FDOT TRANSPORTATION SYMPOSIUM 2019

ABC in Florida - A Practical Look into Past, Present, and Future FDOT Projects Utilizing ABC Techniques

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Florida DOT is no stranger to long waterway crossings.....

Consideration of PBES has traditionally lent itself to long waterway bridges in Florida

Let's begin with a trip down to Fort Myers and visit the Edison Bridge!

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Utilizing ABC: Long Waterway Projects

- Edison Bridge (Fort Myers, FL)
  - Twin structures approximately 1-mile in length built in 1992
  - ABC Components: Precast columns and pier caps

Top: Overall view of precast pier construction for the Edison Bridge.

Left: View of completed Edison Bridge.

Utilizing ABC: Long Waterway Projects

- Vessel collision design criteria governed footing design
  - Cast-in-place footings
- Precast, I-shaped columns
  - Reduced weight of column segments
- Maximum precast column segment height: Approximately 40 ft.
- Precast, U-shaped caps

Top: View of typical Edison Bridge precast column segments in the precast yard.

Right: View of precast pier assembly (cap and column).

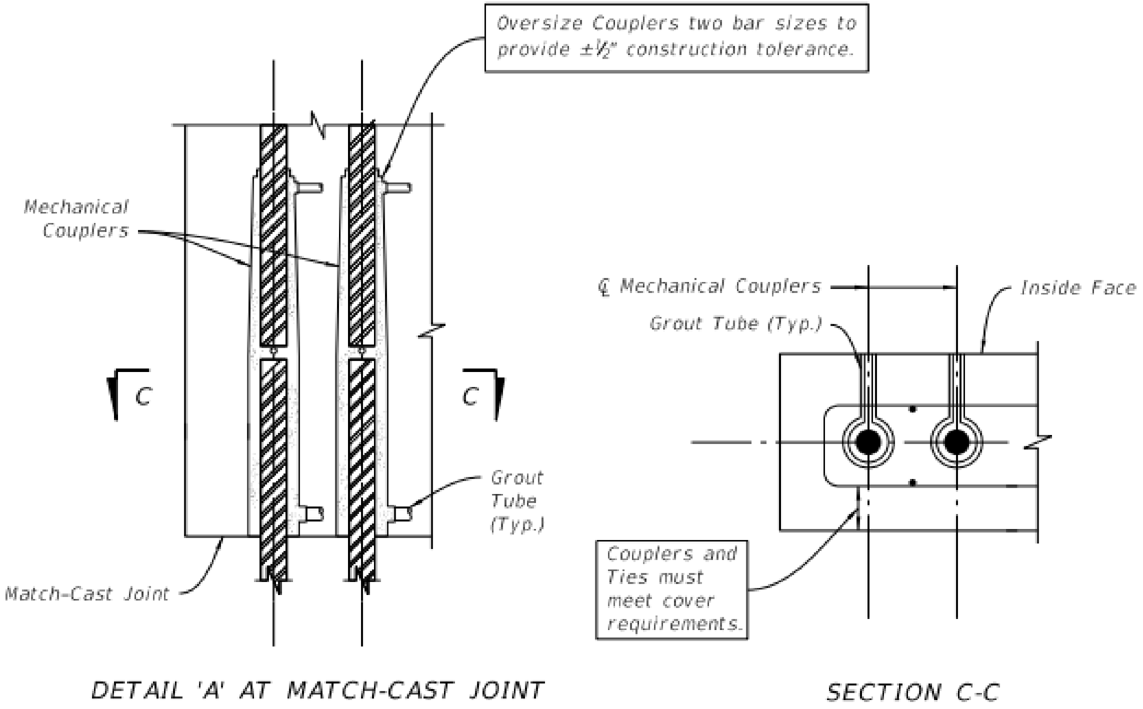
Utilizing ABC: Long Waterway Projects

- Connection between precast segment and CIP footing used mechanical couplers
  - Grouted-sleeve connections
- Use of transfer template to ensure alignment of footing dowel bars with precast segment cast-in couplers

View of precast column segment being set on CIP footing.

Utilizing ABC: Long Waterway Projects

- Transfer template manufactured at the same location as the precast segment bulkhead.
- Using template, dowel bars were installed in CIP footing, assuring proper alignment.
- Embedded sleeves were oversized by two bar sizes, providing ½-inch tolerance for fit-up.



Conceptual detail for grouted sleeve mechanical couplers for precast-to-precast or precast-to-CIP concrete connections.

Utilizing ABC: Long Waterway Projects

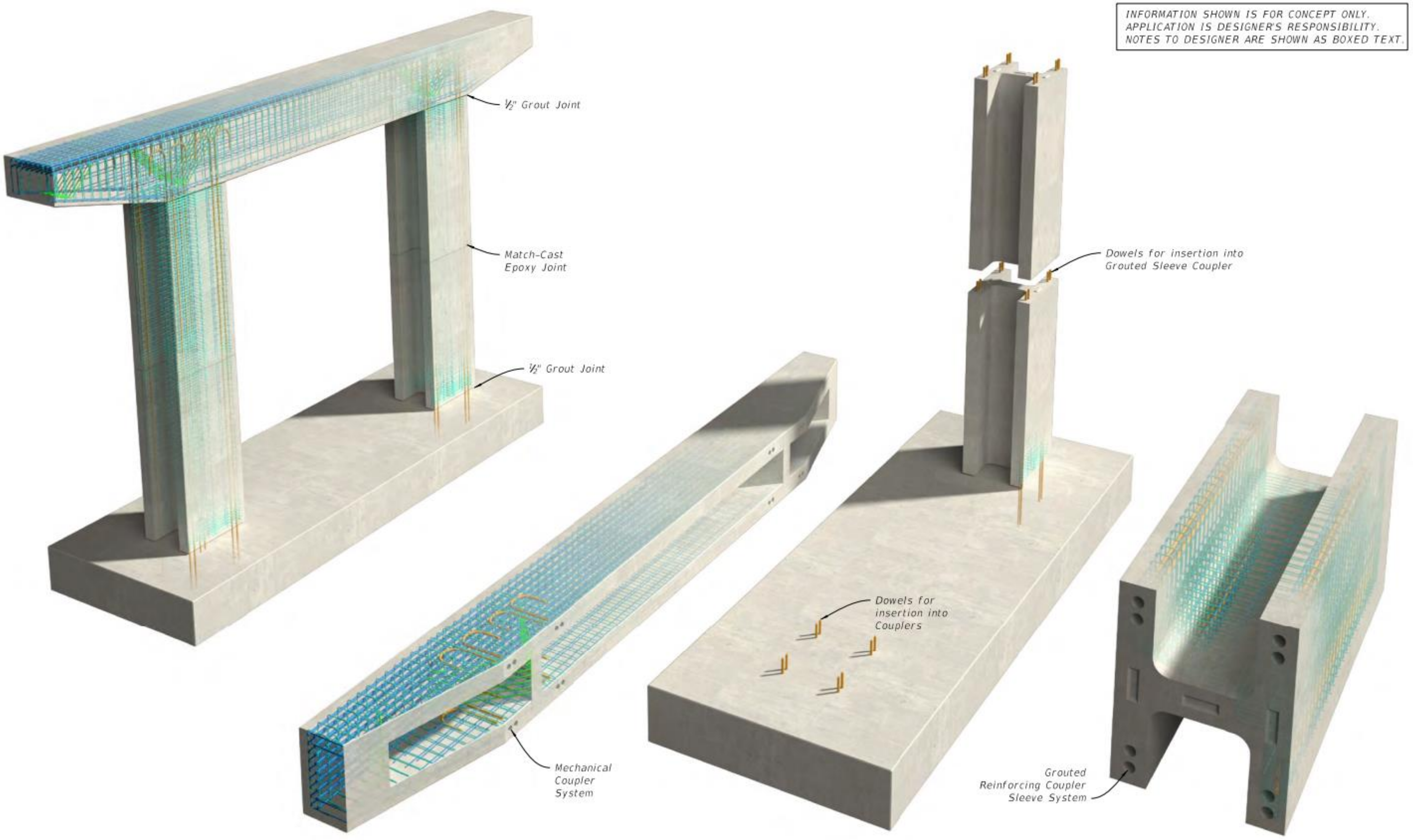
View of precast column segment formwork in the precasting yard.

View of precast column segment with bulkhead form.

Utilizing ABC: Long Waterway Projects

- Erection rate:
  - 6 columns per day
  - 3 caps per day
- Each bridge took 1 year to build
- Contractor saved 2 months for each bridge
- Bridge in service for almost 30 years
  - No major durability issues
- Bottom Line:
  - Magnitude of scale
  - Uniformity and good construction access
  - Minimizing time on water (associated high insurance and labor rates)

Erection of precast cap assembly during construction.



Excerpt from FDOT SDM Visualization Examples for PBES Conceptual Drawings.

Let's now take a trip to Pensacola!

Utilizing ABC: Long Waterway Projects

- Pensacola Bay Bridge (US-98 over Pensacola Bay)
  - Twin 3-mile long bridges
  - $398 million design-build project awarded to Skanska – WSP
- Currently in construction
  - Anticipated EB bridge opening: July 2019

WSP Visualization for the new Pensacola Bay Bridge, currently in construction.

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Skanska's 22-acre "near"-site casting yard is approximately 4 miles away. Allows for direct barge access between casting yard and project site.

Utilizing ABC: Long Waterway Projects

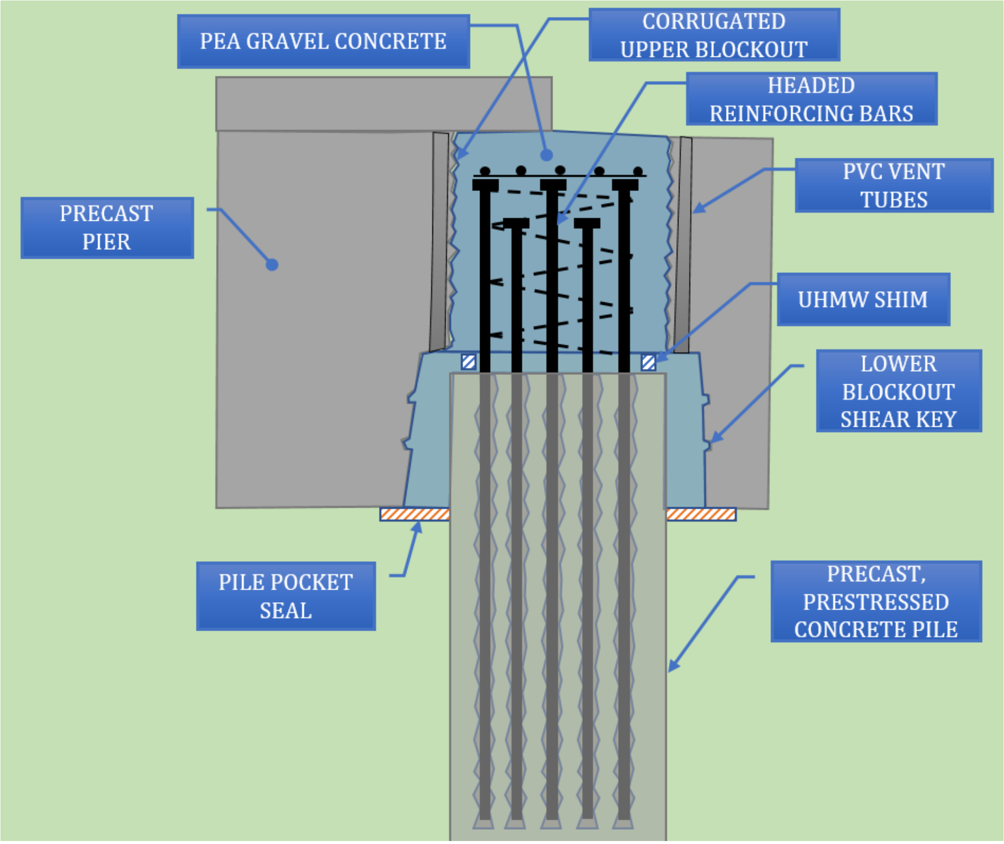
- PRECAST PIER ASSEMBLIES
  - Low-level approach pier assembly with precast caps, columns, and footings.

View of low-level precast piers supporting vehicular bridge over Pensacola Bay.

View of low-level precast pier assembly in the precast yard.

