Prestressed/Precast Florida-Slab-Beams for Robust Local Bridges and Accelerated Construction

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Featured Speaker: Steve Nolan, P.E., Senior Structures Design Engineer,

Description: The Florida-Slab-Beam (FSB) is a standard for local bridge construction in Florida. This presentation will include:

1) Part 1 - An overview of the FDOT's ABC-EDC Policy;

2) Part 2 – Development and implementation of the FSBs, including:
   a) Highlights from the first demonstration project in Tallahassee using ABC techniques, lessons learned, and subsequent improvements made to the FSB system;
   b) FDOT’s development of complete superstructure Standard Plans for efficient and consistent incorporation into local bridge projects and broader deployment;
   c) Ongoing research to incorporate UHPC connections into the FSB system to further accelerate construction and improve robustness of the connections between PBES elements; and
   d) Discussion of early efforts and future plans to incorporate corrosion-resistant materials into the FSB system with the goal of further improving durability and lengthening the maintenance-free service life. The presentation will include design and construction details as well as lessons learned.
Part 1: Overview of the FDOT’s ABC-EDC Policy

FDOT Structures Manual (Vol.1-SDG & Vol.2-SDM) and the Florida Design Manual (FDM) formally the PPM

- Florida’s History of ABC/PBES Projects
- Current Policies
  - Project Evaluation for ABC
  - Available Resources
- Recent Projects
  - US 90
  - Orange Ave.
Introduction: Past FDOT Projects

Example Projects:

- US 41 (Business) Edison Bridge (1993);
- I-295 Southbound Buckman Bridge (1997);
- Reedy Creek WDW (1997 - Privately Funded);
- SR 300 St George Island Bridge (2004);

Photo: Berger/ABAM Engineers Inc.
Projects that benefit from ABC-PBES:

- Large projects: Assembly line/mass production was economical
- Water Projects: Minimize work over water

Strategies and details are evolving as a result of the in-house efforts and the increasingly competitive Design-Build environment.
**Bridge Development Report** (BDR)

- Procedure outlined in the *Plans Preparation Manual (PPM)* Section 26.9

- **PPM** 26.9.2.9: “Investigate the use of either partial or full precast bridge alternate(s) with the specific purpose of accelerating bridge construction and reducing user impacts.”

- Conduct Feasibility Study: Example Questions are in **PPM Exhibit 26-F**.
Factors to consider during **BDR Feasibility Study** Include:

- Traffic Impacts
- Hurricane Evacuation Routes
- Aesthetics
- Durability
- Connections
- Practicality
- Constructability
- Etc.
### SAMPLE ASSESSMENT MATRIX
- *example values in italics*

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<th>Selection Factor</th>
<th>Factor Weight (%)</th>
<th>Score (0 to 5)</th>
<th>Weighted Score*</th>
<th>Score (0 to 5)</th>
<th>Weighted Score*</th>
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<tr>
<td>Factor 5 - Construction Duration</td>
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<td>Factor 6 - Durability</td>
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<tr>
<td>Factor 7 – Environmental Impacts</td>
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<td>5</td>
<td>50</td>
<td>2</td>
<td>20</td>
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<td>Factor 8 – Aesthetics</td>
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<td>5</td>
<td>75</td>
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<td>45</td>
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<tr>
<td>Factor 9 – Other</td>
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<tr>
<td>Factor 10 – Other</td>
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<tr>
<td><strong>TOTAL (Σ Factor Weights = 100%)</strong></td>
<td>100</td>
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<td>410</td>
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<tr>
<td><strong>TOTAL (Excluding Indirect Cost Factor)</strong></td>
<td>90</td>
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<td>360</td>
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</table>

*Weighted Score = Factor Weight x Score  **See following explanation, Instructions “6.”*
Current FDOT Policy

◆ If Precast is not an advantage:
  ✓ Explain the reasons in the BDR.

◆ If Precast alternate is viable:
  ✓ Evaluate preliminary precast alternate and associated Traffic Control compared to conventional using the assessment matrix in PPM Exhibit 26-F.
  ✓ Provide a preliminary cost estimate.
  ✓ Discuss with District Structures Design Engineer prior to finalizing recommendation in BDR.
Resources

Developed By Structures Design Office:

- **Structures Detailing Manual** *(SDM)*, Section 25 = PBES
- Case Studies: Considerations for Prefabricated ABC Approach.
- Case Studies: Cost Comparisons Conventional Versus Prefab Construction.

