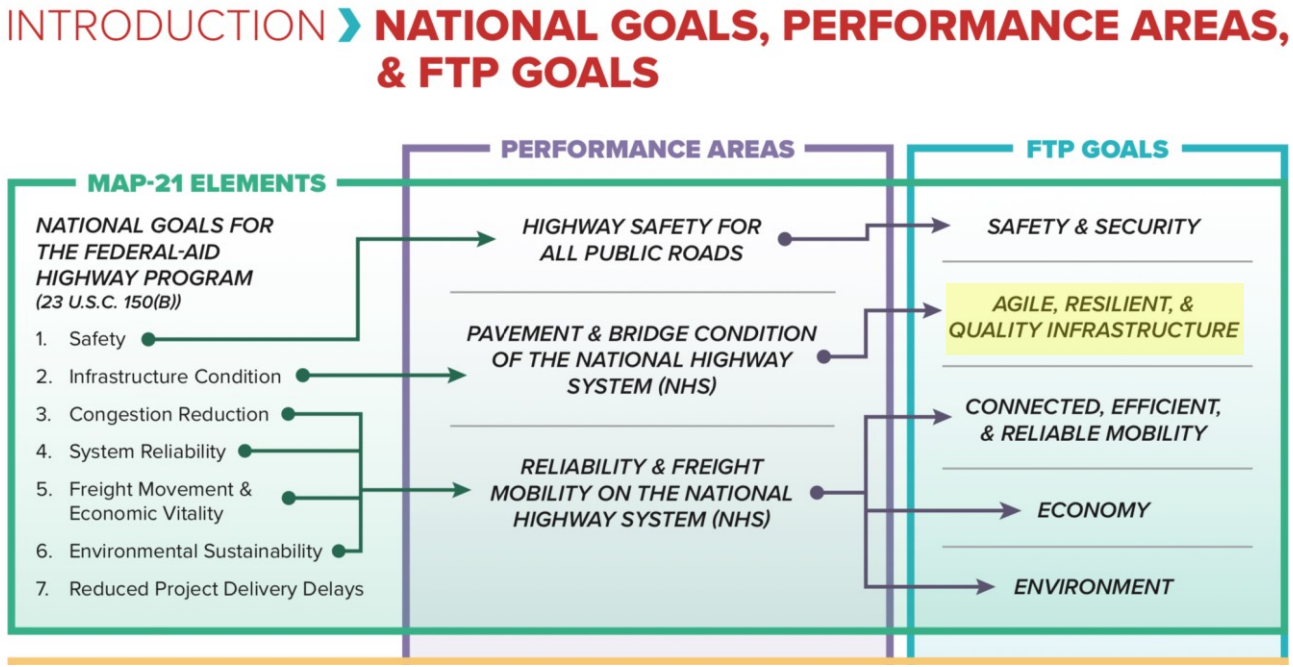


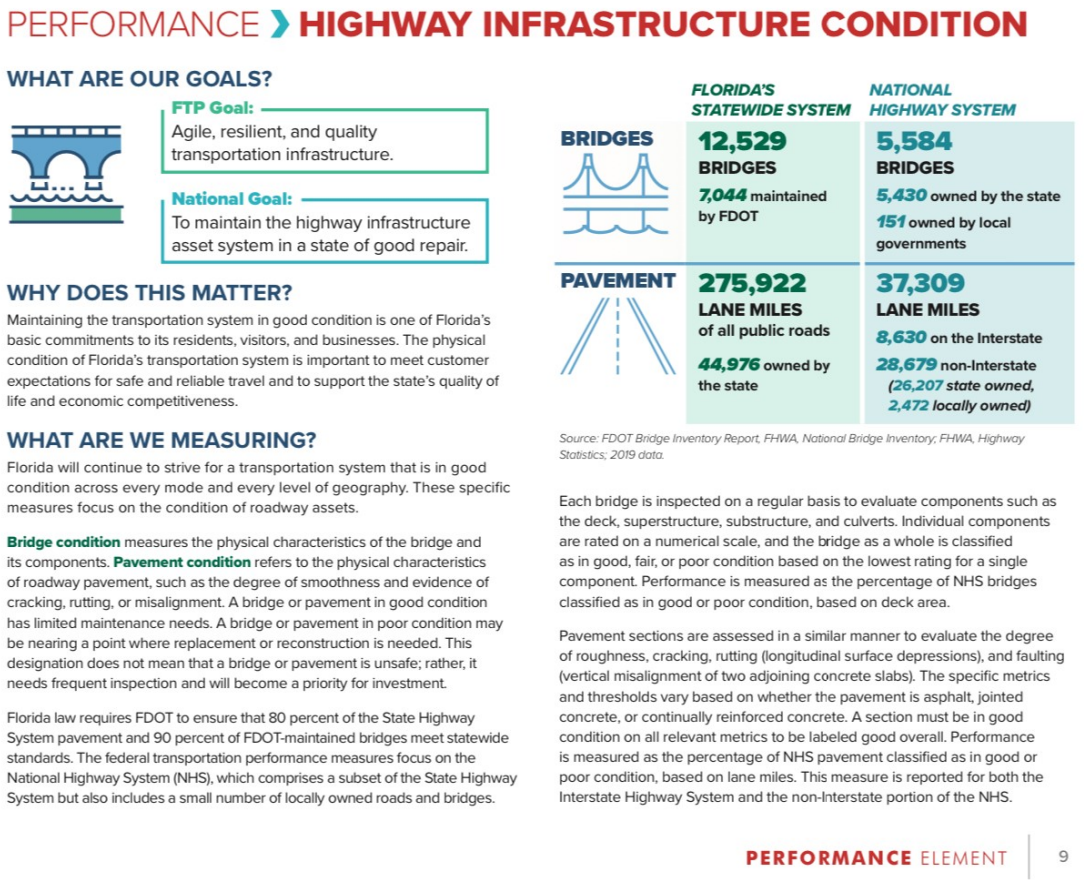
***ATP** – Alternative Technical Proposal (similar to ATC for D-B)*