Utilizing ABC: Long Waterway Projects

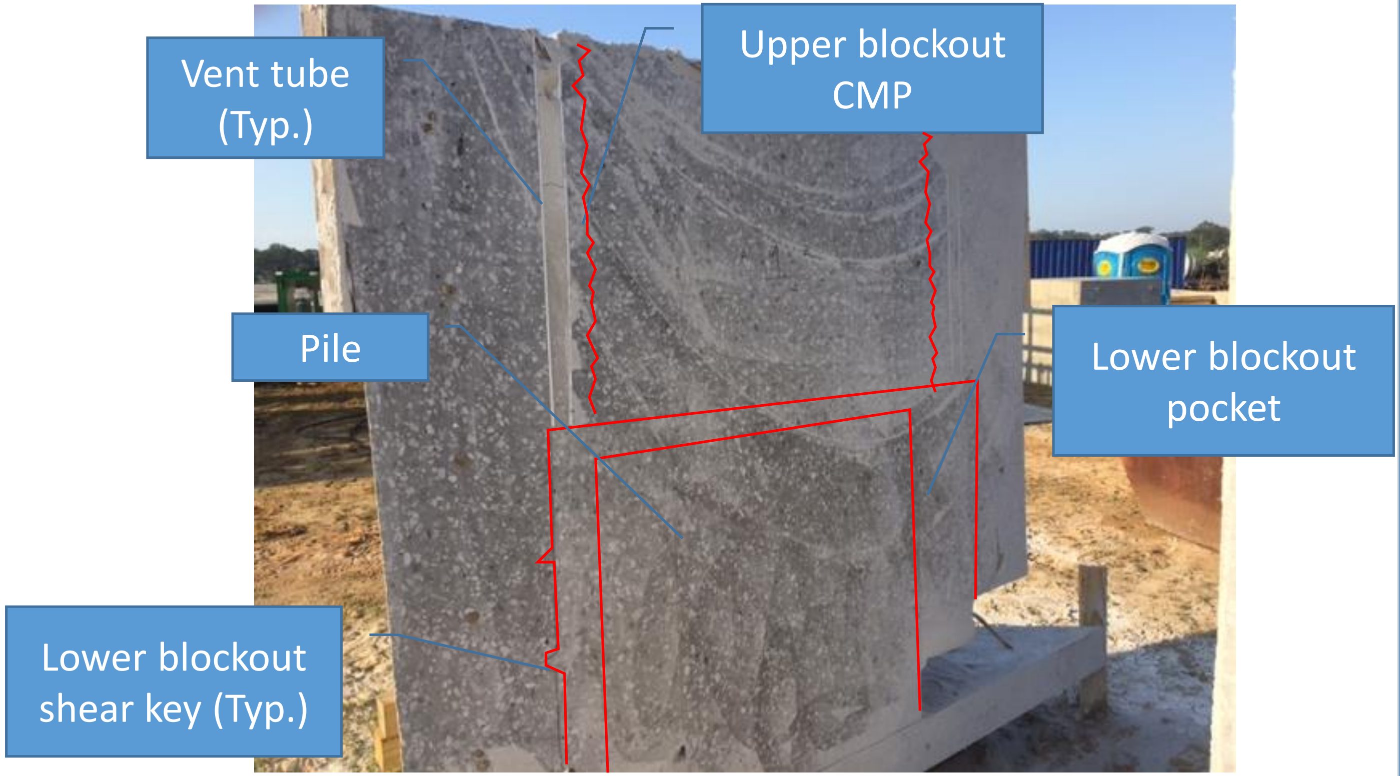
- Pile-to-precast footing connections
  - Piles embedded into precast footing a minimum of 2-ft.
  - Lower blockout sized to account for misdriven piling per FDOT specifications tolerances.
  - Detail allows for inspection access.
  - Final Department acceptance of detail contingent upon successful full-scale mockup test.
- Basic 3 Step Process:
  - Seal
  - Dewater and surface prep
  - Place concrete for connection



Conceptual detail for pile-to-precast footing connection.

Utilizing ABC: Long Waterway Projects

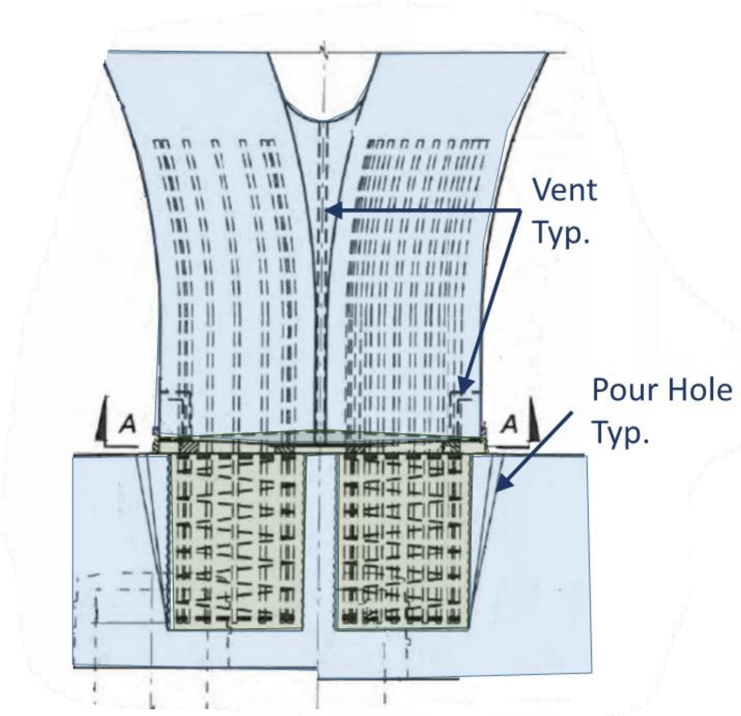
- Plans included mock-up testing parameters and associated acceptance criteria.
- Mock-up testing for connection performed twice.
- Test performed in a submerged setting (i.e. pool).



Results of second pile-to-precast footing mock-up test after grouting operation and saw-cutting of specimen for inspection.

Utilizing ABC: Long Waterway Projects

- Footing to precast column connections
  - Lower blockout in footing receives column steel.
  - Considered a "blind pocket" due to lack of inspection access.
  - Final Department acceptance of detail contingent upon successful full-scale mockup test.



Conceptual detail of footing to precast column connection.

Mock-up testing for the footing to precast column grouted connection. First attempt shown. Three tests performed.

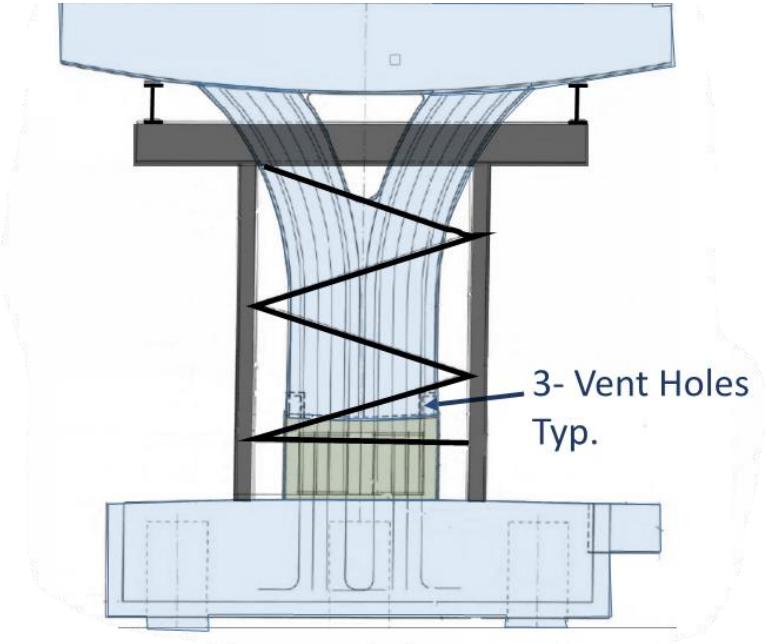
Utilizing ABC: Long Waterway Projects

- PRECAST PIER ASSEMBLIES
  - High-level piers consist of precast columns and caps connected to CIP footing.
  - Variable-height, CIP closure pours.
  - Utilizing consistent formwork for precast components.

View of high-level precast pier assembly on falsework.

View of completed high-level pier assembly.

Utilizing ABC: Long Waterway Projects



Concept for forming high-level pier assembly. Pedestal rebar not shown for clarity.

View of high-level pier CIP footing with projecting column steel prior to placement of precast pier assembly and closure pour.

Removal of closure pour forms for high-level pier assembly.

Utilizing ABC: Long Waterway Projects

- PRECAST "PI-GIRDER" UNITS
  - Monolithic, pretensioned concrete beam utilizing modified FIB forms.
  - Isolated shared use path (approach spans) adjacent to vehicular bridge.
  - Entire unit precast offsite, eliminating need for casting traditional CIP deck on formwork.

View of precast pi-girder units stored in the precast yard.

Utilizing ABC: Long Waterway Projects

- PRECAST SHELL “BATHTUB” FORMS
  - Precast stay-in-place shell forms for high-level pier CIP footings.
  - Not considered structural, yet integral with footings.
  - Concerns during design with long-term durability. Stainless steel reinforcement utilized in vertical form walls.

View of precast bathtub forms stored in the precast yard.

Utilizing ABC: Long Waterway Projects

- Lessons learned:
  - Importance of performing full-scale mockup testing and inspection of each unique PBES connection detail.
  - Clarification of strict acceptance criteria for mock-up testing.
  - Avoiding blind pocket details per the recommendations of FDOT Structures Detailing Manual.
  - Identifying projects that may utilize PBES details and requiring these details be reviewed during project procurement.
    - Design-Build: Alternative Technical Concepts (ATCs)

Overall view of low-level approach span construction.

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Next stop, Daytona Beach!

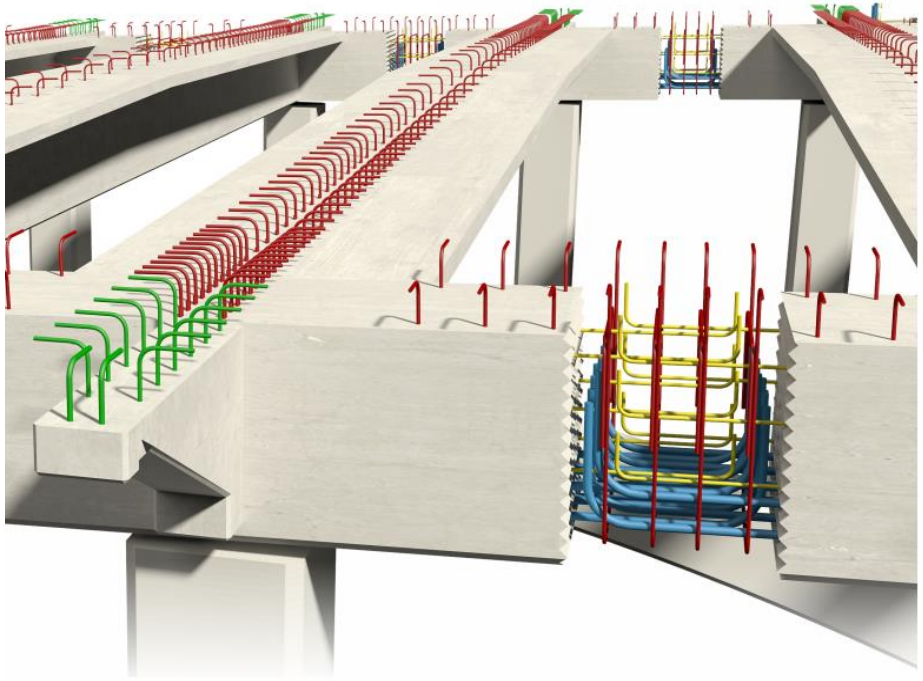
Utilizing ABC: Open Spandrel Arch

- Veterans Memorial Bridge Replacement (Daytona Beach)
  - Open spandrel arch bridge
  - PBES components:
    - Main and approach span arch rib segments
    - Hanger T-beams

View of Veterans Memorial Bridge main span construction.

Utilizing ABC: Open Spandrel Arch

- Connection detail for approach span T-beams
- Ease of placement due to staggered hook bar alignment between sections (splice overlap).
- Use of double U-shaped stirrups
- Use of shear keys on vertical face of precast sections.
- Conceptual detail incorporated into FDOT Structures Detailing Manual.
- Connections detailed so components can be lowered into place with easy-fit up

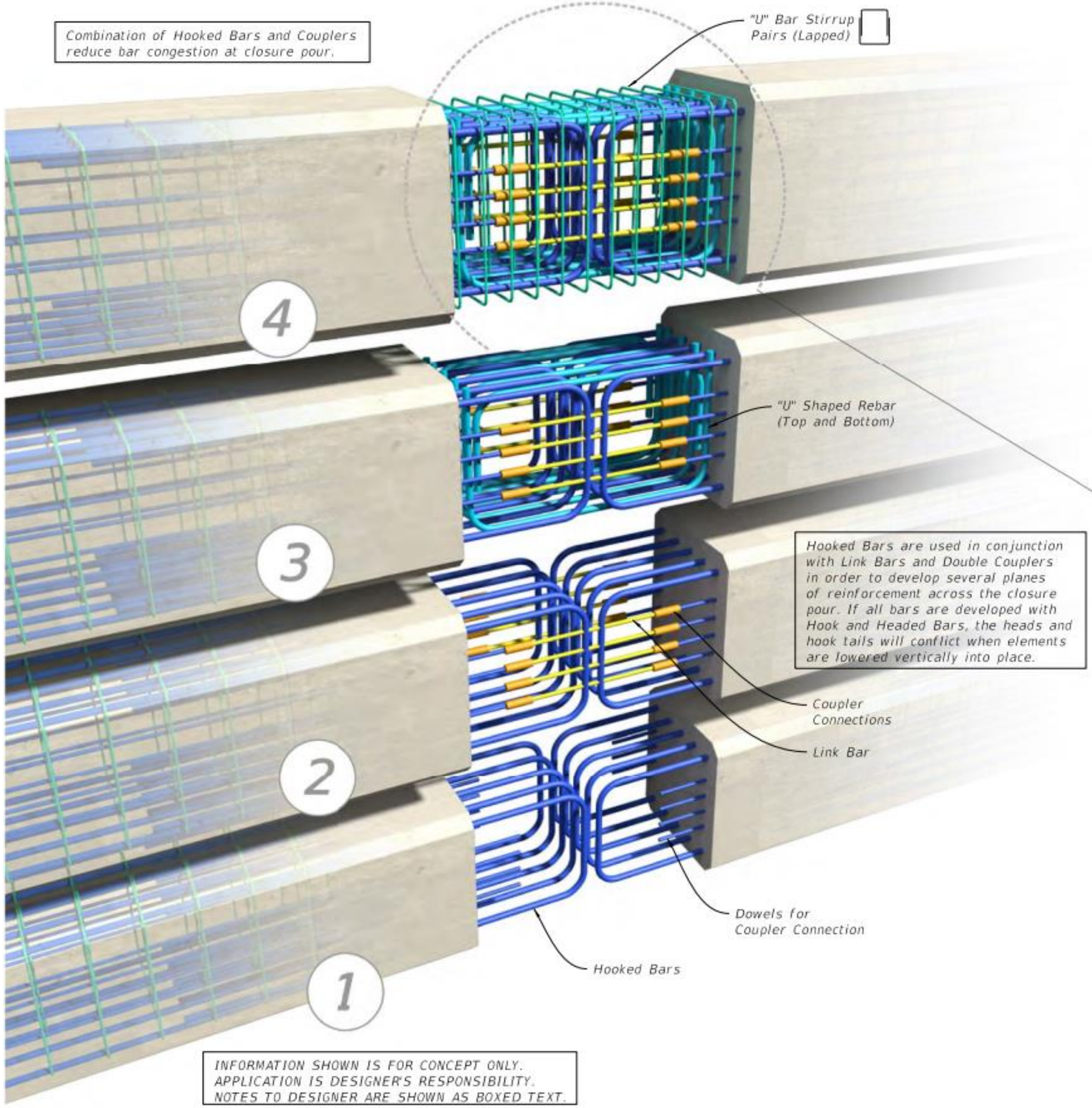


Visual rendering of T-beam precast section closure pour detail (Acknowledgement: WSP).

