PBES - Precast Bent Cap Development and Implementation

Steve Nolan, P.E.

Introduction

• 1996 FDOT Study & Past FDOT Projects - Buckman, Edison, St George, etc.
• TxDOT - Research, Projects & Standards
• FHWA’s Every Day Counts Initiative
• FDOT’s Invitation to Innovation – EDC-PBES
• NCHRP Report 631
• SHRP2 Project R04-RR1
• US 90 Demonstration project (IBRD) - Overview & Lessons Learned
• Preliminary FDOT Developmental Design Standard – Index D20700
• Mathcad Design Program (Beta version)
• Implementation Schedule & Training
• Information References & Questions
Past FDOT Projects (1990 - 2004)

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).

1996 FDOT Study
TxDOT- Research, Projects & Standards

TxDOT sponsored research projects at CTR related to Precast Bent Cap Systems and Connections:


Example Projects:

- Red Fish Bay and Morris-Cummings Cut Bridge (1994)
- Lake Ray Hubbard Bridge (2002)
- Lake Belton Bridge (2004)
TxDOT- Research, Projects & Standards

Bridge Standards PBC-P and PBC-RC:
- Initially released in 2011
- Drawings updated January 2015
  [http://www.dot.state.tx.us/mdotorgchart/cmd/cserve/standard/bridge-e.htm](http://www.dot.state.tx.us/mdotorgchart/cmd/cserve/standard/bridge-e.htm)

FHWA’s Every Day Counts Initiative

Innovative Solutions for tomorrow’s transportation needs

FHWA’s Every Day Counts Initiative


In the end of 2012, sponsorship of the EDC-1 innovations by the Every Day Counts initiative came to a close, and a new set of innovations, EDC-2, was selected for deployment. Some of these were holdovers from EDC-1, including PBES, while others were new to the Every Day Counts initiative.

FDOT’s Invitation to Innovation – PBES
FDOT’s Invitation to Innovation – PBES

NCHRP Report 681
(Project 12-74)

SHRP2 Project R04-RR1


Source: NCHRP 12-74 (Restrepo et al., 2011).

Figure 3.33. Grouted duct connection.

Source: NCHRP 12-74 (Restrepo et al., 2011).

Figure 3.34. Cap pocket connection.

Source: NCHRP 12-74 (Restrepo et al., 2011).

Figure 3.35. Cap pocket connection close-up.

---

SHRP2 Project R04-RR1 & 2

http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-R04-RR-2.pdf (June 2013)
US 90 Demonstration Project Overview

### Little River EB & WB
- Expanded Polystyrene used to create a void for reduced weight
- CIP Beam Pedestals

### Hurricane Creek EB & WB
- CIP Beam Pedestals

<table>
<thead>
<tr>
<th>Bridge</th>
<th># of Spans</th>
<th>Span Length</th>
<th>Intermediate Bent Caps</th>
<th>Precast Deck Panels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little River EB</td>
<td>4</td>
<td>3 @ 110', 1 @ 106'</td>
<td>Precast (Reinforced)</td>
<td>✓</td>
</tr>
<tr>
<td>Little River WB</td>
<td>4</td>
<td>3 @ 110', 1 @ 106'</td>
<td>Precast (Reinforced)</td>
<td>✓</td>
</tr>
<tr>
<td>Hurricane Creek EB</td>
<td>1</td>
<td>110'</td>
<td>n/a</td>
<td>✓</td>
</tr>
<tr>
<td>Hurricane Creek WB</td>
<td>1</td>
<td>110'</td>
<td>n/a</td>
<td>✓</td>
</tr>
</tbody>
</table>

All bridges have cast-in-place abutments, drilled shafts, and precast/prestressed I-Beams.
US 90 Demonstration Project Overview

Grout holes & Fill joint

US 90 Demonstration Project Specification Modifications

Required submittals of:
- Precast Placement Plan
- PBES Erection Stability
- Grouting Plan
  - Material
  - Equipment
  - Hardware
- Grout Demo/ Mock-Up

Specified:
- Materials
- Tolerances
- Minimum Ages/Strength
- Installation
- Grouting
US 90 Demonstration Project Lessons Learned

1. Pre-approved grouts expedite construction;
2. Need more robust grouts with less temperature sensitivity;
3. Pre-construction mock-up was valuable;
4. CIP Beam seats provided versatility;
5. Simple span configuration simplified panel design and fabrication, but increased lateral loading on substructure;
6. Lifting from precast bed is critical for controlling cracks in non-prestressed elements;
7. ABC cost increase mostly due to deck panels. Precast bent caps are cost competitive with CIP construction.

Proposed FDOT Developmental Design Standard – Index D20700
Proposed FDOT Developmental Design Standard – Index D20700 series

Source: US90/Little River (90% Structures Plans)

Pile Bent with Blind Pile Pocket Connections – Prestressed Concrete and Steel Pipe Piles

Source: SHRP2 Report S2-RD4-RR-1 & 2 (ABC Toolkit)

Pile Bent with Open Cap Pocket Connections – Steel H-Piles
Proposed FDOT *Developmental Design Standard* – Index D20700 series

**Pier Cap with Grouted Duct Connections – Concrete Columns & Drilled Shafts**

Proposed FDOT *Developmental Design Standard* – Index D20700 series

Grout Rheology Mockup Testing:

- Efflux Time 20-30 seconds;
- Temp. 70-80 degrees:

<table>
<thead>
<tr>
<th>Material</th>
<th>MIN</th>
<th>MAX</th>
<th>MIN</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>45</td>
<td>50-60</td>
<td>45</td>
<td>50-60</td>
</tr>
<tr>
<td>Soil</td>
<td>45</td>
<td>50-60</td>
<td>45</td>
<td>50-60</td>
</tr>
<tr>
<td>Mining water</td>
<td>45</td>
<td>50-60</td>
<td>45</td>
<td>50-60</td>
</tr>
<tr>
<td>Moisture content</td>
<td>45</td>
<td>50-60</td>
<td>45</td>
<td>50-60</td>
</tr>
<tr>
<td>Grout at mixed</td>
<td>50-60</td>
<td>90</td>
<td>50-60</td>
<td>90</td>
</tr>
<tr>
<td>Placed temp.</td>
<td>50-60</td>
<td>90</td>
<td>50-60</td>
<td>90</td>
</tr>
</tbody>
</table>
Mathcad Design Program

Implementation & Training

- Beta Testing of Mathcad Program - July 2015
- Draft Developmental Design Standard Index D20700 District & Industry Review - August 2015
- Preliminary Release - September 2015
- Design Update Training - August 2015

Research --> Demonstration Project --> DDS --> Design Standard Index
Information References


Questions?

Contact Information:
Steve Nolan (State Structures Design Office)
Ph. (850) 414-4272
steven.nolan@dot.state.fl.us