CLEAR CREEK CANYON FULL WIDTH FULL DEPTH DECK PANELS

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ABSTRACT

The Clear Creek Canyon project focused on rehabilitating three bridges built in the 1950 located in a canyon with limited access. Deterioration had occurred due to weather, anti-icing chemicals and a high traffic volume. Pier columns and caps were rehabilitated using traditional techniques, while the deck was completely replaced using precast, prestressed concrete, full depth, full width, transverse deck panels. The panels were tied together using interconnecting #5 bars. Lightly tensioned strands were placed at the areas of high negative moment. The structure was made composite with the use of shear studs placed on the existing girders through block-outs in the concrete panels. The road was shut down completely and all three bridges were re-decked in 12 days. The full depth precast deck panel solution provided a fast track construction technique with minimal disruption to the public.

Keywords

Construction, Creative Solutions, Decks, Deck Panel, Full Depth, Rapid Construction, Rehabilitation, Repair.

Introduction
As the Federal and local highway systems age, new techniques must be employed to repair and replace structures with minimal cost and impact to the public. Replacing concrete bridge decks is an economical way to extend the life of structures when the other structural elements are in good condition. Unfortunately, costs resulting from detours or temporary structures can be high. Efforts are now being made to accelerate project schedules to reduce the impact to the public. Precast components are ideal for fast track projects. This paper showcases a project where the use of precast prestressed concrete, full width, full depth, deck panels allowed three structures to be completely re-decked in twelve days.

Background
The Clear Creek Canyon project focused on rehabilitating three bridges built in 1950. Structure F-15-BA is a single span structure, 154’-5” long with steel girders and a non-composite cast-in-place deck. Structure F-15-BC is a three span structure, 37’-11”, 100’-0” and 28’-2” and also had steel girders with a non-composite deck. Structure F-15-L is a three span structure on a horizontal curve with span lengths of 25’-9”, 58’-0” and 25’-9”. All three structures had significant deterioration due to weather, high traffic volume, and anti-icing chemicals.

US 6 is located in a canyon with limited access. Due to the geography of the canyon, a section of the highway needed to be closed to complete the work. The Colorado Department of Transportation (CDOT) design engineers included a project specification that limited the closure to 30 days in order to minimize the impact to the public and local businesses. To ensure the project was finished as quickly as possible the project was let as a cost plus time bid which included incentives for finishing early.

Structure rehabilitation consisted of replacing the bridge decks, and concrete repair for pier caps and columns at all three structures. The contractor was able to begin the rehabilitation on the substructure under full live load without impacting traffic. After closing the canyon all three structures were worked on simultaneously. Six crews working 24 hours a day, two twelve hour shifts, were able to replace 18,605 Sq. Ft. of concrete deck with a total of 71 precast panels. All of the work requiring the closure was completed in 12 days, including two bad weather days, earning the contractor $206,000 in incentives.

The full depth precast prestressed concrete deck panels were an innovative design for the State of Colorado. Designers and project engineers worked together to come up with the simplest techniques and sequencing possible for construction. The Contractor was proactive in troubleshooting the new system. The following construction sequence was used:

- ✓ Held planning meetings between State, Contractor, and Precaster
- ✓ Precast fabrication
- ✓ Repair not impacting traffic performed on structures
- ✓ Closed highway to traffic
- ✓ Removed existing deck and cleaned girders
- ✓ Erected precast panels

- ✓ Installed shear studs, grouted joints, block-outs, and haunches
- ✓ Tied rebar and placed concrete for type 7 bridge rail
- ✓ Applied waterproofing membrane
- ✓ Applied asphalt overlay
- ✓ Opened highway to traffic

PRECAST PANEL DESIGN

The precast panel deck design was approached as a typical cast-in-place (CIP) deck would be. The panels were designed according to the AASHTO LRFD Bridge Design Specifications, third Edition and the 5th edition of the PCI Design Handbook. Important details to replicate a CIP deck were panel to panel connections, and placing longitudinal steel through multiple panels to deal with the negative moment over the piers. The lifting condition determined how many strand and the amount of mild reinforcing required in each panel. Twenty-two 0.6" dia. 270 ksi strand were used in the 8'-0" x 38'-0" x 8" panels. The top and bottom mats were made up of #4 bars but D20 mesh could have been substituted for convenience. The original deck had a low rating in part because of the non-composite deck. One of the steps we took to increase the bridge rating was to make the new deck composite with the girders.

