FAST-TRACK BRIDGE REDECKING:
ROUTE 64 OVER POMME DE TERRE LAKE

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ABSTRACT

A "fast-track" method of deck replacement has recently been completed in southern Missouri. The concept of full-deck replacement while maintaining traffic (in both directions on a two lane bridge) during the daytime was proven successful on the Route 64 Bridge over Pomme de Terre Lake. (A few temporary lane closures were required to complete some minor construction tasks.) This 1,684' long continuous composite steel rolled beam bridge was redecked in only 6 months with the bridge being shut down during each night of construction from 7 pm to 7 am. The key to this "fast-track" method is match-cast panels which are post-tensioned together after installation. The full-width and full-depth panels are supported by four stringers and provide a roadway width of 24'-10".

Keywords: Bridge, Precast, Panel, Full Width, Post Tension, Deck

PROJECT BACKGROUND

The bridge over Lake Pomme de Terre was originally designed and built by the Corps of Engineers in 1962. The bridge roadway is 22'-0" wide and carries two 11' lanes. The superstructure consists of four composite continuous steel stringers (W36x150). There are seventeen 90'-0" spans and end spans of 76'-10". The superstructure comprises five units (a typical unit is 360' long) that are joined by a pin and hanger connection located 18'-0" from the pier. The grade of the bridge is level (0% grade). The substructure consists of two column bents with spread footings. Because of the tall pier heights, the superstructure girders are post-tensioned to the pier capbeams.

Although the stringers and substructure were in good condition, the six inch composite deck was rated deficient by the owner, Missouri Department of Transportation (MoDOT), because of advanced deterioration brought on by deicing salts. Because the bridge connects the towns of Pittsburg and Nemo, and the length of the nearest detour route was 28 miles, MoDOT deemed it essential that the bridge remain in service during construction. Additionally, the local economy of these towns is very reliant on the tourism industry and most of their income is generated during the summer months.

ADVANTAGES OF PRECAST PANELS

To replace the deck, the initial choice was to use the typical method of cast-in-place staged construction, which had an estimated construction time of 18 months. During the analysis of the existing deck for staged construction, it was determined that the interior deck cantilever overhang did not have sufficient strength to allow emergency vehicles or school buses. Another major concern was that the lane width during construction would only be 9'-6" on the bridge during Stage I traffic.

At this point in the project, the MoDOT District Maintenance Engineer, Dave O'Connor, proposed using some type of deck replacement that could be done in overnight closures. HNTB then studied various types of deck replacement schemes and recommended using full-width full-depth precast panels that are post-tensioned together longitudinally. The safety barrier curbs would also be cast with the segments in the casting yard (although this was subsequently changed during construction to slip-forming after the panels were placed). Additionally, a 1.5 inch thick silica fume overlay would provide a smooth riding surface and an extra layer of protection at the joints from chloride penetration. This method of construction was estimated to take 8 months to complete.

The significant advantage of using the full-width full-depth panels is that they could be cast off-site ahead of time and then be brought to the job site for placement during the nightly closures. Match-casting and post-tensioning of the panels was provided to eliminate any closure pour joints in the deck. Figure 1 shows the typical cross-section with the locations of the post-tensioning bars. On other bridges using full-depth precast panels, closure joints had been found to be vulnerable to chloride penetration and thus deterioration. Various bridges with full-depth panels and there field performance were discussed in a paper by Issa et al[1]. Two examples of closure joint problems that were discussed are the Route 235 Bridge over Dogue Creek (Virginia DOT) and the Amsterdam Interchange Bridge (New York State Thruway Authority).