Implementing Technology for Longer-Lasting Bridges & Structures

Inspire Innovation

How does a more agile and equitable process align with FTP goals?





Why? Bridge Durability & Structural Advancement

- **Durability** needs – low-maintenance, extended service-life, cost-effective solutions, reducing work zones.

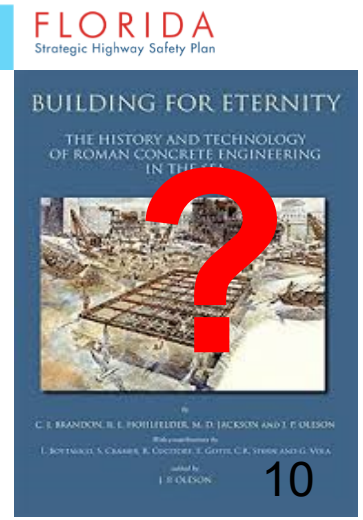
- **Structural** needs – Inspectable, repairable, robust, extended span lengths (light-weight and/or high-strength & high-endurance):

  - HSSS-Prestressed Concrete *(2205 Duplex SS)*
  - CFRP-Prestressed Concrete *(Carbon strands)*
  - FRP-Reinforced Concrete *(Glass & Basalt)*
  - Ultra-High Performance Concrete *(UHPC)*
  - Light-weight Concrete or FRP *(Longer spans and/or less shipping cost)*

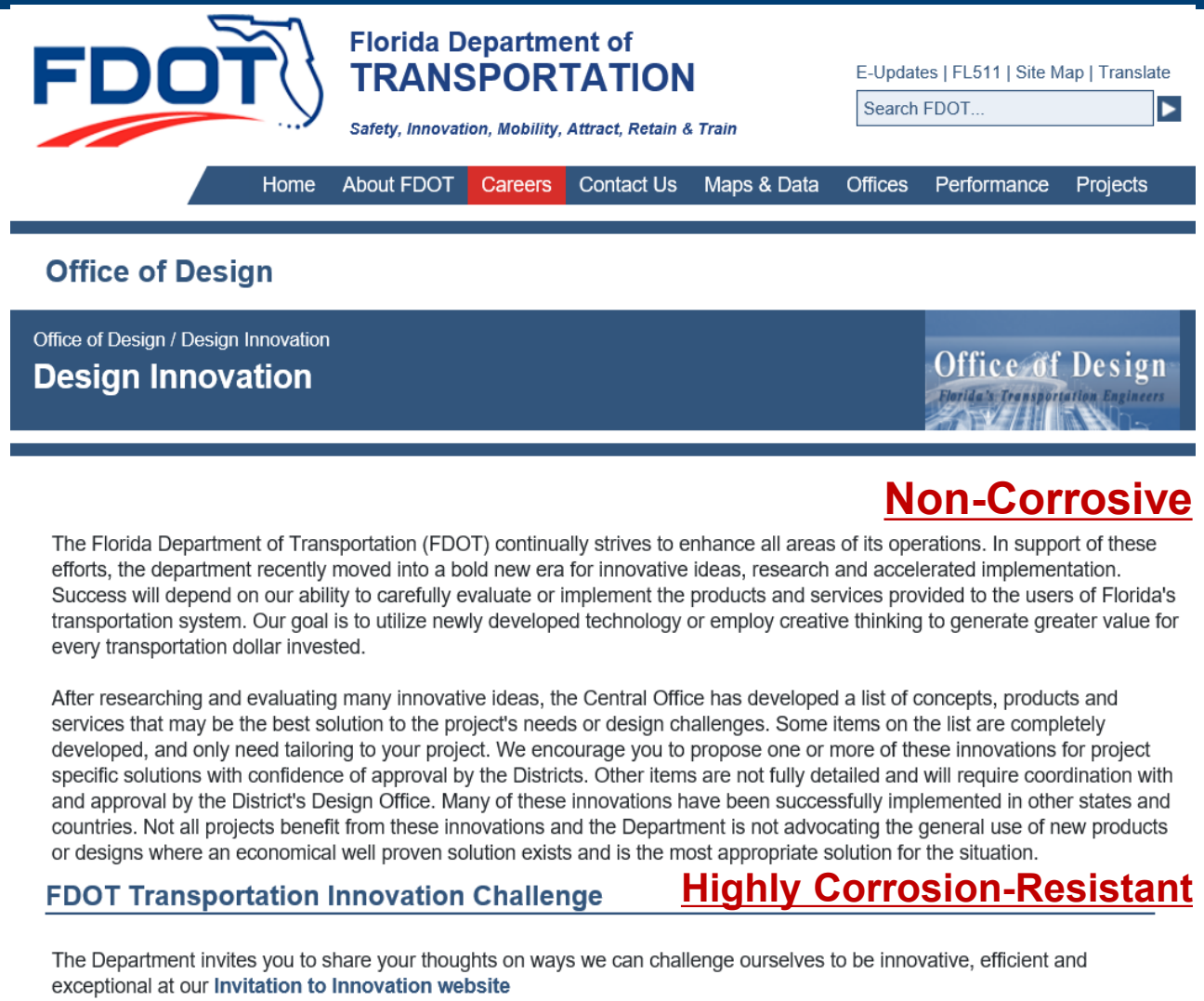
Highly Corrosion-Resistant (HCR)

