


<b>EDC</b> <b>Case Studies</b>	<b>Case Study #6</b>	 STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION
<i>Every Day Counts</i> <i>Case Studies</i>  Department of Transportation Structures Design Office	<h1>CASE STUDY #6</h1> <h2>Construction of a Long Bridge Viaduct Located in the Median of an Existing Interstate</h2>	

- The purpose of this presentation is to demonstrate the sort of factors influencing the decision to employ Prefabricated Bridge Elements and Systems for rapid project delivery. Bridges showcased in these case studies are not real FDOT projects, but the sites have been chosen because of their unique design constraints and ability to illustrate various accelerated bridge construction considerations. For each case, particular constraints will be assumed and then possible prefabricated ABC approaches will be explored.
- This case study features construction of a long bridge viaduct located in the median of an existing interstate.
- Of particular interest in this case study is the limited area for construction in the median and minimizing impacts to adjacent interstate lanes.

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- This photo rendering depicts an existing multi-lane at-grade interstate with a proposed new long viaduct to be constructed in the center of the interstate median.
- The challenge of this project is to determine how to construct the long viaduct while minimizing the traffic impacts on the existing at-grade facility.



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- This photo shows an actual completed long viaduct located in the median of an existing interstate.
- The purpose of this viaduct is to accommodate three reversible managed lanes.
- The lanes take traffic into the city-center in the morning; the process is reversed in the afternoon.



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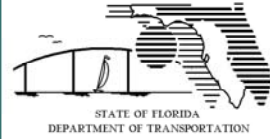
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***Conventional Construction Approach:***

- Crane Access –Crane places beams from outside the footprint of the new viaduct.
- Uniformity and Economy of Scale – It is assumed that the viaduct to be constructed is very long and repetitive.
- Interstate Corridor– This case study assumes a very congested interstate corridor.

- The sketch to the left shows a typical construction method in which a crane places beams from outside the footprint of the new viaduct. This method of construction would be very disruptive to the operations of the existing interstate.
- This case study assumes that the viaduct to be constructed is very long and uniform.
- Also assumed is the viaduct to be constructed in the median of a very congested interstate corridor.



## Problem Statement

**What are ways to minimize user impacts, provide construction access, reduce construction time, as well as reduce overall cost?**

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- What are ways to minimize environmental impacts, provide construction access, reduce construction time, as well as, reduce overall cost?



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- One solution is to develop a top-down span placement and delivery concept that minimizes disruption of the existing interstate.
- The photo on this slide depicts a conventional top-down construction segmental span-by-span technique where the segments are delivered from the previously placed viaduct with a hauler and then placed onto an under-slung truss and stressed one span at a time. This construction technique can construct approximately 2-3 spans per week, on average.



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***Prefabricated Construction Approach:***

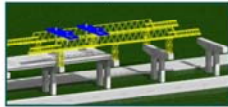
- Top-Down Construction – The size of the project justifies the cost of the special equipment required to facilitate top-down construction.
- Prefabricated Substructure Components - Pier components could consist of flowable concrete, polystyrene utilizing rebar couplers for connections between prefabricated elements. Due to footing lifting weights, precast concrete bathtub forms within the river could be considered. See Case Study #2 for more information.
- Rubber tire straddle cranes could be utilized to assemble prefabricated substructure elements in the median.

To accomplish the goals of reduced user impacts, provide construction access, reduce construction time, as well as, reduce overall cost, here are a few considerations:

- Top-Down Construction – The size of the project justifies the cost of the special equipment required to facilitate top-down construction.
- Precast pier columns and caps could consist of flowable concrete and polystyrene blocks to reduce weight utilizing rebar couplers for connections between prefabricated elements. See Case Study #2 for more information.
- Rubber tire type straddle cranes could be utilized to assemble prefabricated substructure elements in the median.



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***Prefabricated Construction Approach (cont.):***

- Full Prefabricated Span Solutions – Concepts that utilize prefabricated full-span near-site casting and delivery using Self-Propelled-Modular-Transporters (SPMT's) should be considered.
- Precast Advantage – may consider shored construction and composite dead loads for increased structural efficiency.
- Near Site Casting – assume that there is sufficient space within the R.O.W. at the end of the viaduct to place a casting yard.

