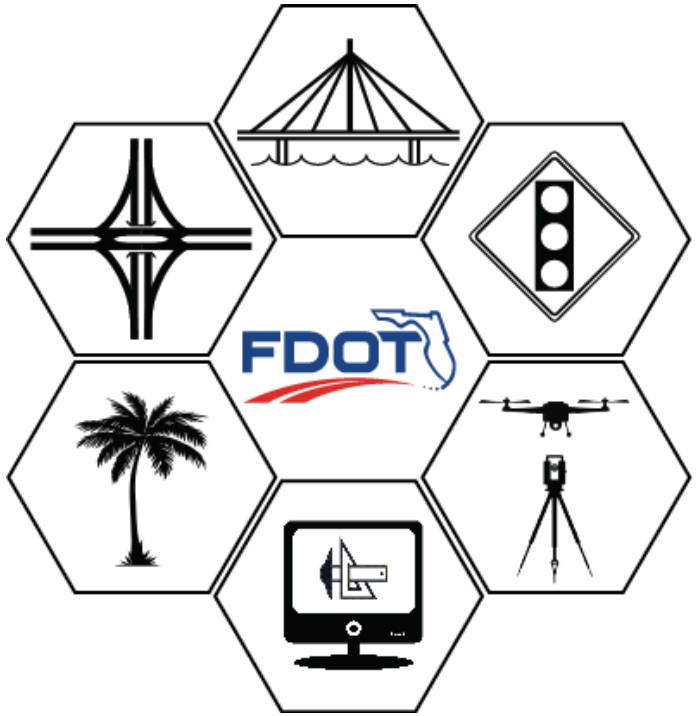


FDOT TRANSPORTATION SYMPOSIUM 2019

UHPC in Bridges in Florida

Steve Nolan and Todd Mitchell

FDOT TRANSPORTATION SYMPOSIUM

UHPC in Bridges in Florida - *Outline*

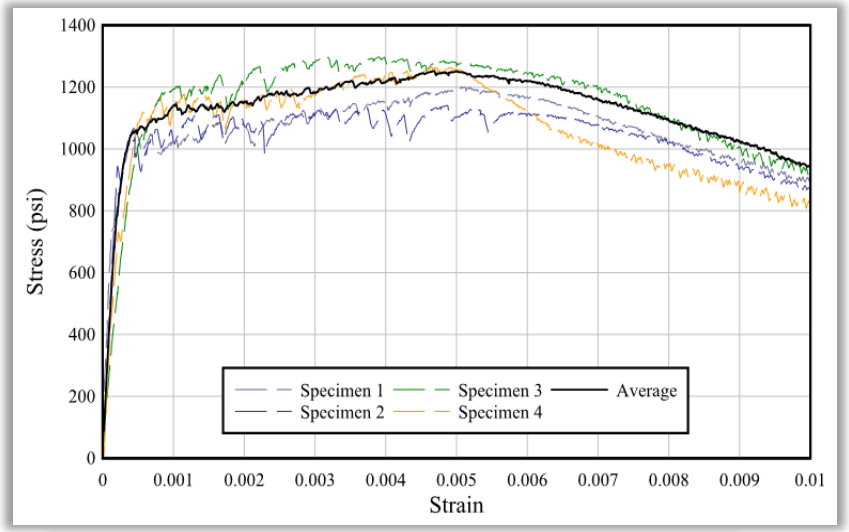
- What is UHPC?
- FDOT Current Design Guidance & Resources;
- Florida Projects completed or approved;
- Project Showcase (with Video);
- Ongoing Research;
- What Next?

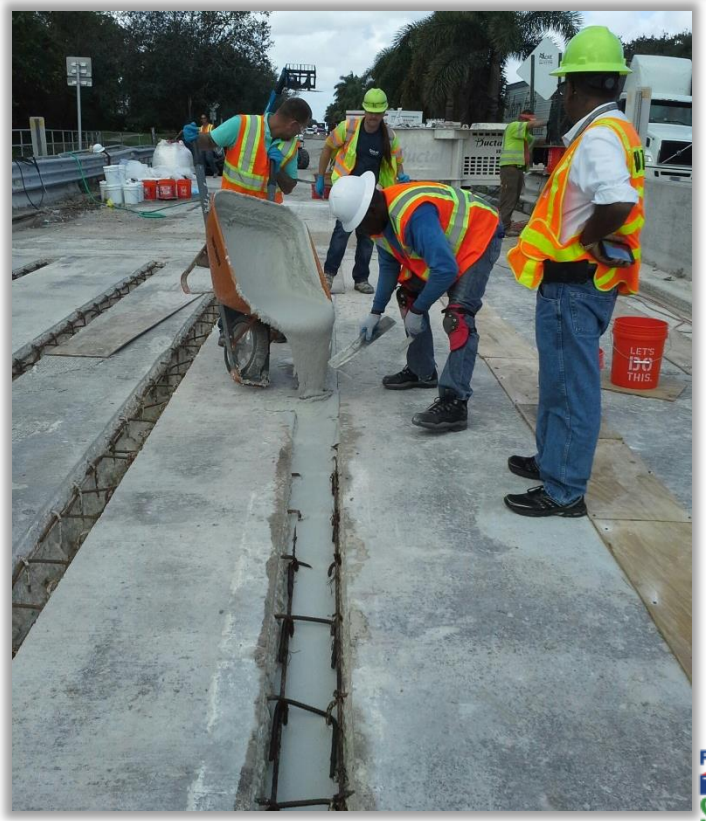
https://transportationsymposium.fdot.gov/User/ClassDescription?classdescription=UHPC%20Bridges%20in%20Florida

What is UHPC?

