Accelerated Precast Bridge Approach Slab Replacement

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ABSTRACT

Bridge owners are frequently faced with the need to replace critical bridge components during limited or overnight road closure periods. This paper presents the development, casting, installation and lessons learned of a precast concrete bridge approach slab specifically designed by the Iowa Department of Transportation to address the problem of deteriorated bridge approach slabs and the need for accelerated replacement.

A precast concrete approach slab was designed and constructed on twin bridges north of Waterloo, Iowa on Highway 63. Driving lane and shoulder sections of the bridge approach were replaced in 11 hour windows during day and night construction to demonstrate the feasibility of using the precast bridge approaches in an accelerated repair procedure. The contractor was able to meet the strict time requirements by using the precast units and successfully completed the work.

Keywords: accelerated bridge construction, precast concrete, bridge approach slabs

Introduction

The Office of Bridges and Structures at the Iowa Department of Transportation has had to deal with the on going problem of settlement and deterioration of approaches slabs due to bridge and back fill settlement. This settlement may be caused by a number of reasons, such as integral abutment action, poor construction, heavy traffic, and poor drainage of the backfill.

The precast bridge approaches are intended for use in either new construction or retrofit applications and can be installed in single-lane-widths to permit staged construction under traffic. By using the precast sections, limited closure of the lanes (less than 12 hours) were achieved along with the placement of higher quality approach slabs in the bridge approach area.

Iowa Project (O'Brien County)

The first precast pavement project was done in Northwest Iowa and was a joint project with the Iowa Department of Transportation, Federal Highway Administration, the Bridge Engineering Center at Iowa State University and Transtech of Austin, Texas.

Located in O'Brien County in northwest Iowa on IA 60, the precast approaches were only used on the north bound lanes. The panels were attached directly to the integral abutments of the prestressed concrete bridge. See Figure 1. Eight 12 inch panels were placed at each end for a total length of 76 feet 11 inches measured along centerline. The panels next to the abutment were skewed 30 degrees to match the bridge abutments and the remaining panels were 14 ft x 20 ft. Once placed the approaches were post-tensioned both transversely and longitudinally using 0.6 inch diameter strands spaced at approximately 24 inches. See Figure 1, 2 and 3 for a details and photos of the project.