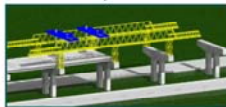
Other ways to reduce user impacts and costs:

- Concepts that utilize prefabricated full-span near-site casting and delivery using Self-Propelled-Modular-Transporters (SPMT's) should be considered.
- Precast Advantage – full-span near-site casting offers the advantage of utilizing the composite section to carry slab dead loads to increase structural efficiency of the superstructure because span can be shored during deck placement. This may not be a good option in deicing states, but in Florida, where deck replacements are rare, this is acceptable.
- Near Site Casting – assume that there is sufficient space within the R.O.W. at the end of the viaduct to place a casting yard.



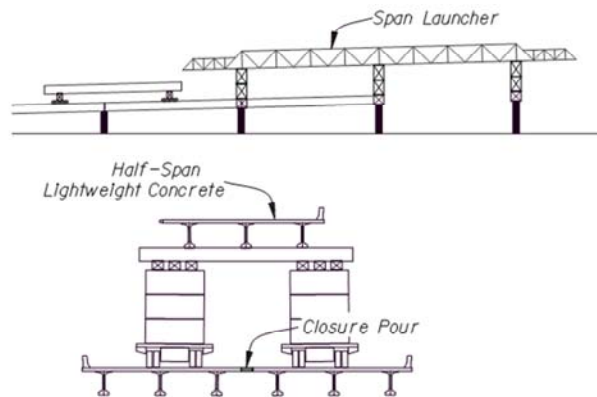


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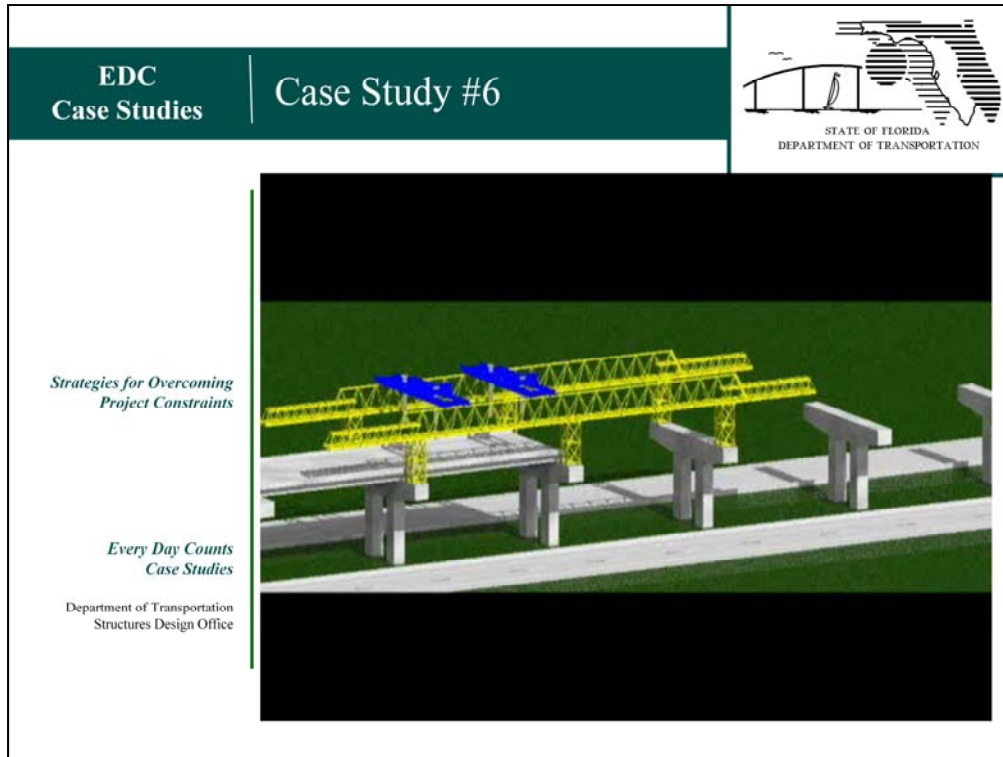
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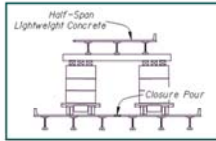
**SPMT's used as a span delivery system for top-down construction.**