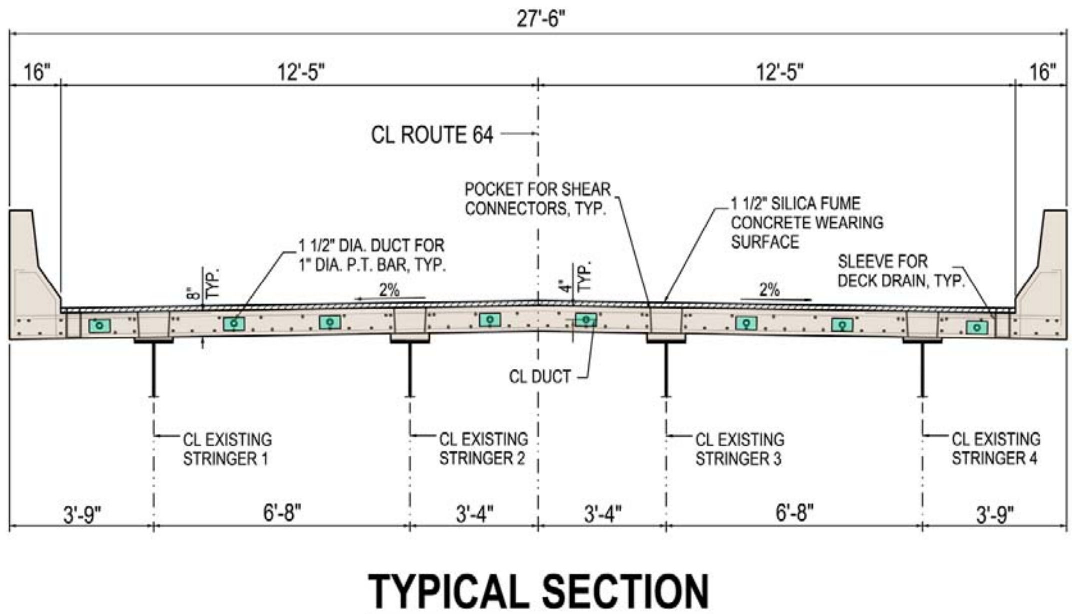

Figure 1. Typical Cross-Section

A composite deck was required to provide the superstructure with sufficient capacity, consistent with the original design. To accomplish this, 9”x12” blockouts (in plan) were provided in the panels to allow for shear connector (3/4” diameter shear stud) installation on the girders after the panels were placed. See Figure 2 for details of a typical panel. Also note the partial depth blockouts provided for the post-tensioning bar couplers (shown at the duct callout).

The full panel size was 10’-0” long and 27’-6” wide, which was dictated by shipping considerations. The panels that were placed directly over the pier locations required extra consideration because the existing vertical post-tensioning bars connecting the stringers to the pier extended into the deck. (These existing vertical post-tensioning bars were used in the original design to tie the superstructure to the piers and thus reduce slenderness effects in the piers.) The solution to this dilemma was to provide a larger blockout (approximately 2’-4”x3’-3’) in those locations. Because of these large blockouts, the shipping and handling stresses became very important in the design of these panels.

To fill the haunches and blockouts for the shear connectors and post-tensioning couplers, a flowable grout was required that would reach a compressive strength of 2500 psi before traffic could be allowed on the bridge. After discussing this requirement with several concrete suppliers, several products were found that could provide this strength in as little as 2 hours. For this project, the SikaGrout 300PT product was used for the flowable grout.

