New Mexico's 32-Day Bridge

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ABSTRACT

In Fiscal Year 2002, the Innovative Bridge Research and Construction Program (IBRCP) established by TEA-21 awarded the NMDOT $500,000.00 for the replacement of the Mountain Valley Road Bridge over Interstate 40 (I-40) near Tijeras, New Mexico. The funding paid the Federal share of the cost of this project. This project demonstrated the application of innovative bridge materials and innovative material technology, which consisted of the use of High Performance Concrete (HPC) in Rapid Bridge Construction.

The Contractor for the bridge was Reiman Corporation from Cheyenne, Wyoming. Construction began in February 2004. The cast-in-place substructure work for the new bridge was built under the old bridge. Once the cast-in-place substructure work for the new bridge was completed, the old bridge was closed to traffic, demolished, and the superstructure of the new bridge completed and opened to traffic within 32 calendar days. The new bridge was then completed on July 22, 2004 for a total construction time of five (5) months.

The new bridge is a two (2) span prestressed concrete box girder bridge with a concrete deck and concrete barrier railing, 239 feet total length x 52 feet wide. The box girders are 4'-0"x 4'-0" standard box girders, 116'-9" span lengths, consisting of 12,000 psi HPC, and 0.6" diameter low-relaxation strands. See "Figure 1 – Transverse Section."

A time-lapse video clip showing the construction has been assembled. This project was not a standard bridge replacement project and had many challenging tasks. The use of precast box girders and precast pier cap significantly minimized construction time, and reduced user cost versus conventional construction methods. Careful planning, research, and partnering with the Contractor made this rapid bridge construction project a success. This project opened doors to innovative, cost and time effective technologies that will be used in bridges of the future.

Keywords: HPC, Precast Pier Cap, Rapid Bridge Construction, 32 Calendar Days.

INTRODUCTION

In Fiscal Year 2002, the Innovative Bridge Research and Construction Program (IBRCP) established by TEA-21 awarded the NMDOT $500,000.00 for the replacement of the Mountain Valley Road Bridge over Interstate 40 (I-40) near Tijeras, New Mexico. The funding paid the Federal share of the cost of this project. This project demonstrated the application of innovative bridge materials and innovative material technology, which consisted of the use of HPC in Rapid Bridge Construction.

The main goal of this project was to utilize HPC materials and precast substructure units to replace the existing interstate overpass in the same location with minimal roadway user impacts. The Contractor for the bridge was Reiman Corporation from Cheyenne, Wyoming. The cast-in-place substructure work for the new bridge was built under the old bridge with minimal impacts to traffic. Once the cast-in-place substructure work for the new bridge was completed, the old bridge was closed to traffic on June 1, 2004. The old bridge was then demolished, and the superstructure of the new bridge substantially completed and opened to traffic on July 3, 2004, for a total of 32 calendar days. The total construction time for the new bridge was five (5) months. Precast HPC box girders and a precast pier cap were used, which significantly minimized construction time, and reduced user cost versus conventional construction methods.

CONDITION OF OLD BRIDGE

The old bridge was a grade separation bridge over I-40, located in a growth area east of Albuquerque, New Mexico in District 3. The old bridge was built in 1969, which consisted of five (5) simple spans utilizing prestressed concrete girders. See "Figure 1 - Photo of Old Bridge." The existing bridge was on a 26° skew and was 302 feet long x 34 feet wide. The abutments consisted of concrete caps on timber piles. The piers consisted of concrete pier caps on concrete columns and spread footings. According to the last bridge inspection report, the deck, superstructure and substructure were in poor condition with advanced section loss, deterioration and spalling. The sufficiency rating was 58.5.

Figure 1 - Photo of Old Bridge

NEW BRIDGE

One of the main goals of the project was to build a majority of the substructure under the old bridge while keeping the old bridge open to traffic.