Utilizing ABC: Open Spandrel Arch

- Wider closure pours connecting precast arch segments.
- Reinforcing extensions connected between segments with link bars and mechanical couplers.
- U-shaped hook bars – Additional planes of steel.

Visual rendering of arch rib precast section closure pour detail (Acknowledgement: WSP).

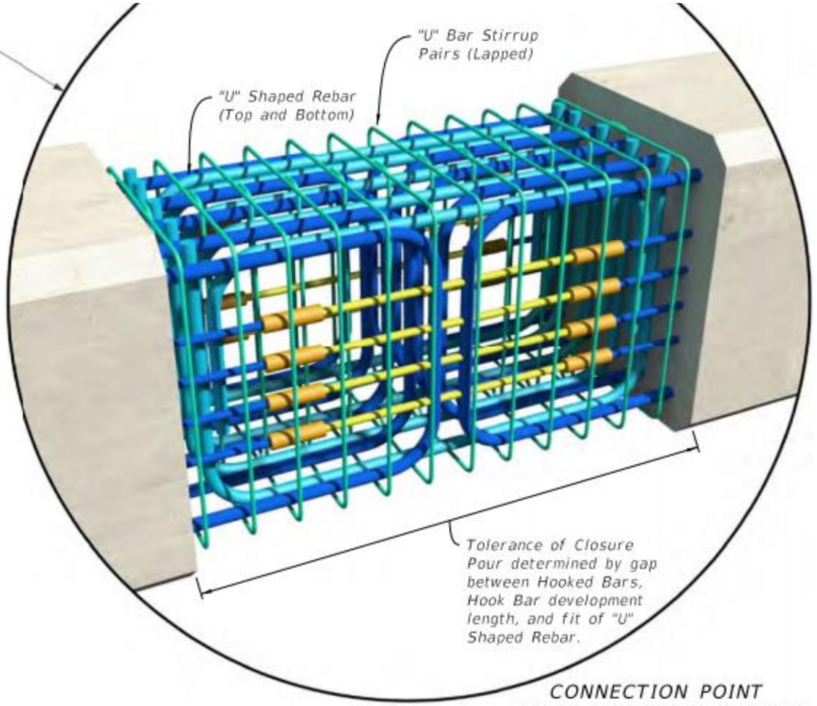


STEP 1 Place Precast Segments.

STEP 2 Field cut Link Bar. Place Couplers with removable stops or pins on Link Bar. Place Link Bar in position and slide Coupler to splice Link Bar to Dowels. Quality control of Coupler positioning is required. Secure Coupler according to Manufacturer's recommendations. See sketch below.

STEP 3 Install "U" shaped Rebar (Top and Bottom).

STEP 4 Install "U" Bar Stirrup Pairs (Lapped).



CONNECTION POINT
READY FOR CLOSURE POUR

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Utilizing ABC: Open Spandrel Arch

- Important to note: PBES connection details need to consider means that simplify field assembly
  - Fabrication and erection tolerances
  - Alignment of reinforcement
- Simplify formwork!
- Create transparent design solutions to enhance quality and long-term durability
- Make connections large enough to facilitate assembly and fit-up.

View of approach span construction (Acknowledgement: FINLEY Engineering Group).

And finally, let's go to Jupiter!

Utilizing ABC: Bascule Bridge Replacement

- Twin, double-leaf bascule bridges built in 1958
- Structurally deficient and functionally obsolete
- Programmed for replacement
- Complex restraints:
  - Limited R/W
  - Historically sensitive properties and landmarks (i.e. Jupiter Lighthouse)
  - Adjacent utilities

View of existing SR-5/US-1 Federal Highway Bridge in Jupiter, FL.

Utilizing ABC: Bascule Bridge Replacement

- Pros and cons of phased construction vs. full detour evaluated
- Assessment concluded full detour most advantageous.
- Typical detour time based on conventional bascule pier replacement: 2+ years
- Look to ABC…….

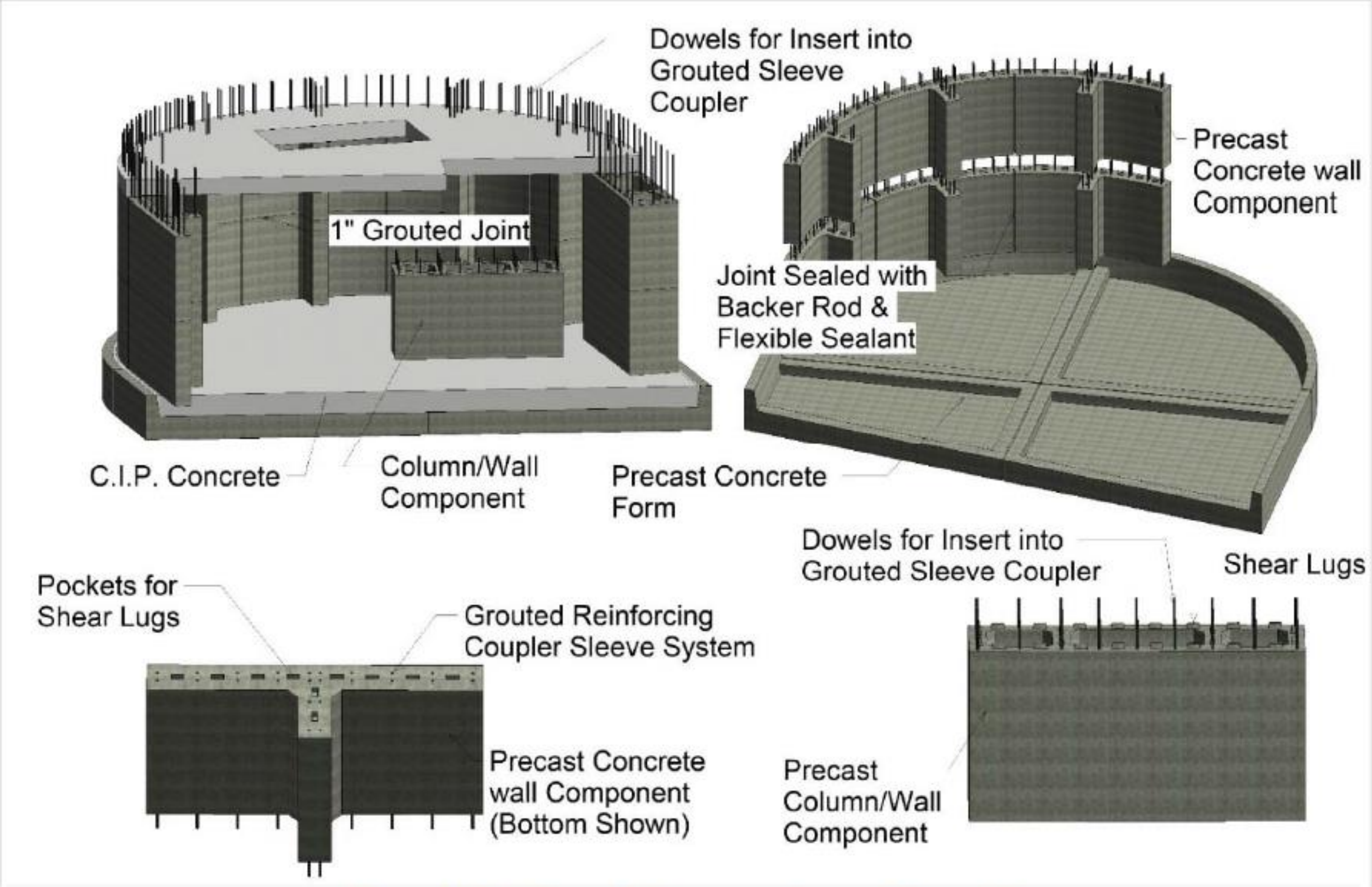
View of existing SR-5/US-1 Federal Highway Bridge in Jupiter, FL.

Utilizing ABC: Bascule Bridge Replacement

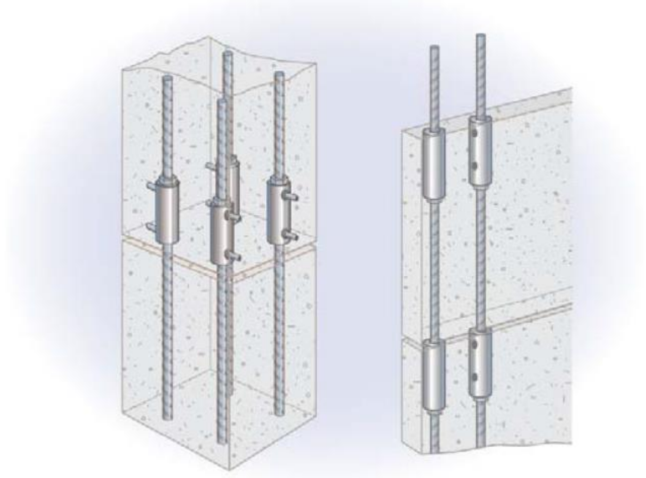
- ABC "pre-prep" stage:
  - Focus on the *critical path* items: *bascule pier construction.*
  - Focus on items needed to be in place and planned-for prior to shutdown/detour phase.
- Portions of new bridge built outboard of existing bridge.
- Once closed, construction impacts can be minimized by temporarily realigning navigation channel.
  - **Result: Uninterrupted barge access for bascule pier construction.**
- ABC components: Bascule piers, control house, and bascule leaves.

View of existing SR-5/US-1 Federal Highway Bridge in Jupiter, FL.

Utilizing ABC: Bascule Bridge Replacement



Bascule Pier Precast Components and Assembly



Precast Components Connected with Grouted Sleeve Couplers and Dowels

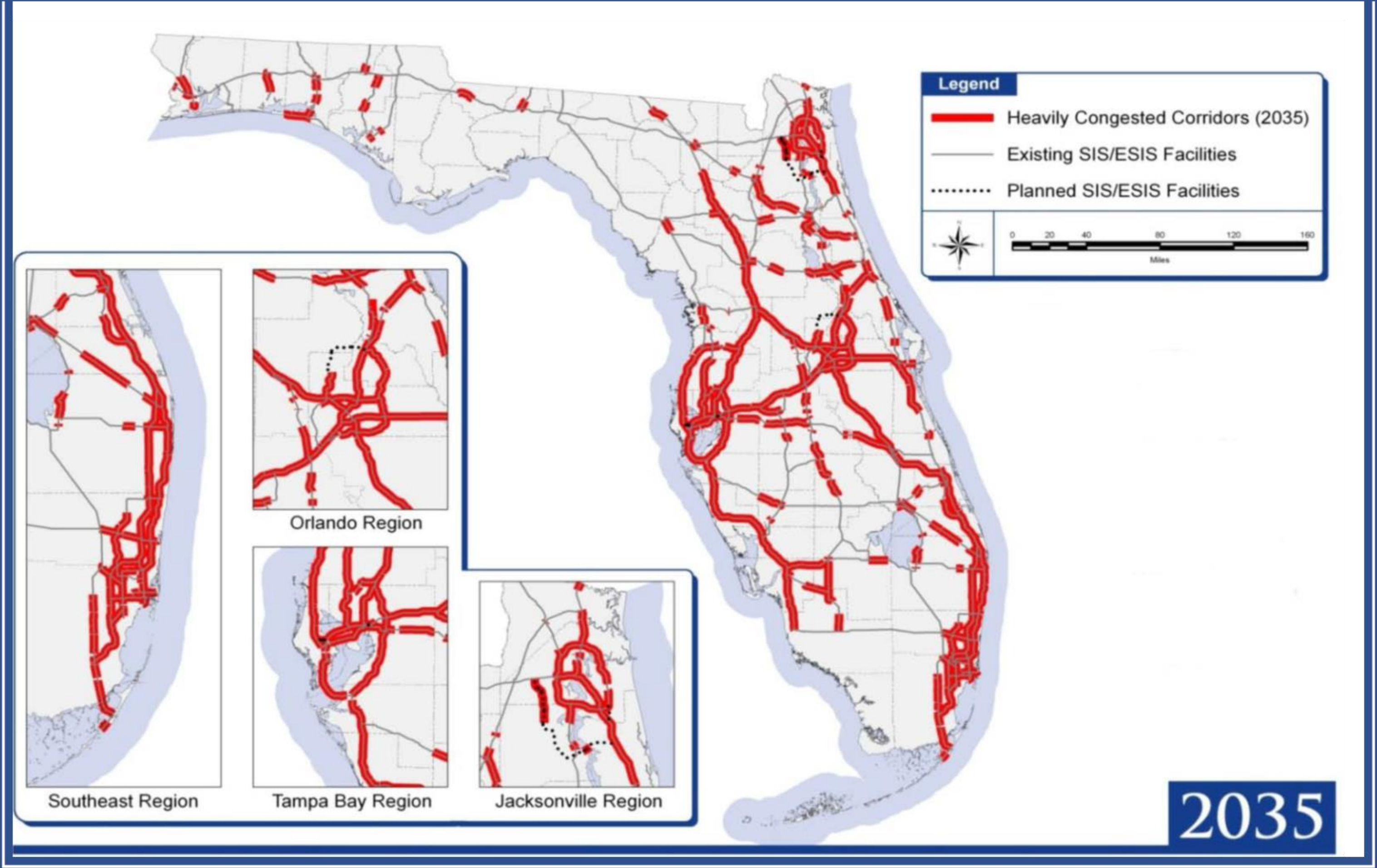
Example conceptual PBES details being considered for the bascule pier assemblies. (Acknowledgement: Hardesty & Hanover, LLC)

Interconnectivity and fit-up are critical!