Posted on **Structures Design Office** website:

http://www.fdot.gov/structures/innovation/PBES.shtm
http://www.fdot.gov/structures/edc/

Other Links:

http://www fhwa dot gov/bridge/prefab/successstories/091104/index cfm
http://www fhwa dot gov/bridge/prefab/if09010/
Resources

**Structures Detailing Manual**, Section 25 = PBES

- Design and Construction of PBES
- Components and Connections
- Examples
Figure 25.3.3-2  Precast Unit Connection

Include consideration of sweep with fabrication and erection tolerances in joint reinforcement placement.
Resources: SDM Examples

Figure 25.3.3-4 Headed Bars and Hooks Closure Pour

- Headed Bars
- Staggered Hooks/Headed Bars to facilitate placement
Figure 25.4.3.4-2  Shaft-Column Connection

- Pre-Cast Column
- Grouted Sleeve Coupler
- ½" Grout Joint with Shim for Grade Control

With Spread Footing (No Piles)
Figure 25.4.3.6-1 Precast Footing
**Figure 25.4.3.8-2 Pile Cap Erection Process**

1. **Step 1:** Cut Piles to prescribed elevations based on Modified Special Provisions.

2. **Step 2:** Set Precast Cap on bed of grout and on the Friction Collar at the prescribed elevation, displacing excess grout.

3. **Step 3:** Insert Cage/Seal Plug.

4. **Step 4:** Field bend Pedestal Bars.

5. **Step 5:** Presoak five hours to Saturated Surface Dry condition. Cast Plug and Pedestal.
Figure 25.4.3.8-2 Pile Cap Erection Process

Step 1: Cut Piles to prescribed elevations based on Modified Special Provisions.

Step 2: Set Precast Cap on bed of grout and on the Friction Collar at the prescribed elevation, displacing excess grout.

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Recent FDOT Projects

US 90 over Little River in Gadsden County, FL:

- 2 - Four Span Bridges 436’ long
  - Precast Bent Caps, Beams and Deck Panels
  - Constructed in 2014

- 2 - Simple Span Bridges 110’ long
  - Precast Beams and Deck Panels
  - Constructed in 2014
US 90 over Little River
US 90 over Little River
US 90 over Little River
US 90 over Little River
ABC-PBES Other Benefits

- Improve Durability/Quality.
- Enhance Aesthetics.
- Reduce Environmental Impacts.

Quality

Speed

Cost
Part 2: FSBs for Robust Local Bridges

**Featured Speaker:** Steve Nolan, P.E., Senior Structures Design Engineer, State Structures Design Office, Florida Department of Transportation

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# Standard Plans (Design Standards) Primer

## eBooklet
- Combined Available IDS (11mb)

## OF CONTENTS AND REVISIONS
- Cover
- Content
- Introduction
- Revisions

## Abbreviations and Symbols
<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
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<tr>
<td>001</td>
<td>Standard Abbreviations</td>
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<tr>
<td>002</td>
<td>Standard Symbols</td>
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## Erosion Control and Water Quality
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<td>Permanent Erosion Control</td>
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<td>105</td>
<td>Shoulder Sodding and Turf on Existing Facilities</td>
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## Drainage
- (199-288, 293-295) Drainage Contact
- (289-292) Structures Contact
Data Tables (Convey Designer's project specific intent to the Contractor)

Indexes (for Contractor)

IDS (for Designer)
The Road to the FSB’s

- 1944 Precast Units
- 1955 Prestressed Units (PSU)
- 1959 Sonovoids
- 1984 Discontinued use of PSU
- 1988 PSU w/ Transverse P.T.
- 2008 PSU
- 2016 D20450 Series Florida Slab Beam
Precast Slabs Beams (1940’s)

- **Index 1889**: Precast Arched Bottom Beams (1944)
  - 15 foot spans, 34” wide, Grade 33 rebar.
Preceding Slabs Beams (1940’s)

- **Index 2366: Precast Rectangular Slab Beams (1949)**
  - 15 foot spans, 39” wide, Grade 33 rebar;
  - 10” C-I-P closure pour, with lap welded rebar splices.
Precast Slabs Beams (1950’s)

**Index 2569: Precast Rectangular Slab Beams (1950)**

- 15 foot spans, 39” wide, Grade 33 rebar;
- 10” C-I-P closure pour with keyways and lap welded splices.
Precast/Prestressed Slabs Beams (1950’s)

- **Index 3457: Prestressed Rectangular Slab Units (1955)**
  - 15 foot spans, 4’ to 5’ wide, Grade 250 3/8” dia. Strand;
  - 10” C-I-P closure pour with keyways and lap welded splices.
Precast/Prestressed Slabs Beams (1950’s)

- **Index 3684:** Prestressed Keyed Slab Units (1956)
  - ✓ 30 foot spans, 2.5’ wide, two rows of Grade 250 SR strand;
  - ✓ 4” C-I-P structural concrete topping with integral closure pour;
  - ✓ 1’-0” ± C-I-P makeup width/joint.
Index 3684-mod: Prestressed Keyed Slab Units (1958)

- 30 foot spans, 2.5’ wide, two rows of Grade 250 strand;
- 4” C-I-P concrete overlay with integral closure pour;
- 1’-0” ± C-I-P makeup width/joint.
- 2~Transverse Post-Tensioned Bars at third-points (300 ft-lbs.)