SUPERSTRUCTURE

The new bridge was chosen as a two (2) span prestressed concrete box girder bridge with a concrete deck, 239 feet total length x 52 feet wide. The new bridge was built on the same alignment as the old bridge. The box girders are 4'-0"x 4'-0" standard box girders, 116'-9" span lengths, consisting of 12,000 psi HPC, and 0.6" diameter low-relaxation strands. This is the 2nd bridge in New Mexico history to utilize HPC in prestressed girders. The box girders were post-tensioned together to prevent cracks from reflecting through the concrete deck. See "Figure 2 – Transverse Section" for superstructure details.

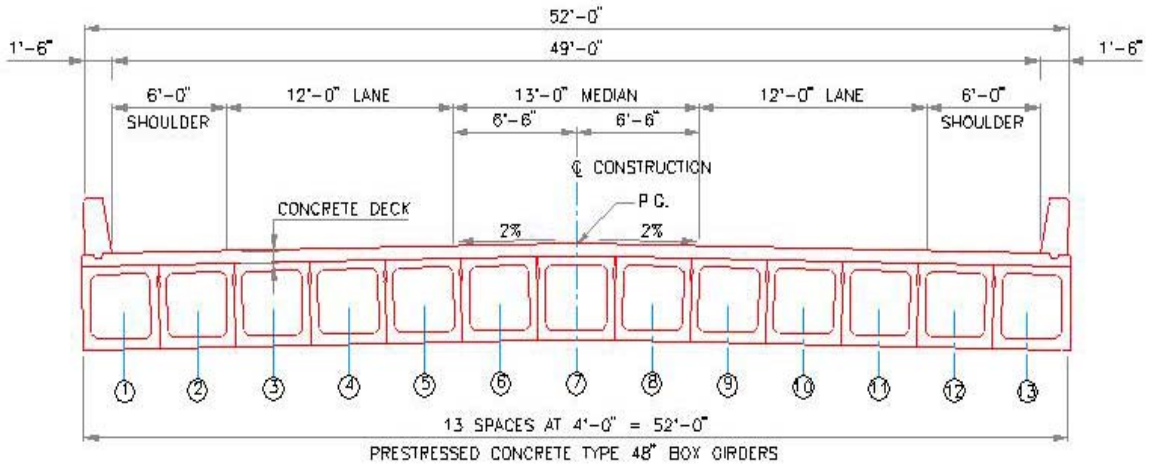

Figure 2 – Transverse Section

SUBSTRUCTURE- ABUTMENT DESIGN

The NMDOT District 3 Office provided a future widening typical for I-40. The location of the new abutments provides adequate room for the future widening. During the design of this project, the most challenging task was the selection of the abutment type. Three (3) abutment options were looked at. The following are the options proposed along with pros and cons for each option:

Option No. 1 – Drilled Shafts with Precast Abutment Caps

Pros

1. Very simple details to construct.
2. Minor excavation required.

Cons

1. Spill-through abutment would impact clear zone and future expansion of I-40.
2. Design of precast abutment cap on drilled shafts difficult.
3. Weight of precast abutment cap may make it difficult to transport and lift.

Option No. 2 – Abutment on Spread Footing with MSE Walls
Pros
1. Easy to construct spread footings.
2. Good soil conditions for MSE Walls.

Cons
1. Not enough vertical clearance under existing bridge to lift MSE wall panels.
2. Problems with installing MSE Wall reinforcement.
3. Design Team did not see this as a feasible option for this project.

Option No. 3- Full Height Concrete Abutment on Spread Footing
Pros
1. Increased clear zone under I-40 for future widening.
2. Soil conditions ideal for spread footings.
3. Majority of abutments can be constructed prior to closing the existing bridge.

Cons
1. Large amount of concrete, excavation and backfill needed to construct.

From the three options, the Design Team felt Option No. 3 - Full Height Concrete Abutments on Spread Footing lent itself more to the goals of this project than the other two options. See "Figure 3 – Plan View," and "Figure 4 – Longitudinal Section" for new bridge details.