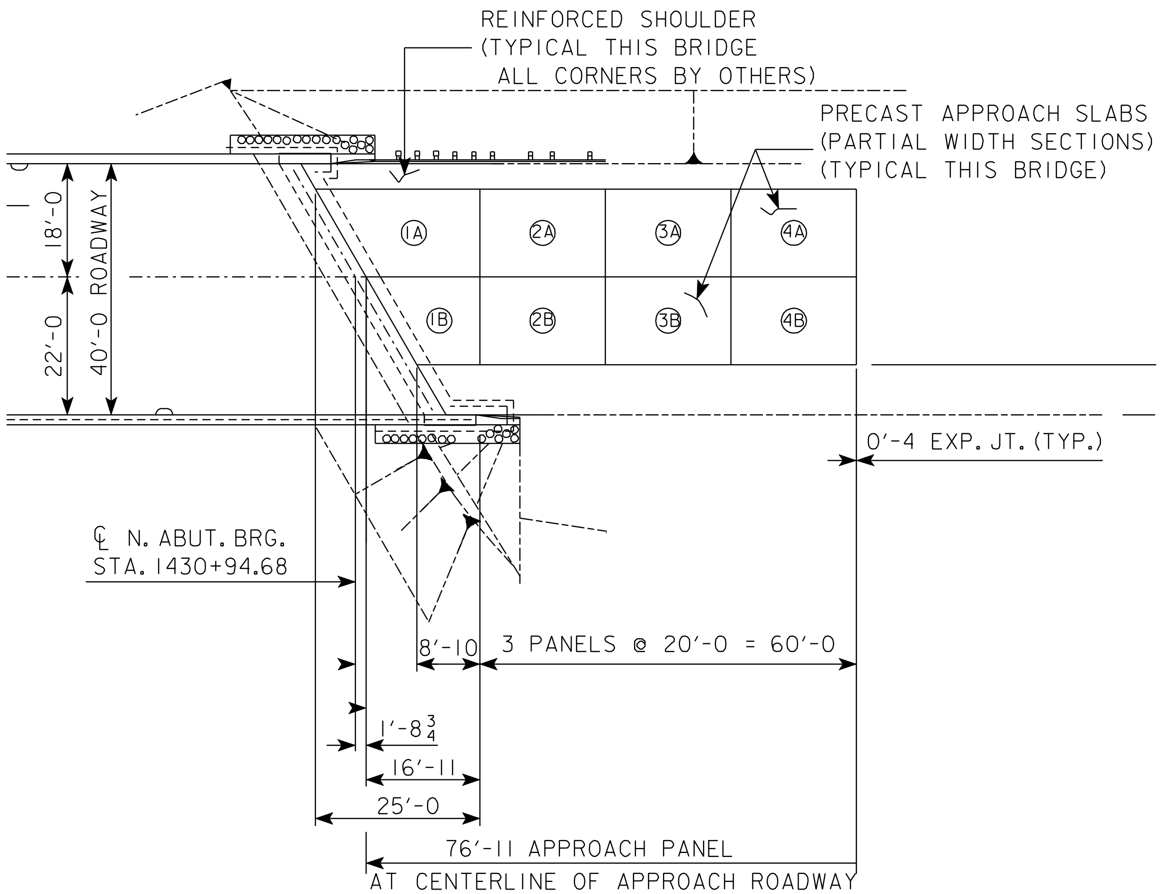

Figure No. 1
(Plan View North Approach)

Figure No. 2
(Placement of First Panel at Abutment)

Figure No. 3
(Completed Approach)

Bremer Co (Design 208)

After the successful completion of the first project in O'Brien County, a project was selected for an accelerated repair using the precast panels. The replacement would be limited to 11 hour lane closures with day and also night replacement to demonstrate the feasibility of the repair. This project was funded through the state with no federal research funds. The project was located north of Waterloo, Iowa on divided US 63 near the town of Denver, Iowa. Average daily traffic for the site was relatively low (5800 vehicles per day), so if problems developed during the replacement, the impact on the public would be limited. In addition, ramps were available at the interchange site, which could be used to carry traffic if necessary. See Figure 4 for project location.

