PROJECT

West Mesquite Interchange AT I-15

NDOT's First Bridge Slide Using Accelerated Bridge Construction

by Adam Searcy, Nevada Department of Transportation; Mike Dobry, Horrocks Engineers; and Laycee Kolkman, HDR Engineering Inc.

In early January 2012, the Nevada Department of Transportation (NDOT) lifted a new bridge on Interstate 15 (I-15) and slid it 60 ft into its permanent location in a matter of hours.

The West Mesquite Interchange was NDOT's first use of accelerated bridge construction (ABC) technology. With ABC, crews were able to build the 159.5-ft-long bridge (including approach slabs) in six months less time than with traditional methods and for millions of dollars less than the cost of a typical rebuild.

The I-15 interchange was part of a $15 million project to widen Falcon Ridge Parkway in Mesquite, Nev., and to increase capacity for projected future traffic in the city (the original project estimate was approximately $25 million). The improvements, which were completed in April 2012, widened the parkway, increased the bridge length, added roundabouts at interchange ramps, replaced 1200 ft of existing mainline pavement, and included new landscaping and lighting that creates a welcoming entrance to this popular tourist destination.

ABC Conditions

The interchange was in a prime location to accommodate Nevada's first bridge slide and fulfill the goal to reduce construction impacts on I-15. The following factors led to the decision to use ABC:

- Ample land was available adjacent to the final location for building the bridges on temporary foundations.
- There were no viable alternate routes.
- Precast concrete components were available.
- High traffic and freight volumes.
- The location of the bridge at an interchange allowed interstate traffic to be routed down the ramps during the demolition of the existing bridges and the slide, avoiding any closures on I-15.
- Traditional methods would have required significant I-15 traffic restrictions to construct the bridges.

Aerial photo of West Mesquite Interchange following the I-15 southbound bridge slide. Photo: NDOT.

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WEST MESQUITE INTERCHANGE AT I-15/ MESQUITE, NEVADA

PROGRAM MANAGER: HDR Engineering, Omaha, Neb.

BRIDGE DESIGN ENGINEER: Horrocks Engineers, Pleasant Grove, Utah

GEOTECHNICAL ENGINEER: Intermountain GeoEnvironmental Services Inc., Salt Lake City, Utah

SURVEYOR: Forsgren, Mesquite, Nev.

PRIME CONTRACTOR: W.W. Clyde, Springville, Utah

CONCRETE SUPPLIER: Sunroc Corporation, St. George, Utah

PRECASTER: Hanson Structural Precast Eagle, Salt Lake City, Utah, a PCI-certified producer

Construction and Materials

Bridge construction began in mid-November 2011 adjacent to the freeway. Crews expedited the work by using precast concrete components.

The actual construction of the single-span bridge followed the same steps as traditional, build-in-place construction with the exception of the foundations. Temporary hollow-bar soil nails were used to support the existing structure while the permanent foundations for the new bridge were constructed underneath the existing bridge. The design specified a temporary steel substructure to support the new, 10,000 ft^2 superstructures. The shotcrete for the soil-nails had a specified compressive strength of 4000 psi, while the grout for the hollow-bar nails was specified to be 3000 psi.

Precast concrete components were used to significantly reduce construction time. These included 9-ft 9-in.-spaced precast, prestressed concrete Utah bulb-tee beams (UBT58). Nonprestressed, 3.5-in.-thick, partial-depth, precast concrete deck panels were used to eliminate deck formwork, allowing faster placement and improving safety for the public and construction workers. The overall thickness of the bridge deck is 8 in., including a 4.5-in.-thick, cast-in-place concrete topping.

Workers set bridge girders in preparation for sliding a 1000-ton bridge into place on the superstructure. Photo: Alan Preston.

Specified compressive strength for the cast-in-place concrete and deck panels was 4000 psi, while the precast concrete girders used 9000 psi compressive-strength concrete. As a time-saving strategy for ABC, flowable fill with a compressive strength of 200 to 500 psi was used to backfill behind the abutments and under the approach slabs after the bridges were slid into their permanent locations.

Bridge longevity was an important focus, given the project investment. Prestressed concrete girders increased durability and lowered maintenance requirements. Although not required in Clark County, Nev., epoxy-coated reinforcing bars were used in the precast concrete girders to reduce the probability of corrosion and extend the life of the girders. The structures were designed and detailed for a 75-year service life.

The final bridge dimensions measure 111 ft 6 in from center-line between each abutment, with an additional 24 ft to account for the approach slabs at each end and an overall width of 45 ft 11 in.