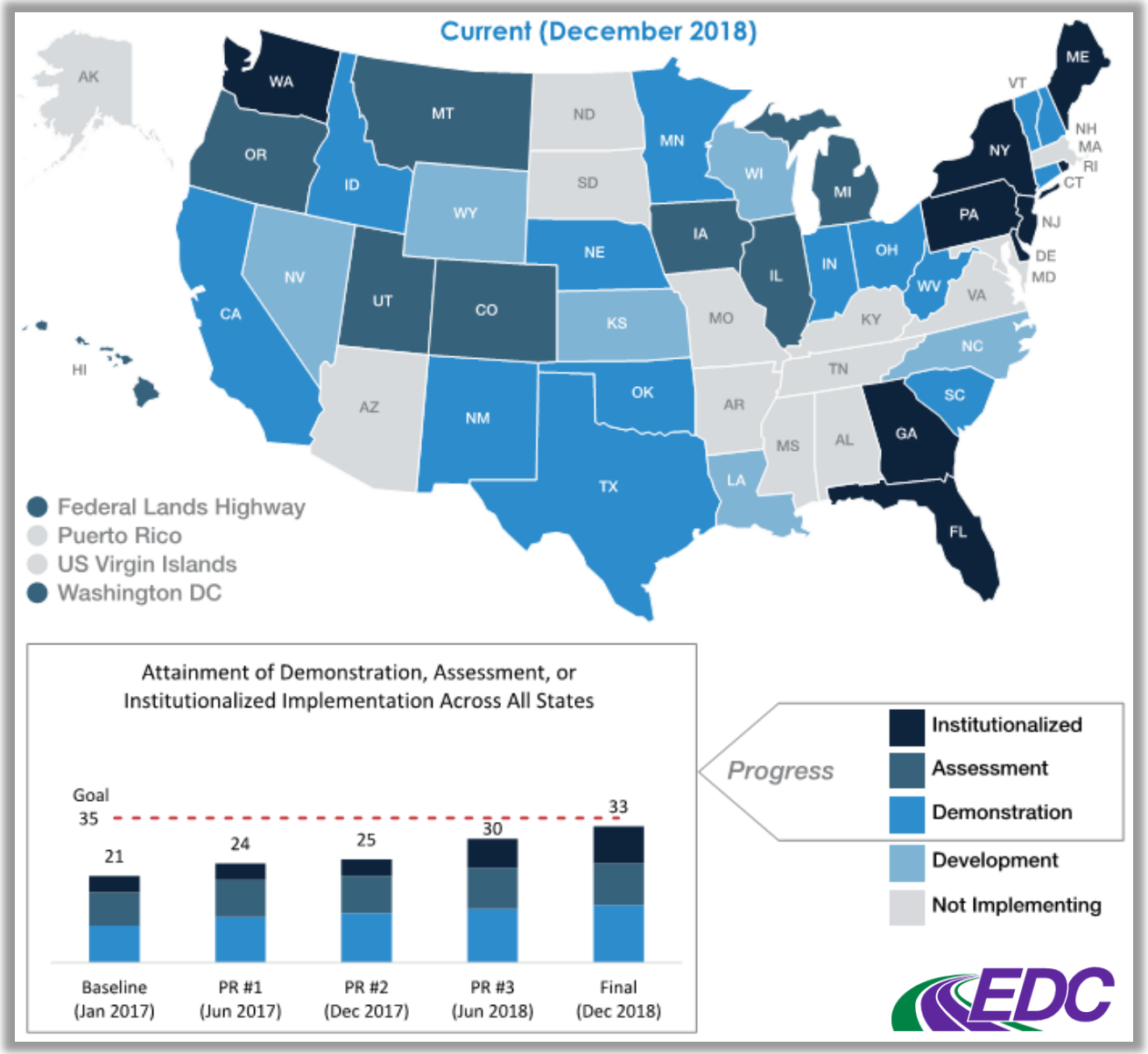
- **Ultra-high performance concrete** (**UHPC**) can be used to create simple, strong, long-lasting connections needed for successful construction using prefabricated bridge elements.
- **UHPC** is a steel fiber-reinforced, portland cement-based composite material that delivers performance far exceeding that of conventional concrete.
- Field-cast **UHPC** has emerged as a solution for creating connections between prefabricated components with better long-term performance than typical connection designs.
- **UHPC** allows for small, simple-to-construct connections that require less concrete and do not require post-tensioning.
- The mechanical properties of **UHPC** allow for redesign of common connection details in ways that promote ease and speed of construction.

Source (April 2019):
https://www.fhwa.dot.gov/innovation/everydaycounts/reports/edc4_final/





What is UHPC? – *EDC 3 & 4*



- 33 States attained have demonstration, assessment, or institutionalized stages of implementing **UHPC** connections for prefabricated bridge elements
- FDOT has completed four construction projects with a 5th awarded:

  (*https://www.fdot.gov/structures/innovation/uhpc.shtm#Projects*)
- FDOT has six related research projects: *-06; -11; -28; -94; -101; -105.*