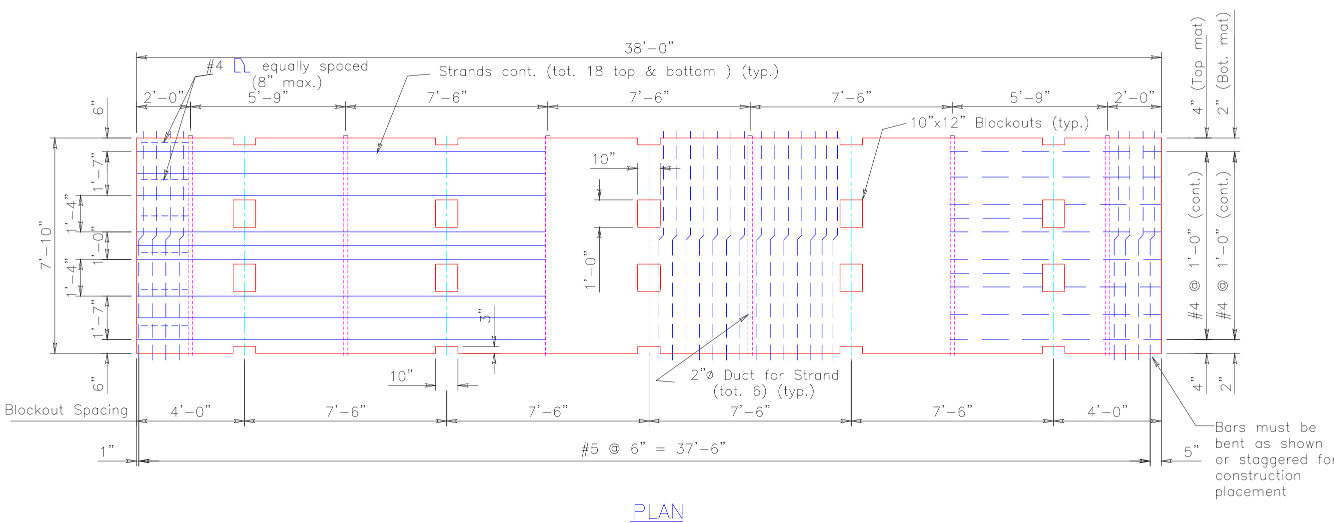

Figure 1: Plan View of Deck Panel

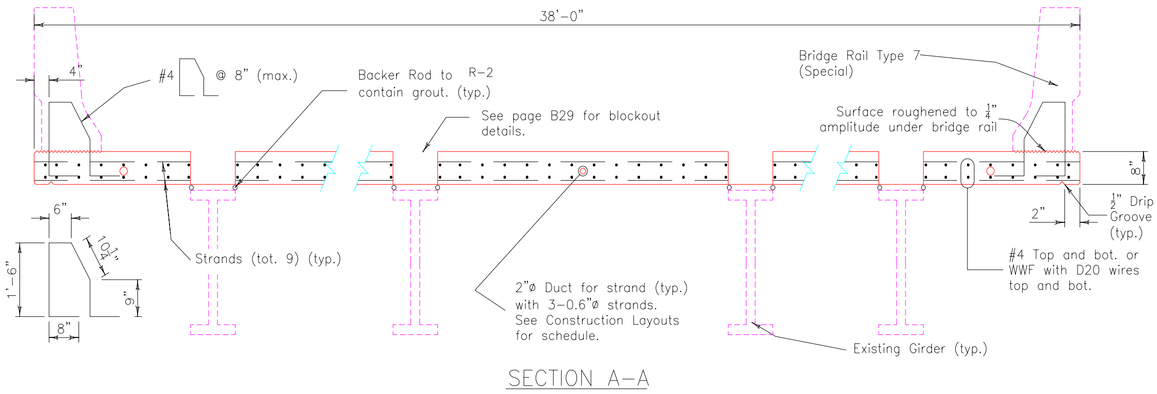

Figure 2: Section Cut of Superstructure

To create composite action between the girders and deck panels, headed anchor studs were welded to the top flange of the girders through block-outs in the panels. The shear forces were calculated according to LRFD Art. 6.10.10. The fatigue requirement dictated that four 7/8" diameter headed anchor studs be placed in every block out. The block-outs were sized to accommodate the welding gun and the studs. Spacing for the block-outs followed the AASHTO maximum allowed spacing of 2'-0" for shear connectors. After the panels had been set in their final position the studs were welded in place.