Switching Gears!!!!

Corridor Expansion Needs

2012 Snapshot – Florida's Transportation System Cannot Meet Increase in Demand



Source: FDOT Systems Planning Office (2012)

FDOT work mix is changing!

Challenges of a growth state

Florida's Growth Projections

- Additional 6 million residents by 2030
- 160 million visitors annually by 2025
- 69% increase in freight tonnage by 2040

Source: 2017 Florida Transportation Commission Presentation
Florida's Smart Future: Innovation in Policy and Technology Planning
By: **Beth Kigel**

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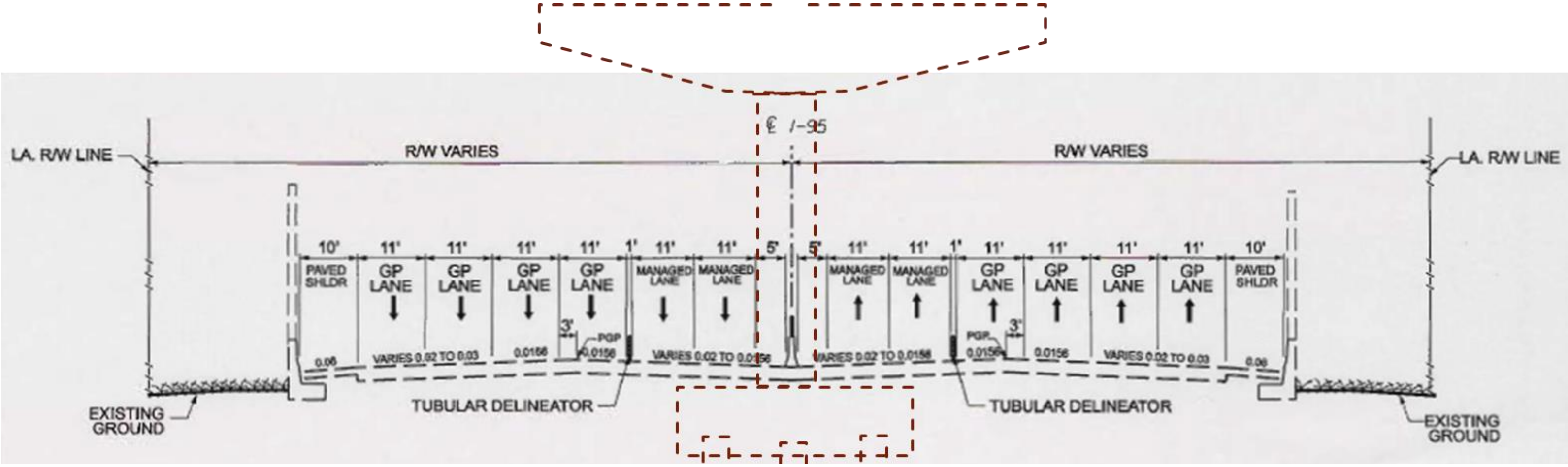
Discussion on Next-Generation ABC Bridge Concepts for Highly Urbanized Construction

- …that focus on the Nighttime Work Window…so all Lanes can be opened by 6:00 AM each Morning;
- …all work operations can be performed safely;
- …. with transparant designs and robust performance.

Utilizing ABC: Future ABC Concepts

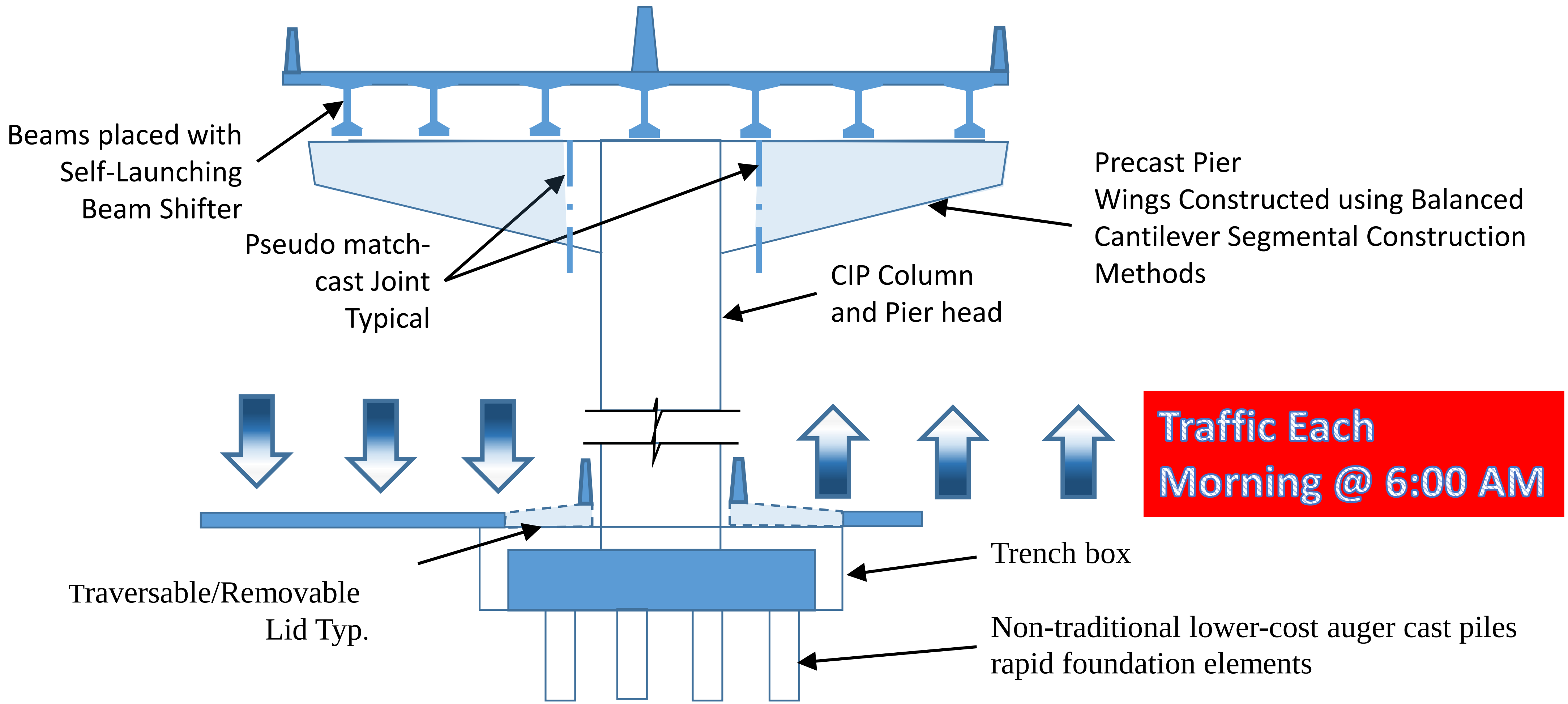


Challenges exist with urban expansion projects due to constrained R/W. Planning studies are underway in major urban areas to construct viaducts in the medians of busy interstates.

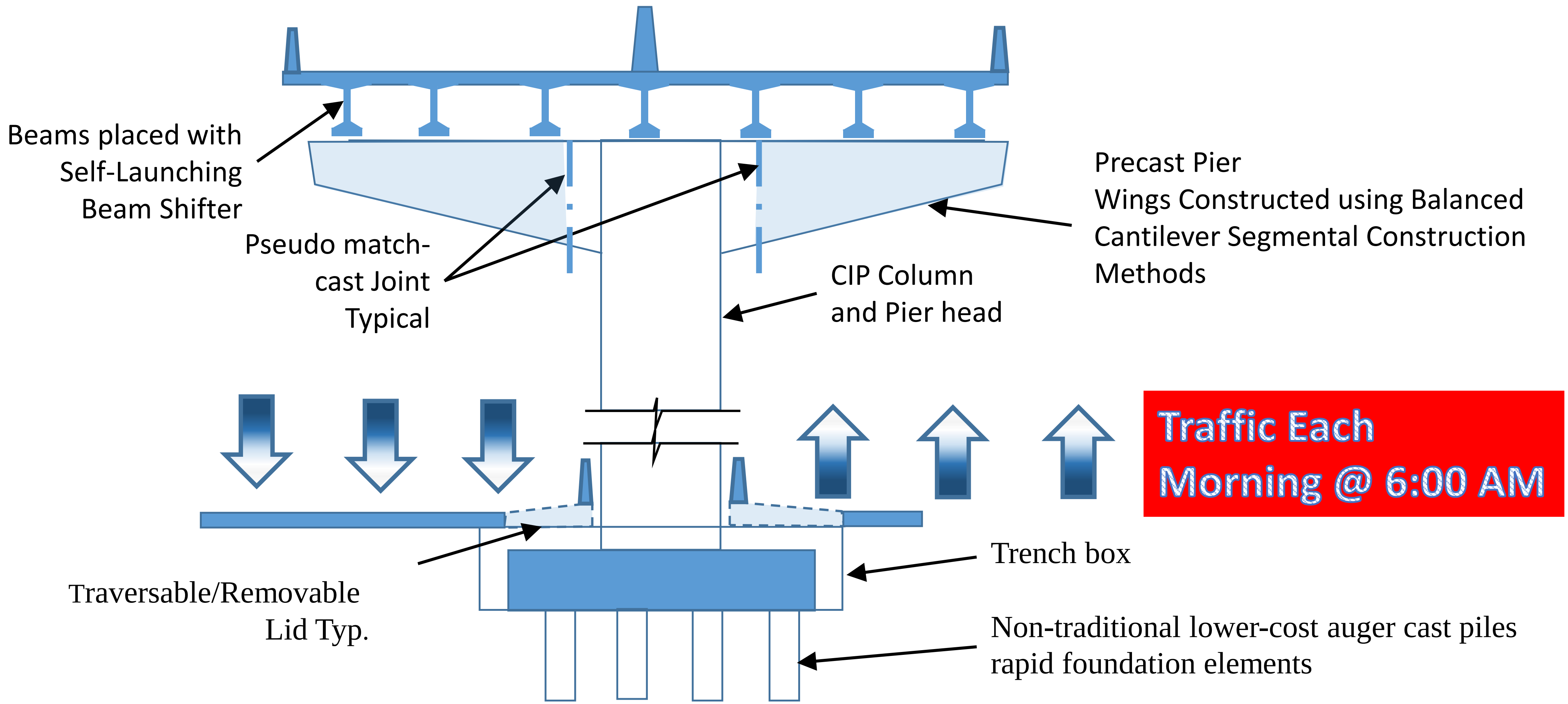
- Trench box footing forms with removable lid slabs?
  - Augercast Piles?
  - Hybrid CIP/Precast Piers?
  - Beam Shifter?

By what means can the viaduct be built and still maintain all lanes of traffic during rush hour?

In other words, how can we isolate the work from traffic?



