

# Building Bridges at the Speed of Segmental



MONTHLY WEBINAR

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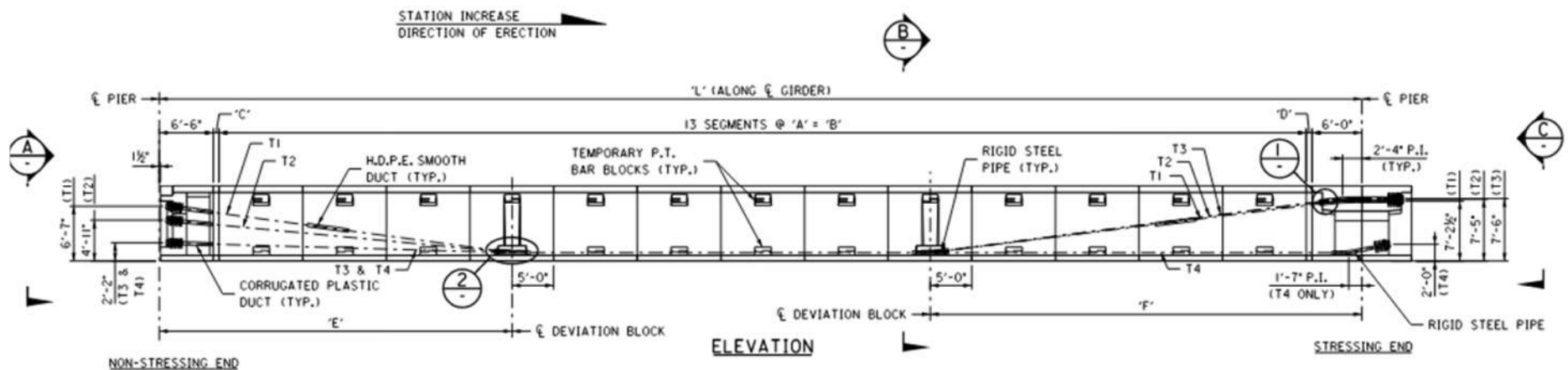
JANUARY 18th, 2024



Accelerated Bridge Construction  
University Transportation Center

# Segmental Bridge Basics

- A bridge that is segmented into short lengths and constructed one piece at a time. Segments are match-cast connected to provide a completed span.
- The segments are typically concrete box structures providing full bridge depth sections including the top deck.
- Segments can provide the full bridge cross-section or be connected transversely to provide wider bridge sections.



# Why Choose Segmental?

- Accelerated Bridge Construction
  - Repetitive process for efficient construction.
  - Constructing full bridge section minimizes forming and finishing work.
- Complex Site and Environmental Constraints
  - Reduced Footprint and Top-Down Construction.
- Economical Long-Span Bridges
- Elevated Viaducts / Rail Transit Bridges
  - Narrow piers and girder soffit require minimal clearance in confined areas.
  - Bridge section follows curvature of rail.
- Improved/Elevated Aesthetics

# ABC and Segmental Bridge Construction

- ABC-UTC-IBT Mission
  - The mission of the ABC-UTC-IBT is to reduce the societal costs of bridge construction by reducing the duration of work zones, focusing special attention on preservation, service life, construction costs, education of the profession, safety and development of a next-generation workforce fully equipped with ABC knowledge.
- Precast Segmental Bridge Construction
  - Rapid Precast Segmental Erection Techniques
  - Reduced Construction Footprint / Impacts to Travel Lanes
  - Erection Methods to Reduce Traffic Closure Durations – Night / Weekends
- FHWA Accelerated Bridge Construction Manual
  - *“Precast segmental construction can be considered an ABC method because it is faster than cast-in-place segmental construction.”*

# Segmental Bridge Types

- Cast-in-Place (CIP) Balanced Cantilever
- Precast Balanced Cantilever Method
- Precast Span-by-Span Method
- Unidirectional Cantilever Method
- Incrementally/Progressively Launched
- Cable-Stay / Extrados Bridges
- Arch Construction
- Precast Segmental Substructure