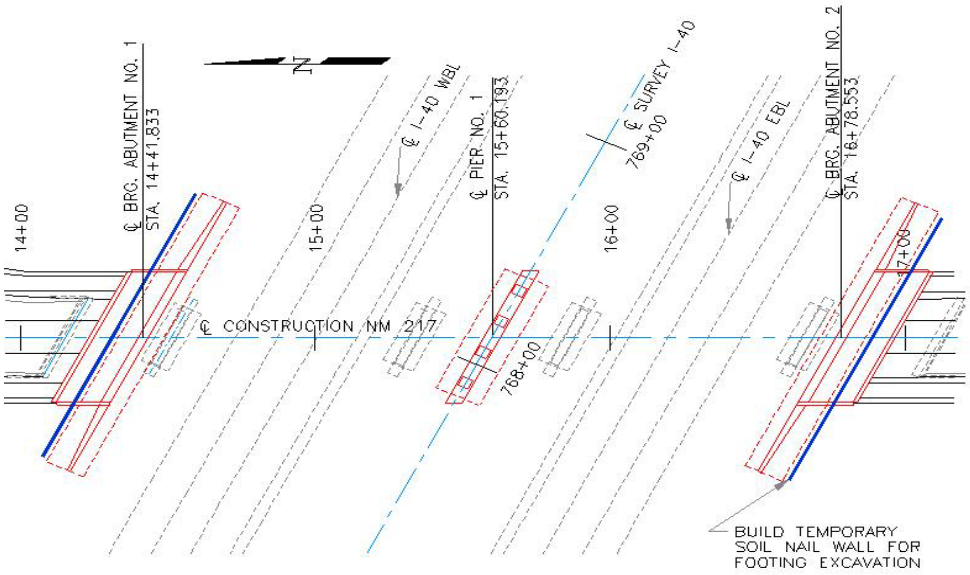

Figure 3 - Plan View

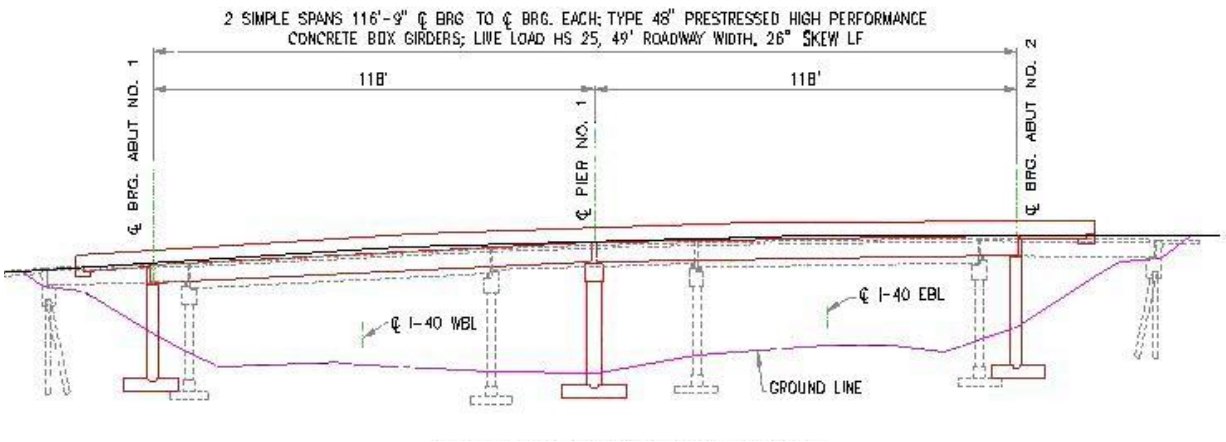

Figure 4 - Longitudinal Section

SUBSTRUCTURE - PIER DESIGN

The type of pier selected for this project was a precast pier cap on cast-in-place concrete square columns and spread footing. The soil conditions were ideal for this type of pier. There was enough vertical clearance under the old bridge for the Contractor to construct the footing and pier columns. Once the old bridge was closed to traffic and demolished, the precast pier cap was erected in 1 day.

