

## **TDOT Fast-4 on I-24 – ABC Project Using Design-Bid-Build**

Ted Kniazewycz, P.E., F.ASCE, Director – Structures Division, TN DOT (615)741-3351  
[ted.kniazewycz@tn.gov](mailto:ted.kniazewycz@tn.gov)

### **ABSTRACT**

The Tennessee Department of Transportation has embraced the Accelerated Bridge Construction and alternate project delivery philosophies in the completion of several diverse projects. Recently, the Department successfully utilized the more traditional Design-Bid-Build (DBB) delivery method on the high-profile Fast-4 project in downtown Nashville where two pairs of bridges were replaced with only 4 weekend closures. A high degree of plans coordination by the engineer and the development of a comprehensive logistic plan by the contractor along with attention to design, detailing and execution were all required to lower project risk and deliver a successful DBB ABC project.

### **INTRODUCTION**

The TDOT Fast-4 on I-24 project was the first large scale Design-Bid-Build ABC project undertaken by the Tennessee DOT. The project included the replacement of four bridges over four weekends utilizing prefabricated bridge elements (PBES) on existing strengthened substructures. The PBES utilized precast, prestressed concrete box beams with longitudinally oriented conventionally reinforced full depth deck panels. The geometric configuration of two bridges led to a framing system that had tapered box beam spacing and full depth panels that were trapezoidal in shape such that no two beams or panels were of the same dimensions.

The project design followed TDOT's ABC philosophy of minimizing inconvenience to the traveling public by limiting full roadway closures to a maximum of 56 continuous hours over a regular Friday night to Monday morning work period.

Prior to the weekend closures, the substructures were widened and strengthened to facilitate the required geometric configuration for the project. The addition of shear walls provided capacity to the existing caps and allowed for the shifting of the beam bearing areas for the new beams. This work could be completed under regular work schedules as it did not impact the traveling public.

The contractor for the project, Bell & Associates Construction, LP out of Brentwood, Tennessee, had full responsibility to determine the means and methods for completing the project – including the phased demolition of the project, logistics for on-time sequential delivery of the beams and panels, and installation of all required components within the maximum 56-hour work window. Some complicating factors on the project include an active mainline CSXT railroad track under two of the bridges along with restricted right-of-way that limited working and staging areas for the numerous PBES components. For the largest bridge replacement effort, there were a total of 155 loaded trailers with beams or panels that had to be maneuvered through the congested site. An additional complication on the site was the need to establish level bearing areas between the existing beams to allow for the placement of variable height steel shims during the weekend construction phases. These bearing areas incorporated the smaller existing beam seats and were constructed using conventional concrete and mild reinforcing. Once these areas were completed, the Contractor could obtain the bearing area elevation and calculate the needed shim thickness.

Other details incorporated into the project included a new TDOT continuity diaphragm detail that provided connection to the substructures with minimal weekend construction impacts, deck continuity reinforcing for the full depth deck panels and a refined deck joint detail that helped to simplify the panel fabrication process.

## PROJECT DETAILS

The Fast-4 project involved the major rehabilitation of two pairs of bridges along a ½ mile stretch of I-24 in downtown Nashville. The traffic within the project limits was approaching 130,000 ADT with no break in traffic volumes between week-day and week-end counts due to the number of business and tourist destinations accessed from this interstate corridor. The bridges were experiencing deck failures which resulted in emergency lane closures causing major traffic disruptions. TDOT selected their preferred ABC method that took advantage of the bridge components that were still serviceable and allowed for new precast concrete elements to be fabricated to fit the serviceable components. Additionally, the prefabricated elements could be procured at an on-demand schedule which resulted in minimal impact to the traveling public and reduced risk to the contractor since the bridge elements were new construction and there was total control on the element dimensions and opportunities to provide improved fit-up tolerances.