- This slide shows one simple-span beam concept that would allow for rapid span placement of the viaduct using SPMT's and an overhead gantry/span launcher.
- This top-down construction technique would have very little impact on the traffic below.
- Due to the number and uniformity of bridge elements, this sort of project is conducive to utilizing precast substructures.
- Note that the construction of the longitudinal closure pour is not on the critical path.
- Also splitting the span in half reduces the temporary loading demands of the completed structure. Splitting the cross section into thirds is also possible.
- Because the construction of the longitudinal closure pours are not on the critical path, this concept is lightning fast - approximately 2 spans per day or up to 1 mile of bridge per month could be constructed. In fact the speed in which the foundations and substructure components could be constructed is the controlling item affecting construction time.
- This concept could be applied for both simple span prestressed concrete and steel beam depending on span length and structure weight.
- The spans would be placed on standard neoprene bearing pads and shimmed as required.
- Rubber tired straddle cranes should be considered in order accelerate placement of the precast substructure elements in the interstate median out in front of the lightning quick span launcher operation.



➤ This short video shows the construction sequence of the span launcher. The sequence of construction would be as follows:

- Construct near-site precasting yard at one end of the viaduct. Utilize the yard to fabricate precast substructure elements, as well as, to fabricate half spans.
- Cast pre-fabricated spans while constructing substructure elements of viaduct.
- Assemble span launcher and forward onto piers.
- Deliver prefabricated spans to span launcher using SPMT's. Place spans using span launcher.
- Advance span launcher, and repeat the process until viaduct is constructed.





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- Other possible solutions include a similar full-span delivery and placement system using an overhead gantry. This photo shows a simple span segmental bridge example.
- Whereas this system is lightning fast, the designer needs to factor-in the additional costs of the stronger foundations necessary to accommodate the temporary load condition of delivering a full-span on the completed structures versus a partial-span. This temporary load condition includes the self-weight, the weight of the span that is delivered, the SPMT's as well as the weight of the overhead gantry. Also the superstructure also has to be strengthened to accommodate this temporary load condition.
- For the purpose of this case study, a full-span option was considered and excluded due to the added superstructure and substructure costs. A simple-span steel or prestressed concrete beam option was chosen so that the cross-section could be broken up into halves or thirds to reduce the temporary loads.

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<p><i>In Summary...</i></p>  <p><i>Every Day Counts Case Studies</i></p> <p>Department of Transportation Structures Design Office</p>	<p><b><i>Potential Prefabricated Elements:</i></b></p> <ul style="list-style-type: none"> <li>➤ <i>Florida I-Beams (FIBs), U-Beams or Simple-Span Steel—standard FDOT construction</i></li> <li>➤ <i>Prestressed Concrete Piling – standard FDOT construction</i></li> <li>➤ <i>Pier Column –utilize flowable concrete mixes with embedded polystyrene blocks designed to be connected to precast cap and footing elements using grouted rebar couplers</i></li> <li>➤ <i>Pier Cap – should be considered along w/footings and columns</i></li> <li>➤ <i>Span-by-Span Segmental – top-down construction minimizes impact to adjacent interstate and allows ABC</i></li> <li>➤ <i>Prefab Complete Superstructure – most-rapid construction option</i></li> </ul> <p><b><i>Elements not Beneficial for Prefabrication:</i></b></p> <ul style="list-style-type: none"> <li>➤ <i>Bent Cap – typically easy to construct end bents in-situ</i></li> <li>➤ <i>Prefab Full-Depth Deck Panels – not beneficial if complete superstructure is cast nearby in conjunction with SPMTs</i></li> </ul>	

In Summary...

Potential elements for prefabrication include:

- Florida I-Beams, U-beams or simple span steel – already standard practice in Florida
- Prestressed Concrete Piling – already standard practice in Florida
- Precast Pier Components – Columns and Caps – utilize flowable concrete mixes with embedded polystyrene blocks designed to be connected to precast cap and footing elements using grouted rebar couplers without the need for post-tensioning
- Precast Pier Footings– evaluate considering the weight and demands. Consider precast bath-tub stay-in-place form detailed such that no metallic elements penetrate the structural concrete shell interface.
- Precast Segmental Span-by-Span construction – minimizes impacts to the adjacent interstate and allows for accelerated bridge construction
- Prefab Complete Superstructure – most-rapid construction option

Elements not considered beneficial for prefabrication include:

- Bent Cap – typically easy to construct end bents in-situ
- Prefab Full-Depth Deck Panels – not beneficial if complete superstructure is cast nearby in conjunction with SPMTs