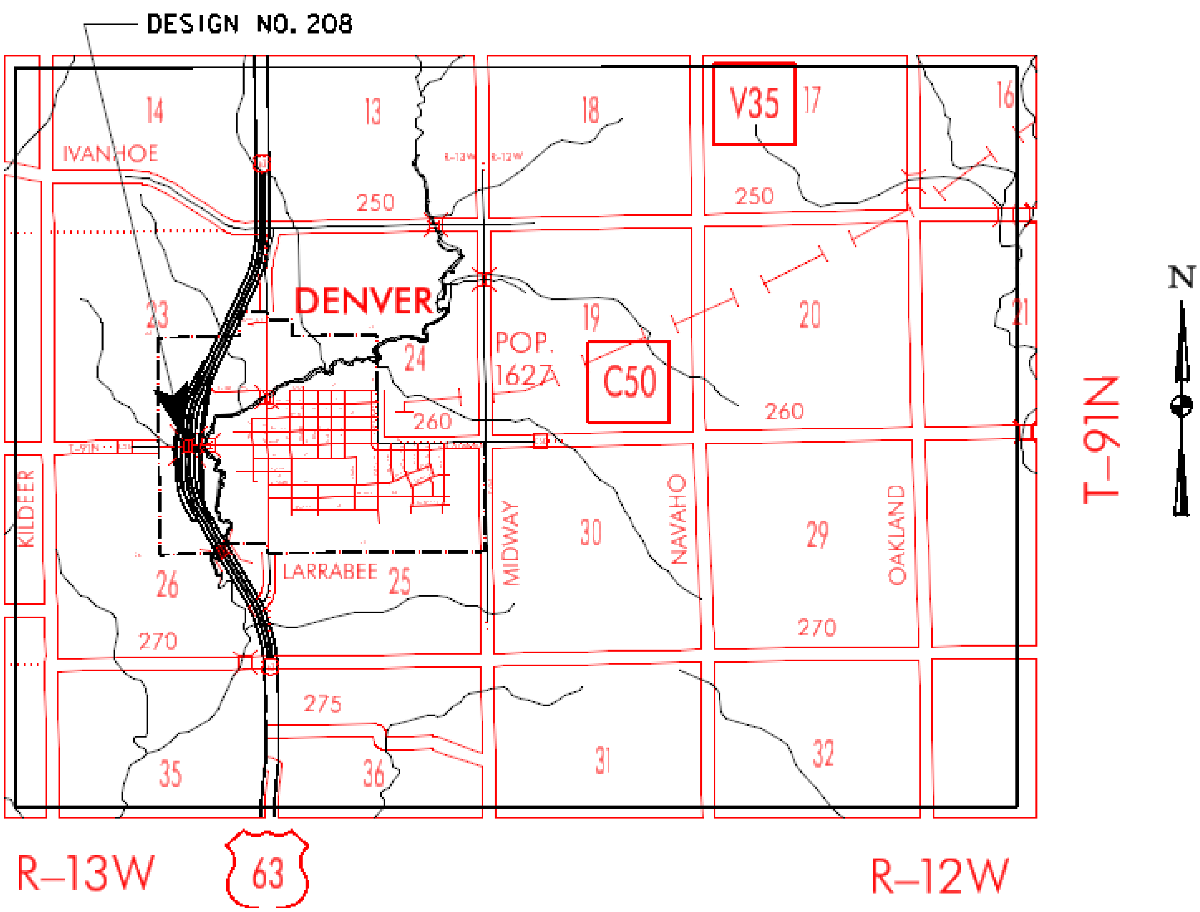

Figure 4
(Project Location)

Constructed in 1994, the existing approaches had seen settlement at all bridge ends with significant settlement at the south abutments of both bridges. All four approach slabs were replaced. The roadway width was 40 ft (two 12 ft lanes, 10 ft and 6 ft shoulders)

Panel Description

Four precast panels were provided at each abutment location (Two 12 foot wide roadway panels and a 3’-10 and 7’-10 shoulder panel) for a total width of 35 ft 8 in with the balance provided by a cast-in-place slab to allow an easier matchup with the existing bridge gutterline. The panels were approximately 24 ft 4 in long measured along the centerline of the roadway and set on neoprene pads tied to the existing abutment paving notch with a drilled in and epoxy grouted 5/8 in stainless steel bars. A pavement expansion joint (Iowa Standard EF Joint) was provided in the precast section four foot from the end of the existing pavement. See Figure 5 and 6 for details.