There is still at least one example of this type of superstructure under traffic in Florida, CR 445 over Alexander Springs Creek. An engineer from the FDOT State Bridge Maintenance office recently stated, “…my favorite prestressed slab [is], CR-445 over Alexander Springs Creek. Altogether neglected, and nonetheless in excellent condition” (4).

Preceast/Prestressed Slabs Beams (1950’s)

- **Index “various”: Prestressed Voided Slab Units (1959)**
  - 30 foot spans, 2.5’ wide, two rows of Grade 250 SR strand;
  - 1’-0” ± C-I-P makeup width/joint.
  - Asphalt overlay;
  - Transverse Post-Tensioned Bars at mid- or third-points (500 ft.-lbs. tightening torque).
Precast/Prestressed Slabs Beams
(1960’s - 1984)

- **Index “various”:** Prestressed Voided Slab Units (1959)
  - ✓ 30 - 40 foot spans;
  - ✓ Asphalt overlay;
  - ✓ Transverse Post-Tensioned Bars at mid- or third-points (500 ft.-lbs tightening torque);
  - ✓ Reflective cracking due to loss of transverse prestress and grout degradation.
Precast/Prestressed Slabs Beams
(1990 - 2000’s)

- **Index (none):** Prestressed Slab Beams
  - District 7 (Tampa) PSB;
  - Integral 6” structural concrete topping and RC keyway;
**Precast/Prestressed Slabs Beams**

(1990 - 2000’s)

- **Index (none):** *Prestressed Slab Beams*
  - District 7 (Tampa) PSB;
  - Integral 6” structural RC topping and RC keyway;

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<th>Completed</th>
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<td>Pinellas</td>
<td>Causeway Blvd</td>
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<td>2007</td>
<td>CR470/Gospel Island Rd over Lake Henderson</td>
<td>Citrus</td>
<td>CR 470</td>
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<td>2008</td>
<td>Suncoast Parkway Trail over SR 50</td>
<td>Hernando</td>
<td>SR 589</td>
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<td>US301 over Little Bullfrog Creek</td>
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<td>US 301</td>
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<tr>
<td>2010</td>
<td>US301 over Tadpole Creek</td>
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<td>Fred Howard Park Bridge Replacement</td>
<td>Pinellas</td>
<td>Howard Park C’way</td>
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<td>2014</td>
<td>US19 from N. of Whitney Rd to S. of Seville Blvd</td>
<td>Pinellas</td>
<td>SR 55</td>
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<tr>
<td>2017</td>
<td>US301 over Big Bullfrog Creek</td>
<td>Hillsborough</td>
<td>US 301</td>
</tr>
</tbody>
</table>
Precast/Prestressed Slabs Beams
(1990 - 2000’s)

**Poutre Dalle:**

- Poutre Dalle System was a proprietary design originally developed in France
- Adopted by MnDOT in 2005 after a joint AASHTO, NCHRP and FHWA sponsored Scan Tour of Europe in April 2004.
- The system was promoted by FHWA under their Prefabricated Bridge Element Systems (PBES) initiative for use by other states with MnDOT initially holding a workshop showcasing two demonstration projects \(^{(7)}^{(8)}\).


Precast/Prestressed Slabs Beams (2000’s)

- **Index 20350 series:** Prestressed Slab Units (2008)
  - Pilot project began 2008 – SR30 (Gulf County);
  - Statewide Standard published in 2010;
  - 2.5’ to 5’ wide, 12 & 15” thick, CIP 6” RC structural topping;
  - Based partially on recommendations from FDOT Research Project BD545-9 (9);

Precast/Prestressed Slabs Beams (2000’s)

- **Index 20350 series:** Prestressed Slab Units (2008 - 2014)
  - Shrinkage/Reflective cracking issue;
  - Reverted to “Developmental” status in 2012;