Structural Advancement

Work zone fatalities make up approximately two percent of overall fatalities and two percent of serious injuries in Florida. Specifically, work zone crashes represented 385 fatalities and 2,414 serious injuries from 2015 to 2019, with the number trending upward over time. Work zone crashes compound the situation because of the risk they create to roadside workers who were present in the work zone in 35 percent of the fatal crashes and 44 percent of serious injury crashes. These crashes also can create tremendous disruption to roadways until they are cleared. Solutions include targeted enforcement in work zones, implementation of smart work zone applications, and efforts to educate drivers about work zone safety.



What? Bridge Durability & Structural Advancement



Previously: "invitation-to-innovation"

Structures Design Office

Curved Precast Spliced U-Girder Bridges

Fiber Reinforced Polymer Reinforcing

FRP Members and Structures

Geosynthetic Reinforced Soil Integrated Bridge System

Geosynthetic Reinforced Soil Wall

Prefabricated Bridge Elements and Systems

Segmental Block Walls

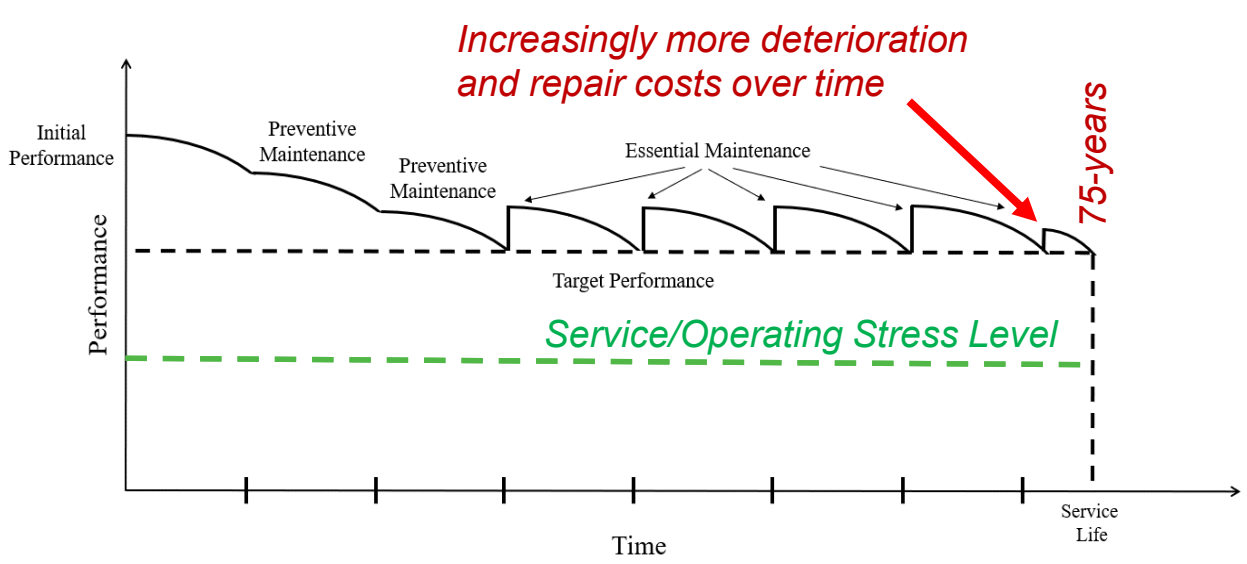
Ultra-High Performance Concrete (UHPC)

