PROJECT

Las Vegas Airport Interchange

New Mexico builds a bridge under a bridge to accelerate schedule

by Raymond M. Trujillo,
New Mexico Department of Transportation

Nearly complete bridge on Frontage Road 2142 to the Las Vegas, N.Mex., airport. Photo: Fernando Quiroga.

In New Mexico, many bridges carrying interstate traffic or local roads over interstates are reaching the end of their design and service lives. Due to increased traffic volumes and vehicle weights, many of these are considered functionally or structurally deficient. The state is methodically prioritizing and replacing these structures yearly.

In 2012, the bridge carrying frontage road (FR) 2142 over Interstate 25 (I-25) in Las Vegas, N.Mex., was determined to be structurally deficient and rapidly deteriorating. Replacement of this bridge, the Las Vegas Airport Interchange, became a priority for the District 4 office of the New Mexico Department of Transportation (NMDOT).

Background

The NMDOT engineers established the need to reduce the duration of construction and minimize inconvenience to the travelling public because closure of the bridge would require a 5-mile detour to access the airport. The existing alignment and profile grade were to be maintained to eliminate the cost and time required for reconstruction of the approach roadway.

Methods Used to Accelerate and Accommodate Under-Bridge Construction

- Construction of abutments and piers under existing bridge
- Abutment excavations stabilized with retaining walls and soil nails
- Drilled, cast-in-place concrete micropiles
- Precast concrete abutment caps with back walls
- Precast concrete pier cap
- Precast concrete wingwalls
- Shallow adjacent precast concrete box girders
- Transverse post-tensioning
- Reduced thickness cast-in-place concrete composite deck that required no supporting formwork

The bridge design engineer proposed replacing the existing five-span bridge with a two-span structure, placing the center pier between the two existing median shoulder piers. Early on, the NMDOT Bridge Design Bureau recommended incorporating accelerated bridge construction (ABC) techniques. For this bridge, a reduced closure could be accomplished by constructing the foundation and part of the substructure under the existing bridge while it remained in service. In addition, prefabricated bridge elements and systems (PBES) components would be used. NMDOT has had success with this method on previous bridge projects.

The new Las Vegas Airport Interchange Bridge is 170 ft long and 36.17 ft wide. It carries two, 12-ft-wide travel lanes and two, 4-ft 7-in.-wide shoulders plus 1-ft 6-in.-wide barrier rails.

profile

LAS VEGAS AIRPORT INTERCHANGE / LAS VEGAS, NEW MEXICO

BRIDGE DESIGN AND CONSTRUCTION ENGINEER: Quiroga Pfeiffer Engineering Corporation (QPEC), Albuquerque, N.Mex.

PRIME CONTRACTOR: El Terrero Construction LLC, Rio Rancho, N.Mex.

PRECASTER: Coreslab Structures (ALBUQUERQUE) Inc., Albuquerque, N.Mex.–a PCI-certified producer

POST-TENSIONING CONTRACTOR: El Terrero Construction LLC, Rio Rancho, N.Mex.

Foundations

A spread footing was used at the pier. Since adequate space was not available for spread footings at the abutments, micropiles were selected on which a pile cap was cast to support the abutment walls. The existing fill slope at the abutments needed to be excavated in order to drill and cast the micropiles. During this construction, a temporary retaining wall was constructed and stabilized with soil nails.

Micropiles were selected for this bridge because they could be constructed under low headroom. NMDOT had not used them previously but construction was straightforward. An alluvial soil layer, 9.5 ft thick at abutment 1 and 6.5 ft thick at abutment 2, overlaid bedrock. A 7.5-in.-diameter hole was bored 15 ft into bedrock. A 7-in.-diameter steel casing was placed in the alluvial layer, extending 6 in. into the pile cap and 12 in. into bedrock. A neat cement grout with 4 ksi design compressive strength was tremied into the hole and around the casing. One no. 14 epoxy-coated Grade 75 reinforcing bar was inserted for the full depth. The bar extended 12 in. from the top of casing and was threaded with double nuts and washer plate to anchor it in the cap. The foundation required 17 vertical and 15 batter piles under each abutment and 14 vertical and 10 batter piles under each retaining wall that extends 37.5 ft from each side of both abutments.

Substructure

Substructures were built in two phases. The first phase included installing the micropiles and cast-in-place concrete construction for the abutment and retaining wall pile caps, the abutment walls, the spread footing at the pier, and the three pier columns.

After the first phase substructure components were constructed under the existing bridge while still in service, the ABC-PBES strategy was implemented. The existing bridge was closed to traffic and demolished. The precast concrete abutment caps and pier cap were immediately set in place to complete the substructure.

The cast-in-place concrete pier columns and precast concrete pier cap are shown in the foreground with the cast-in-place concrete retaining and abutment walls with precast concrete abutment cap in the background. Photo: Fernando Quiroga.

The precast abutment caps are L-shaped, providing both the 2-ft-wide girder seat and a 1-ft-wide back wall. Overall, they are 3 ft wide and approximately 7 ft 3 in. high by 36 ft 6 in. long.

The precast concrete pier cap is rectangular in cross section, 4 ft 6 in. wide by approximately 4 ft 4 in. high, and 36 ft 6 in. long.