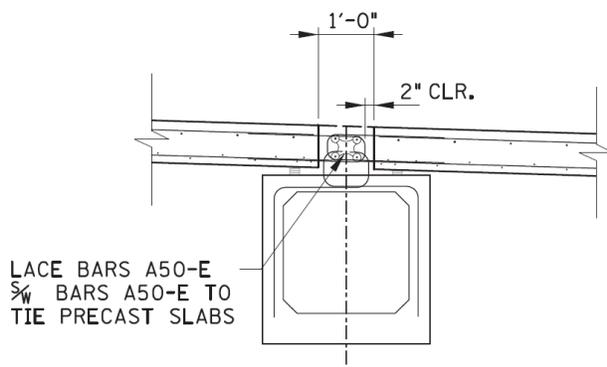
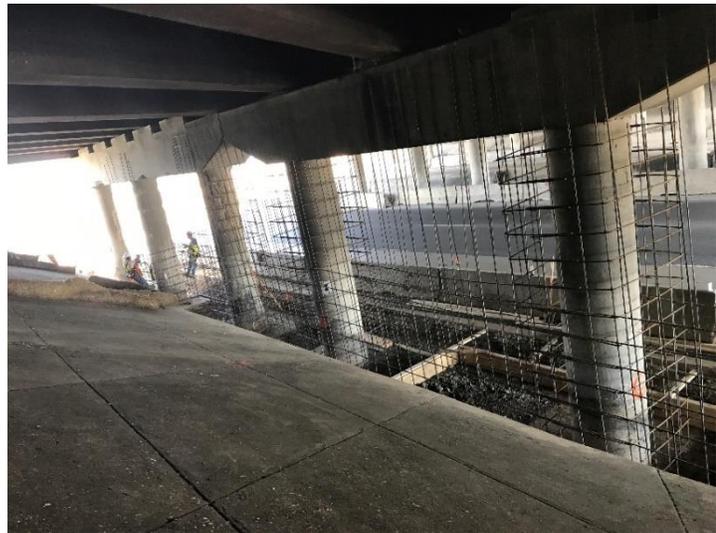
**SPRING STREET BRIDGE SITE**

These two bridges were four-span structures comprised of AASHTO Type III beams with continuous concrete decks. The structure was constructed at a 45-degree skew and had accommodations for full cloverleaf entrance / exit ramps. The substructures were multi-post bents and stub type abutments supported on driven HP piles.

Because of the need to adjust beam seat location and redistribute where loads were applied, the existing substructures were strengthened through the addition of reinforced concrete shear walls.

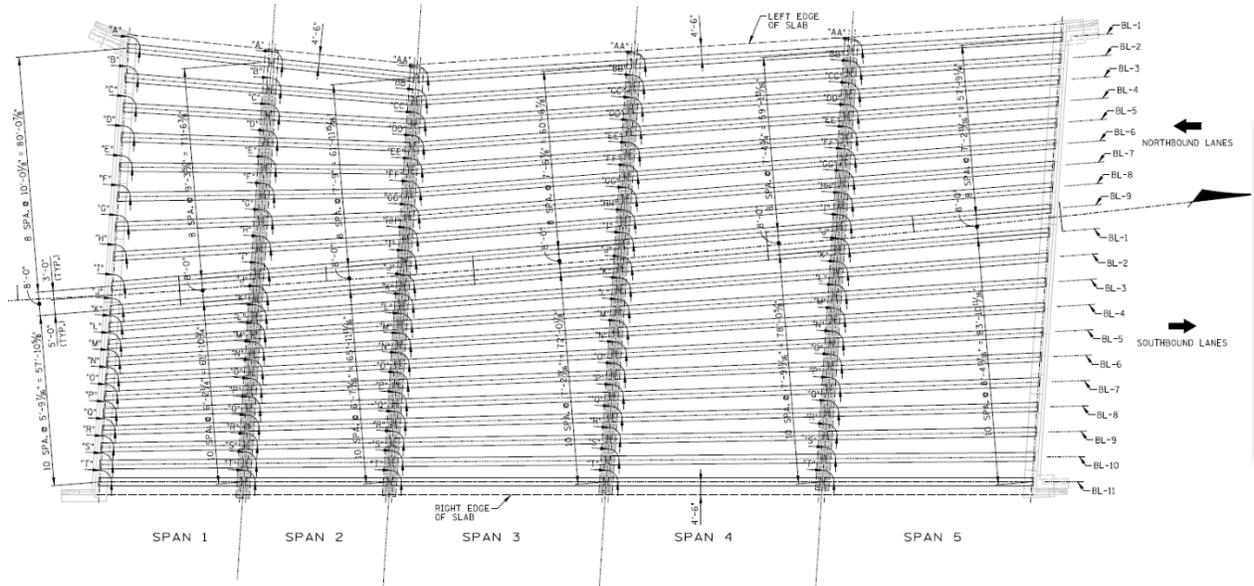
For this location, it was possible to place the new prestressed box beams in a parallel framing configuration which allowed for uniform beam lengths per span and typical dimensions for the full depth deck panels.

