



# PBES - Precast Bent Cap Development and Implementation

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## 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)

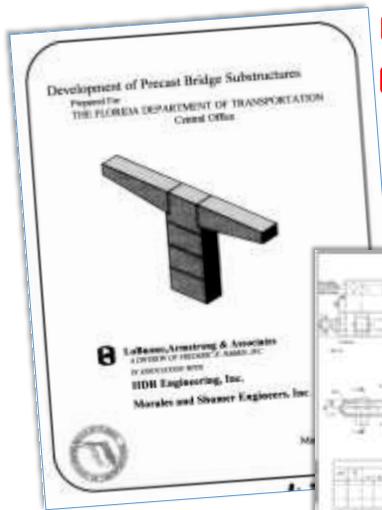
Example Projects:

- 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).

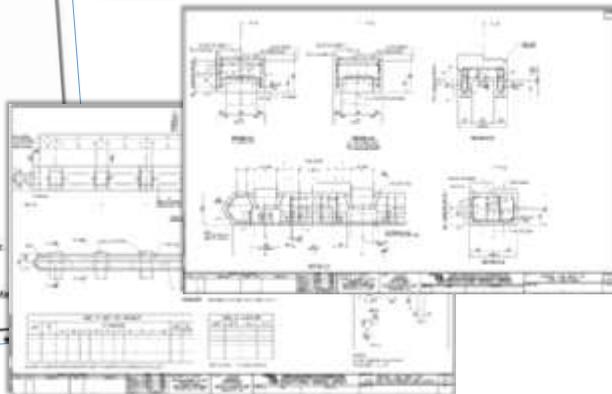


Photo: Berger/ABAM Engineers Inc.

## 1996 FDOT Study



Component	Configuration	Configurations
Multi-Column Pier Cap	Solid Rectangle (IA)	Inverted U (II)
Multi-Column Pier Column	Hollow Rectangle - Rounded Corners (IIB)	I-Shaped (IVA)
Pier Bent Cap	Solid Rectangle (IV)	Inverted U (V)
Streamlined Pier Column	Hollow Rectangle - Rounded Corners (IIB)	Double I-Shaped (III)
Streamlined Pier Cap	Solid Cantilever (IIB)	



## TxDOT- Research, Projects & Standards

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

- [1410-2F](#) (1998), "A Precast Substructure Design For Standard Bridge Systems"
- [1748](#) (2001), "Development of a Precast Bent Cap System"
- [4176](#) (2006), "Anchorage for Grouted Vertical-Duct Connectors in Precast Bent Cap Systems"
- Miller, M., Holt, J. and McCammon, V., (2014) "*Precast, Pretensioned, Rectangular Bent Caps*", Accelerated Bridge Construction-University Transportation Center, Proceedings: 2014 National ABC Conference, Miami FL., December 4-5, 2014.



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5

## TxDOT- Research, Projects & Standards

*Example Projects:*

- *Red Fish Bay and Morris-Cummings Cut Bridge (1994)*
- *Lake Ray Hubbard Bridge (2002)*
- *Lake Belton Bridge (2004)*



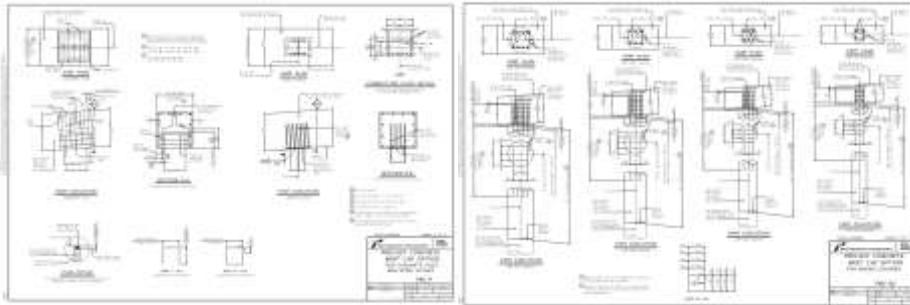
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6

## TxDOT- Research, Projects & Standards

### Bridge Standards **PBC-P** and **PBC-RC**:

- Initially released in 2011  
Webinar from Feb 2012: [http://ftp.dot.state.tx.us/pub/txdot-info/brg/0212\\_webinar/holle.pdf](http://ftp.dot.state.tx.us/pub/txdot-info/brg/0212_webinar/holle.pdf)
- Drawings updated January 2015  
<http://www.dot.state.tx.us/insdtdot/orgchart/cmd/cserve/standard/bridge-e.htm>