The precast pier cap was then post-tensioned vertically to the tops of the pier columns, which provided the necessary mechanism to transfer moments. This system has been used effectively in several bridges built by Texas DOT and Florida DOT. 1½" diameter stress bars projecting out of the pier columns were anchored in the tops of the pier columns. The precast pier cap was lowered into place, the bars tensioned, and the ducts grouted.[1] See "Figure 5 – Pier Details" and "Figure 6 – Cap to Column Connection."

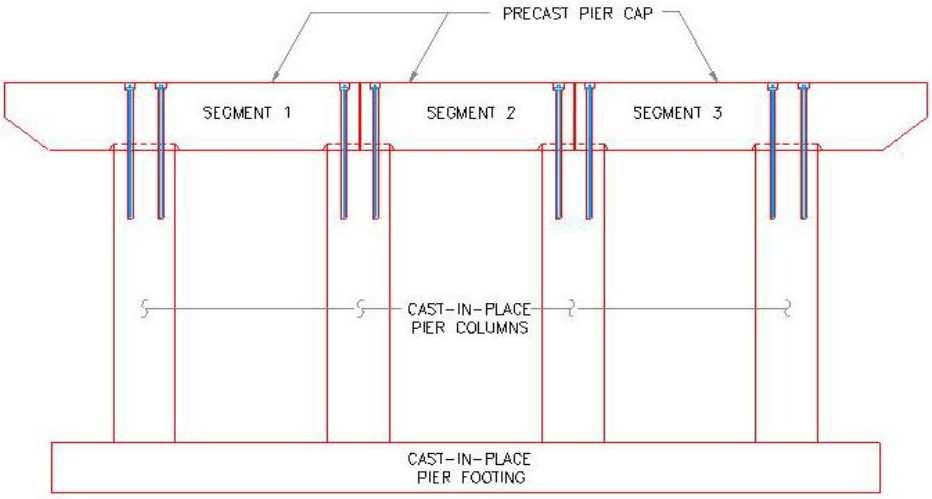

Figure 5 - Pier Details

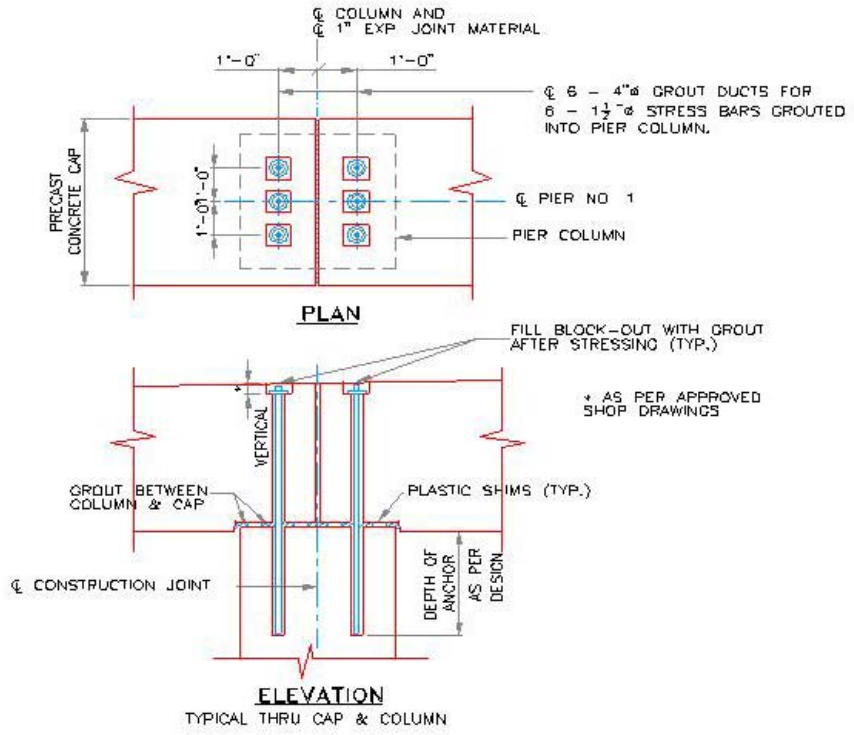

Figure 6 - Cap to Column Connection

SCHEDULE

Prior to closure of the old bridge to traffic, the Contractor was required to have all precast pier cap components and prestressed box girders fabricated. The Contractor was also required to set up a "Pre-Closure of Bridge Meeting" with the NMDOT District 3 construction personnel and NMDOT Bridge Design Section two (2) weeks prior to closure of the old bridge to ensure that the Contractor had all equipment, materials, and construction personnel necessary to accomplish the work within 45 calendar days.

There were certain operations that the Contractor was allowed to perform after the new bridge was opened to traffic. Such operations as applying the Special Surface Finish and the Penetrating Water Repellant Treatment were done after the new bridge was opened to traffic, and two (2) lanes for traffic remained open at all times.

Table 1 below shows the sequence of construction of the new bridge as performed by the Contractor. The total number of calendar days that the bridge was closed to traffic was 32.

Table 1 – Sequence of Construction

Stage No.	Stage Description	Date
1	Prior to closure of old Bridge No. 6935, pier footings, pier columns, abutment footings, and abutment retaining walls were built; all other miscellaneous construction (i.e. relocation of utilities, etc.) were completed; scissor detours were built on I-40 to accommodate I-40 traffic during removal of old bridge components and placement of new bridge components.	February 16 to May 31, 2004
2	Closed old Bridge No. 6935 to traffic.	June 1, 2004
3	Removed old bridge railing, deck, girders, pier columns and cap, abutment caps and approach slabs. Switched I-40 traffic as necessary during removal operations.	June 1 to June 7, 2004
4	Placed precast pier cap. Post-tensioned pier cap to pier columns and grouted.	June 2, 2004