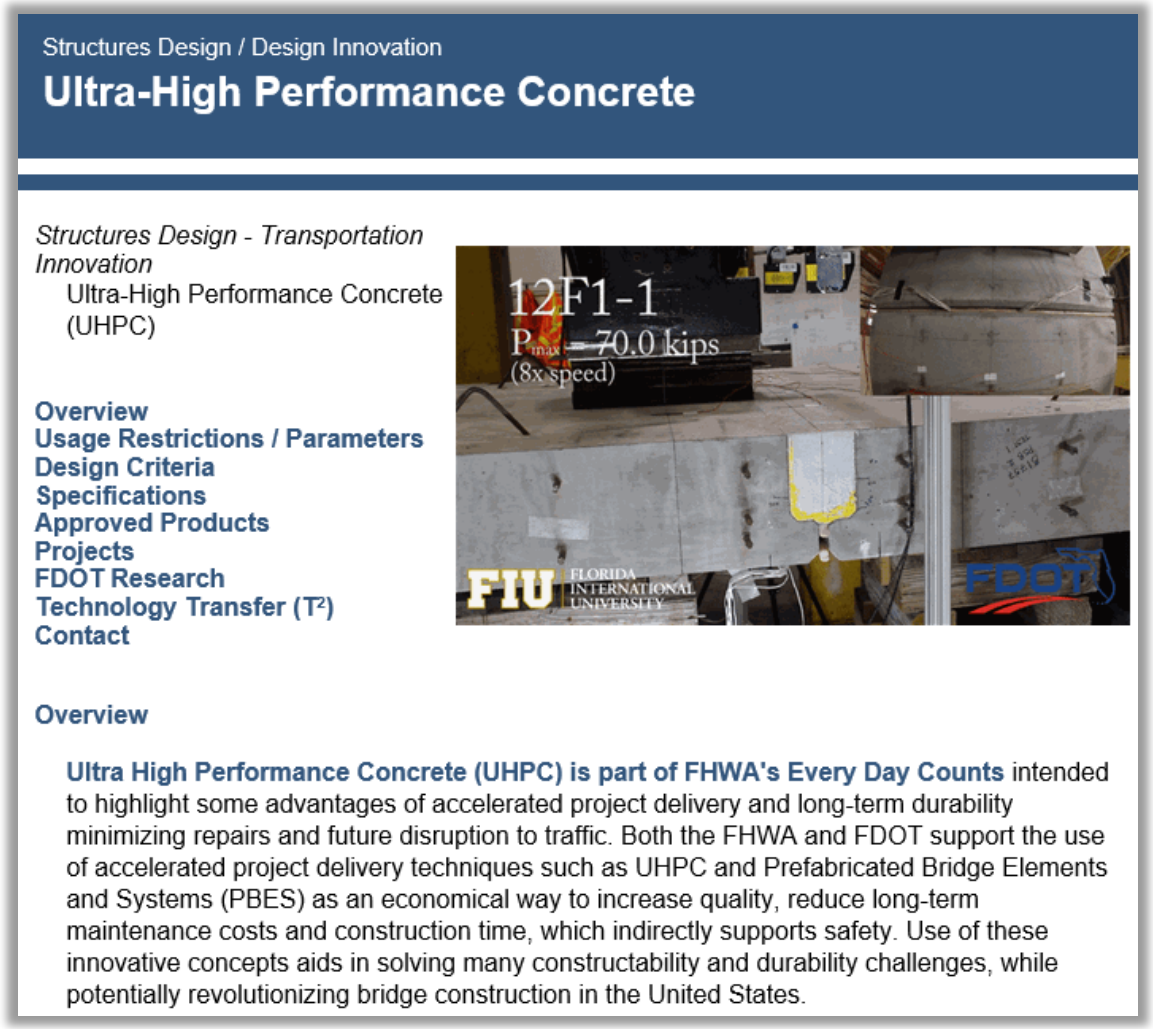
  (*https://www.fdot.gov/research/documents.shtm*)

What is UHPC? – *EDC 3 & 4*

Pulaski Skyway (NJ)

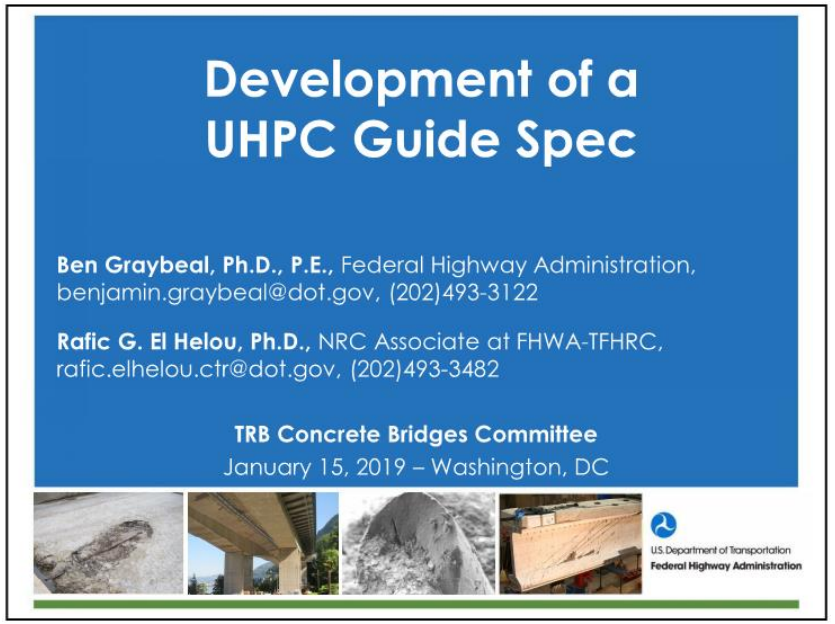
- The 3.5-mile-long deck replacement in northern New Jersey was completed in 2018 after nearly 5 years of construction.
- The **New Jersey Dept. of Transportation** used precast deck panels connected with **UHPC**, stainless steel rebar, and a polyester concrete overlay to maximize the durability of the new deck and minimize the need for future repairs and traffic disruption on the heavily traveled bridge.
- The project is the largest user of **UHPC** to date in North America, using more than **5,000 cubic yards of UHPC** to connect nearly 1 million square feet of deck panels.

FDOT Current Design Guidance & Resources



http://www.fdot.gov/structures/innovation/UHPC.shtm

- **FDOT *Developmental Spec* 349;**
- **Transportation Pooled Fund** 1434/TPF-5(366);
- **FHWA** *Guide Specification Development*;



FDOT TRANSPORTATION SYMPOSIUM

FDOT Current Design Guidance & Resources

Structures Design / Design Innovation

Ultra-High Performance Concrete

Structures Design - Transportation Innovation

Ultra-High Performance Concrete (UHPC)

Projects:

FDOT and affiliated projects in Florida can be explored using theFHWA Tool. Please contact the coordinators at the bottom of the page to have your in the Map.