**TEXAS DEPARTMENT OF TRANSPORTATION**

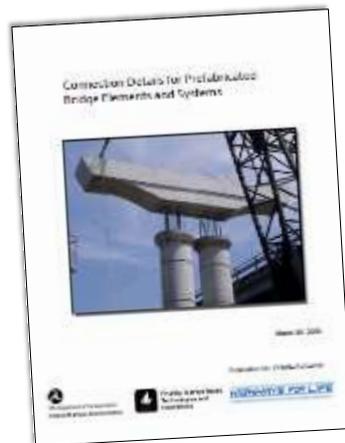

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Bridge Standards (English)

7

## FHWA's Every Day Counts Initiative

Connection Details for Prefabricated Bridge Elements and Systems (2009): <http://www.fhwa.dot.gov/bridge/prefab/if09010/>




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8

# FHWA's Every Day Counts Initiative

EDC-2 Report: <http://www.fhwa.dot.gov/everydaycounts/reports/edc-2-finalreport/>

**Every Day Counts: Building a Culture of Innovation for the 21st Century**

**EDC-2 Final Report**

March 2013

**Prefabricated Bridge Elements and Systems**

**Project Highlights**

**ACCELERATED BRIDGE CONSTRUCTION**

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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 hold-overs from EDC-1, including PBES, while others were new to the Every Day Counts initiative.

# FDOT's Invitation to Innovation – PBES

**Invitation to Innovation**

**INITIATION INNOVATION**

**Every Day Counts - Prefabricated Bridge Elements & Systems (EDC-PBES)**

**EDC - Prefabricated Bridge Elements & Systems**

**Website Overview - Video (WVR)**

**INVITATION TO INNOVATION**

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# FDOT's Invitation to Innovation – PBES

The 2015 FDOT Structures Manual has been released. Chapter 25 of the Structures Detailing Manual (SDM) has been added and provides design considerations for detailing PBES for FDOT contract plans. A compilation of PBES concepts with annotated notes to designers that supplement this new chapter of the SDM is provided here (PDF).

Structures Detailing Manual  
25 - Prefabricated Bridge Elements and Systems  
Type No. 625-022-015  
January 2015

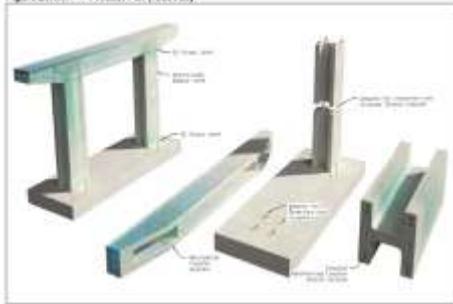
## 25 PREFABRICATED BRIDGE ELEMENTS AND SYSTEMS (PBES) (Rev. 01/15)

### 25.1 DESIGN CONSIDERATIONS - GENERAL

Prefabricated Bridge Elements and Systems (PBES) are bridge components fabricated offsite or in a near-site construction time, as compared to cast designs. PBES are project specific to shapes of components and connects and viable means of transportation of design and CADD technician to real design, detailing, and construction teams to for general design contracts to develop a quality set of PBES plan.

- A. This Chapter contains PBES design considerations:
1. Applicability
  2. Connections
  3. Components

Figure 25.4.3.1.1 Precast Pier Assembly



FDOT can provide cost estimates for PBES design contracts to assist in construction management.

# NCHRP Report 681 (Project 12-74)

[http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp\\_rpt\\_681.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_681.pdf) (October 2010)

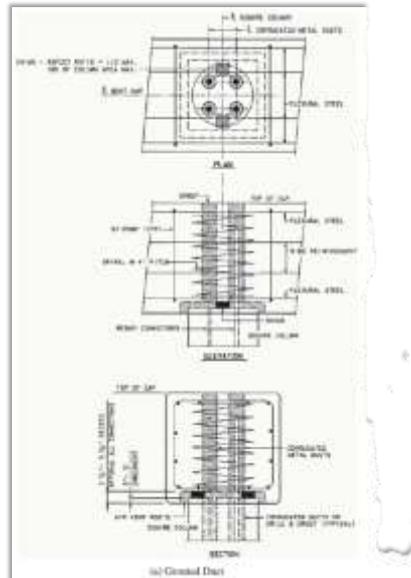


Figure 3.1. Alternative precast bent cap connections for SDC A

# SHRP2 Project R04-RR1

[http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2\\_S2-R04-RR-1.pdf](http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-R04-RR-1.pdf) (Oct. 2007 – March 2014)



Source: NCHRP 12-74 (Restrepo et al., 2011).  
Figure 3.33. Grouted duct connection.