Having both new beams and panels reduced the risk of panel fit-up issues. Additionally, the connection of the panels to the box beam was designed to be only 12" wide which provided ample support width for the deck panels on the 36" wide beams. The deck panels were orientated parallel to the beams instead of the more traditional transverse orientation. Panels were designed to a maximum length of 45 feet which allowed for a single panel in the end spans and two panels in interior spans. Joints between the panels in both transverse and longitudinal directions were strengthened with lacing bars which provided a strong connection between the panels and the projecting beam stirrups.



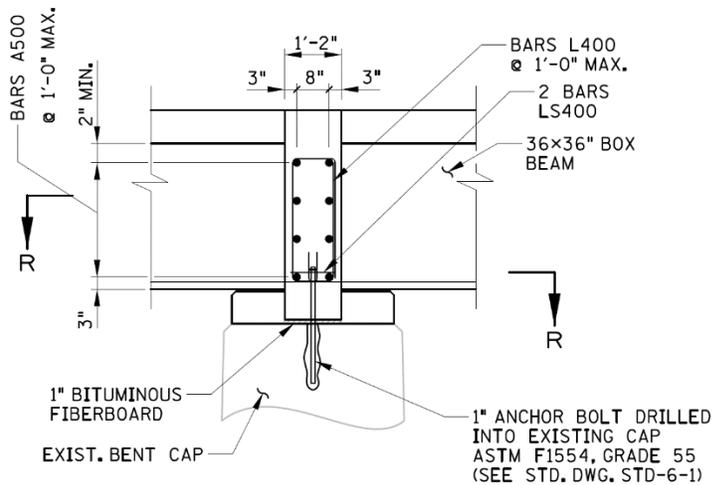
**OLDHAM STREET BRIDGE SITE**

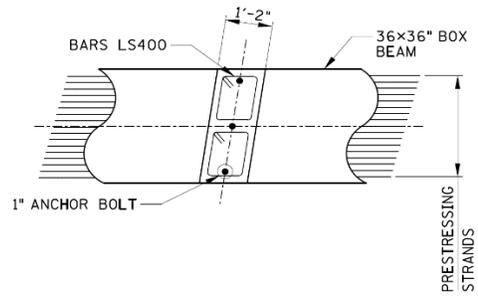
These bridges were five span continuous bridges with steel beams spanning over a local road and a mainline CSXT railroad. The rehabilitated bridge utilized the existing substructures which had to be strengthened for the heavier precast superstructure and variable beam spacing.