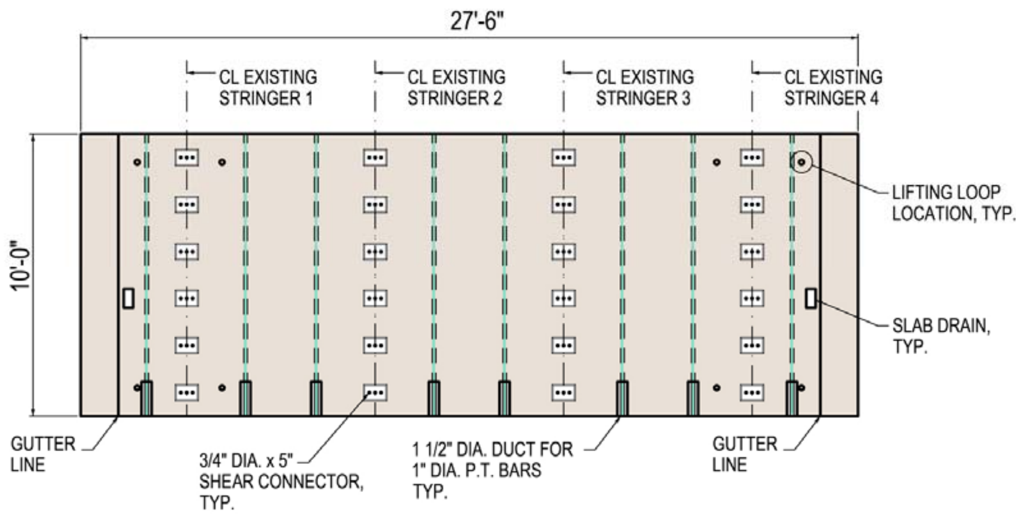

Figure 2. Plan View of Typical Panel

CONSTRUCTION

The project was let on March 19th, 2004 and Columbia Curb & Gutter (CCG) was awarded the contract based on low bid. Notice to Proceed was issued on May 17th, 2004, and CCG was allowed to have the first nightly bridge closure on June 21st, 2004. The last panel was placed on August 31st, 2004.

For the overnight replacement concept to be successful, the contractor needed to have a reasonable amount of time to complete this work. Before the project was bid, HNTB and MoDOT determined a bridge closure window of 7 p.m. to 7 a.m. (with a work week of Sunday night through Thursday morning) and this was specified in the contract documents.

The HNTB design team had determined that it would be feasible (and demanding) to remove a significant amount of deck and replace it during the closure window. This demanding concept required many operations to occur in one night:

- Remove the existing deck, including shear connectors

- Clean and prime the top flange of the steel girders
- Place and align the full-depth match-cast panels
- Connect post-tensioning bars
- Post-tension each panel to the previous panels
- Weld new shear connectors
- Fill the shear connector blockouts with grout

The original concept was to perform all of the operations listed above in the 12 hour construction window, but CCG decided to split the operations into a 2-step process that overlapped on consecutive nights. For a typical location, the deck removal (by saw cutting between flanges and chipping out the concrete over the flanges) and preparation of the top flange were performed on one night and then the panels were installed at this location the following night. Figure 3 shows a panel being placed and aligned. In order to accomplish this, the contractor fabricated a set of temporary bridge panels (consisting of steel grating and W sections) that could be reused each night. See Figure 4 for a photo of a temporary deck panel. The contractor also proposed using a temporary barrier system utilizing part of the existing bridge barrier rail so that the permanent safety barrier curb could be slip-formed at the end of the project.

Figure 3. Panel Placement

For the first few nightly closures, the contractor only placed two or three of the 10’ long panels. After the initial learning curve was over, however, the contractor was able to place five to seven panels on a given night. Each panel was placed individually, post-tensioned to the previously placed panels and the alignment adjusted if required. After all panels were placed for that night's operations, the shear connectors were welded and grout placed. Since the connections of the existing vertical post-tensioning at the piers were required to be inspected, these locations impeded the contractor's progress slightly. Additionally, when the contractor reached an expansion joint location, the panels were dimensioned to be a few feet from each side of the joint. At these locations, the contractor would "skip" over the joint and place the panels to start the next unit. After construction progressed into the next span, during one of the nightly closures the new expansion joint was placed and a small area of deck poured. This pour was also required to reach a compressive strength of 2500 psi before being opened to traffic.

After all of the deck panels were placed, a typical staged construction sequence with only one lane of the bridge open to traffic was set up to allow for slip-forming of the safety barrier curb followed by placement of the 1.5" thick overlay on each half of the deck. See Figure 5. By contract, the staged construction portion of the project could not start until after Labor Day (the traditional end of the tourism season). The total staged construction time on this project was only 7 weeks!

Figure 4. Temporary Deck Panel

Figure 5. Stage Construction at End of Project

MODOT'S PERSPECTIVE

From the bridge owner's prospective there are three parts of this project that stand out. They started in design, carried through construction and ended in public relations.

First, there was great cooperation between all parties to get this job done faster and better. HNTB, as MoDOT's design consultant, was willing to redesign the bridge deck replacement using precast segments even though the plans were 90% complete using conventional cast-in-place methods. The process was set into motion with a suggestion by one of MoDOT's local engineers to implement ideas he got from attending the first National Prefabricated Bridge Elements Conference held in St. Louis in 2003. Before the redesign was completed, HNTB held a meeting with MoDOT Design, Construction, Materials and Research officials to go over the new precast design plans and to find out what kind of wearing surface would best work to protect the deck sections and incorporated these suggestions into the plans. At the project pre-bid conference, four months before the letting, HNTB presented the concept to contractors and precasters and answered all questions. Honestly, the contractors and precast concrete people were very leery as to whether they could prepare a bid on this short notice for a special project like this. MoDOT pressed on with the letting but feared it might not get an acceptable bid.