+ Stainless-Steel Prestressing Strand & Rebar

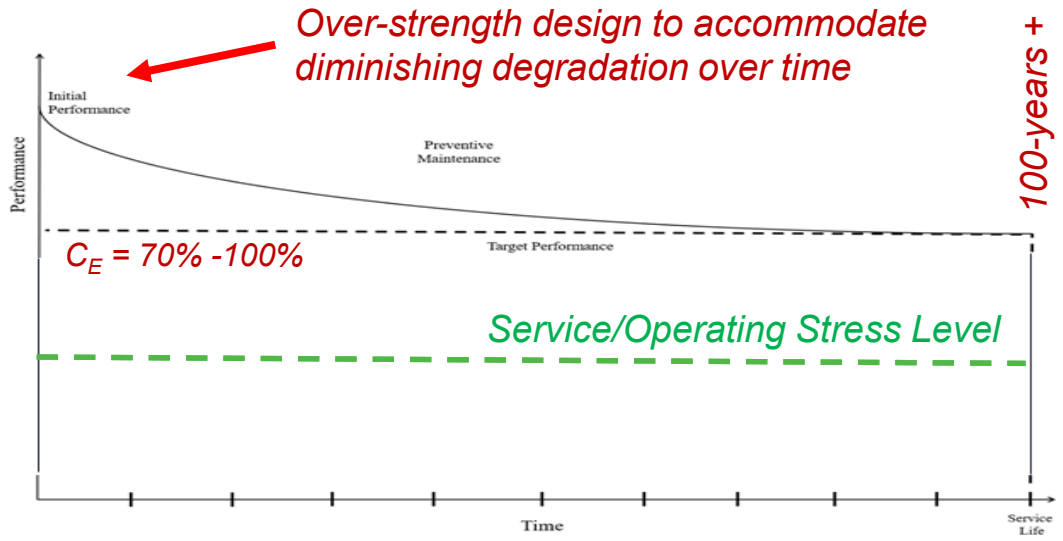
Design Innovation: ADAB for Highly Corrosion-Resistant Bridges & Structures (2021)

How? Cost Justification (Life-Cycle Cost)

LCC & LCA can show the sustainable (economic and environmental) advantage of composite structures in the coastal environment:



Current CS-RC/PC process

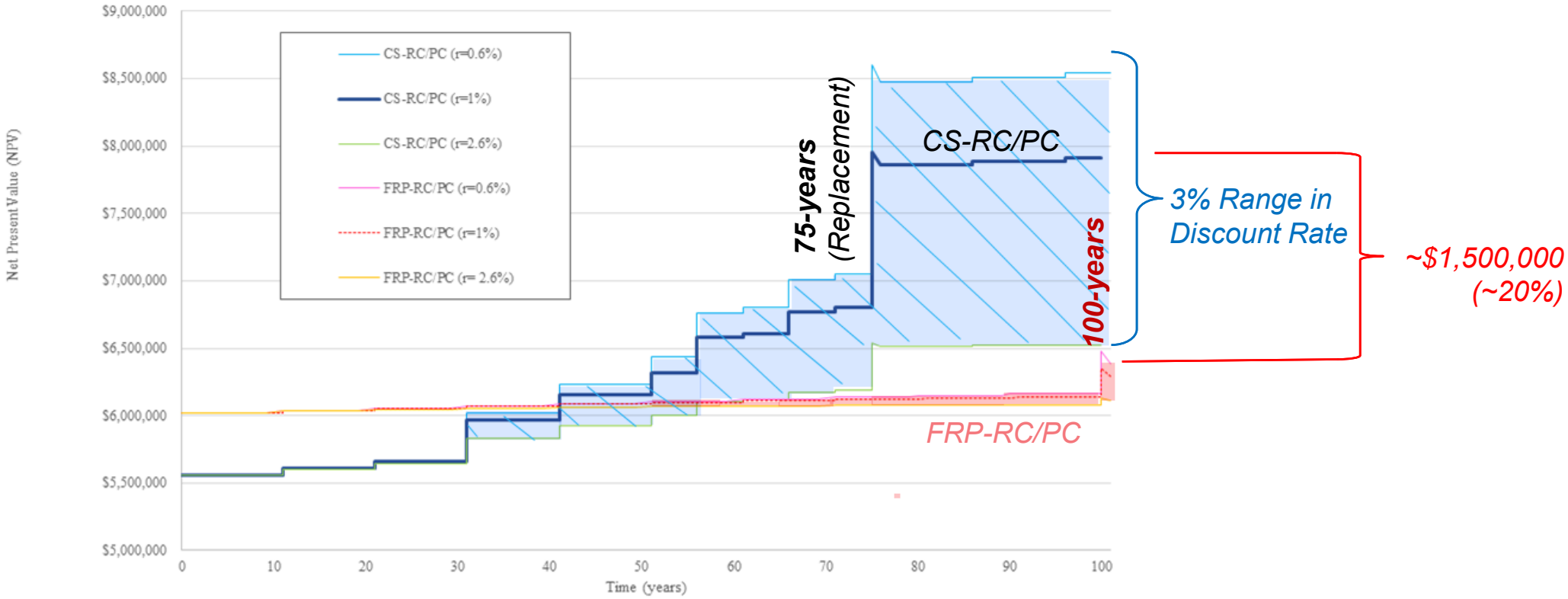


HCR-RC/PC alternative

Charts: Cadenazzi, T., Dotelli, G., Rossini, M., Nolan, S., and A. Nanni. (2019). Cost and Environmental Analyses of Reinforcement Alternatives for a Concrete Bridge. Structure and Infrastructure Engineering.