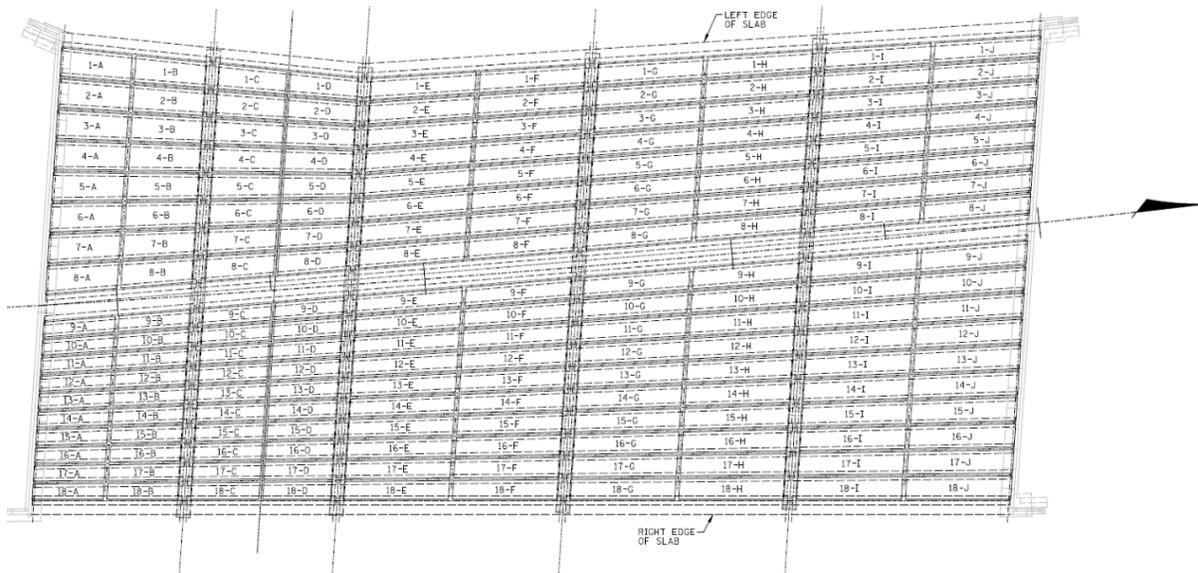
**FRAMING PLAN**

Beams were equally spaced at each substructure on each side of the CL of the roadway. This provided a uniform layout for the beams and allowed for controlled dimensions of the panels. It was important for the beams to align at each substructure so that the new diaphragm detail developed by the department could be utilized. TDOT had traditionally used a diaphragm that ran the full length of the bent providing continuity for the superstructure. The new detail only provides the diaphragm for the width of each beam.



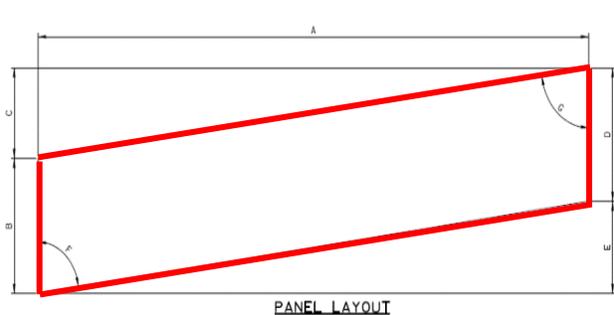


With the variable beam spacing for the panels, the panel geometry was the next issue to tackle. The parallel framing of the beams resulted in each beam being a unique length. It also made every full depth deck panel a unique dimension.

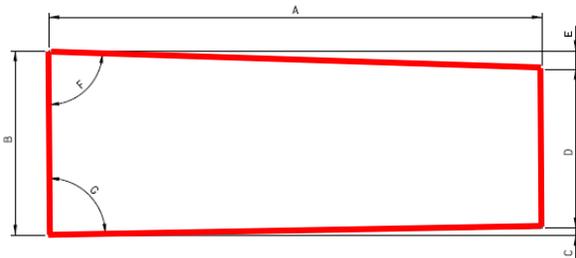


**PANEL LAYOUT PLAN**

The panels for all bridges were drawn to full size scale with all rebar included. This provided assurances that conflicts during the panel erection process would be lessened during the closure weekends - which reduced risk for the Contractor and the Department. The panels were dimensioned and labeled such that shop drawing preparation would be easily confirmed against the contract plans. Each of the 180 deck panels on the Oldham Street bridge had unique dimensions and corner angles.