Beams placed with Self-Launching Beam Shifter
Pseudo match-cast Joint Typical
Precast Pier Wings Constructed using Balanced Cantilever Segmental Construction Methods
CIP Column and Pier head
Traffic Each Morning @ 6:00 AM
Trench box
Traversable/Removable Lid Typ.
Non-traditional lower-cost auger cast piles rapid foundation elements



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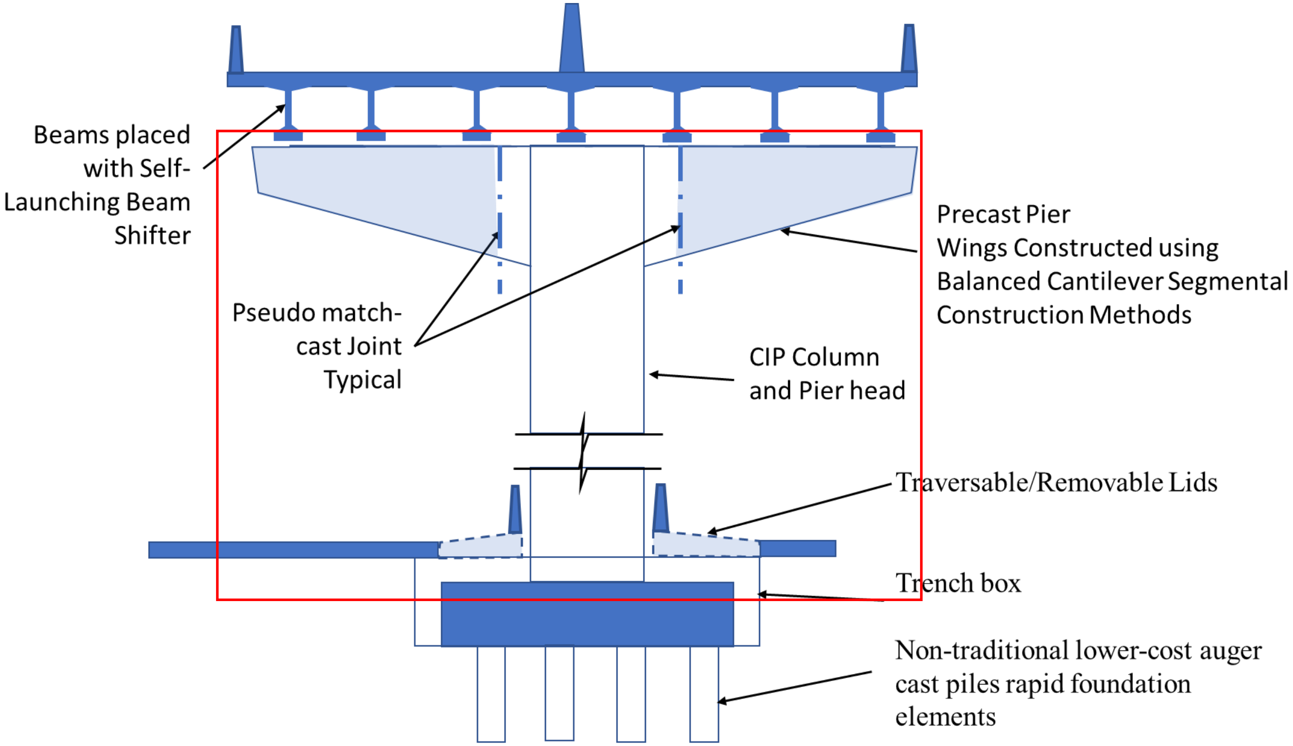
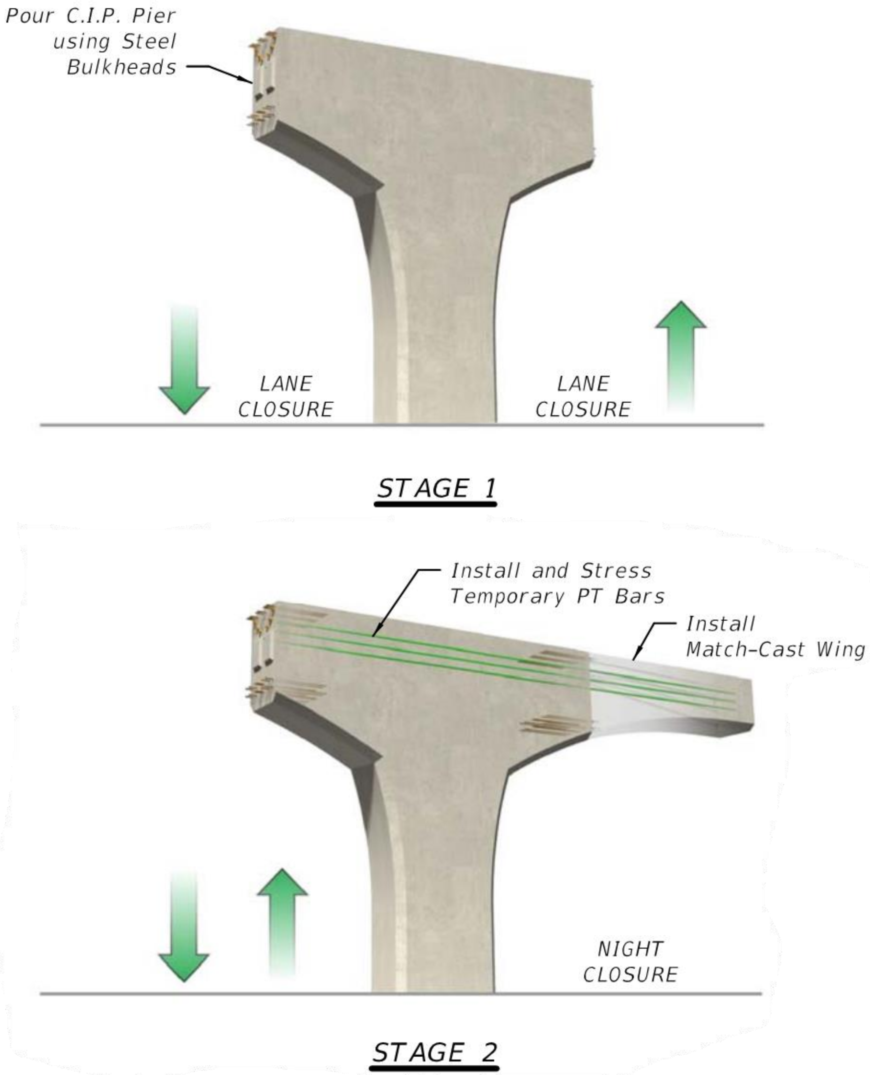
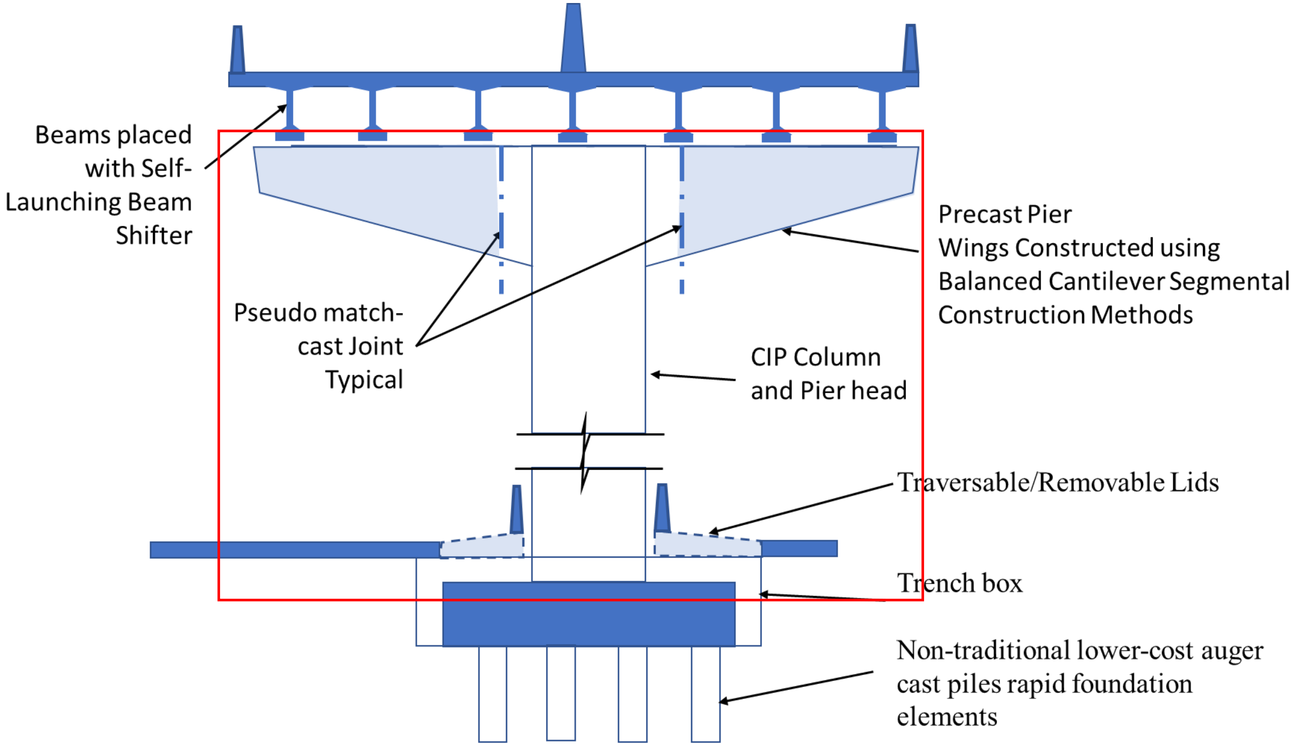
SUBSTRUCTURE CONSTRUCTION

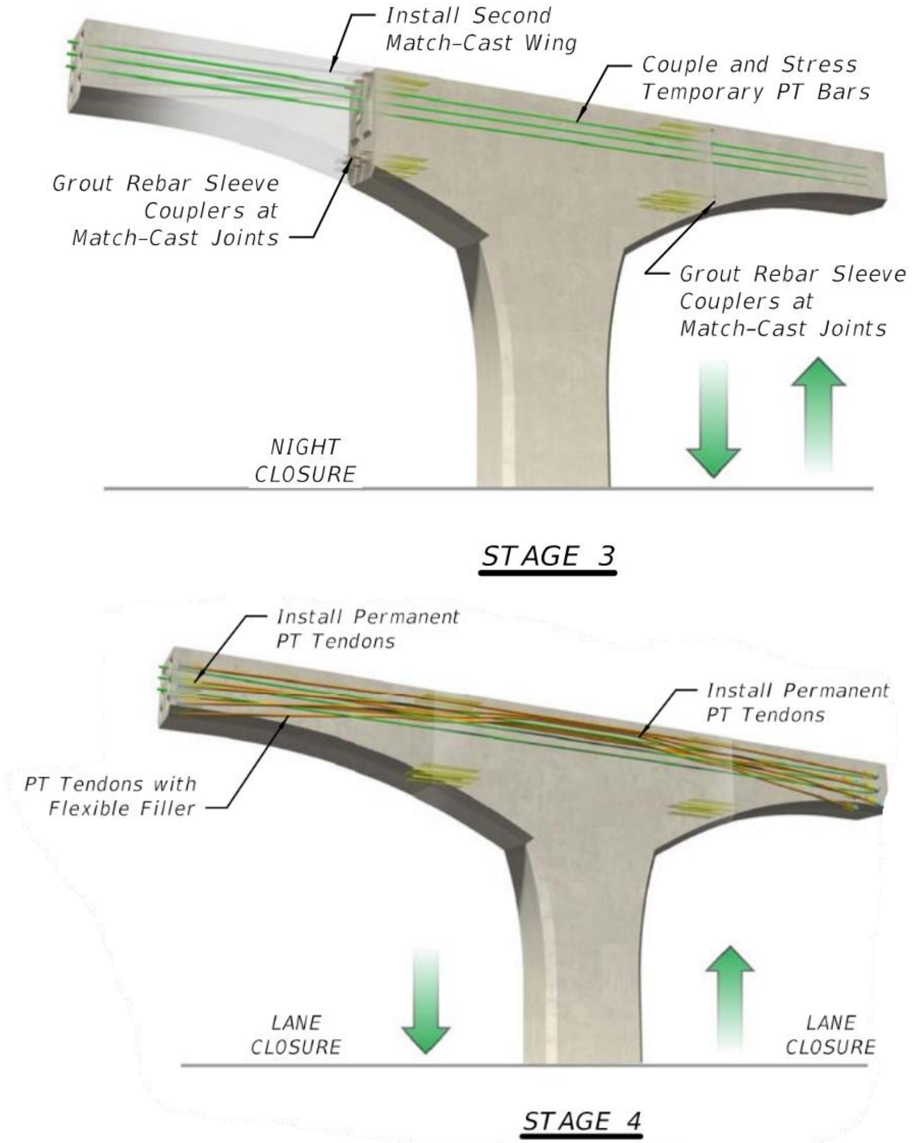




To address hammerhead pier construction constraints due to traffic control limitations, segmental construction methods can be utilized.