Columbia Curb and Gutter Co. was awarded the bridge contract for $5.5 million. CCG did nothing particularly novel on the job but approach was definitely new thinking in Missouri. They planned the job very well; and came up with some innovations to get it accomplished.

- They decided to cast the deck on site by complete continuous sections. (Out of 162 sections only one failed inspections and had to be re-cast.)
- Used temporary bridge sections to split deck removal and deck replacement into two separate jobs. (Actually had 3 separate crews working simultaneously – casting, removing old deck and setting new deck for most of the summer and additionally a structural steel painting crew and expansion joint and pin and hanger replacement crew.)
- Again not a new idea but it worked flawlessly – CCG used an angle iron and jacking system to set the panels to grade and act as forms for the girder haunches and shear connector pockets. (Final grade after the overlay was nearly perfect)
- Decided to slip-form the barrier in place - to provide temporary barrier for safety and to protect the reinforcing steel, the posts and channel barrier from the old deck were re-used as they removed it each night.

CCG completed the job before schedule on all operations and never paid any penalties. Most notably they never failed getting the deck open to two-way traffic by 7AM.

The community was very happy because they were included throughout the planning of the job (public Hearings, etc.). The Lake Area Chamber of Commerce expressed its gratitude that everything MoDOT and HNTB promised came to fruition. There was no restriction to summer tourism and no width restrictions ever placed on any special or emergency vehicles. Instead of two summers of traffic problems they experienced none over the summer of 2004 and the project was completed in six months. Any extra costs were well outweighed by eliminating the traffic congestion and by the goodwill gained by MoDOT from the local residents and summer visitors.

COST COMPARISON

During the initial study, cost implications of using the full depth panels were considered. The initial thought was that this concept would cost slightly more than conventional stage construction, but would be offset by reduced traffic control costs. The low bid for this job was only about 9% higher than the original estimate (based on staged construction). (This project also included repainting the superstructure and retrofitting the pin & hanger connections.) By looking at some other MoDOT projects that were primarily deck replacements (see Table 1) and normalizing the costs based on the complexity of the deck removal, the costs for this project (*Rte. 64 bridge*) can be compared with other methods of deck replacement.

County/Project	Deck Cost	Deck Removal Cost	Ratio of Removal Cost	Normalized Deck Cost	Comments
St. Louis	$32 / SF	$3.50 / SF	2.42	$77.70 / SF	Staged construction
Chariton	$40 / SF	$6 / SF	1.42	$56.67 / SF	Bridge closure
Rte. 64 Bridge	*$56 / SF*	*$8.50 / SF*	*1.00*	*$64.50 / SF*	Precast panels, over water

Table 1.

Although the deck costs are highest for the Rte. 64 bridge, the deck removal costs reflect the complexity of each project. This project has the highest deck cost, largely due to the fact that 90% of the work had to occur over water. By using a normalized deck cost (based on the ratio of the deck removal costs), the precast panel method is 37% less cost than the staged construction method and only 14% higher than the bridge closure (which doesn't take into account the cost impact to the community). Another important item that is not considered above is the benefit of reduced traffic control costs.

CONCLUSION

This innovative method of using full-width full-depth precast panels for overnight bridge deck replacements proved to be cost competitive with staged construction and beneficial for minimizing the impact to the traveling public and local economies. The benefits to the local community included minimizing the impact on tourism, maintaining emergency vehicle and school bus access during the day, and reducing the construction impact from daily for two years to 2½ months of overnight work. This "fast-track" concept could be further extended to replacing bridge decks in areas with high traffic control costs, bridges with skewed supports, or on larger bridge rehabilitation projects where construction time is a significant factor.

REFERENCES

1. Issa, M. et al, "Field Performance of Full Depth Precast Concrete Panels in Bridge Deck Reconstruction," *PCI Journal*, V. 40, No. 3, May-June 1995, pp. 82-106.