Fast-Facts sheets for selected projects are listed below:

- **I-95 over CR5A - Precast Deck Panel Replacement**
- I-95/JT Butler Interchange Bridge U-Beam Repair
- **SR 714/Danforth Creek - Sonovoid Rehab**
- **US441 over Taylor Creek - Span 12 Replacement**
- **US41 over Sunset Waterway Link-Slab**

http://www.fdot.gov/structures/innovation/UHPC.shtm

- **Project Fast-Facts Sheet**

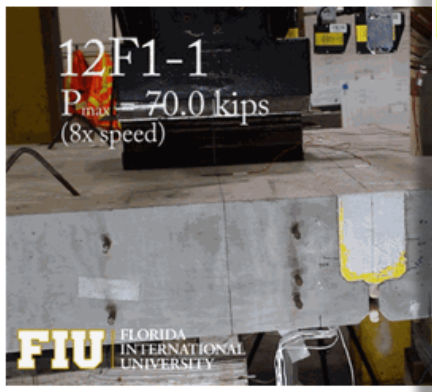
FDOT Current Design Guidance & Resources

Structures Design / Design Innovation

Ultra-High Performance Concrete

Structures Design - Transportation Innovation

Ultra-High Performance Concrete (UHPC)



Overview
Usage Restrictions / Parameters
Design Criteria
Specifications
Approved Products
Projects
FDOT Research
Technology Transfer (T²)
Contact

Overview

Ultra High Performance Concrete (UHPC) is part of FHWA's Every D
to highlight some advantages of accelerated project delivery and long-ter
minimizing repairs and future disruption to traffic. Both the FHWA and FD
of accelerated project delivery techniques such as UHPC and Prefabricated Bridge Elements and Systems (PBES) as an economical way to increase quality, reduce long-term maintenance costs and construction time, which indirectly supports safety. Use of these innovative concepts aids in solving many constructability and durability challenges, while potentially revolutionizing bridge construction in the United States.

http://www.fdot.gov/structures/innovation/UHPC.shtm

- **Design Criteria**

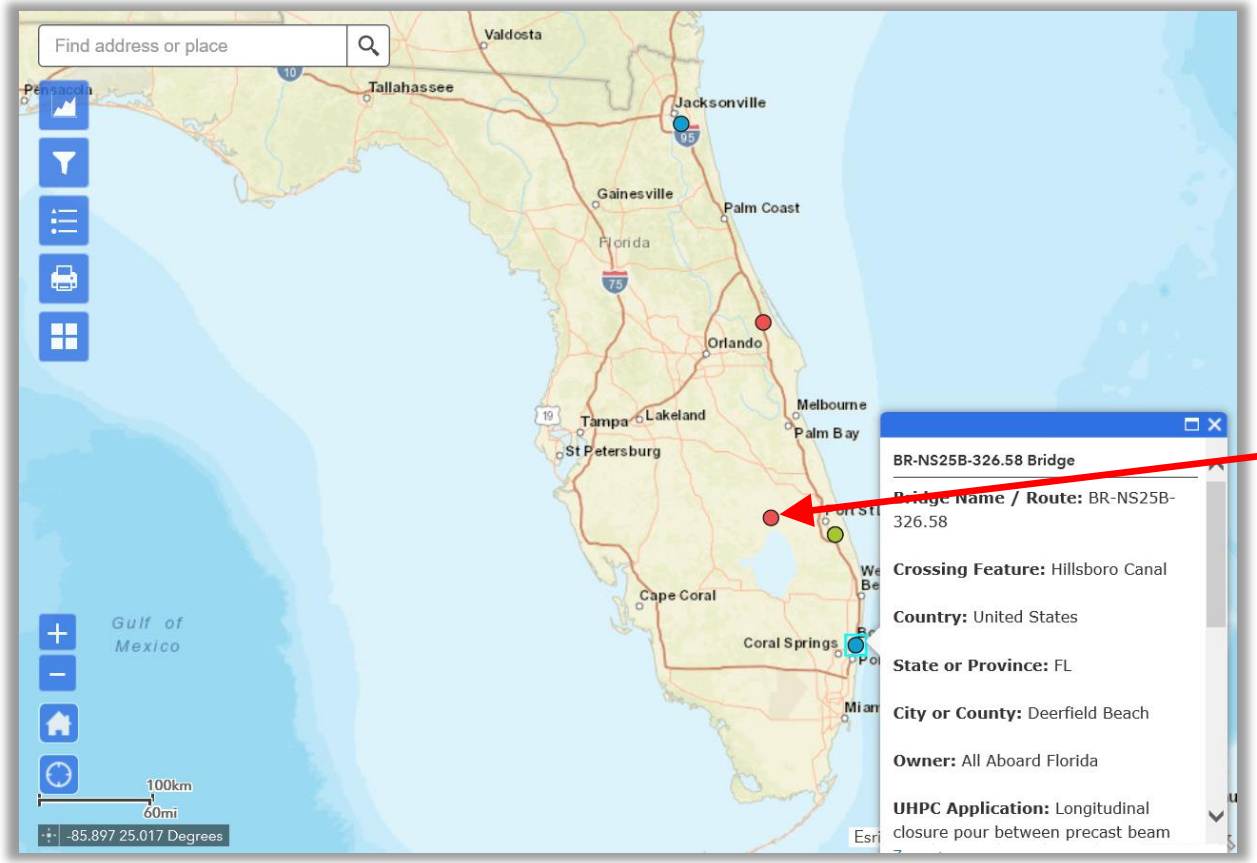
Design Criteria

See the following references for the application of UHPC for concrete reinforcement:

- **Ultra-High Performance Concrete: A State-of-the-Art Report for the Bridge Community (FHWA-HRT-13-060)**
- **Design and Construction of Field-Cast UHPC Connections (FHWA-HRT-14-084)**
- **Field Testing of an Ultra-High Performance Concrete Overlay (FHWA-HRT-17-096)**
- **Properties and Behavior of UHPC-Class Materials (FHWA-HRT-18-036)**
- **FHWA Every Day Counts EDC 3 Final Report, pg. 52, May 2017.**(discusses FDOT UHPC projects)