SUBSTRUCTURE CONSTRUCTION





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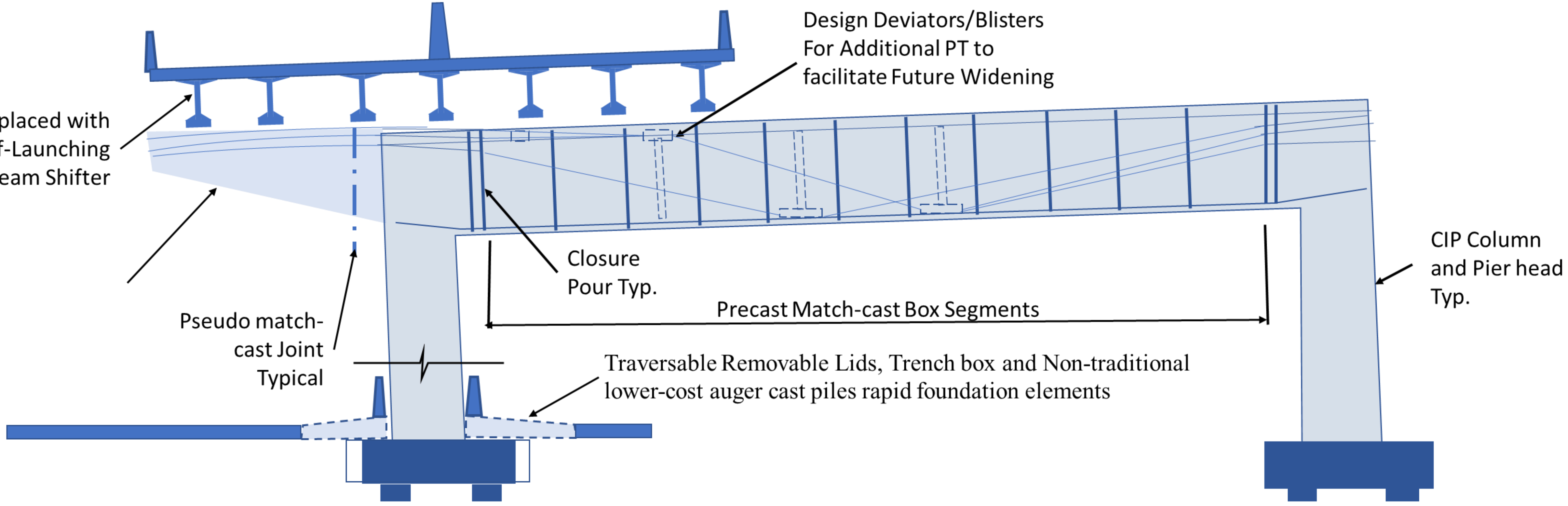
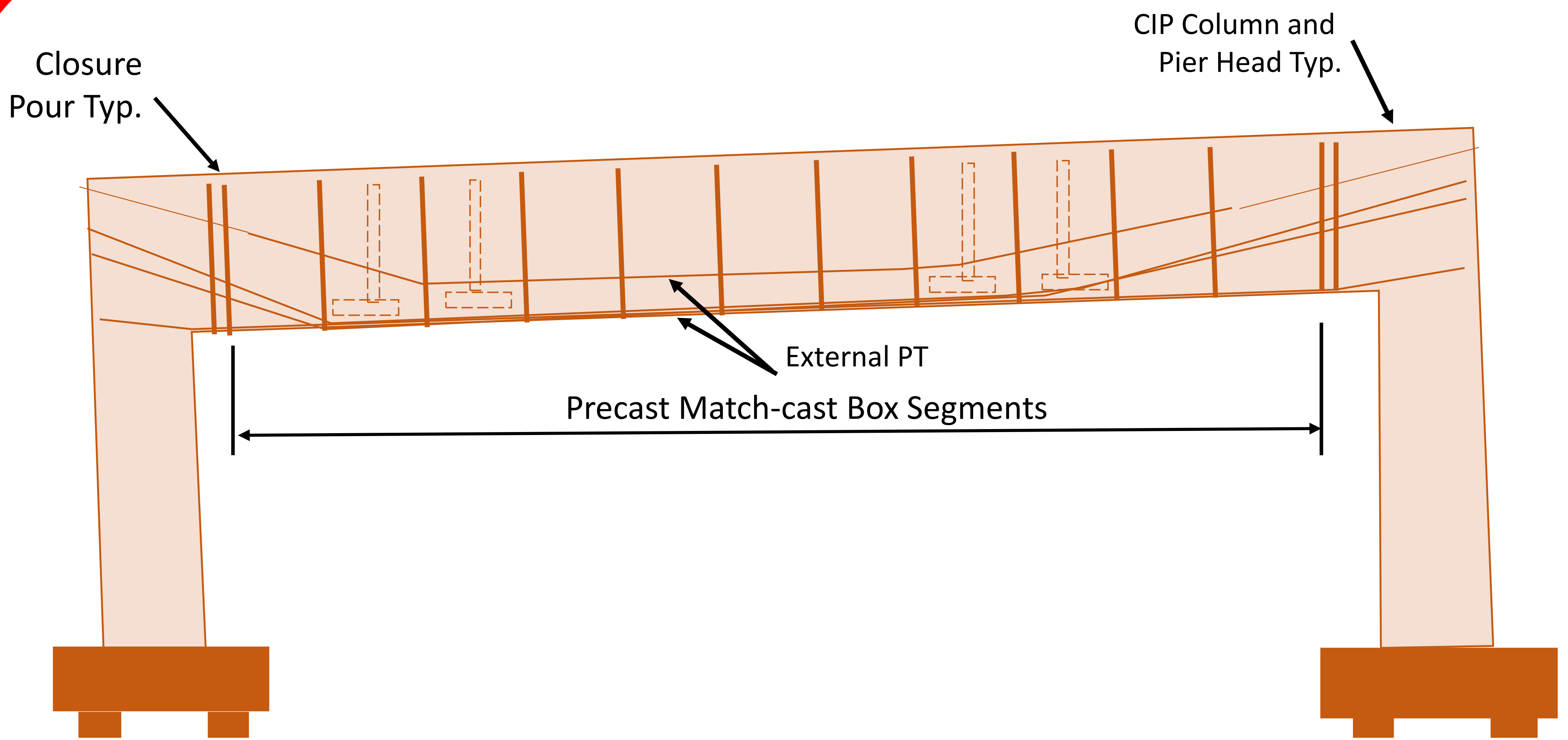
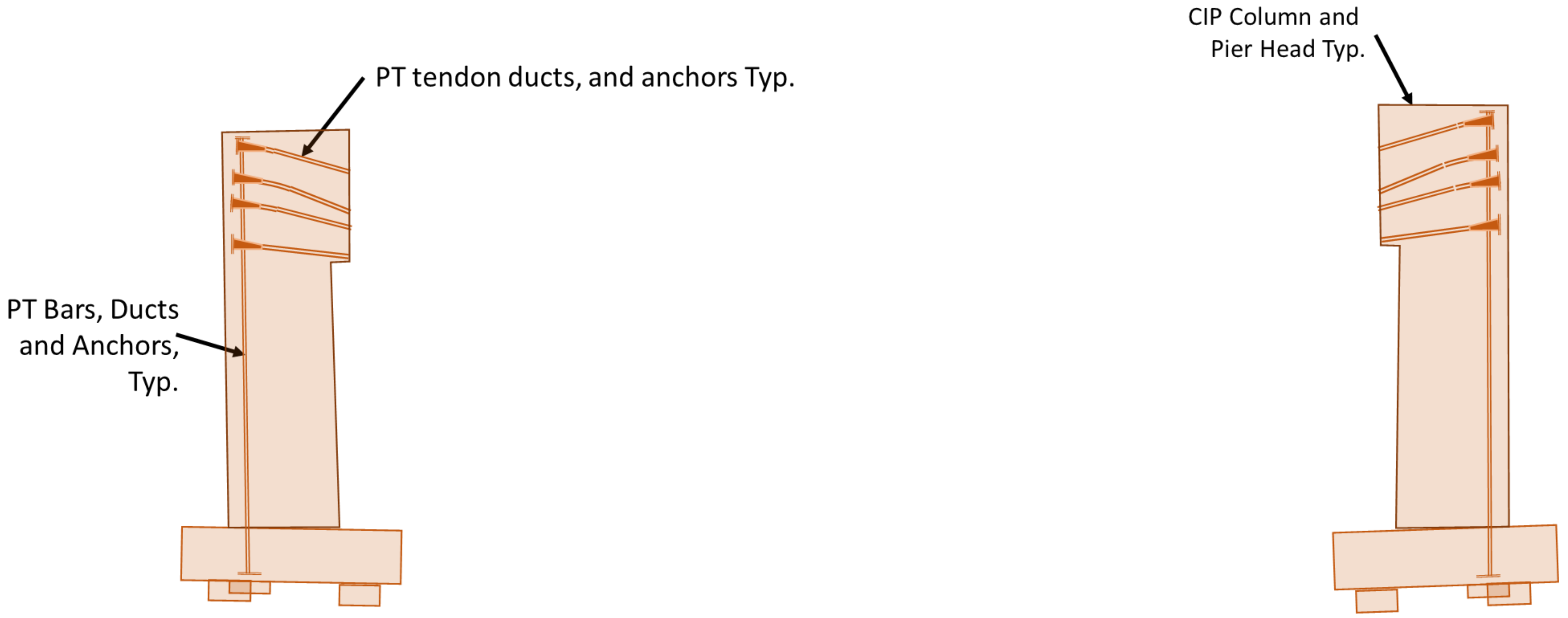


Straddle pier Utilizing Segmental Span-by-Span Construction Techniques
Two Part "L" Shaped Truss not Shown

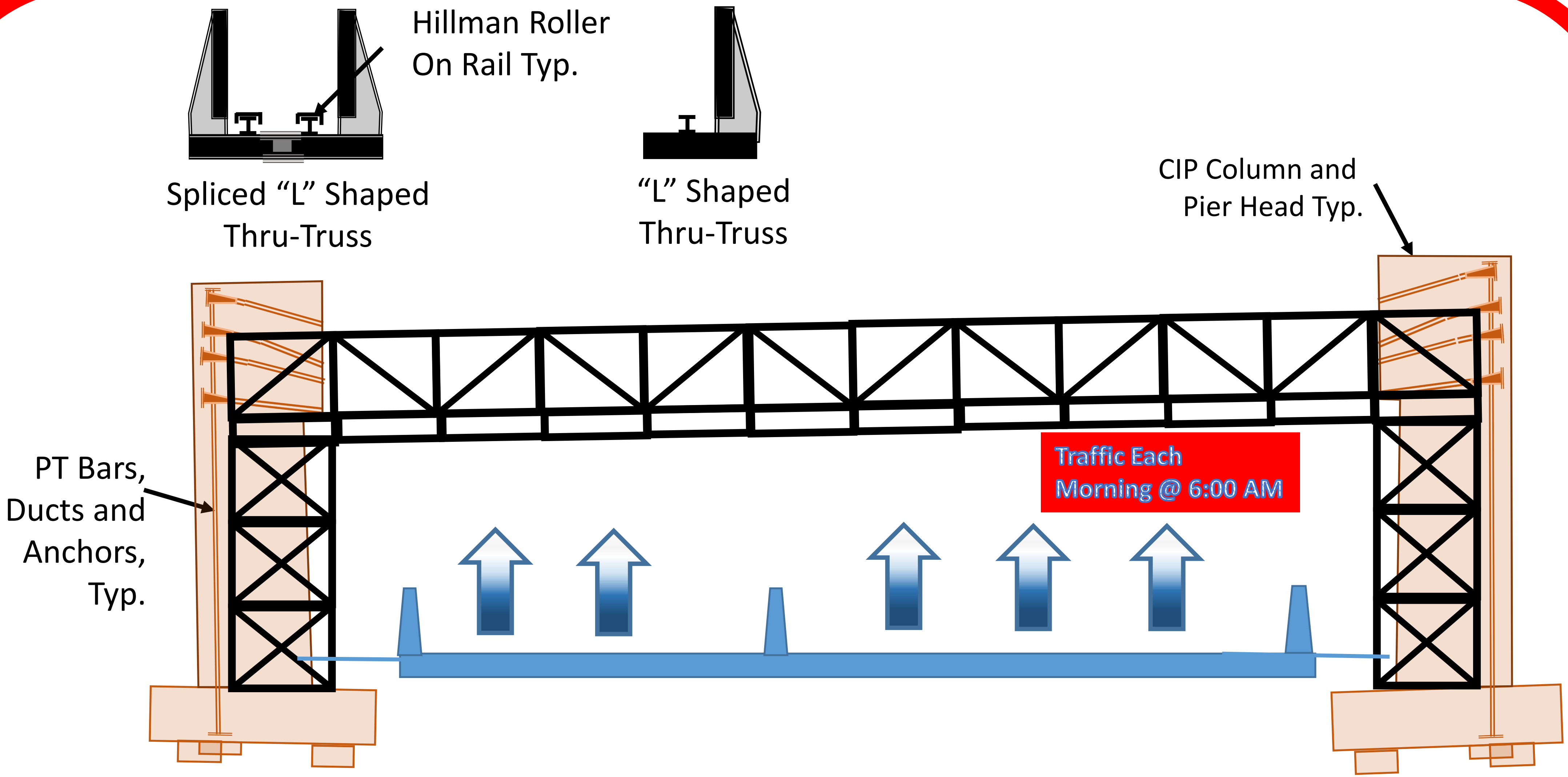
This same concept could be utilized for post-tensioned straddle piers built utilizing segmental, span-by-span construction techniques. Let's now look at a conceptual construction sequence for a rigidly-framed post-tensioned straddle pier….