# When Precast Segmental Makes Sense?

- On or off-site prefabrication of segments in controlled environment in casting yard.
- Improved quality control - segments can be inspected/rejected prior to erection.
- Production can be protected from weather (cold/rain).
- Repetitive factory production process.
- Safety and access for workers.
- Expedited Construction
- Reduce Traffic / Construction Impacts



# Considerations for Pre-casting

- Segment size may be limited by transportation and handling restrictions.
- Girder depth limited based on hauling routes.
- Trailer delivered segments – typically 10ft deep with spans up to 275ft.
- Barge delivery from casting yard to site – spans up to 450ft for balanced cantilever and 1250ft for cable stay bridges.
- Economy in Scale – ~ 200 segments or more to be economical unless other conditions influence cost.
- Standard details improves economy – simple designs lead to savings.
- Segment pre-casting may be performed by the Contractor or a Pre-caster.

# Segment Pre-casting – Casting Yard

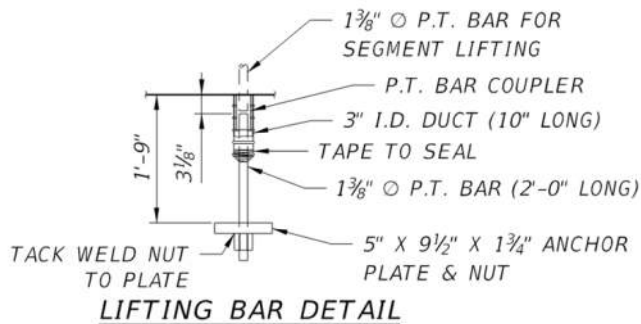
- Can be on-site or off-site
- Size varies based on project
  - ~2,000 Precast Segments
- Casting Operations
  - Reinforcing pre-assembled in a jig
  - Lowered into form for casting
  - All PT and embedded items installed
  - Core form inserted from rear
  - Concrete delivered and poured
  - Forms removed and segment advanced for match-casting
  - After match-casting, segment is stored