Source: NCHRP 12-74 (Restrepo et al., 2011).  
Figure 3.35. Cap pocket connection close-up.



Source: NCHRP 12-74 (Restrepo et al., 2011).  
Figure 3.34. Cap pocket connection.

Table 3.5. Connection Types for U.S. Seismic Regions

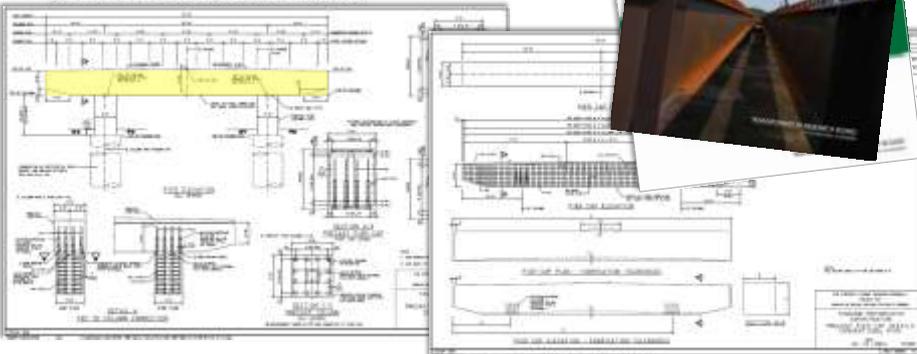
Column-to-Cap Connection Type	Seismic Design Category
Grouted splice sleeve*	A, B, C
Grouted duct	A, B, C, D
Cap pocket†	A, B, C, D

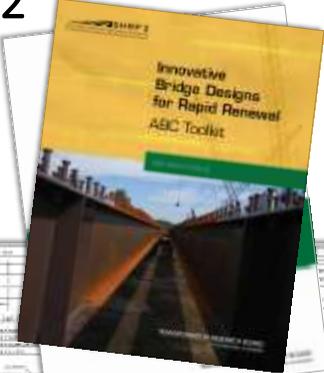
\*NCHRP 12-74 has recommended use for limited-ductility applications only.  
†NCHRP 12-74 tested both a link-ductility and a full-ductility cap pocket connection.

# SHRP2 Project R04-RR1 & 2

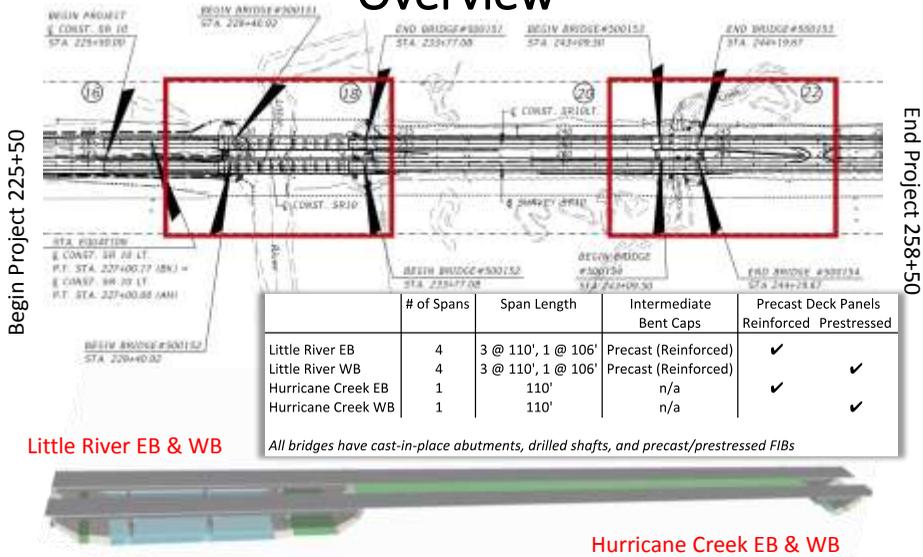
[http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2\\_S2-R04-RR-2.pdf](http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-R04-RR-2.pdf) (June 2013)