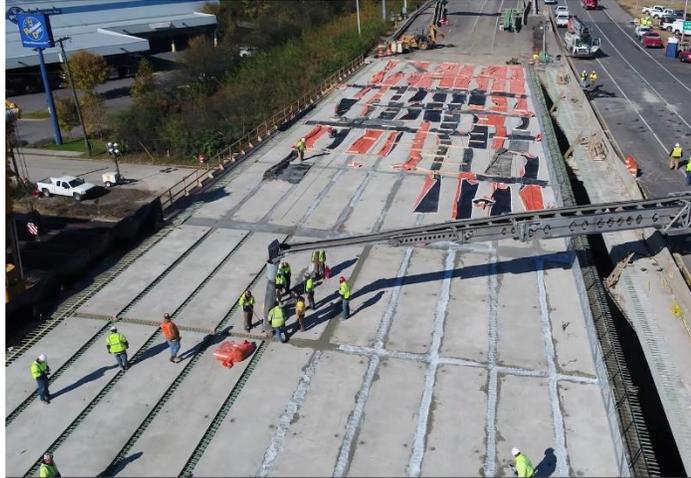


**PANEL LAYOUT**



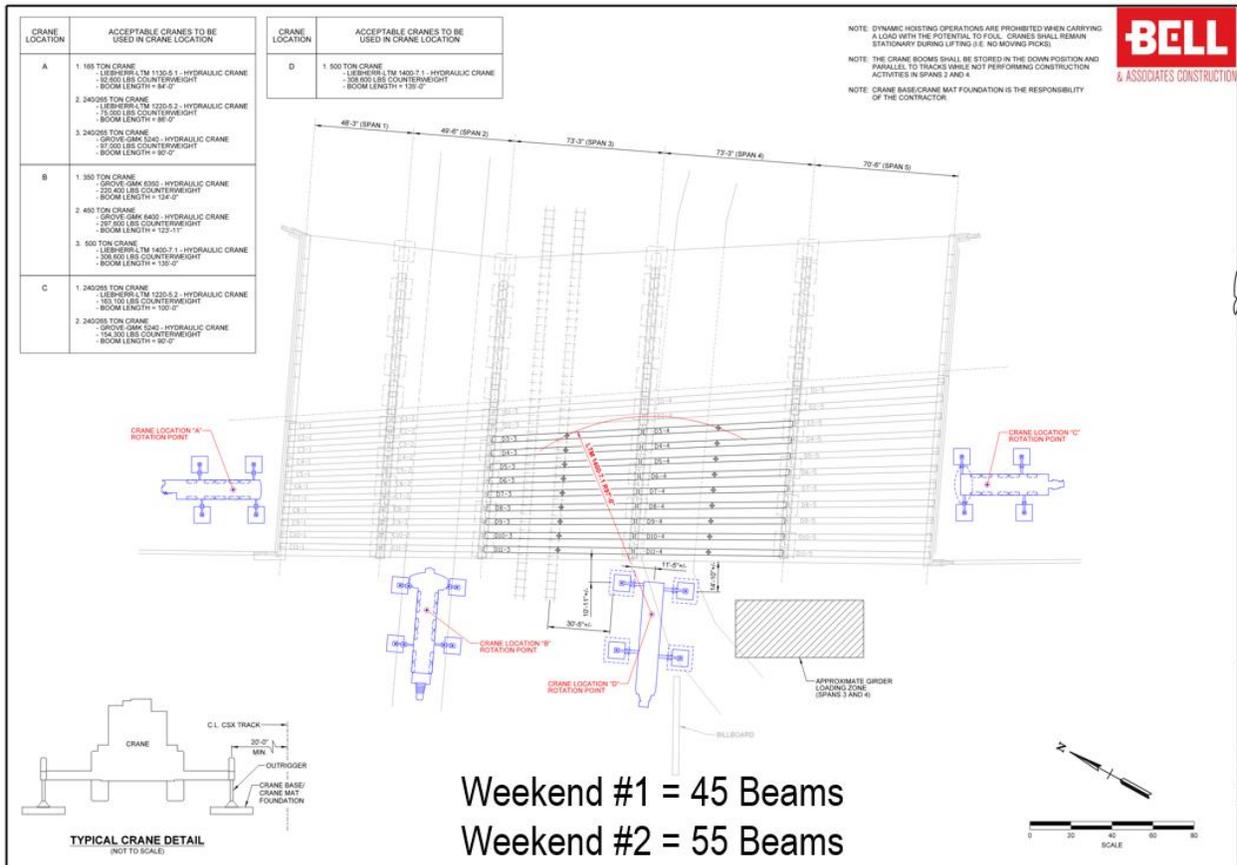
**PANEL LAYOUT 2-B @ 2-D**

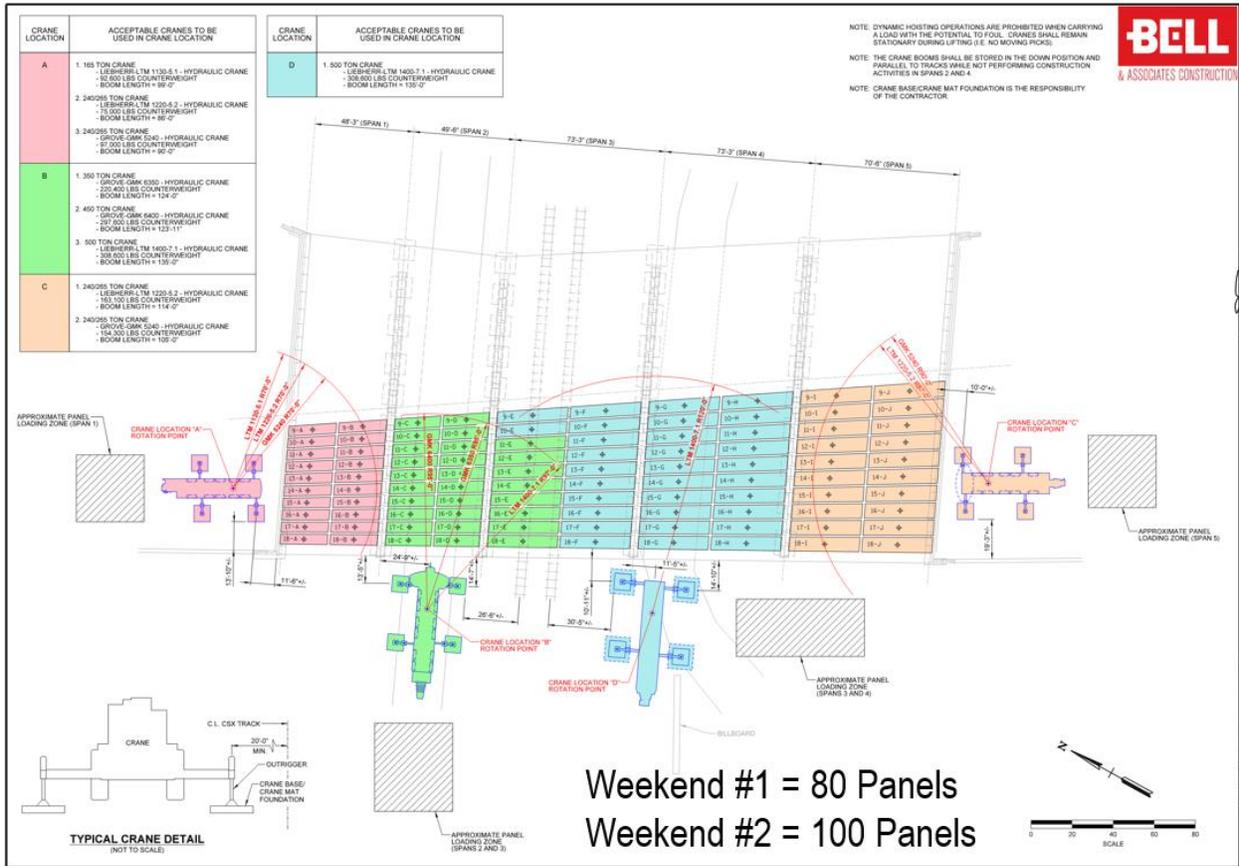
The closure pour material was specifically formulated for this project. Standard high strength, non-shrink grouts were not readily available in the quantities required. For the entire project, approximately 40,000 bags of this material would have been required and the production time would not have met the compressed schedule required by TDOT. The important mix parameters needed for this project include early strength gain, low chloride ion penetration, and exceptional bond strength. The final mix design provided 4000 psi in 4 hours (6,000 psi at 24 hours) with a one-hour pot life in the ready-mix truck which allowed 3-4 yard batches to be used on the project.



### CONSTRUCTION LOGISTICS

An extensive construction erection plan had to be developed to meet the requirements of the CSXT Railroad. These plans included location of all cranes and identified unloading zones for all precast elements. The railroad also required crane capacity to be 150% of the actual rigged load weight. These requirements added to the complexity of the project.