How? Cost Justification (Life-Cycle Cost)

Life-Cycle Cost (LCC) analysis can show the sustainable (economic) advantage of FRP structures in the coastal environment:



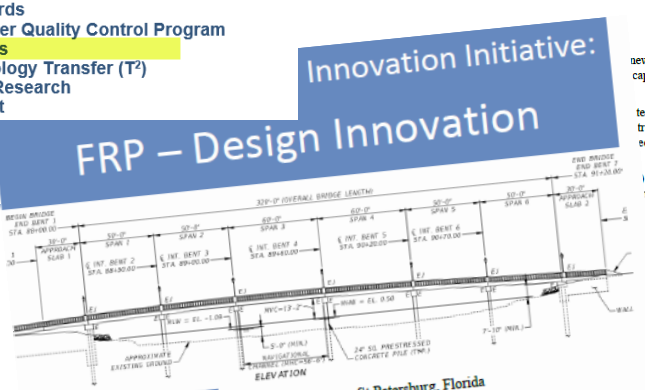
Example LCC Comparison of Carbon Steel-RC/PC verses FRP-RC/PC bridge *(adapted from Cadenazzi et al. 2019)*

How? Project Examples to build upon…

Structures Design - Transportation Innovation
Fiber Reinforced Polymer (FRP)
Reinforcing Bars and Strands

Fast-Facts:
https://www.fdot.gov/structures/innovation/FRP.shtm#link9

Innovation Initiative:
FRP – Design Innovation

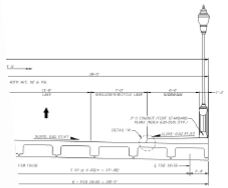


Fast Facts:
Carbon & Glass Fiber-Reinforced Polymer

FDOT

Project Location: St Petersburg, Florida
Agency: Florida Department of Transportation
URL: http://www.fdot.gov/structures/innovation/FRP.shtm
Project Name: 40th Ave NE over Placido Bayou
Bridge No. 157141
FPID: 443600-1-58-01
Project Description: Bridge replacement and over Placido Bayou with CFRP/GFRP FSBs, Bent Caps and Piling
Project Purpose & Need: Replacement of local agency 2-lane bridge, with widened raised sidewalks and bicycle lanes using corrosion-resistant prestressed and reinforced concrete elements for extended durability. The new bridge is 320-feet long x 58-feet wide, four (4) 50-foot spans and two (2) 60-foot spans in the navigation channel with 13-foot vertical clearance at MHW, for passage of recreational watercraft. The existing 19xx superstructure is composed of hollow prestressed "Sonovoid" slab units with severe underside corrosion above the channel navigation spans.
Overall Budget/Cost Estimate: $ 5,300,000 (Bridge)

new vehicular bridge to use CFRP pretensioned slab-caps using GFRP-RC. Abutments and embankment
ted in the splash-zone require concrete using ternary trafine flyash or calcium nitrate additives. Also, ed to zero, and waterproofing sealants may be
using CFRP prestressing strands and GFRP rosion with no need for reduction in the AASHTO
strands (approx. 90,000 LF + 15,000 LF Strands SB (18"x36" and 18"x58") x 49' & 59' units.
transverse reinforcement in FSBs
le bent caps and bulkhead caps and 7,000 #6's)
estressed concrete piles (approx. 4350 LF) ,800 SF)
liminates the need for additional concrete r corrosion protection. Lightweight quipment costs because of the handling. Other costs for the owner.



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opher.gamache@cardno.com
Mohammadi, P.E.

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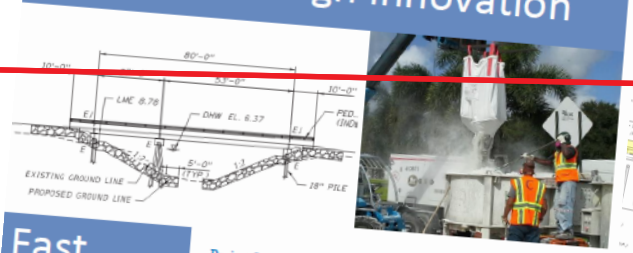
1 | Page