Florida Projects completed or approved…

- FHWA's UHPC Bridges Interactive Map



https://usdot.maps.arcgis.com/apps/webappviewer/index.html?id=41929767ce164eba934d70883d775582

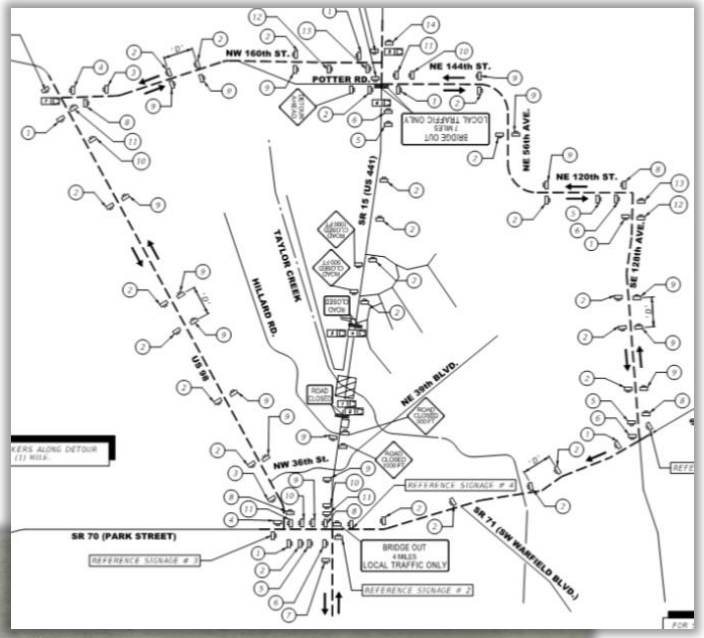
1. **SR 714/Danforth Creek** - D4, Sonovoid longitudinal joint rehabilitation;
2. **I-95/JT Butler Interchange** – D2, Spliced U-girder repair;
3. **I-95 over CR5A** – D5, Precast deck panel replacement:
4. **US 441/Taylor Creek** – D1, Precast bridge deck beam longitudinal joint;
5. **Railroad Bridge over Hillsboro Canal** – All Aboard Florida (now *Virgin Trains USA*): Longitudinal decked beam joints;
6. ***New -*** **US41 over Sunset Waterway** – D1, Link-slab with FRP rebar – *8/27/19 project construction begins.*

US 441 Over Taylor Creek #910021

- 12 Span Bridge North of Okeechobee
- Originally Constructed 1958
- Rehabilitated 2009

Why this project?

- Span 12 had severe cracking to bottom of deck
- Previous 2009 Repair failed
- Needed quick span replacement to minimize a 30 mile detour on major truck corridor
  - Orange industry is second largest industry in Florida
- Access needed for school buses Friday and Monday



Accelerated Bridge Construction needed!!

US 441 over Taylor Creek

- The span would be replaced in a weekend
  - Closing Friday night 8pm
  - Opening Monday 7am
- Conventionally Reinforced Precast Slab Units
  - Cast weeks ahead of closure
  - Adjacent to bridge for quick construction
- Use UHPC for closure pour
  - Concrete $1,000/cy
  - UHPC $5,000/cy

UHPC vs. FDOT Standard Mix Designs

- **UHPC 15,000 psi**
  - Cement Premix 3700 lb/cy
  - Water 219 lb/cy
  - Super Plasticizer 51 lb/cy
  - Accelerator 39 lb/cy
- **UHPC**
  - Density 155 lb/cf
  - Slump 0.5 in
  - Cure Time 12 hr

- **FDOT 5,500 psi Mix Design**
  - Cement/Flyash 700 lb/cy
  - Water 296 lb/cy
  - Aggregate 1550 lb/cy
- **FDOT**
  - Density 140 lb/cf
  - Slump 7 in
  - Cure Time 28 days

Construction Schedule

- **Friday**
  - 8pm – Close bridge
  - 9pm - Start span demobilization
- **Saturday**
  - 6am – Start bridge prep
  - 8am – Move Slab
  - 12pm – UHPC Pour
  - 4pm – Start UHPC cure clock (Cures 1ksi/hr @ 120 deg F)
  - 11pm – UHPC reached 6000psi
    - Time to Grind/Groove
- **Sunday**
  - 5am – Start Striping Bridge
  - Start Demobilization of Equipment
  - 9pm – UHPC reached 14,000 psi
  - 10am – Remove MOT
  - 10 pm – Open Road

- Conventional Span Replacement – 55 days scheduled
- Design target time 5 am Monday

Construction time

Moved Span into place

- Saturday 8am

Preparing for UHPC

- Saturday 10am

Seal underside for water tightness

Anchor well!

Water 62.4 lbs/ft

UHPC 155 lbs/ft^3

Safety Meeting Prior to Pour Avoiding Sicilia Exposures

- Silicosis, is an irreversible illness as a result to silica dust

Mixing Starts

- Add dry mix

- Measure (3) admixtures

- ½ Steel fibers for strength

Mixing Starts

- Add dry mix

- Test prior to pour

- Mixer only makes 0.2 yd^3 per batch
- Needed (3) batches for 20’ of closure pour