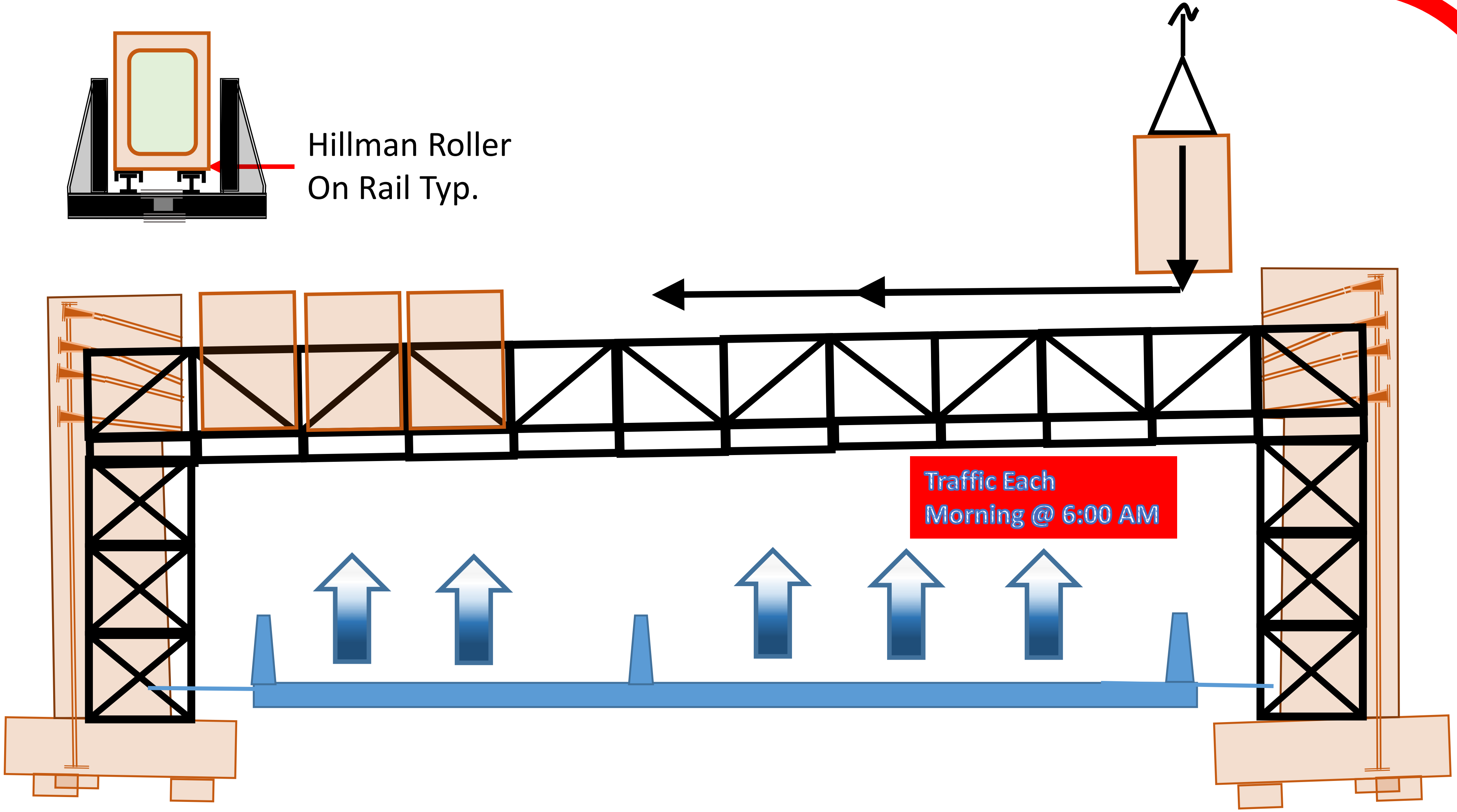
Two Part “L” Shaped Truss not Shown



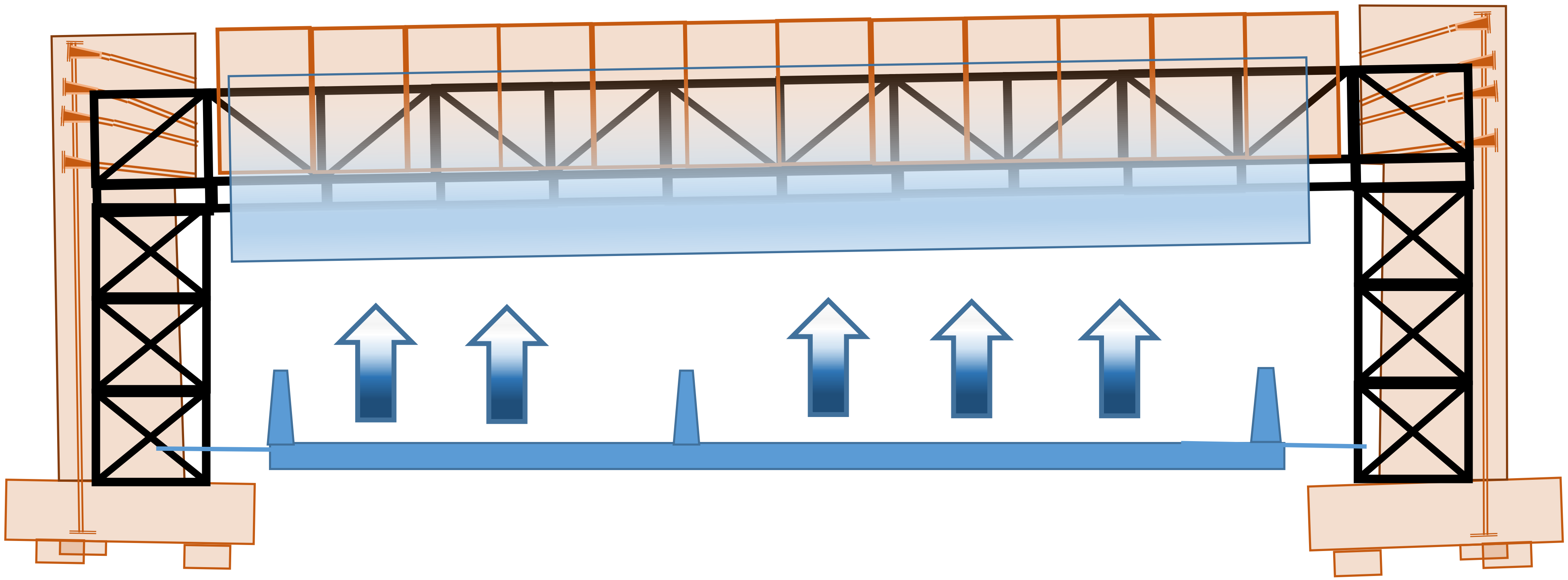
Step 1: Construct Foundations and CIP Columns and Pier Heads



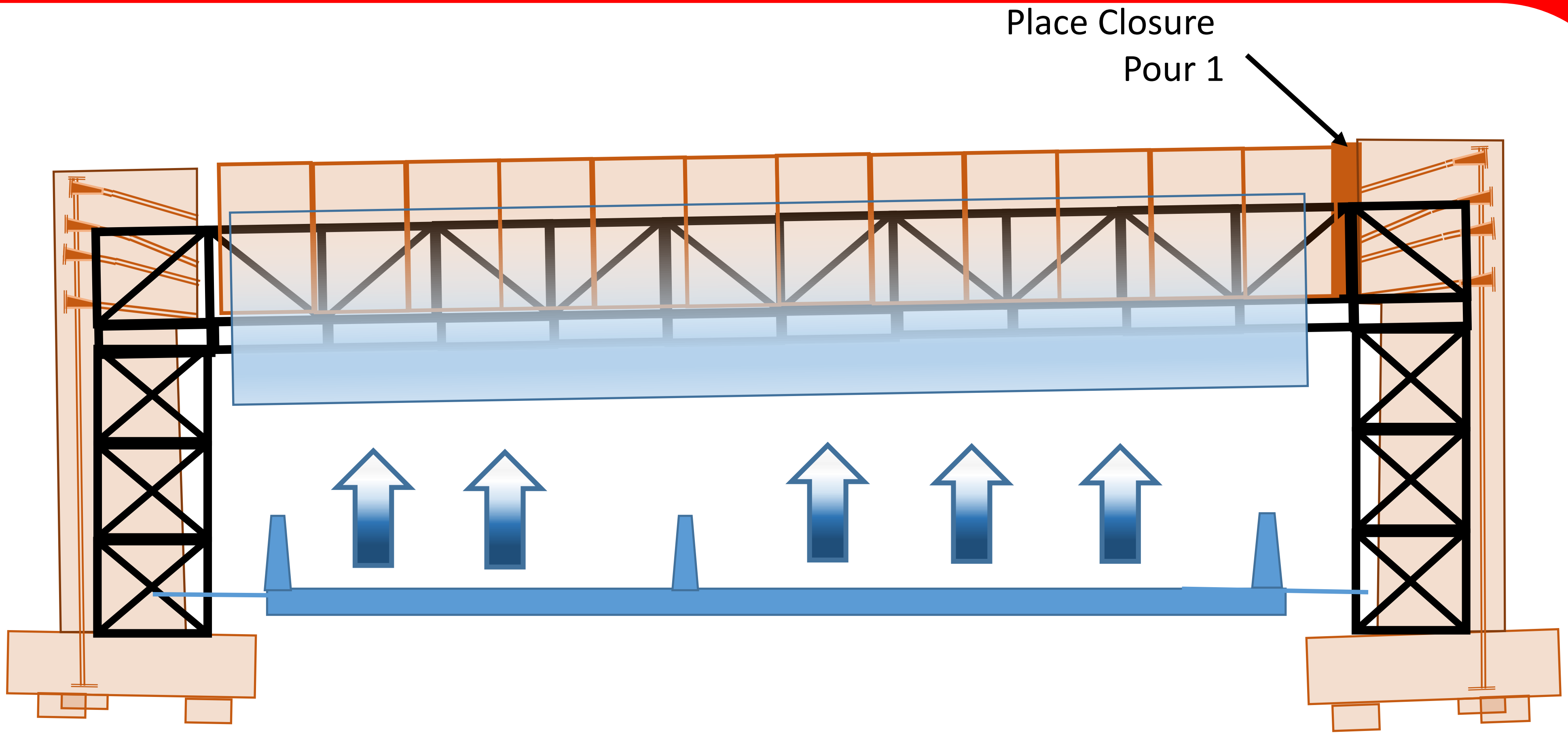
<u>Step 2:</u> Install temporary shoring and Place & Splice Two Part "L" shaped Truss during Nighttime Closure



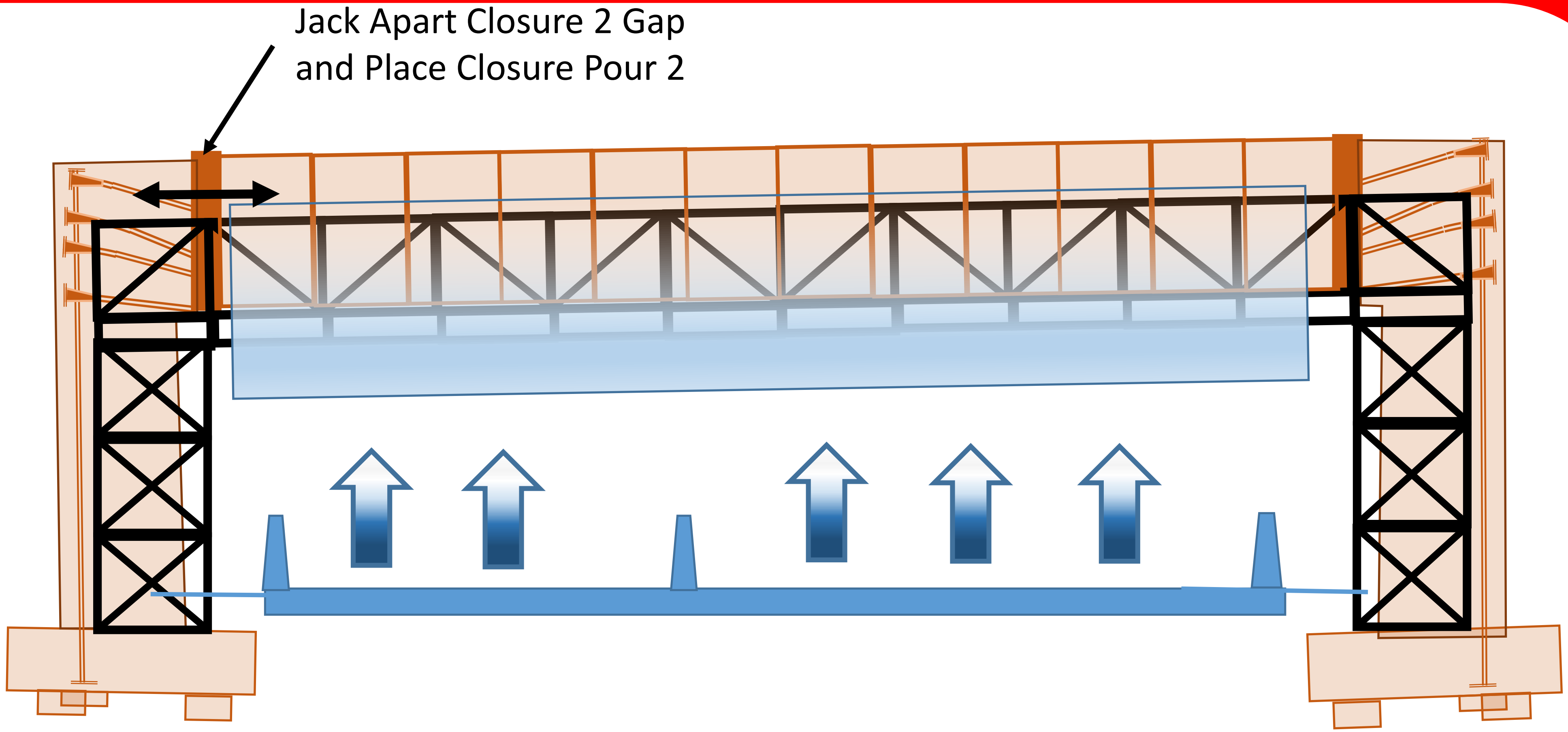
Step 3: Place and Trolley Box Segments into Position



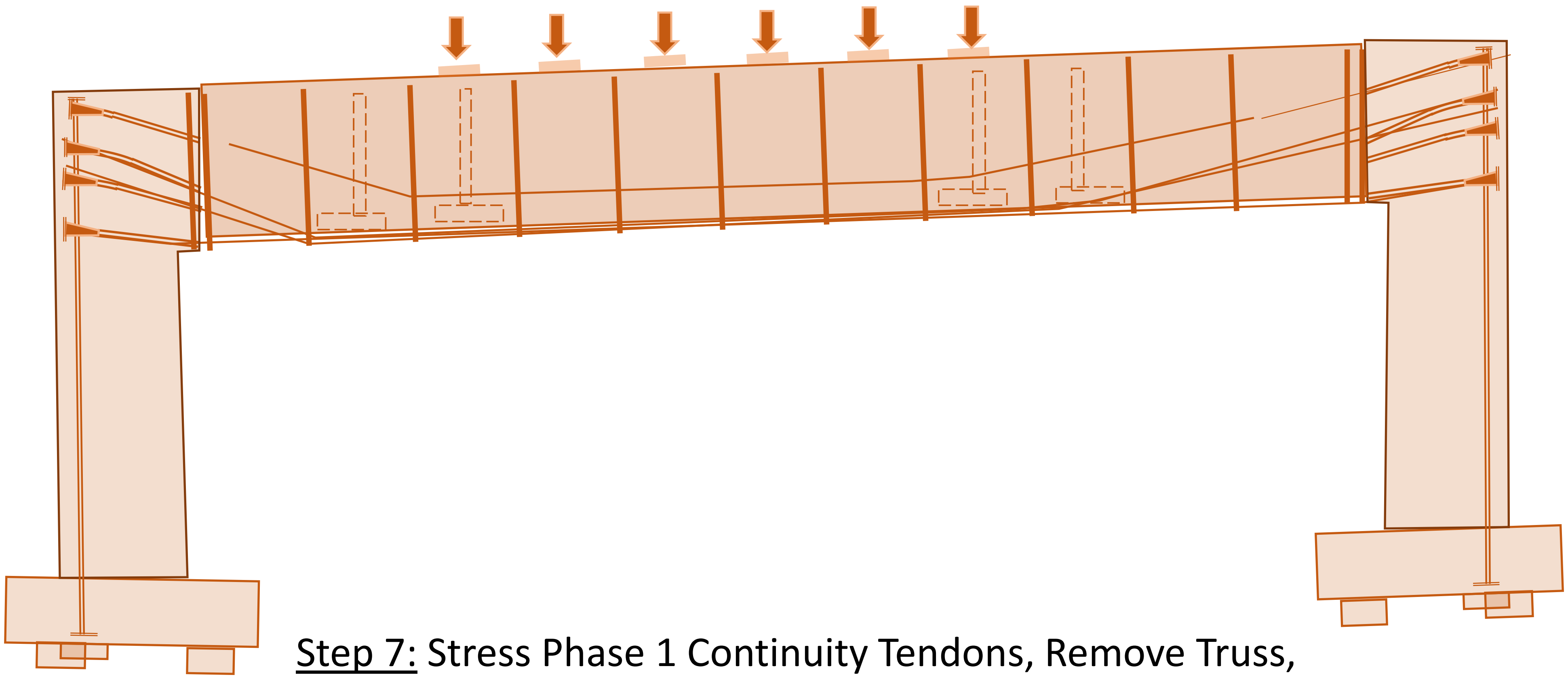
<u>Step 4:</u> Provide Epoxy Squeeze/Fall Protection
Then Temporary PT All Segments Together