FDOT Transportation Innovation Initiative:
UHPC – Design Innovation



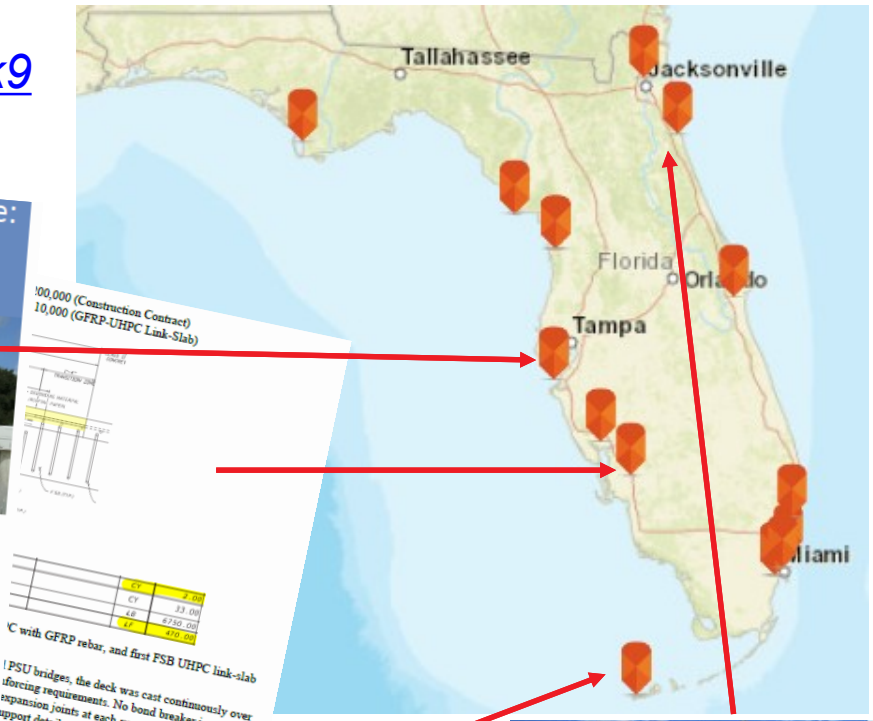
Fast Facts:
Ultra-High Performance Concrete

FDOT

Project Location: FDOT District One
Port Charlotte
Charlotte County, Florida
Agency: Florida Department of Transportation
URL: http://www.fdot.gov/structures/innovation/UHPC.shtm
Project Name: US 41 Pedestrian Bridge over Sunset Waterway
Bridge No. 019004
FPID: 435390-1

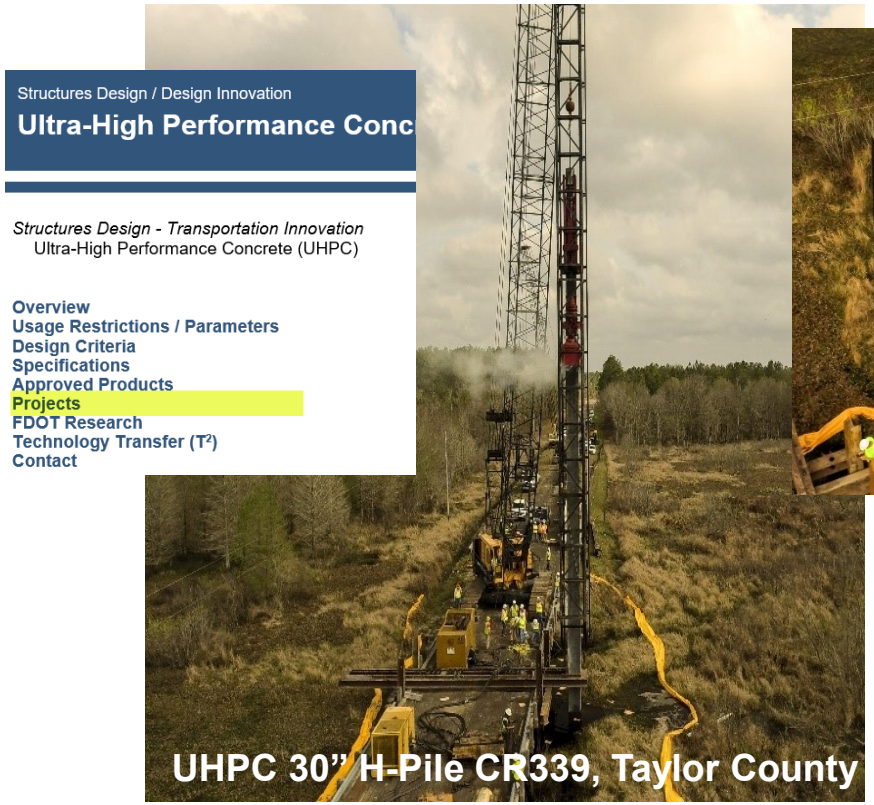
Structures Design / Design Innovation
Ultra-High Performance Conc

Structures Design - Transportation Innovation
Ultra-High Performance Concrete (UHPC)