5	Backfilled abutments and prepped approaches to new bridge.	June 1 to June 23, 2004
6	Placed bearing devices and precast concrete box girders while switching I-40 traffic as necessary. Post-tensioned box girders together. Grouted post-tension ducts.	June 7 to June 11, 2004
7	Place reinforcing bars for deck slab, wingwalls, and portion of concrete barrier rail. Grouted shear keys in box girders.	June 12 to June 18, 2004
8	Poured concrete diaphragms at end of girders, concrete deck slab and wingwalls. Allowed concrete to cure for a minimum 7 days.	June 18, 2004
9	Placed reinforcing bars for approach slabs, and remaining portion of concrete barrier rail. Rock plated abutment slopes.	June 19 to June 27, 2004
10	Poured concrete for approach slabs.	June 24, 2004
11	Placed striping, temporary barrier rail, and permanent signing. Completed diamond-grooving of deck and paved approaches to open new bridge to traffic.	June 27 to July 2, 2004
12	Opened new bridge to traffic.	July 3, 2004
13	Completed permanent concrete barrier rail, pedestrian screening fence, penetrating water repellant treatment, and special surface finish.	July 3 to July 22, 2004

BIDDING OPTIONS

For this project, A + B + C bidding and incentive/disincentive provisions were used to determine the successful bidder. This procedure took into account the price offerings from the bidder, the time the bidder intends to take to substantially complete the bridge work and the time that either direction of through traffic will be reduced to one lane on I-40. The following is the NOTICE TO CONTRACTORS set up for this project:

NOTICE TO CONTRACTORS
9-October-2003

Preparation of Proposal. The bidder shall establish the number of calendar days that will be required to substantially complete the work requiring closure of Mountain Valley Road overpass over I-40. The calendar day number shall be included in the bid proposal. This calendar day number multiplied by the established Bridge Rental Rate for the Mountain Valley Road overpass closure shall be added to the total amount bid for the work items. **The number of calendar days to substantially complete this work shall not exceed 45 calendar days.** Once the Mountain Valley Road overpass is closed to through traffic no suspension of work will be allowed. Bids submitted with the number of calendar days in excess of 45 required to substantially complete the work requiring closure of Mountain Valley Road as described above will be considered non-responsive and shall be rejected.