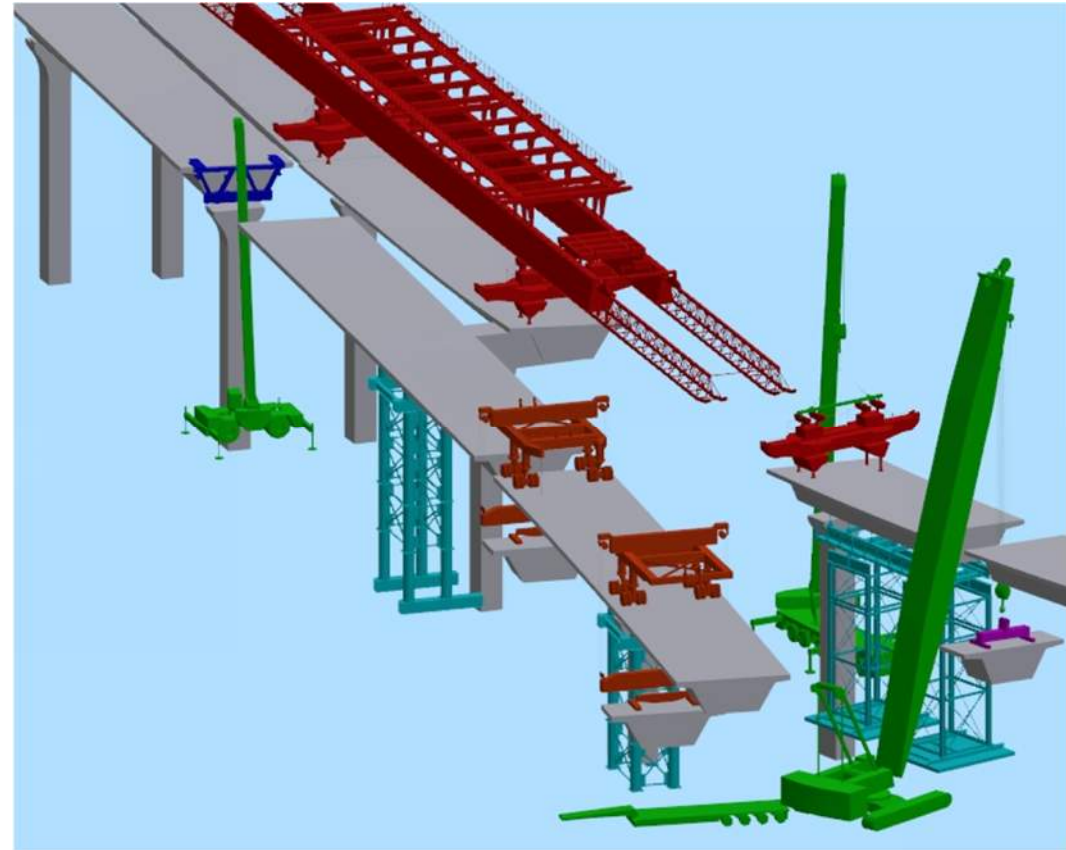
# Precast Segment Handling

- Typical Segment Weight ~70 Tons
- Slings – primarily in the casting yard
- Lifting sleeves / Holes in the deck
- Embedded PT Bars / Anchors
- PT Strand Lifting Loops
- C-Hook Frame



# Precast Segmental Bridge Construction Equipment Reducing Work Zone Impacts

- Ground-Based or Barge Mounted Crane
- Falsework Towers
- Stability Props
- Underslung Truss
- Overhead Gantry
- Lifting Frames
- Mobile Lifters



# Construction Methods

## Span by Span

- Full span supported
- Segments are aligned and connected
- May have alignment closures
- PT installed and stressed
- Segments are released
- Span is complete
- Simple or Continuous Spans
- Up to 7 Spans per Week !?!



# Span by Span Falsework Supported

- Segments erected by ground-based crane on FW Towers and assembled.
- Multiple heading with non-linear sequence, accommodates geometry.
- Requires site access on well graded, stable soil.



# I-59/20 CBD Bridges – Birmingham, AL

## Falsework Supported Span-by-Span Segmental

- Over 1-million square feet of deck
- 2,316 Precast Segments
- 4 Girder Lines – Each 6,600-ft long
- Typical Span Length = 165-ft
- 172 Total Spans
- Traditional Design / Bid / Build
- Winning Bid Price = \$195 million
- Incentive for Early Completion = \$250k / day up to \$15 million
- Disincentive for Late Completion = \$250k / day