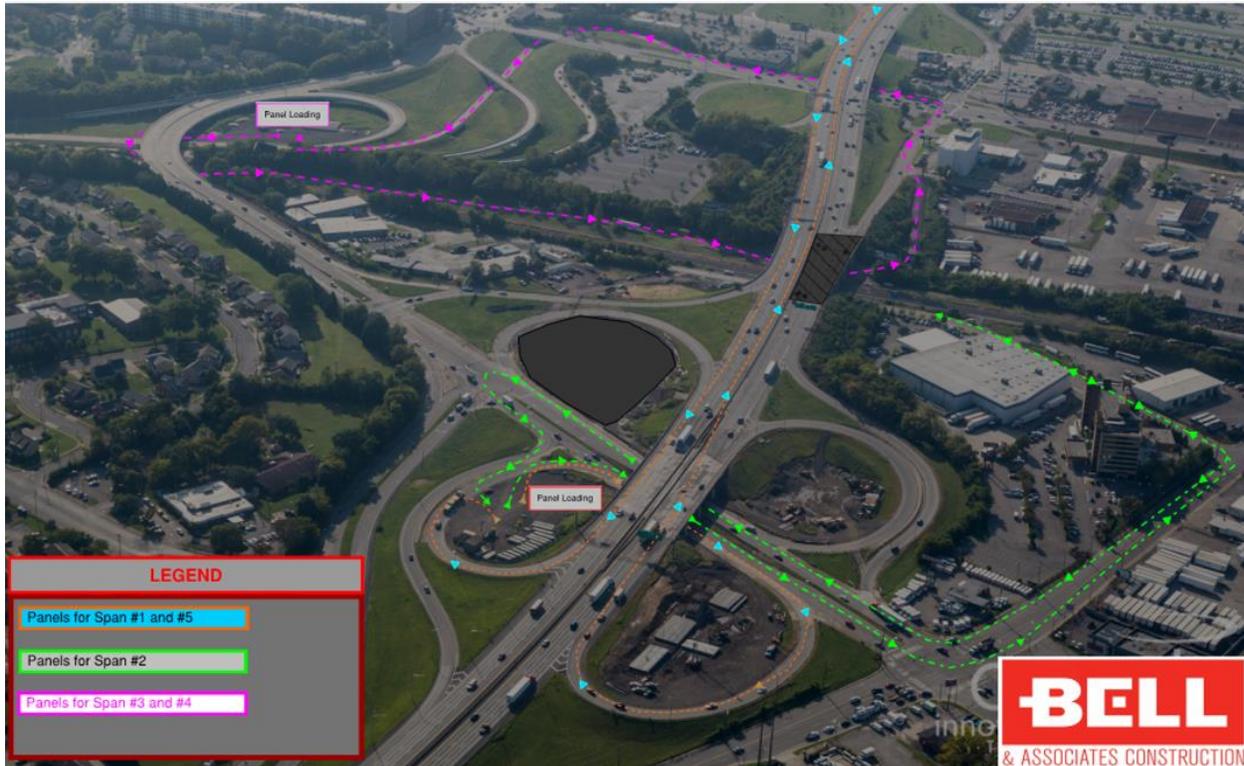


Crane operations were required to cease any time a train had to pass through the construction site. This required that the crane not hold any load that would be in line with the path of the train tracks. This requirement added approximately eight hours to the contractor's schedule as 26 trains was the normal rail traffic in this corridor.

The contractor used a color-coding scheme to make sure the correct beams and panels arrived at the crane in the right sequence. Workers in the marshalling yard and at the work site were in constant communication to keep the constant flow of trucks to the cranes.

To aid in the movement of the precast elements, the design engineer developed a lifting lug configuration and spacing for all elements that allowed the contractor to use the same spreader beam and rigging for all precast elements. The engineer evaluated the full depth panel stresses with the placement of the lifting lugs to confirm that no additional detrimental stresses would be transferred to the panels. This was key since every panel was a unique dimension and the lifting lugs needed to be placed to keep the panels level during the lifting process.

For the second Oldham Street bridge, there were 55 beams and 100 panels to install during the weekend closure period. Each element required a separate trailer for delivery either due to the element weight or overall dimensions. This logistical challenge required the contractor to stage elements in different locations so delivery vehicles could have dedicated routes to each crane location. It also required extra cranes on the project site to load the various trailers since staging areas were limited in the congested urban environment. The contractor developed different routes for each crane location that included running on roads that were open to regular traffic. The movement of the trucks was aided using local law



enforcement at key intersections. During all the installation timeframes, traffic was able to move without major congestion delays for the trucks or local traffic.

## CONCLUSION

The Tennessee Department of Transportation embraces Accelerated Bridge Construction to successfully deliver projects and lessen traffic impacts to the traveling public. Various ABC projects have been completed by numerous contractors such that ABC routine - and even complex projects can be delivered using traditional project delivery methods. For complex projects, such as the I-24 Fast 4 project, close coordination between the Department and the Contractor along with detailed, well-engineering plans can yield an innovative project with lower overall risk to both TDOT and the Contractor.

The goal of ABC projects for TDOT is to minimize impacts to the traveling public and provide structures with an extended service life. Continued improvements in ABC project delivery in Tennessee and the strong performance documented by the entire project team are reflected in the success of the I-24 Fast 4 project.