The sum of these amounts will be used to determine the lowest bidder according to the following formula:

A + B + C = Contractor's bid for evaluation of the lowest bidder.

Where:

A = Contractor's total bid amount for the work items

B = Contractor's bid to substantially complete the work = **b x RUC** where:

b = Number of Calendar Days required to substantially complete the work

RUC = Road User Cost for I-40 = **$1000.00/day**

C = Contractor's bid for lane and bridge closures = (**c x BRR**) where,

c = Number of Calendar Days bid to substantially complete the work requiring closure of Mountain Valley Road over I-40 overpass and

BRR = Bridge Rental Rate = **$10,700.00/day**

The above formula will be used solely for determining the lowest bidder and will have no effect on the actual total bid cost for completing the work.

Early Completion of the Work Incentive
If the Contractor substantially completes the work requiring closure of the Mountain Valley Road over I-40 overpass in less than the total number of calendar days bid, an incentive will be paid to the Contractor. This incentive (I) will equal the number of calendar days bid (c) minus the actual number of calendar days required to substantially complete the work (d) multiplied by the Bridge Rental Rate for the Mountain Valley Road overpass closure (BRR).

$I = (c – d) X (BRR)$

The maximum incentive is limited to two percent of the Contractor's total bid for the work items (0.02 X A).

To receive an early completion of the work incentive the Contractor cannot exceed the number of calendar days bid to substantially complete the work requiring closure of Mountain Valley Road overpass over I-40.

Late Completion of the Work Disincentive
If the number of calendar days required to substantially complete the work requiring closure of the Mountain Valley Road over I-40 overpass is in excess of the total number of calendar days bid, a disincentive will be deducted from payments made to the Contractor. This disincentive (P) will equal the actual number of calendar days required to substantially complete the work (d) minus the number of calendar days bid (c) multiplied by the Bridge Rental Rate for the Mountain Valley Road overpass closure (BRR).

$P = (d – c) X (BRR)$

For the Late Completion of the Work Disincentive, the Lane Rental Rate and the Bridge Rental Rate for NM 217 overpass provisions will be evaluated and applied independently, and the disincentives shall be cumulatively imposed for the failure to meet each requirement.

COST
The total cost was $1,536,816.11 for bridge work only. This equates to $123.00 per square foot. Although this cost per square foot is above the average cost for bridges in New Mexico, the rapid bridge concept significantly minimized construction time, and reduced user cost. Also, studies show that the use of HPC significantly increases the design life of the bridge. It is estimated that the HPC box girders have a design life of 100 years. The sufficiency rating for the new bridge is 100, which is the highest sufficiency rating a bridge can receive.

CONCLUSION

This project was not a standard bridge replacement project and had many challenging tasks. The most challenging portions of this project were the construction of the abutments, which were time consuming and were in a confined area under the old bridge; I-40 traffic control; and initial post-tensioning of the box girders together. The site conditions and substructure work for this project made it difficult to standardize the substructure.

Careful planning, research, and a close partnering with the Contractor made this rapid bridge construction project a success. This project demonstrated the use of rapid bridge construction utilizing HPC for the NMDOT and others. It will open doors to innovative, cost and time effective technologies that will be used in bridges of the future.

REFERENCES

1. Precast/Prestressed Concrete Institute, "Chapter 16- Additional Bridge Products - 16.6.4.1.1 – Post-Tensioning," *PCI Bridge Design Manual,* September 2001.

Figure 7 - Profile of Completed Bridge