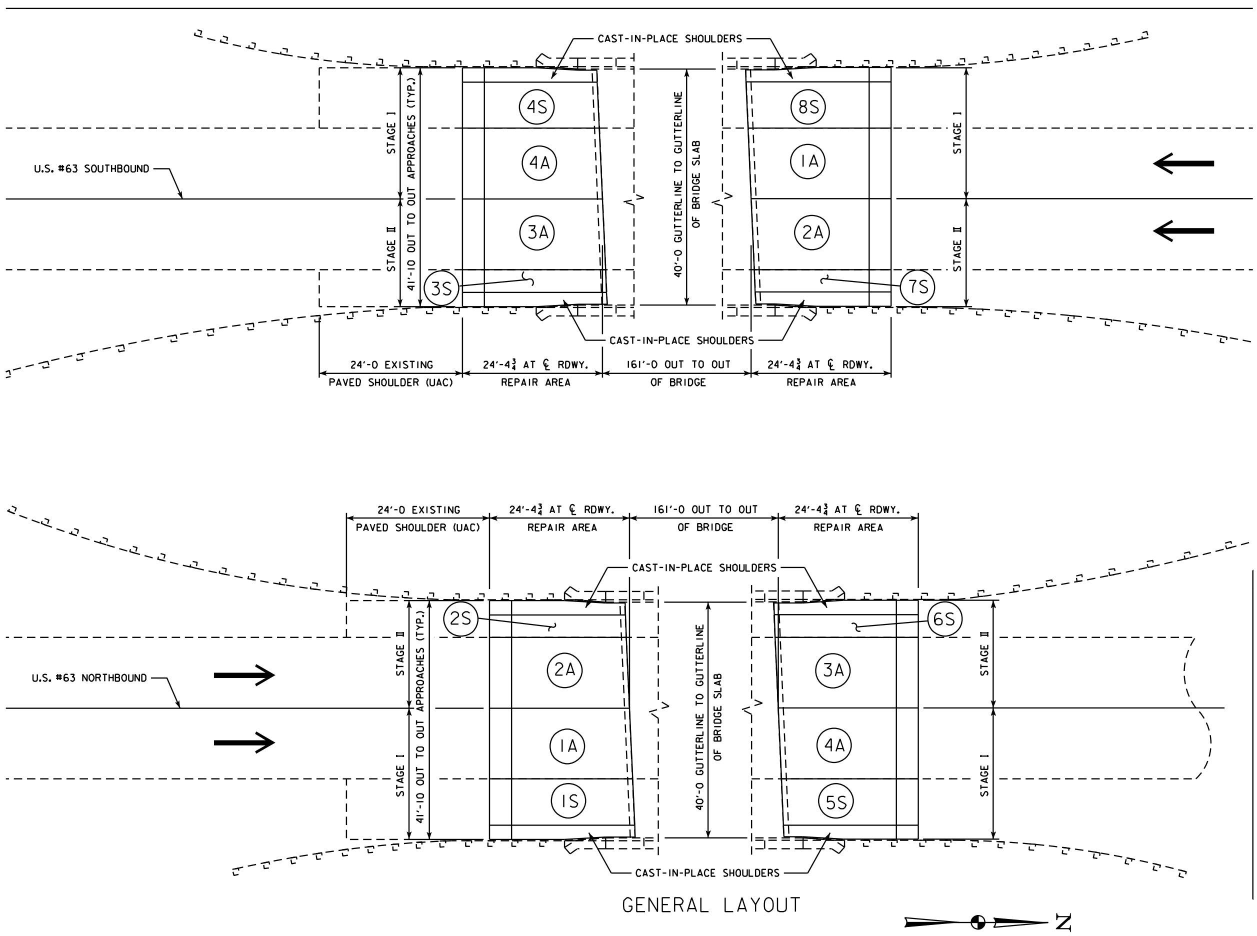

Figure 5
(Plan view construction site)