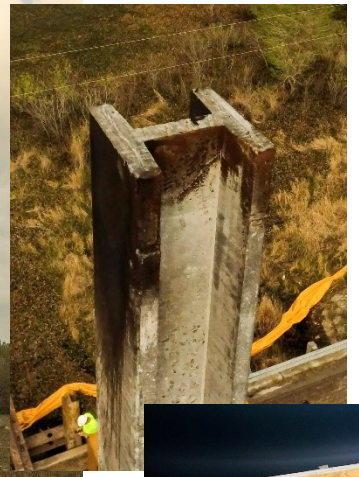


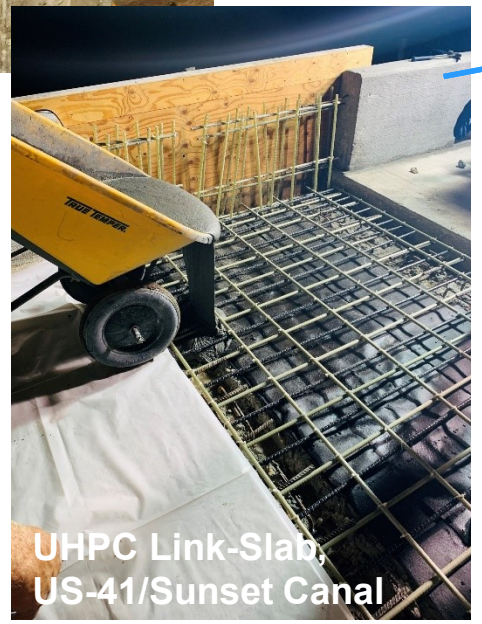
How? Project Examples to build upon…

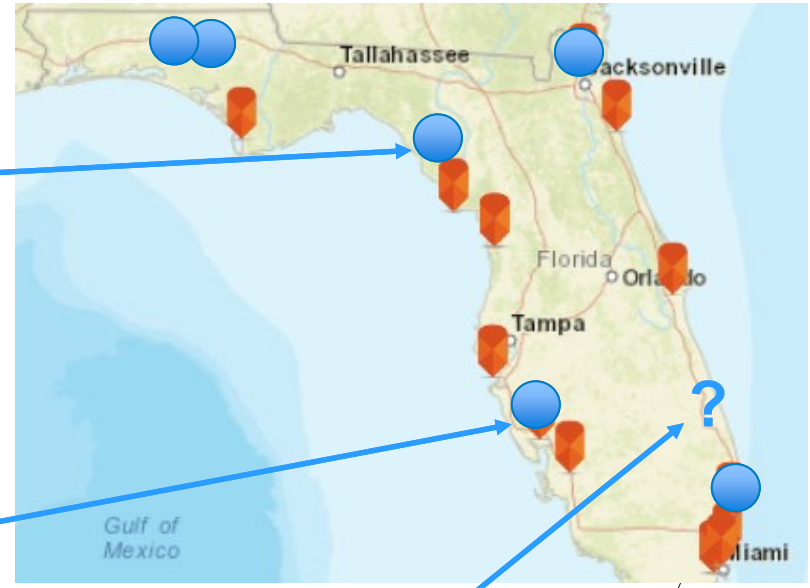
- Fast-Facts: https://www.fdot.gov/structures/innovation/FRP.shtm#link9

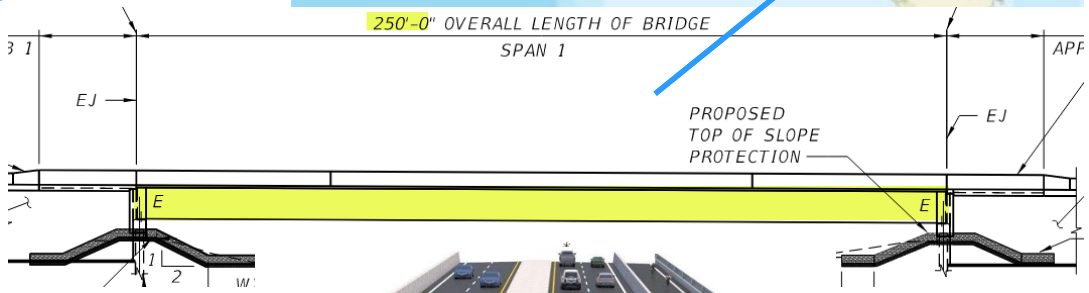


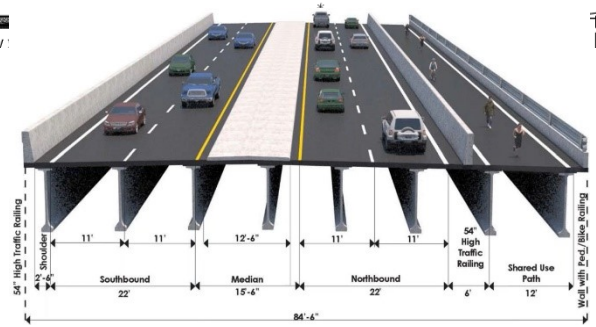
UHPC 30” H-Pile CR339, Taylor County




UHPC Link-Slab,
US-41/Sunset Canal







Innovative Structural Research & Demonstration Project implementation by the Florida DOT (2021)

Implementing ATP's and ADAB for Longer-Lasting Bridges & Structures

Negative effects of a more agile and equitable process?

- **Agile** – *mistakes due to new procedures & doing more with the same or less.*
- **Equitable** – *cost & time for design and/or construction.*

- **Incentives** – ATP's = *no cost sharing with the Department,*
  – ADAB = *additional design fees.*
- **Empowering other Stakeholders** – ATP's = *loss of control,*
  – ADAB = *more bid effort for Contractors.*

Implementing ATP's & ADAB for Longer-Lasting Bridges & Structures

Inspire Innovation

Negative effects of a more agile and equitable process?