Both types of caps are connected to their supporting elements with grouted reinforcing bar splicers that fully develop the reinforcement across the joints. The abutment caps contain four groups of 10 no. 8 sleeves and the pier caps contain 10 no. 9 sleeves at each connection to a pier column.

Two additional precast concrete elements were used at each abutment. Irregular-shaped wingwalls are approximately 9 ft 3 in. long by 7 ft high and 15 in. thick. Each wall was connected to the cast-in-place concrete abutment wall using 26 no. 8 grouted bar splicers.

Superstructure

Once the substructure was completed, nine NMDOT Type 39 precast, prestressed concrete adjacent box girders were erected on each of the two spans. The box girders are 39 in. deep and 48 in. wide by 84.5 ft long. The design concrete compressive strength was 9.5 ksi at 28 days and 7.0 ksi at prestress transfer. These girders allowed increased vertical clearance over I-25 and maintained the existing profile grade.

The box girders were transversely post-tensioned together in groups of three with single girder overlaps between groups. Two post-tensioning tendons were used at quarter points. The tendons were 1-in.-diameter, 150 ksi threaded bars inserted through 2¼-in.-diameter ducts except at the center girder where 3-in.-diameter ducts were used to accommodate the change in

After demolition of the existing bridge, the precast concrete abutment cap with back wall is placed on the abutment wall. The bar extensions will extend into the bar splice sleeves embedded in the precast concrete wingwalls. Photo: Fernando Quiroga.

NEW MEXICO DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTION: A two-span, adjacent box-girder bridge with span lengths of 85 ft on foundations and partial substructures that was built under an existing bridge in service to expedite the construction schedule

STRUCTURAL COMPONENTS: Eighteen, 39-in.-deep by 48-in.-wide, adjacent, precast, prestressed concrete box girders with a 5.5-in.-thick, composite, cast-in-place concrete deck; precast concrete pier cap on cast-in-place concrete columns on spread footing; precast concrete abutment caps on cast-in-place concrete abutment walls and retaining walls supported by pile caps on drilled, cast-in-place concrete micropiles; precast concrete wingwalls

BRIDGE CONSTRUCTION COST: $1,757,114; $282 per sq. ft.

AWARDS: 2015 PCI Design Award for Best Bridge with a Main Span from 76 to 149 ft; 2015 Excellence in Concrete Award by ACI New Mexico chapter

The cast-in-place concrete pier columns are complete and await demolition of the existing bridge. Photo: Fernando Quiroga.

trajectory, considering the center girder was placed level and the girders on each side were set with a 2% down slope. The girders were post-tensioned prior to grouting the shear keys using load-indicating washers to establish the necessary forces in the bars.

Shear key grout was required to be prepackaged commercial material and attain compressive strength of 6 ksi. Prior to grouting, the girder shear keys were required to be saturated, surface dry after a 24-hour wetting period. After the grout was rodded into the shear keys, it was required to be water cured for 72 hours.

A 5.5-in.-thick concrete deck was placed on top of the box girders to provide a wearing surface and to distribute live loads.

Phasing and Traffic Control

Single lane closures on I-25 were required at times when equipment needed to be located adjacent to traffic, when bridge demolition occurred, and when precast concrete elements were lifted into place. Crossovers were built to switch traffic to one side when the work needed to be located over the travel lanes. The adjacent box girders provided a safe work platform for deck construction and only required edge forms for the cast-in-place concrete deck.

Summary

Although ABC methods have been used by NMDOT on earlier bridge projects, ABC methods are not commonly used. This project reaffirms the department's willingness to use ABC methods when they will benefit the traveling public.

The ingenuity of this bridge replacement was combining cast-in-place concrete with PBES elements to expedite construction during the critical 45-calendar-day bridge closure. It should be noted the demolition of the existing bridge, the completion of the substructure, and construction of the superstructure were all accomplished in 1 week. The contractor elected to use the full 45 days to complete the deck cast, construction of bridge railing, the approach slabs, approach roadway tie-in, and painting of the bridge.

The precast concrete elements were produced in a local fabricator's yard so formwork and reinforcement layout were readily accessible for inspection. This provided better control of the materials and tighter dimensional tolerances required for fit-up, especially considering the jobsite extension of dowels to mate with splicing sleeves in the precast concrete components.

Drilling for micropiles proceeds under the shadow of the existing bridge. The single no. 14 reinforcing bar in each pile is supported on the top of the steel casing. The temporary soil-nailed retaining wall is in the background. Photo: Fernando Quiroga.

The project was very positively received by all involved. The project manager stated, "This was a great design and an excellent contractor to work with." District 4 was pleased with the work and made a presentation of the project at the NMDOT Engineering Conference. The project received a PCI Design Award as well as an award from the New Mexico chapter of the American Concrete Institute.

Raymond M. Trujillo is the chief of the Bridge Design Bureau with the New Mexico Department of Transportation in Santa Fe, N.Mex.

A substantial portion of construction of the cast-in-place abutment and retaining walls was completed while the existing bridge remained in service. Photo: Tom Cartner.

Color combined with the simple, well-balanced lines of the new Las Vegas, N.Mex., Airport Road Bridge have enhanced the driver experience on Interstate 25. Photo: Fernando Quiroga.