Time to Pour

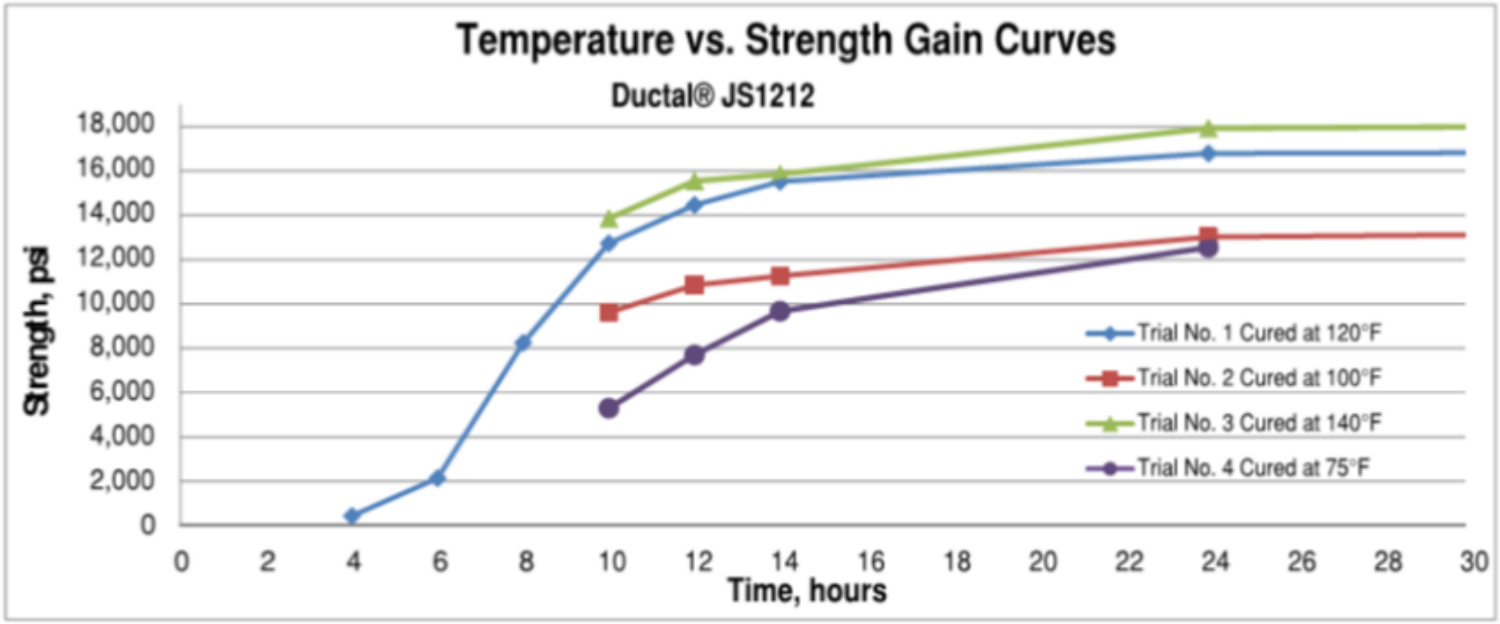

CONE &
GRAHAM
HEAVY CONSTRUCTION

Always pour from one end to avoid cold joints

- Do NOT vibrate UHPC
  - Causes steel fibers to settle
- Break the skim coat ahead of pour to promote adhesion

Monitor the Temperature for curing

- UHPC
  - 7 Hrs – 6,000 psi
  - <12 Hrs – 14,000 psi
- Standard FDOT Deck Design
  - 28 days – 4,500 psi



Fill the bucket with UHPC to ensure joint is even with slab

Time to Grind

- Used a larger grinder for most of the deck
- Hand grinders (right) next to curbs

The Final Product!

- Remove existing brackets and patch

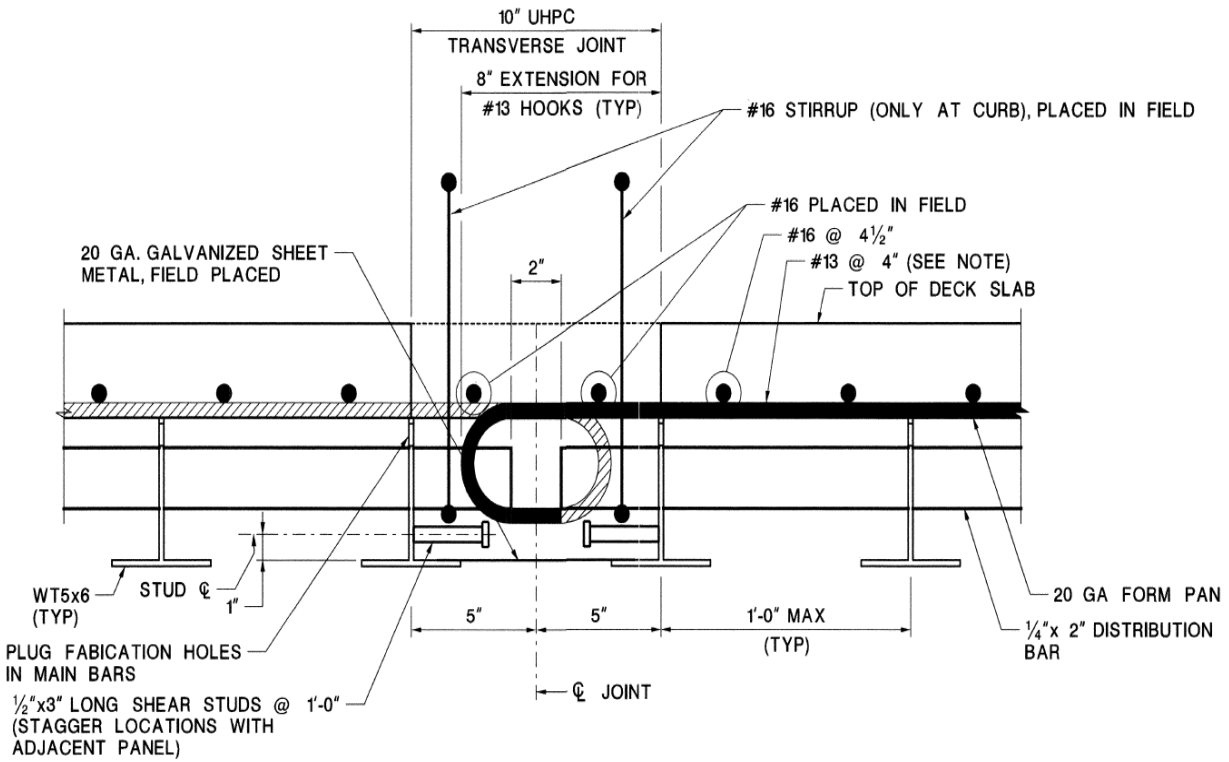
- Place new slab on ¼” neoprene pad

Lessons Learned – from the Contractor

- Due to high truck traffic, no lane closures were allowed from 7 am to 7 pm
  - This made as-built measurements difficult
- Close coordination between both Central Office and the District Material Office
- The UHPC product performed well was easy to place
  - Does require a work plan and upfront coordination
  - Contractor would tweak their curing and temperature monitoring process