STRATEGIC HIGHWAY RESEARCH PROGRAM 2  
PROJECT R04  
INNOVATIVE BRIDGE DESIGNS FOR RAPID RENEWAL  
STANDARD PLANS FOR ABC MODULAR SYSTEMS

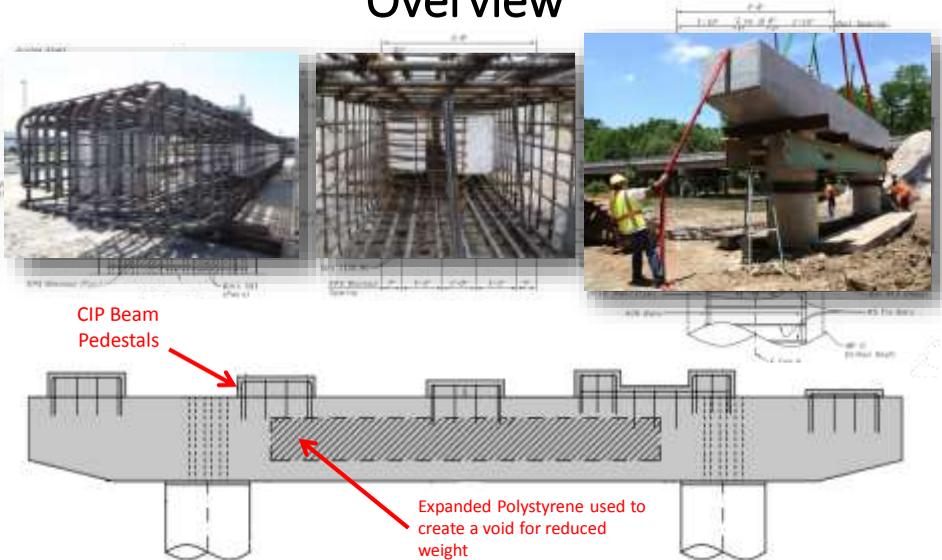




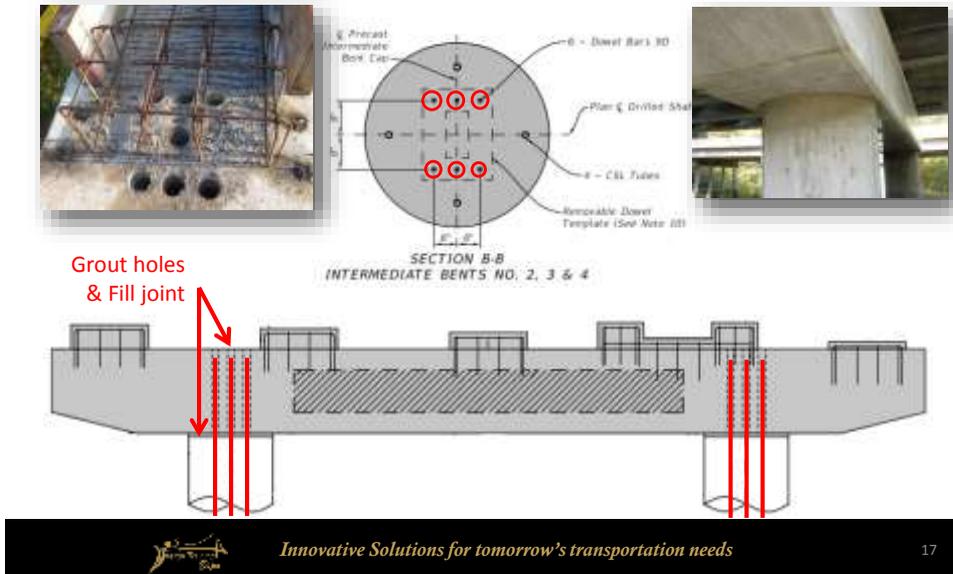
# US 90 Demonstration Project Overview



# US 90 Demonstration Project Overview



## US 90 Demonstration Project Overview



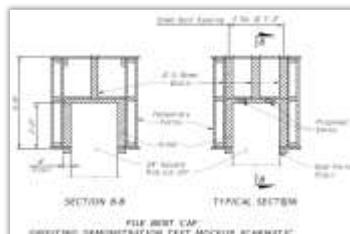
## US 90 Demonstration Project Specification Modifications