Figure 3: Typical Block-Out with Headed Anchor Studs

The transverse connection between panels was completed using interlocking bars spaced at 6" on center. After the panels were set two #5 bars were run transversely through the loops.

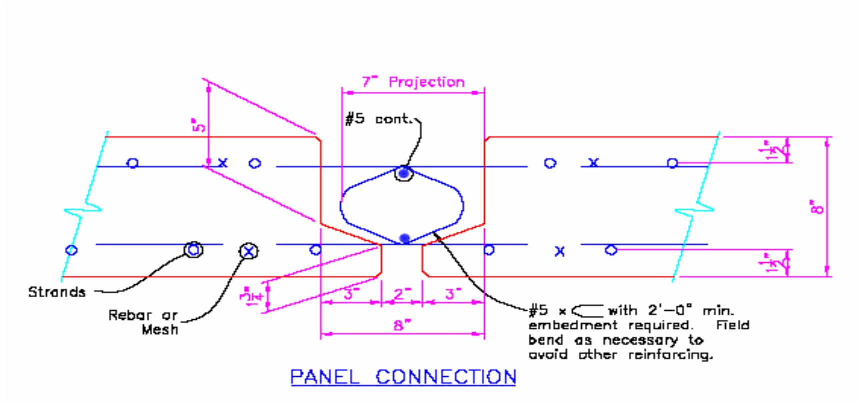

Figure 4: Panel to Panel Connection

Although the original structures were designed as simple spans, the new design made the structures continuous by encasing the girder ends in concrete and adding steel in between the girder ends. The negative moment, and the necessary amount of steel, was then calculated at the piers for the continuous condition. The design challenge was to find a way to allow for continuous reinforcing through multiple panels. Because there was only 8 inches in between panels and so many looped bars it was determined that it would be difficult to install couplers to extend traditional mild reinforcing the entire length needed. The final decision was to use 0.6" dia. strand to provide an equivalent area of steel. The strand offered flexibility, was easily installed and was readily available. Before grout was placed in the block-outs the strand was placed in the ducts using circular chairs and then pulled taught to ensure that the strand did not sag in the duct. The last step was to pump grout through the ducts. Installation of the strand after the panels had been set required a larger block-out in the adjacent panels. This larger block-out allowed room for the post tensioning contractor to install and lightly tension the strand.