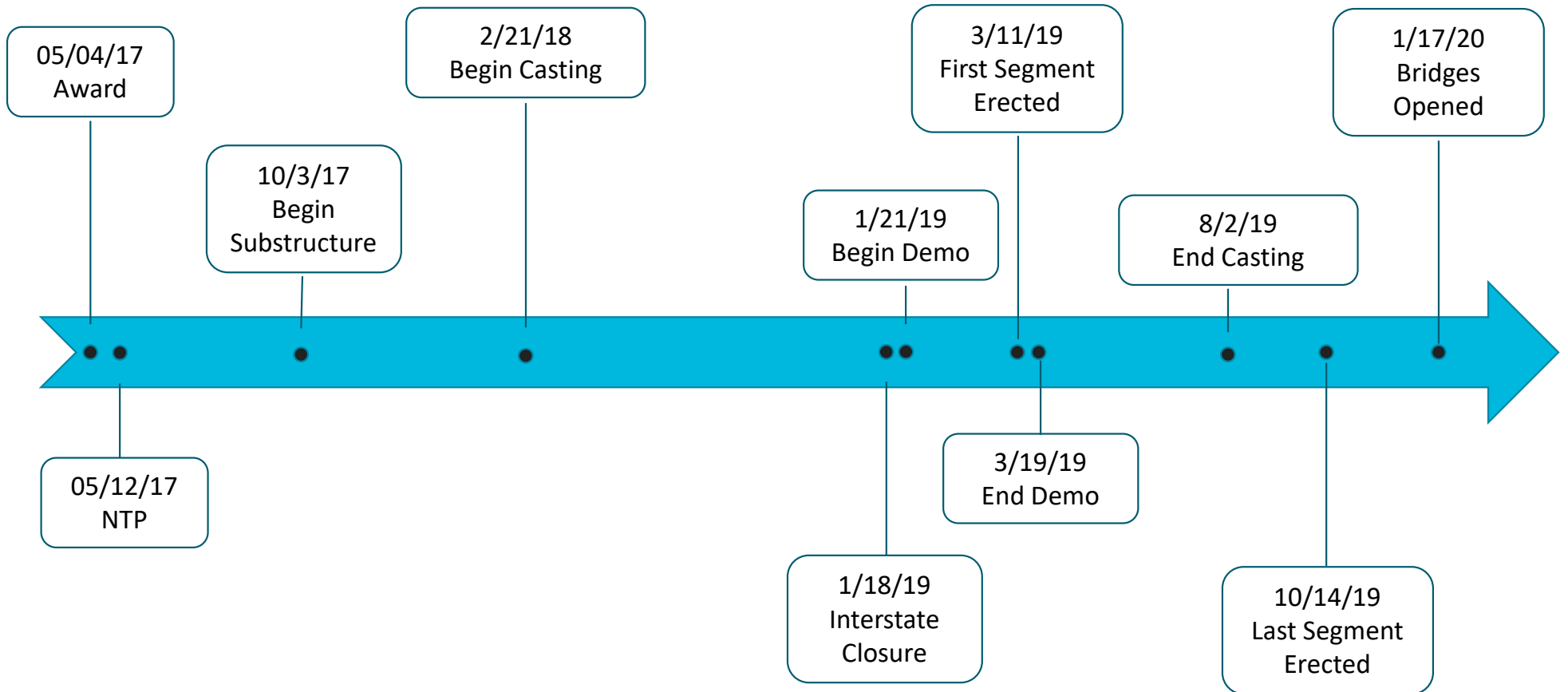


# Why Segmental?

- Only option that could be completed within 12-month shutdown.
- Minimize duration of interstate closure by offsite prefabrication and rapid construction methods.
- Increase span lengths
- Reduce noise
- Improve aesthetics