Other UHPC Details

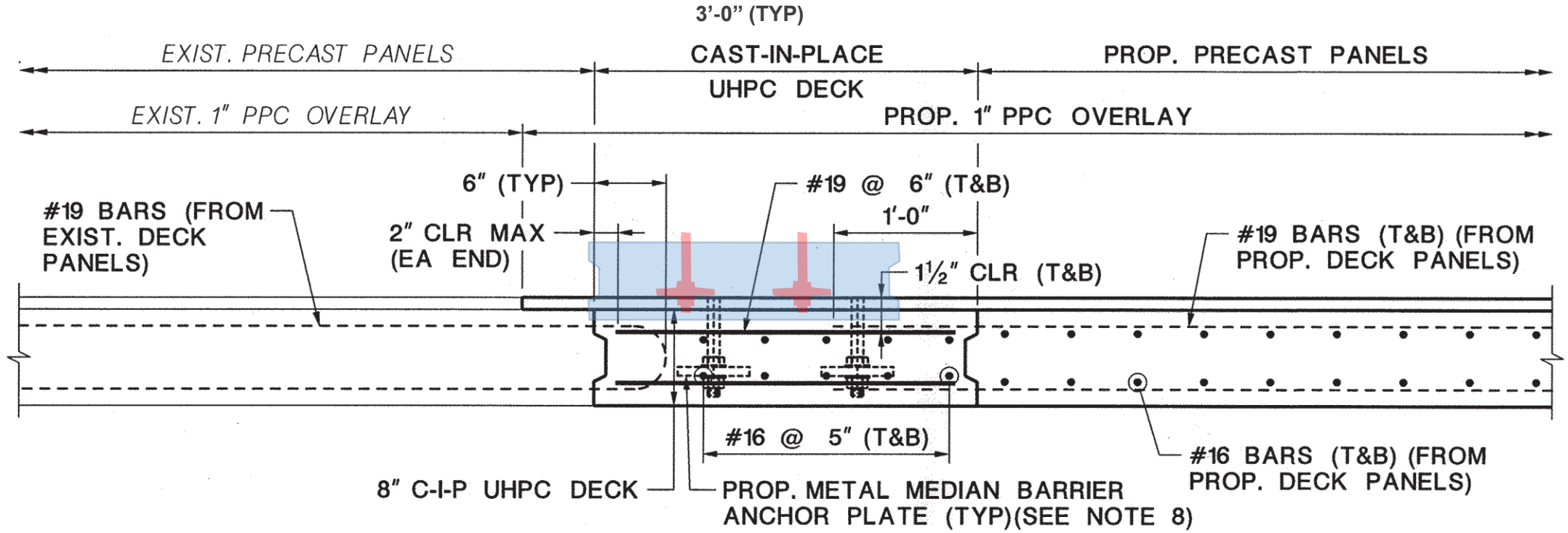
Transverse Panel Joints – Exodermic®



- Benefits of UHPC
  - High Strength
- Narrow Joints, time savings
  - Fast Cure
  - Time Savings
- Flowability
  - Little to no risk of air pockets in congested joints, especially for Exodermic® panel joints
- Durability
  - Joints are more durable than panels, enables full realization of durability measures incorporated in panels.

Other UHPC Details

Longitudinal Joint at Median



Other UHPC Details

Longitudinal Joint at Median

Benefits of UHPC

- High Strength
  - Short rebar development enabled staged construction without rebar couplers, saves time
- Fast Cure
  - Time savings
- Flowability
  - Little to no risk of air pockets in area congested with median barrier anchors
- Durability
  - Median is more durable than panels, enables full realization of durability measures incorporated in panels.

Ongoing FDOT and Related Research

SMO

- **BDV31 977-94**: *"Requirements for Use of Field-Cast, Proprietary UHPC in Florida Structural Applications"* - Completed April 2019;
- **BDV31-977-105**: Requirements for nonproprietary *"UHPC Use in Florida Structural Applications"* – *Began April 2019;*