- **Agile** – *mistakes due to new procedu same or less*
- **Equitable** – *cost & time for design a*
- **Incentives** – *How much will it cost?*
  Alt. Design/Alt. Bid (ADAB) →
- **Empowering other Stakeholders** –

WORK PROGRAM OVERVIEW
$3B NEW LETTINGS BREAKDOWN (FY21/22)

Program Plan	Program Plan Amount	Construction Budget	Construction Amount	New Lettings	New Lettings Amount
Construction	$4,149.6	New Lettings	$3,341.9	Roadway	$1,478.5
				Roadway Resurfacing	$909.3
				Bridge Replacement	$345.6
				Other Lettings	$333.3
				Safety	$166.0
				Bridge Repair	$66.8
				Traffic Operations	$42.4
				Total	**$3,341.9**
		Contingency	$485.2		
		P3 Payments	$172.6		
		LAP Lettings	$120.2		
		Bonus Payments	$29.7		
		Total	**$4,149.6**		
Operations and Maintenance	$1,539.7				
Public Transportation	$1,288.7				
Preliminary Engineering	$1,034.0				
Right of Way	$708.7				
CEI	$567.6				
Administration and Other	$560.3				
Other Product and Product Support	$514.1				
Total	**$10,362.7**				

20 Alt. Bridge Designs/yr.
@ 100 hrs. (average)/project
~ $200K ~ 0.06% BR Const.
< 0.25% BR Design

Implementing ATP's & ADAB for Longer-Lasting Bridges & Structures

Positive outcomes of a more agile and equitable process?

- **Agile** – *more responsive to innovation and scalable deployment*
  – *could bring new business to Florida if market is seen as more open than other states.*
- **Equitable** – *all solutions are evaluated based on value.*

- **Incentives** – *Technology Transfer and Skills building,*
  – *makes FDOT look even more progressive!*

- **Empowerment of other Stakeholders** – *more buy-in or "ownership" of the implementation challenges*

Implementing ATP's & ADAB for Longer-Lasting Bridges & Structures

Options to move forward:

1. Have ***SDO**'s* prepare all the alternate designs, but:
   - *Not enough in-house staff/resources (~ 20 projects/year)*
   - *Perhaps limited to tools development & technical support*

2. Have ***Design Consultant*** contracts allowed negotiable additional hours, for alternate designs:
   - *Superstructure designs & retaining walls only;*
   - *Keep same span configuration & depth for simplicity;*
   - *Improve knowledge transfer, skill and confidence building.*
   - *Keep low-bid construction procurement for now.*

Questions

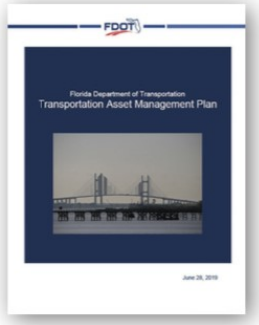
PERFORMANCE › HIGHWAY INFRASTRUCTURE CONDITION

HOW DOES THE FTP ADDRESS THESE TARGETS?

Florida has a long-established and highly effective approach to preservation and maintenance of its bridge and pavement assets. The current practices for asset management are rooted in statutory requirements and implemented by FDOT's strong commitment to maintain the existing infrastructure before implementing capacity projects.

The FTP reinforces this legislative commitment by identifying "agile, quality, and resilient infrastructure" as a long-range goal for all of Florida's transportation system. The current FTP identifies strategies to support this goal, with greater emphasis on identifying and mitigating risks related to extreme weather, climate, and other trends.

Florida's **Transportation Asset Management Plan (TAMP)** describes FDOT's objectives, measures, and processes for improving or preserving the condition and performance of NHS bridge and pavement assets. The TAMP is consistent with the FTP and identifies actions needed to meet the two- and four-year targets. Example strategies documented in the TAMP include:



- **Program the replacement or repair** of all structurally deficient FDOT-maintained bridges and those bridges posted for weight restriction within six years of deficiency identification and program the replacement of all other FDOT-maintained bridges designated for economy replacement within nine years of identification.
- **Balance the programming** of resurfacing projects in relation to needs and optimize the timing of projects through the pavement management system.

In addition, as required by 23 CFR Part 667, FDOT has conducted two statewide evaluations of facilities repeatedly requiring repair and reconstruction due to emergency events. The first evaluation, completed in 2018, focused on NHS roads and bridges. The second evaluation, completed in 2020, included non-NHS roads and bridges that had previously undergone emergency repairs using federal funds. These reports identified a small number of facilities in Escambia, Franklin, Leon, Monroe, and Pinellas counties where emergency repairs had occurred on more than one occasion following an emergency event between 1997 and 2019. Per federal rule, FDOT will determine if there are reasonable alternatives prior to including projects on these facilities in future updates to the Work Program. FDOT will coordinate with MPOs on project priorities identified by the MPOs on these facilities for potential inclusion in the Work Program, and also consider this information in updates to the TAMP. FDOT will update the evaluation following every emergency event, as well as on a regular four-year cycle.

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