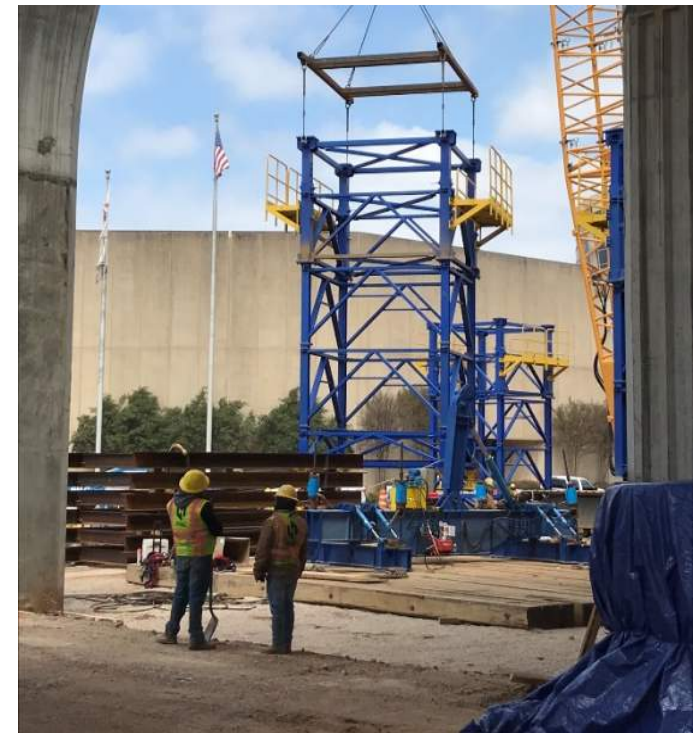


# I-59/20 Project Timeline



# I-59/20 CBD Bridges – Birmingham, AL

## Falsework Supported Span-by-Span Segmental





# I-59/20 CBD Bridges – Birmingham, AL

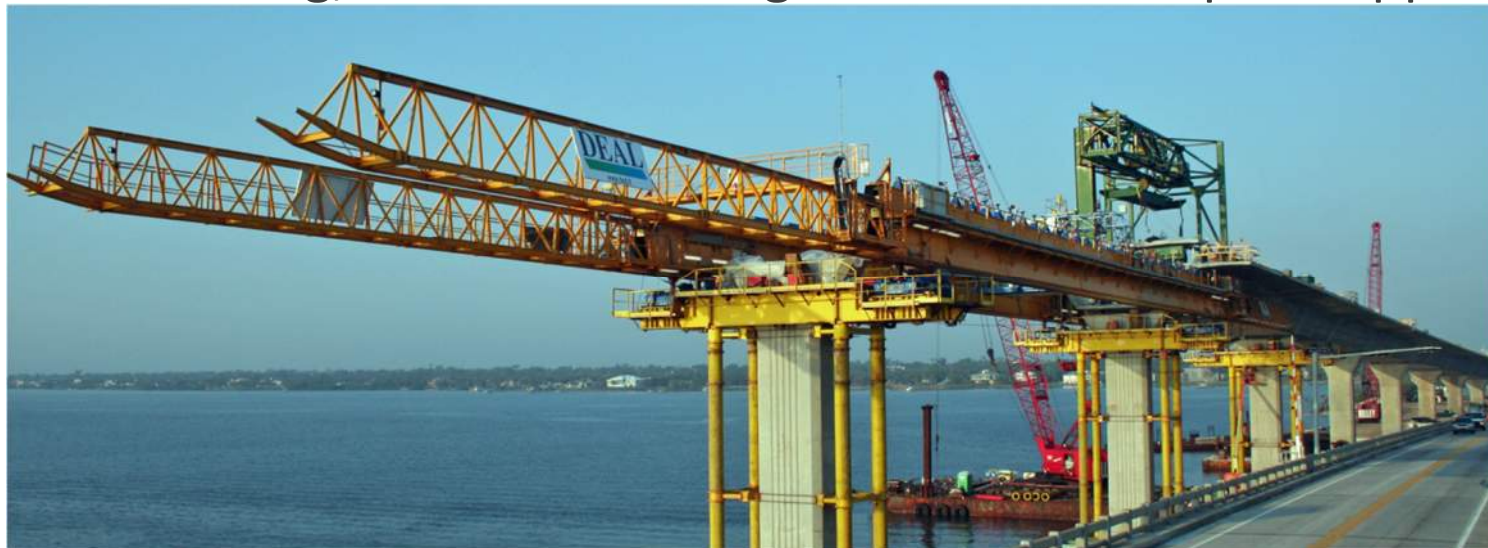
## Falsework Supported Segmental

- All segments erected in 217-days
- Over 10 Segments / Day
- Nearly a Span / Day
- Bridge Cost \$195/SF
- \$15M Incentive worth 60 days
- Up to 8 Headings



# Span by Span Underslung Truss

- Self-Launching or advanced by crane (ground-based or barge mounted).
- Linear construction – segments delivered from rear or from crane.
- Best suited for long, continuous straight sections with pier supports.



# Span by Span Overhead Gantry

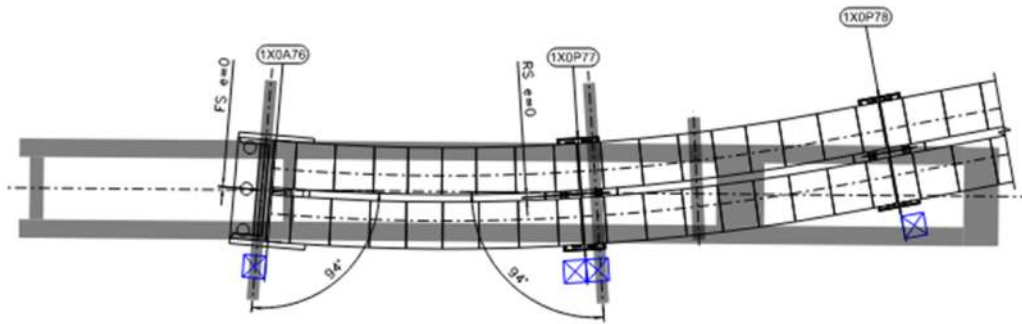
- Self-Launching, winch trolley moves segments and supports.
- Side launching for parallel girders – well suited for long runs.
- Difficult to navigate curvature - may require articulating nose / tail.