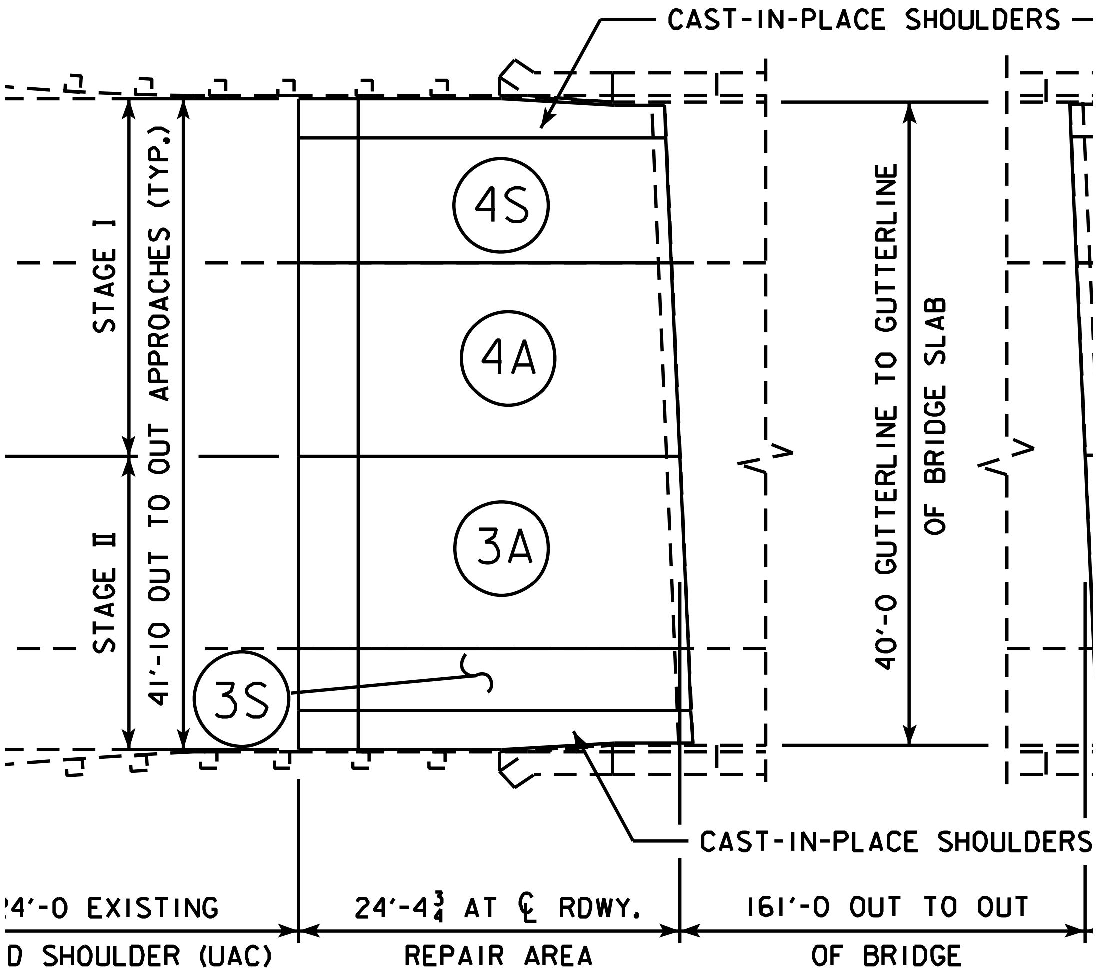

Figure 6
(Plan view of abutment showing individual panels)

Individual panels were 12 inches deep, except at the abutment where the thickness was reduced to 9.5 inches to match with the existing paving notch. The skew for each abutment was field verified and customized for each abutment panel. Skew was approximately 2.5 degrees. Concrete compressive strength was 5000 psi and the main longitudinal reinforcing was number 8 epoxy coated reinforcing bars at 12 inch spacing.

The longitudinal joints used to connect the individual panels was an open joint for the centerline and a keyway joint for the shoulder. The joints included threaded mechanical bars with 3” x 12” full depth grouted pockets spaced at 12 inches. The panels were connected to the existing abutment paving notch with a 5/8 inch stainless steel dowels drilled into the abutment and epoxy grouted and then grouted to the panel using a smaller 3 x 5 inch pocket. See Figure 7, 8, 9, and 10 for design plan details. The connection to the to the existing pavement was by drilled in and epoxy grouted 1 inch diameter epoxy coated reinforcing bars that were then grouted into 3” x 12” pockets that had been cast into the panels.

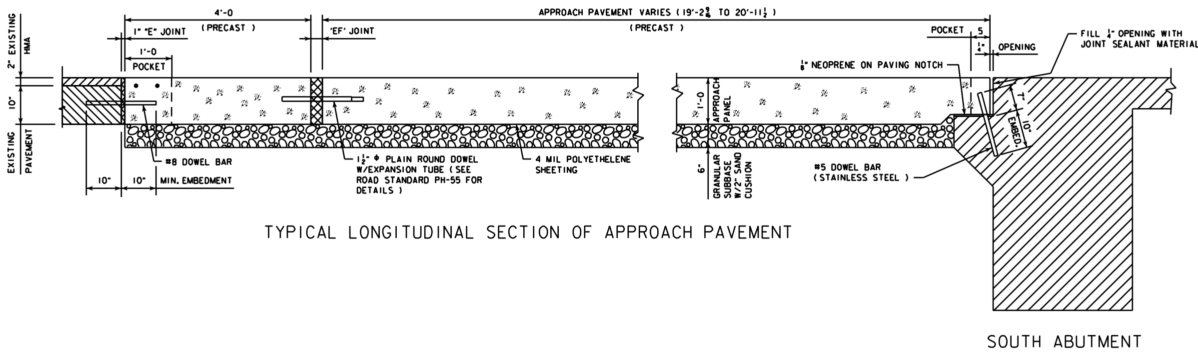

Figure 7
(Centerline cross section of precast panel repair)