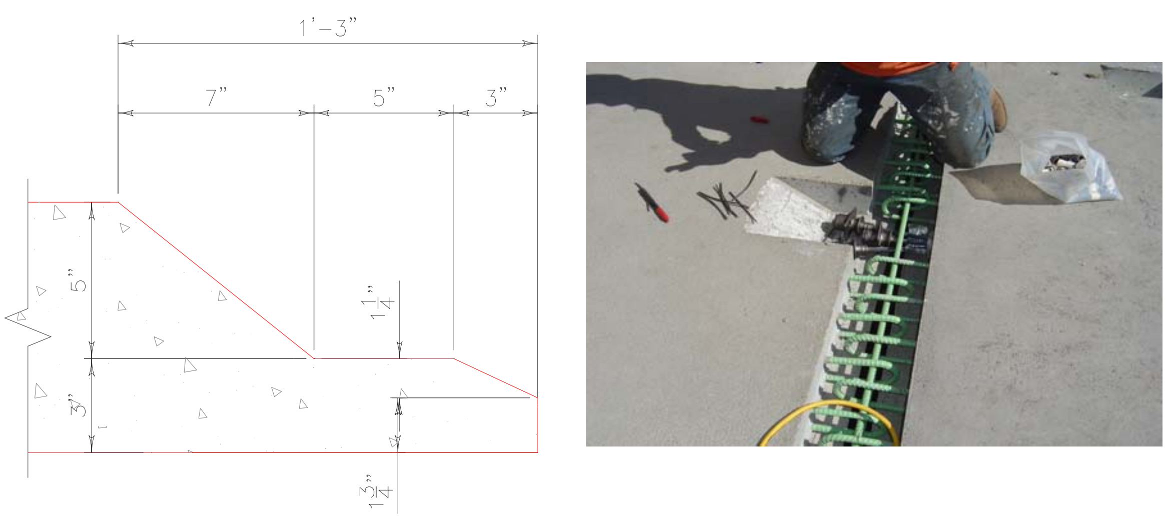

Figure 5: Larger Block-Out for Strand Installation

In order to place an expansion device at the abutment the edge panels were cast with a flat edge. These panels extended onto the top of the abutment approximately 5". The expansion joint was placed between the panel and the approach slab. The approach slab was also made up of precast prestressed panels. One edge of the approach panel sat on the abutment and flow fill was used to set the panel at the appropriate elevation. Plug joints were used at both abutments on all three structures.

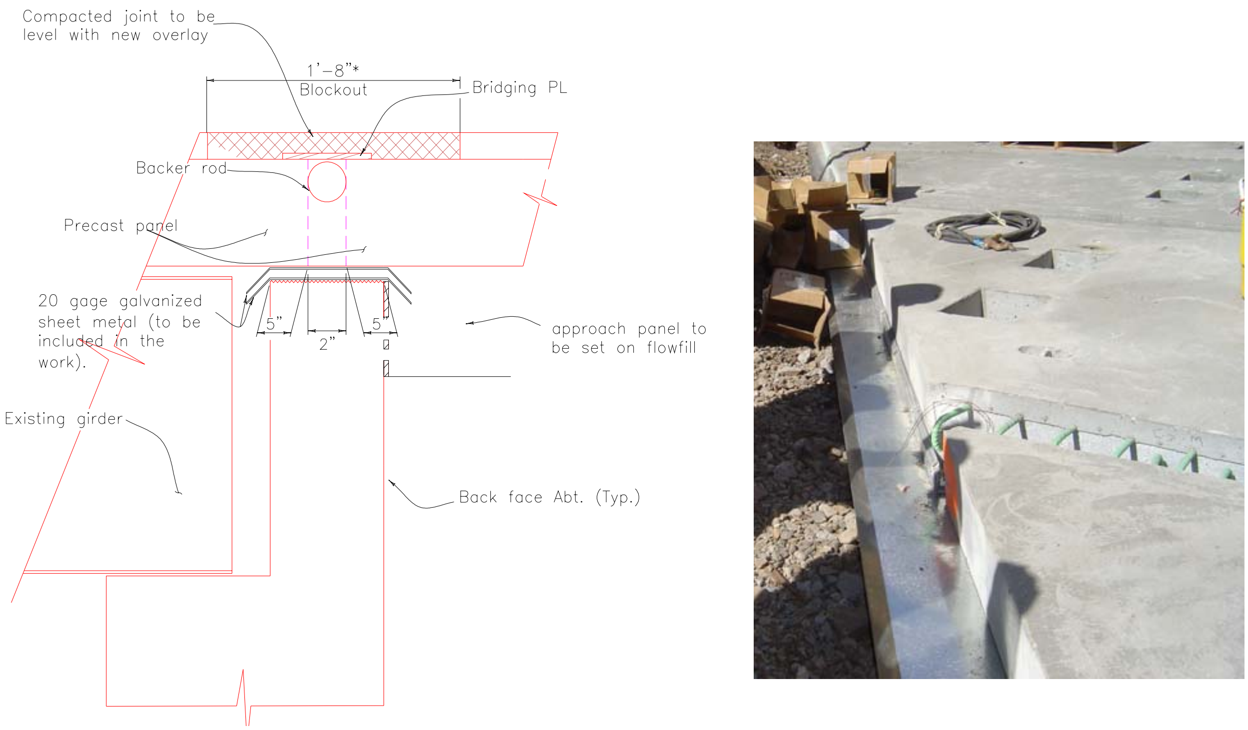

Figure 6: Detail of Expansion Device at Abutment

DESIGN CONSIDERATIONS TO ACHIEVE CORRECT DECK GEOMETRY

During design and the pre-construction meetings concern was raised over potential elevation differences between panels. It was possible that the panels could have some camber and that the panels would not sit evenly on the girders. To solve the problem an adjustable screw and nut assembly was cast into each corner of the precast panels. These allowed the contractor to make small elevation adjustments at each panel panels. Additionally when the concrete was placed in the transverse joint the contractor was able to help smooth the transition between the panels. The screws also ensured that there was space between the panels and top flange of the girder for grout to flow and form an even bearing surface for the panels.