Step 5: Place Closure Pour 1

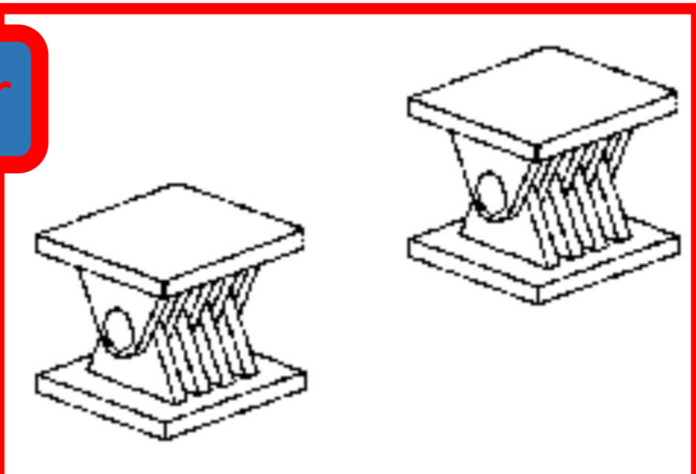


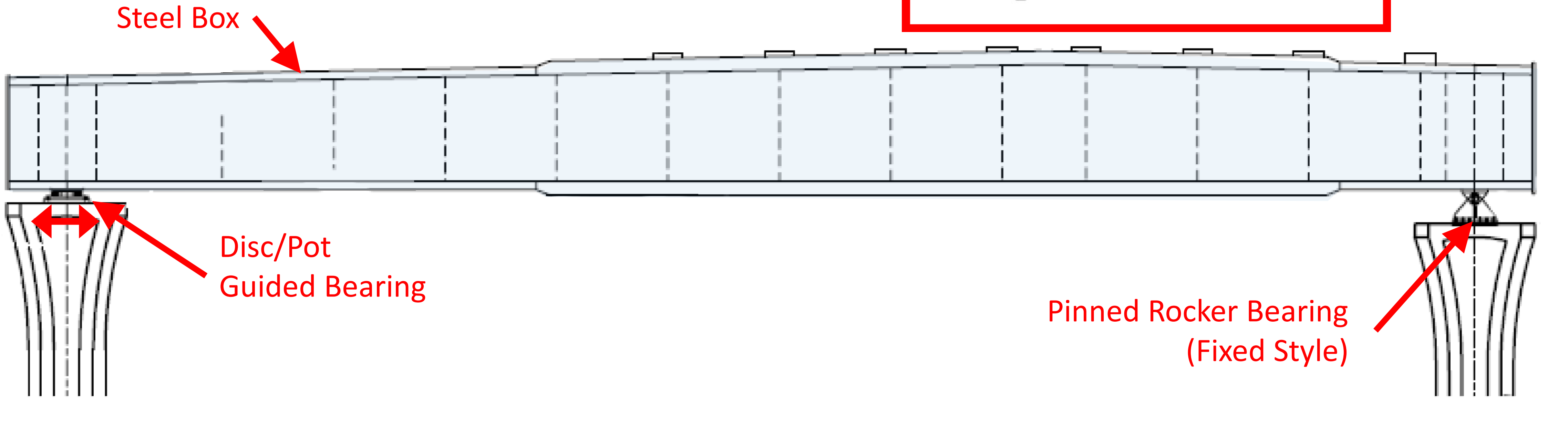
Step 6: Jack Apart Closure 2 Gap and Place Closure Pour 2



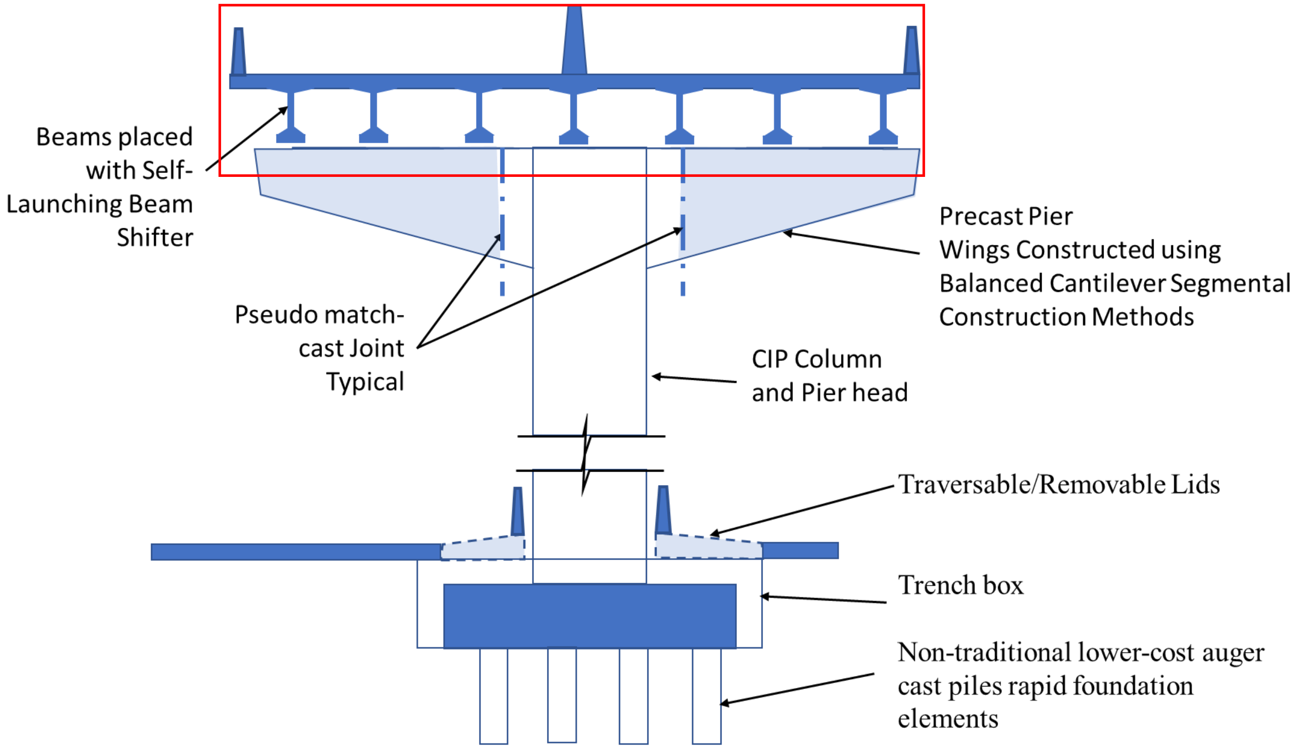
<u>Step 7:</u> Stress Phase 1 Continuity Tendons, Remove Truss, Place Pedestals, Place Beams/Girders and Deck, Stress Phase 2 Continuity Tendons

Non-Integral – Non-Framed Straddle Pier



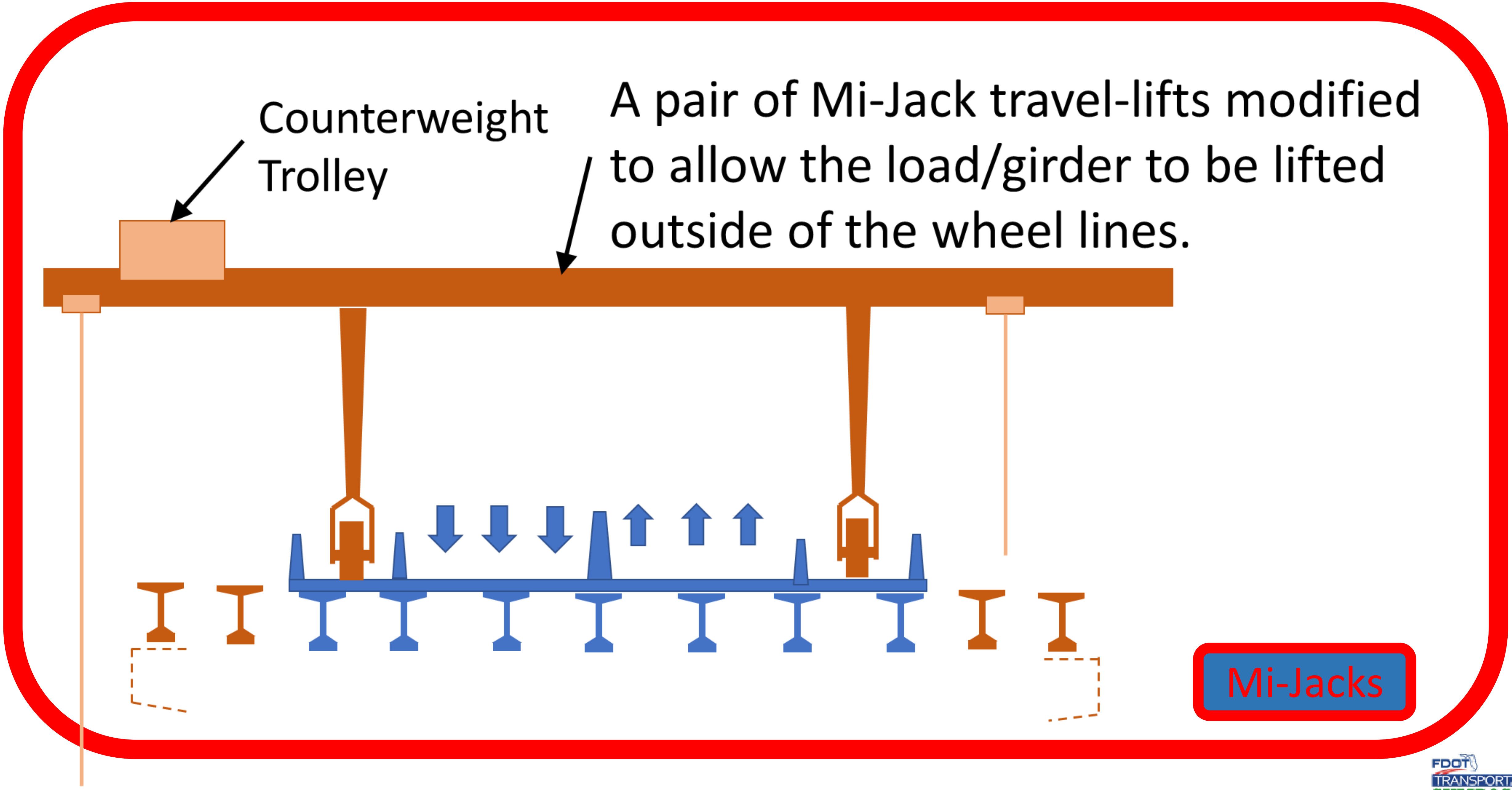


SUPERSTRUCTURE CONSTRUCTION



(Acknowledgement: Archer Western)

<u>Lateral beam shifters</u> are growing in popularity in Florida. Beams can be lifted from the lower roadway during nighttime lane closures and set into position without the need for cranes on the deck.



Counterweight
Trolley
A pair of Mi-Jack travel-lifts modified to allow the load/girder to be lifted outside of the wheel lines.
Mi-Jacks

Just to recap....

- Long waterway bridge projects tend to lend itself to ABC / PBES components
  - Example PBES details: FDOT SDM Ch. 25
- ABC strategies can help solve complex, urban transportation issues associated with a growth state
  - Constructing new ramps over busy interchanges
  - Constructing new bridge viaduct in a confined median
- ABC solutions need to be transparent, safe, and efficient

Questions?

ACKNOWLEDGMENT

1. HDR, Inc. Design Engineer of Record for the Edison Bridge.
2. WSP. Design Engineer-of-Record for the Veterans Memorial Bridge.
3. FINLEY Engineering Group. Construction Engineer-of-Record for the Veterans Memorial Bridge.
4. Hardesty & Hanover. Design Engineer-of-Record for the Jupiter Federal Bascule Bridge Replacement.

REFERENCES

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2. FDOT Structures Manual, Volume 2 [Structures Detailing Manual], Chapter 25 "Prefabricated Bridge Element Systems." (2019)
3. Veterans Memorial Bridge Visualization Sheets, WSP. (2014)
4. Bridge Development Report, SR-5/US-1 Federal Highway From CR-A1A to Beach Road, Sileno, M. Hardesty & Hanover. (2019)