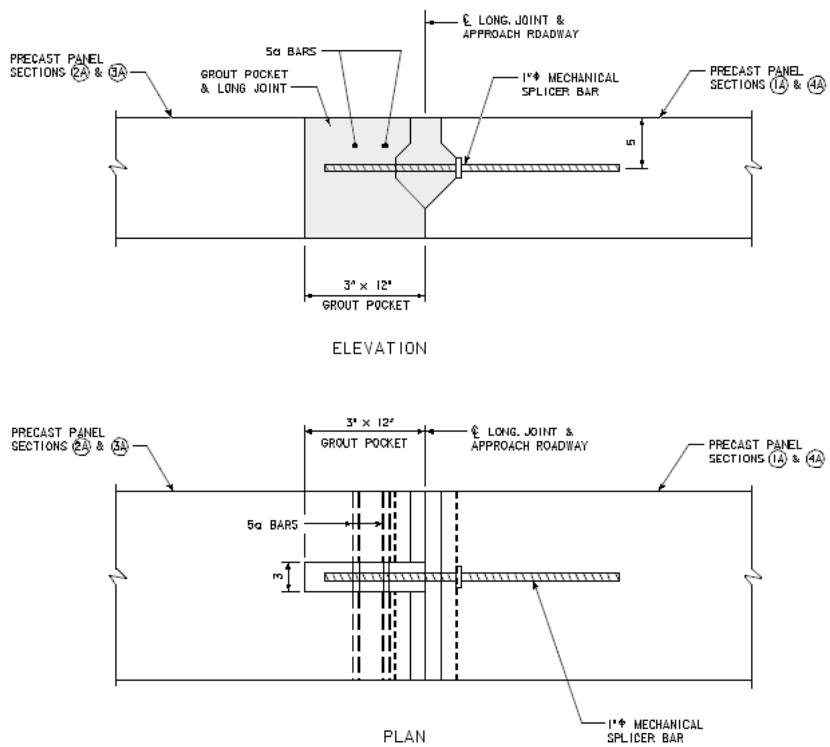

Figure 8
(Typical centerline connection of precast panels)

The shoulder line keyway was connected with epoxy along with the mechanical bar and 3” x 12” pocket. See Figure 9. The grout required for the pockets and centerline joint was a fast setting patching grout with pea gravel used as extender. Required compressive strength was 3,000 psi in 4 hours and 4,500 psi in 24 hours and a 24 hour bond to dry PCC of 1,000 psi. To provide uniform bearing of the panels, access ports and underslab grouting was required for each panel.

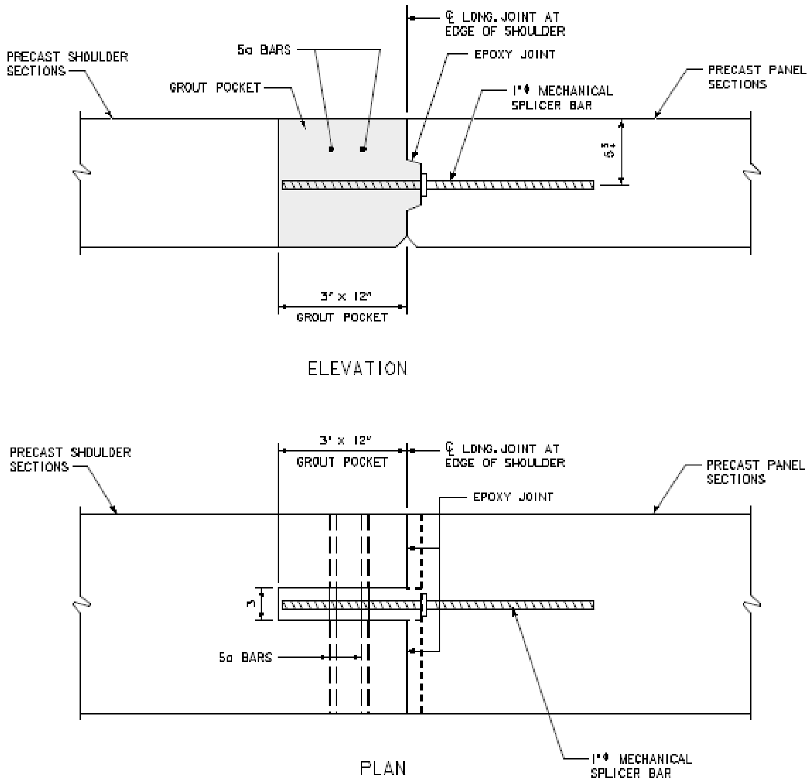

Figure 9
(Typical shoulder line connection of precast panels)