SDO

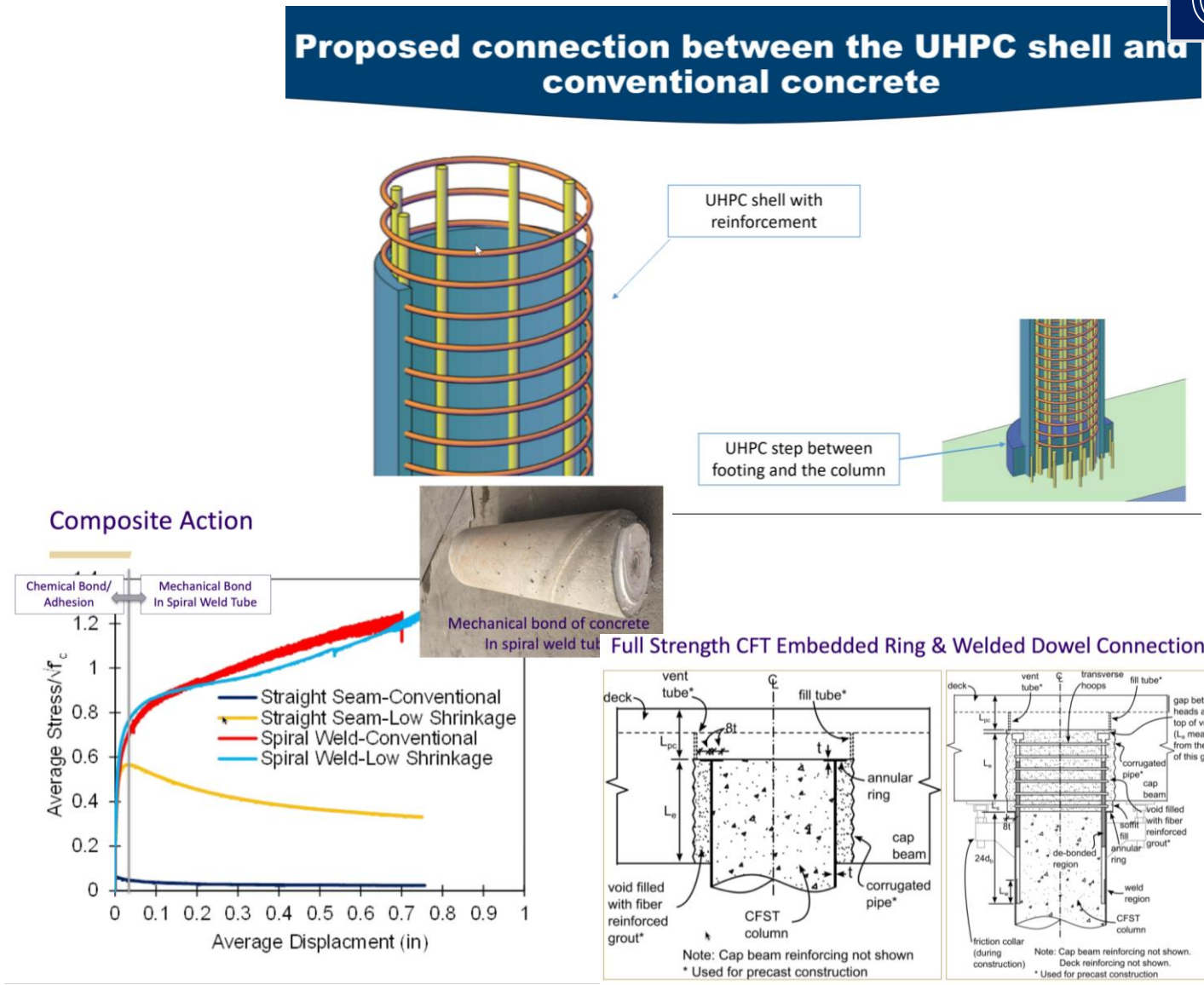
- **BDV29 977-28**: *"FSB Bridge with UHPC Joint Connections"* - 5/1/19;
- **BDV31-977-101**: *"Hybrid Prestressed Concrete Bridge Girders using UHPC"* - 1/31/20;
- **SRC**: *"Large Bars Spliced in UHPC for Bridge Substructure Connections"*, (#8 to #11 bars) - 10/31/19;

Other

- **PCI Research and Development Council:** Multi-year study on UHPC prestressed beam applications. *RFP*;
- **TxDOT** ($1.3M – 4 years) *RFP 19-44* *"Utilization of UHPC Bridge Superstructures in Texas"*

What Next? *ABC-UTC Research*

- **UHPC Shells**
  - Columns
  - Caps
- **Connections**
  - Socket/Pocket
  - CFT Full-moment
- **Encapsulation**
  - Bend End Repairs
  - Pile Corrosion Mitigation



What Next? *ABC-UTC Technology Transfer*

W-03: Non-Proprietary UHPC for ABC, Part 1: Mix Development and Material Properties

Wednesday, December 11, 2019 – 8:00 a.m. to 12:00 p.m.

Workshop Coordinator: Royce Floyd, OU

Speakers (invited): Atorod Azizinamini, FIU; Royce Floyd, OU; David Garber, FIU; Mohamed Moustafa, UNF
John Stanton, UW; Jeffery Volz, OU

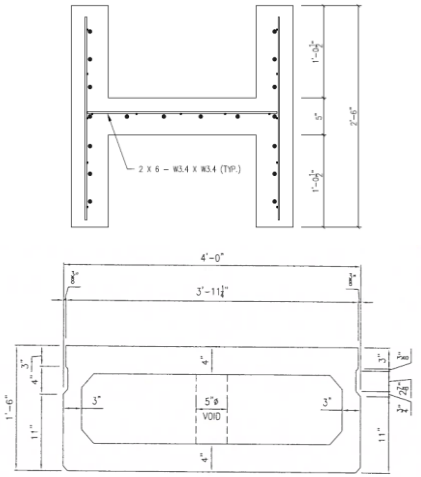
Ultra-high-performance concrete (UHPC) has the potential to provide significant benefits in many applications for ABC due to its superior mechanical and durability properties. This workshop will cover the basics of non-proprietary UHPC mix development, material properties, and applications of non-proprietary UHPC mix designs for ABC. It will include presentations on the need for non-proprietary UHPC, mix design development and material selection, non-proprietary UHPC material properties, effect of regionally available materials on mix performance, and results of ongoing research sponsored by the ABCUTC on structural behavior and durability of non-proprietary UHPC.

9:10-9:40 AM	FDOT Experience with PBES for Small-Medium Span Bridges ***Steven Nolan** - Florida Department of Transportation **Sam Fallaha** - Florida Department of Transportation **Vickie Young** - Florida Department of Transportation	FRIDAY BREAKOUT SESSIONS

FDOT TRANSPORTATION SYMPOSIUM

What Next? *Precast Industry*

- **Standard Concrete Products, Inc:**
  - *First UHPC octagonal pile tested at SRC in April 2018 another one waiting – status.*
  - *Looking at Hollow-Core Slab Beams*
- **Durastress (Cor-Tuf):**
  - *18” sq. solid UHPC piles*
    - *Flexure test 4/2/19 SRC 4-point bending on 30’ pile, single visible crack at point of failure*
    - *4/4/19 driving of 100’ pile (5+ksi comp & 1.6 ksi tension driving stresses with no detectable damage);*
    - Video link 18” PC Pile fabrication, SRC testing and piling diving https://m.youtube.com/watch?v=0VXKIJbIiUo#



Questions

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