### Required submittals of:

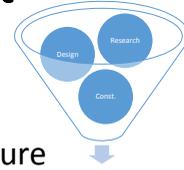
- Precast Placement Plan
- PBES Erection Stability
- Grouting Plan
  - Material
  - Equipment
  - Hardware
- Grout Demo/ Mock-Up

### Specified:

- Materials
- Tolerances
- Minimum Ages/Strength
- Installation
- Grouting



# US 90 Demonstration Project Lessons Learned



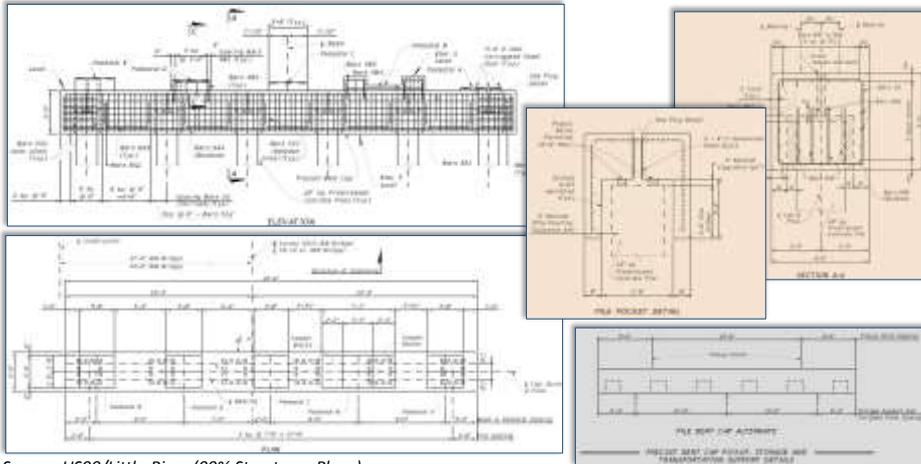
1. Pre-approved grouts expedite construction;
2. Need more robust grouts with less temperature sensitivity;
3. Pre-construction mock-up was valuable;
4. CIP Beam seats provided versatility;
5. Simple span configuration simplified panel design and fabrication, but increased lateral loading on substructure;
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

The collage shows the following documents:

- FDOT Website Screenshot:** Displays the Florida Department of Transportation logo and navigation links. A table titled 'Developmental Design Standards' is visible, with columns for 'Developmental Design Standard', 'Title', 'Monitor/Design/Build/Procure', and 'Status'. The table lists standards like 'High Tension Cable Seals' and 'Overhead Cable Support (Precast) (Index D20700)'. A 'START HERE' arrow points to the 'Developmental Design Standards Usage Process for Design-Build Projects'.
- Project Plan:** Titled 'DESIGN OF OVERHEAD CABLES AND BRIDGE SUPPORTS FOR FDOT DEVELOPMENTAL DESIGN STANDARD (Index D20700)'. It includes sections for 'WBS', 'Risks', and 'Milestones'.
- Technical Drawing:** Shows a perspective view of a bridge structure with overhead cables and supports.

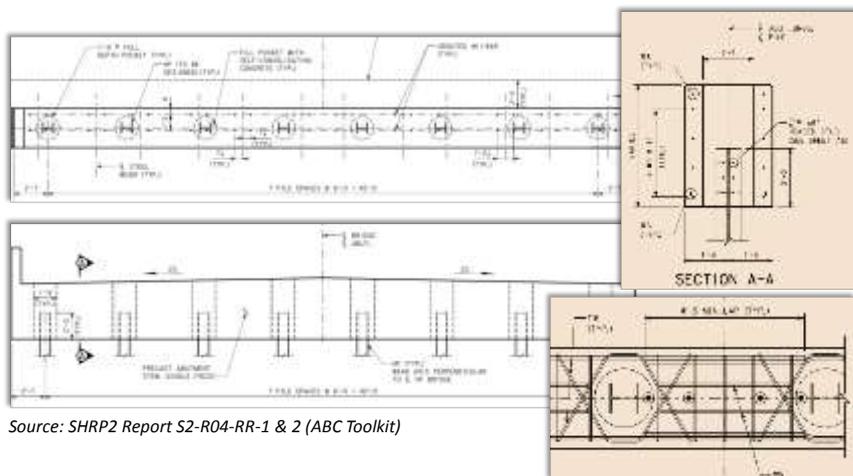
## Proposed FDOT *Developmental Design Standard* – Index D20700 series