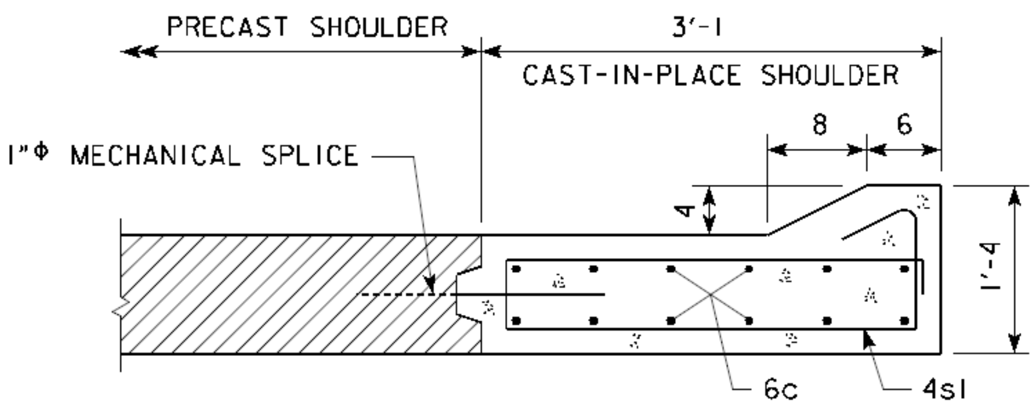

Figure 10
(Cross section of gutter-line with cast-in-place section)

Panel Casting

Panel casting was by Iowa Prestressed Concrete at their Iowa Falls, Iowa plant. There were few problems with the casting the panels. One minor problem was some warping of the expansion joint (Iowa EF joint) that was used for the expansion joint. This detail Road Design pavement standard uses a wood forming system along with a 3.5 inch foam expansion block and 1 ¼ in dowels for shear transfer.

Fit-up tests were required between the 12 ft roadway panels and shoulder panel to verify the keyway tolerance and alignment of the bars and pockets. There were some minor cracking problems in the lower area of the keyway joint during the first fit-up test. This was repaired in the plant and wasn't a problem with later panel checks.

Figure 11 shows preparation for the casting of a shoulder panel and Figure 12 a completed 12 ft roadway panel in the casting yard. Temporary shipping angles were attached to the top of the panels over the expansion joint to prevent movement during handling.

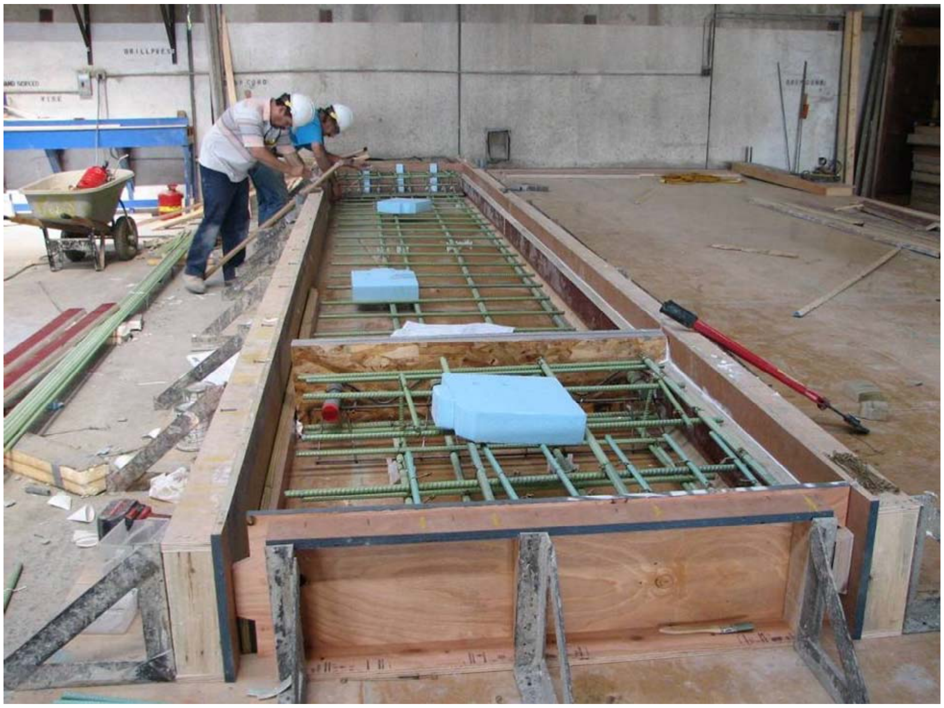

Figure 11
(Forming of shoulder panel)

Figure 12
(12 ft Roadway panel in precasting yard)

Figure 13
(Connection at shoulder line)

Figure 13 shows the roadway section with the 1 in. diameter dowel in place next to the 7'-11 shoulder section before the fit up test. Figure 14 is a side view of the panels during the fit up of the shoulder keyway and Figure 15 a plan view of the pocket locations at the joint.