Bridge Move

The bridge slides were done in two separate moves (I-15 southbound on January 10 and I-15 northbound on January 24) over two 56-hour periods. For each slide, the existing I-15 structure was demolished at the interchange and the new 1000-ton superstructure was slid transversely 60 ft into its final position using two 64-ton capacity hydraulic jacks with a stroke of 3 ft. The approach slabs were slid with the rest of the superstructure.

First, crews rerouted traffic on I-15 through the interchange on- and off-ramps that were temporarily widened to two lanes for the closure. Next, the existing bridge was demolished, which took about 12 hours. Crews then lifted

Construction of the southbound I-15 bridge deck happened directly adjacent to live I-15 traffic. Photo: Alan Preston.

the new bridge 3 in. into the air from its temporary foundations to clean and lubricate the bearings below. In final preparation for the move, crews applied gallons of lubricating dish soap to Teflon-coated elastomeric bearing pads.

The bridge alignment followed a vertical and horizontal curve with a cross slope of 4.6% on the southbound side and 4.7% on the northbound side. The bridge has a 31-degree skew.

Two specialized hydraulic jacks, each controlled by a single joystick, locked into slide rails and pushed the bridge 38 in. every 2 minutes until it was in place. The initial push required 800 to 900 tons with 8 to 9% friction, and approximately 600 to 700 tons and 4 to 5% friction to continue moving the bridge. A steel rail was cast into the temporary support system of the bridge; this rail included steel plates, or "ears." During the move, the ears slid into notches, forcing the bridge to move in only one direction. The jack stayed within this frame, moving the bridge from notch to notch. Once in its final location, crews used jacks to raise the bridge and install the bearings. The actual slide on the southbound bridge took 1 hour and 15 minutes, and the northbound bridge, which did not proceed smoothly and began to come in askew, took 5 hours.

NEVADA DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTION: Two single-span bridges, 111-ft 6-in.-long, plus 24-ft-long approach slabs, with widths of 45 ft 11 in. Built 60 ft away from and parallel with their final location and moved in a transverse slide using accelerated bridge construction

STRUCTURAL COMPONENTS: UBT58 precast,prestressed girders (Utah bulb tee) and conventionally reinforced 3.5-in.-thick precast concrete partial depth deck panels

BRIDGE CONSTRUCTION COST: Approximately $2 million ($200/ft^2) for construction only costs. Another $900,000 for demolition, removal, and slide costs

AWARDS: 2011 Transportation Project of the Year – Institute of Transportation Engineers, Nevada Chapter

Top down view of the hydraulic jack pushing the bridge. Photo: Jackie Borman, HDR.

Side view of the hydraulic jack pushing the bridge. Photo: Jackie Borman, HDR.

Teflon pads on rails assisted the sliding of the approach slab and bridge into place. Photo: Jackie Borman, HDR.

Safety

The bridge construction and slide required detailed planning. From design, scheduling, surveying, and construction, every step took additional time to prepare for the move.

Safety provisions were put into place to ensure workers and the public were able to negotiate the detour. Constructing the bridge using ABC eliminated the need to divert traffic as required for most traditional projects. This kept the construction area safer for motorists, pedestrians, and the workers. Crews installed temporary concrete barriers on either side of I-15 to prevent live I-15 traffic from entering the construction areas and to prevent construction equipment from crossing over into I-15 traffic during the move.

Challenges

As-built dimensions are essential in ABC bridges. Unlike building in place, dimensions must be built to absolute precision to ensure the substructure and superstructure fit together during the slide. Adding to the challenge was the high skew angle on the West Mesquite bridges. The design team performed a thorough analysis to demonstrate bridge performance in this particular skewed geometry.

To expedite the move and avoid costly alternatives, the design team decided to move the approach slabs with the bridge. The approach slabs were built on temporary falsework and shoring along with the rest of the superstructure. All three pieces were elevated together, tied with reinforced cables and reinforcement and coordinated with the jacking system. Approach slabs were slid onto horizontal steel grade beams.

Recycling

The crushed concrete from the old West Mesquite Interchange bridges was hauled to a local golf course and used to construct a new flood control system. The asphalt surfaces were also recycled. The material was rotomilled and used in the aggregate base on new sections of the roadway.

National Attention

The NDOT bridge slide provided more than 150 representatives from 23 different DOTs, the Federal Highway Administration (FHWA), and industry the opportunity to witness ABC techniques and innovation firsthand. The group watched, on site, before attending an FHWA-sponsored workshop highlighting the design and engineering aspects associated with this achievement. More than 100 residents also came out to view the move.

Using ABC techniques, NDOT ultimately saved taxpayers nearly $13 million by eliminating or minimizing closures, detours, and lowering speeds. Based on the successes of the West Mesquite Interchange project, NDOT is now reviewing the applicability of using ABC innovations on other projects in the state.

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