# Span by Span

## Overhead Gantry - Articulating

- Tighter radius applications for navigating bridge curvature or constrained site conditions.
- Added complexity / costs – critical stability checks.
- May be avoided using temporary support towers during launching.



# Construction Methods

## Balanced Cantilever

- Segments erected on each side of pier maintaining a balanced condition.
- Falsework on pier or props used to provide stability.
- Typical cycle of 1 pair of segments/day, can increase to 2 or 3 pairs/day.



# Balanced Cantilever Ground Based Crane

- Most economical when site conditions accommodate crane placement and reach.
- Segment is supported by crane until temporary PT bars are installed.
- Once balancing segment is erected, cantilever tendons are installed.



# Balanced Cantilever Lifting Frame (Beam & Winch)

- Self-launching frames attached to previously completed cantilever and hoist segment into position for assembly.
- Requires segment delivery in position for lifting (barge or trailer).
- Design of cantilevers must consider increased loading.



# Balanced Cantilever Mobile Segment Lifter

- Effective when segment delivery or crane access is limited.
- Mobile lifter can travel along cantilever with segment suspended.
- Once in position, ties down and advances segment, then lifts and aligns segment.
- Stressing basket and jacks suspended from lifter.





# Balanced Cantilever Mobile Segment Lifter

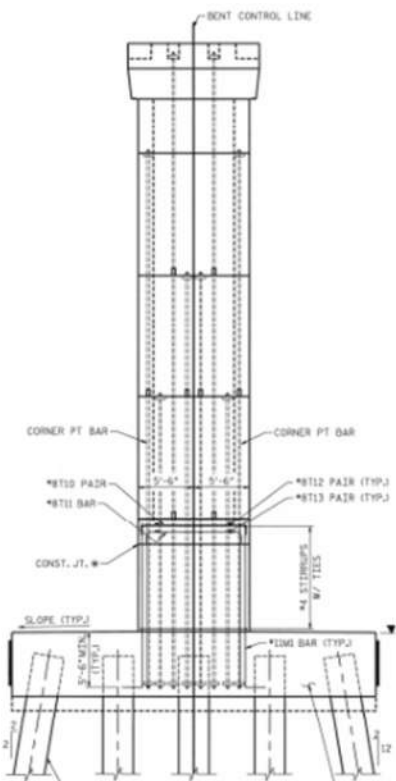


# Balanced Cantilever Overhead Gantry

- Like span-by-span, but gantry only supports trolley for segment placement, not a full span.
- Once erected, segment is supported by the cantilever and released.
- Allows for rear segment delivery along completed bridge sections or delivery from below for direct hoisting.



# Precast Segmental Substructure



# Precast Segmental Substructure

- Installed ~20 Pier Columns per week using this method



# Solve the problem before it occurs!

- ABC Projects require a commitment from all parties.
  - Standard solutions and methods may not be appropriate.
- Simple designs and details lead to efficient construction.
  - If it's hard to draw – it's going to be harder to build.
- Figure out how the bridge will be built first, then design and detail it.
- Leave some room in the design for construction – things happen.
- Have a plan for when things don't go as planned.
  - Anticipate issues that may occur and know how to address them ahead of time.

# Simple Details for Rapid Construction!



# Summary

- Segmental bridges can provide a durable, redundant, efficient and elegant solution to a project when well designed and constructed.
- Once size does not fit all and each project has unique requirements, but there are many options available to satisfy those needs.



For more information: <https://abc-utc.fiu.edu/> Accelerated Bridge Construction / UTC  
[complexbridge@hardestyhanover.com](mailto:complexbridge@hardestyhanover.com) H&H Complex Bridge Group  
<https://asbi-assoc.org/> American Segmental Bridge Institute  
<https://youtu.be/kWfoJveRjQE> ABC Applications in Segmental Bridge Construction  
<https://www.aspirebridge.com/magazine/2012Fall/ABC.pdf>  
[Precast Substructures | Accelerated Bridge Construction \(fiu.edu\)](https://www.aspirebridge.com/magazine/2012Fall/ABC.pdf)  
<https://youtu.be/CcGU1WOXPcQ> ABC-UTC Monthly Webinar Series: Precast  
Substructure Connection Details – AASHTO and PCINE Guidance

## Questions?