Figure 14
(Fit-up test at shoulder line keyway)

Figure 15
(Fit-up test at shoulder line showing pockets)

Construction Sequence

The next series of photos (Figures 16 through 27) are the construction sequence of the project. The existing approach slab was removed in sections as shown Figure 16. The approach had been sawcut into the smaller sections before the 11 hour lane closure started. After removal, the paving notch was cleaned and inspected to make sure an adequate bearing width (minimum 5 inches) was available to support the panels. The existing base course was cleaned of debris and leveled with additional granular backfill and then finished to the required grade with a 2 inch sand leveling course (Figures 17 and 18).

Figure 16
(Construction removing existing approach)

Figure 17
(Cleaning off existing paving notch location)

Figure 18
(Sand leveling surface preparation)

Four mil polyethylene sheeting was added as a bond breaker to allow the panels to move with temperature changes (Figure 19), and the precast panels were placed. The first 12 ft roadway panel and 3'-10 shoulder panel were placed with a crane (Figure 20 and 21).

The shoulder joint was tied together using an epoxy compound in the keyway and the 1 in diameter mechanical bar splicer's, grouted in the 3 in x 12 inch pockets (Figure 22). A temporary cold mix was used between the precast panel and existing pavement at the centerline of the roadway (Figure 23).

Figure 19
(Installation plastic sheeting)

Figure 20
(Installation of first roadway panel)

Figure 21
(Installation of inside 3'-10 shoulder panel)

Figure 22
(Providing epoxy for keyway at shoulder line)

Figure 23
(Grouting pockets and temporary joint at centerline)

Trailer placement of panels

Because of issues with temporary roadway closure and movement of the crane over existing pavement, the contractor also developed and used a trailer for placing the precast panels. This trailer used a hydraulic system for making horizontal adjustments of the panel before lowering it into place. See figures 24 through 27. Wood ramps and plywood were used to allow the trailer wheels to move across the backfill area (Figure 24). The controls for the panel adjustment were located on the top of the trailer (Figure 25) to give the operator a better view of the panel placement. This system was used successfully for both daytime and nighttime placement.

Figure 24
(Installation of panel using trailer transport)

Figure 25
(Installation of panel using trailer transport)

Figure 26
(Installation of panel using trailer transport)

Figure 27
(Night installation using trailer transport system)

Figure 28
(Completed approaches-SBL looking North)

Once the panels were in place a asphalt transition wedge was place between the existing pavement and new precast panels. This was then longitudinally ground to a smooth transition and also to provide texture in the precast panels.

Figure 29
(SBL North Abutment Connection)

Lessons Learned (Conclusion)

Based on the results of this repair project, there was agreement between all people involved that it had been a successful project. Below, are some of the "Lessons Leaned" from the project:

1. After experience replacing the approach at the first abutment, the contractor was able to meet the 11 hour closure windows without any problems during day or night construction. The contractor felt with future projects, two crews could be used for replacement at both abutments during lane closures.

2. Use of the trailer system for placing the panels was successful and the contractor planned on using the system if future projects are let by the Department.

3. Because of problems casting and placing the panels with the keyway joint at the shoulder joint the contractor recommended that the open keyway be used at the shoulder joint as well as the centerline joint.

4. The contractor recommended that series of temporary neoprene pads be used along the paving notch to support the precast panels instead of a continuous pad. These area around the pads would be grouted at the same time as the pockets for the tie bars. This system would make it easier to level the precast panels at the paving notch due to the unevenness of the existing notch surface.

5. The contractor recommended larger grouting pockets (minimum 3 in x 6 in) be used at the panel tie location at the notch to make it easier to drilled in and epoxy grout the stainless steel tie bars.

6. The contractor recommended that limit 20 minute road closures also be allowed in future projects.

In summary, this first project using this accelerated repair method by the Iowa Department of Transportation was successful and there are plans for future bridge approaches repair projects using this same repair method. To help reduce cost, plans are being considered for multiple locations on the same project.