**FIGURES:** Typical longitudinal deck cracking in PSU system (a) SR30A using polypropylene FRC, 2011; (b) & (c) CR12A using basalt FRC, 2013; (d) Addition of “Crack Arrest Strip”, 2014.
Precast/Prestressed Slabs Beams (2010’s)

- **Index D20450** series: *Florida Slab Beams (2014)*
  - Pilot project began 2014 – SR373/Orange Ave (Tallahassee);
  - *Developmental Standard* published in 2016;
  - 3’ to 5’ wide, 12, 15”, & 18” thick, CIP 6” concrete structural topping;
Precast/Prestressed Slabs Beams (2010’s)

- **Index D20450 series:** Florida Slab Beams (2014)

- Pilot project – SR373/Orange Ave over St. Marks Trail;
Precast/Prestressed Slabs Beams (2010’s)

Time Lapse Video: SR373/Orange Ave over St. Marks Trail:
Precast/Prestressed Slabs Beams (2010’s)

- Pilot project – SR373/Orange Ave over St. Marks Trail;
- Prestressed-Slab-Beams: prototype for FSB’s (Index D20450 series)
- GRS-IBS (Index D6025)

Figure: January 2015 status of GRS-IBS implementation from EDC-3 Summit Summary and Baseline Report.

http://www.intrans.iastate.edu/research/documents/research-reports/GRS-IBS_implementation_advancements_w_cvr.pdf
PreCast/PreStressed Slabs Beams (2010’s)

- Pilot project – SR373/Orange Ave over St. Marks Trail;
  - Detour length 1.6 miles
Precast/Prestressed Slabs Beams (2010’s)

- **Index D20450 series:** Florida Slab Beams (2014)
- Pilot project – SR373/Orange Ave over St. Marks Trail;
Precast/Prestressed Slabs Beams (2010’s)

- **Index D20450 series:** Florida Slab Beams (2014)

  ✓ Pilot project – SR373/Orange Ave over St. Marks Trail;
Precast/Prestressed Slabs Beams (2010’s)

- **Index D20450 series:** Florida Slab Beams (2016)

Published *Developmental Standard* and *Instructions*:
Precast/Prestressed Slabs Beams (2010’s)

- **Index D20450 series:** Florida Slab Beams (2017)
- UHPC Joint Investigation;

**FIGURE:** Proposed testing for FSB with UHPC joints currently under research development

(a) full scale fatigue and strength testing; (b) small scale joint mockup.
Precast/Prestressed Slabs Beams (2010’s)

- **Index D20450 series:** Florida Slab Beams (2017)

- UHPC Joint Investigation & HSSS strand testing;

 FIGURES: FDOT research facility, (a) & (b) UHPC high shear grout mixture; (c) UHPC dry mix bags & steel fibers; (d) HSSS-alloy 2205, 0.6” dia. strand coil.
Precast/Prestressed Slabs Beams (2010’s)

- **Index D30000 series:** FSB Superstructure Packages (2017)
  - Intended for Off-System Bridges;
  - 30, 40, 50 ft. span lengths (FSB-12 & FSB-15);
  - 4 bridge clear widths – 18’, 27’, 35’ and 40’;
Precast/Prestressed Slabs Beams (2010’s)

- **Index D30000 series**: FSB Superstructure Packages (2017)

  ✓ For Off-System Bridges;

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**Short Span Bridge Beam Preference Survey**

![Chart: 2012 preference survey results for off-system bridge superstructure package](chart.png)
Precast/Prestressed Slabs Beams (2010’s)

**Index D30000 series: FSB Superstructure Packages (2017)**

**Chart: Florida Off-System bridge span length histogram showing total number of bridges by span length (2011).**
Precast/Prestressed Slabs Beams (2010’s)

- **Index D30000 series**: FSB Superstructure Packages (2017)

![Chart: Florida Off-System bridge crossing type for Structurally Deficient or Functionally Obsolete (2011).](chart.png)
Looking Ahead for ABC-EDC

Other Standards in the works:

✓ **Precast 36” Single-Slope Traffic Railings;**

  Structures Design Bulletin 16-03
  Posted: February 5, 2016
  MASH-16 Implementation Plan
  (Engineering and Operations Memorandum 16-01, Roadway Design Bulletin 16-02, Program Management Memorandum 16-01, DCE Memorandum No. 03-18, DME Memorandum No. 03-18)

✓ **Index D20700 series – Precast Intermediate Bent Caps;**

✓ **Index D30000 series – Off-System Bridge Packages (Superstructure):**
  - 60’ span length (FSB-18);
  - 4 bridge clear widths – 18’, 27’, 35’ and 40’;
Questions?

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