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

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

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

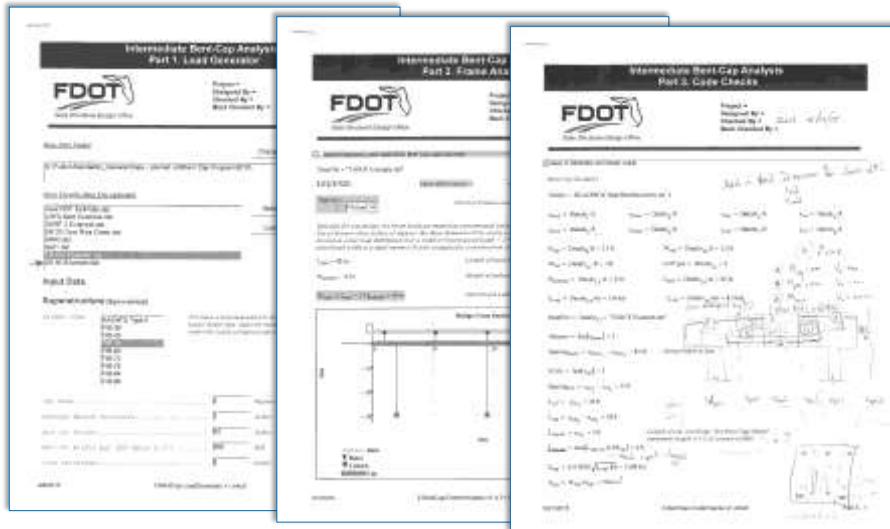


Source: SHRP2 Report S2-R04-RR-1 & 2 (ABC Toolkit)

Pile Bent with Open Cap Pocket Connections – Steel H-Piles



# Mathcad Design Program



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25

## 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*



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26

## Information References

1. LoBuno, Armstrong & Associates, HDR Engineering Inc., Morales and Shumer Engineers, Inc., (1996) "Project No. 510703 - Development of Precast Bridge Substructures", FDOT, Tallahassee, FL, May 1996.
2. Nolan, S.J., (2014) "Precast Bent Caps and Full-Depth Deck Panels for US 90 Over Little River and Hurricane Creek", Accelerated Bridge Construction-University Transportation Center, Proceedings: 2014 National ABC Conference, Miami FL., December 4-5, 2014.
3. NCHRP, "Development of Precast Bent Cap System for Seismic Regions", NCHRP Report 681, Transportation Research Board, National Research Council, 2010, [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp\\_rpt\\_681.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_681.pdf)
4. SHRP 2, "Report S2-R04-RR-1: Innovative Bridge Designs for Rapid Renewal", Transportation Research Board, Washington, D.C. 2014, [http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2\\_S2-R04-RR-1.pdf](http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-R04-RR-1.pdf)
5. Miller, M., Holt, J. and McCammon, V., (2014) "Precast, Pretensioned, Rectangular Bent Caps", Accelerated Bridge Construction-University Transportation Center, Proceedings: 2014 National ABC Conference, Miami FL., December 4-5, 2014.
6. TxDOT, "Precast Concrete Bent Cap Option For Concrete Round Columns", PBC-P Texas Department of Transportation – Bridge Division Standard, January 2015, <http://ftp.dot.state.tx.us/pub/txdot-info/cmd/cserve/standard/bridge/pbcstd01.pdf>
7. TxDOT, "Precast Concrete Bent Cap Option For Concrete Piles and Steel H-Piles", PBC-P Texas Department of Transportation – Bridge Division Standard, January 2015, <http://ftp.dot.state.tx.us/pub/txdot-info/cmd/cserve/standard/bridge/pbcstd02.pdf>



<http://www.dot.state.fl.us/structures/innovation/PBES.shtml>



<http://www.fhwa.dot.gov/everydaycounts/>



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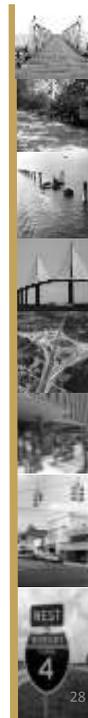
27

## Questions?



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28