Figure 7: Deck panels being set and adjusted using elevation screws

The original design called for grout to be used in the transverse joints, block-outs and haunches. The contractor did use the grout for the haunches but chose to use a high early concrete at the other locations. Vent holes were cast into the panels to accommodate the flow of the grout as well as provide a physical confirmation the grout was completely filling the haunch area.

The second structure's geometry required the bridge deck to be super elevated. To achieve this, angles were spot welded to the top flange of the girder at the appropriate elevation. Then backerrod was glued to the top of the angle to close any gaps between the angle and the bottom of the panels. Initially, the weight of the panel was carried by the adjuster screws. Grout was then placed and created the final bearing surface for the panel to rest on.

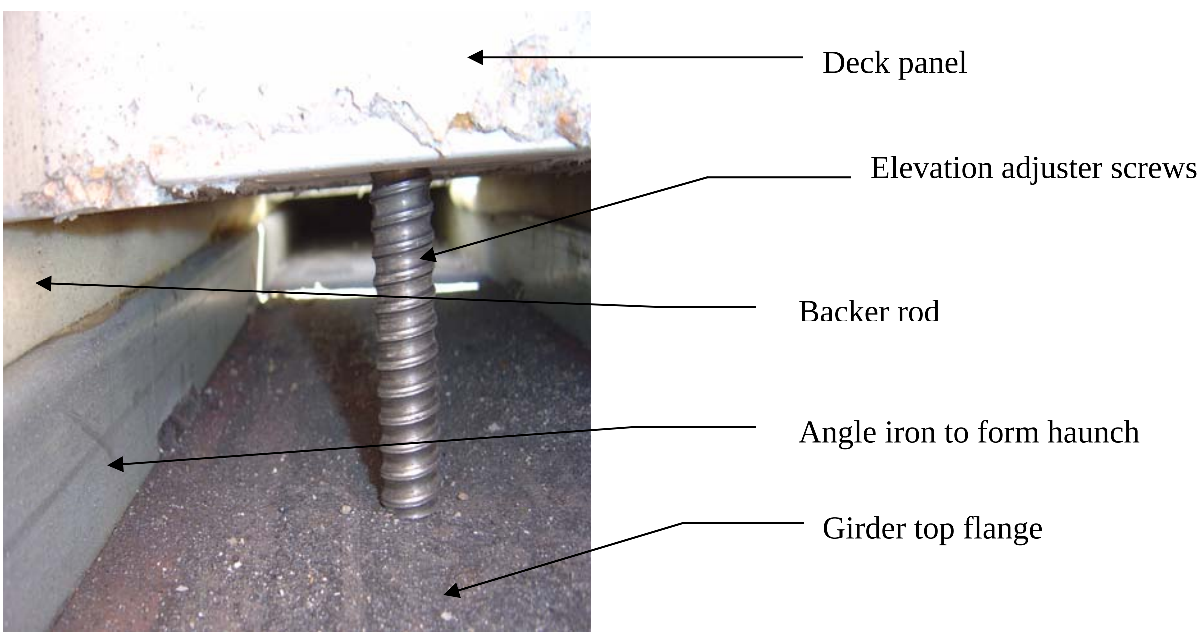

Figure 8: Haunch Forming

CONCLUSIONS

Precast prestressed concrete full depth, full width deck panels were a great success for this fast track project. Because the infrastructure is aging quickly, more and more decks will need to be replaced in order to extend the life of structures. The precast deck panels are an ideal component for less intrusive rehabilitation. They will surely be used on projects to come in areas without easily accessed alternate routes, or where long- term construction would severely impact traffic and local businesses.

References

AASHTO LRFD Bridge Design Specifications, third Edition

PCI Design Handbook, 5th Edition