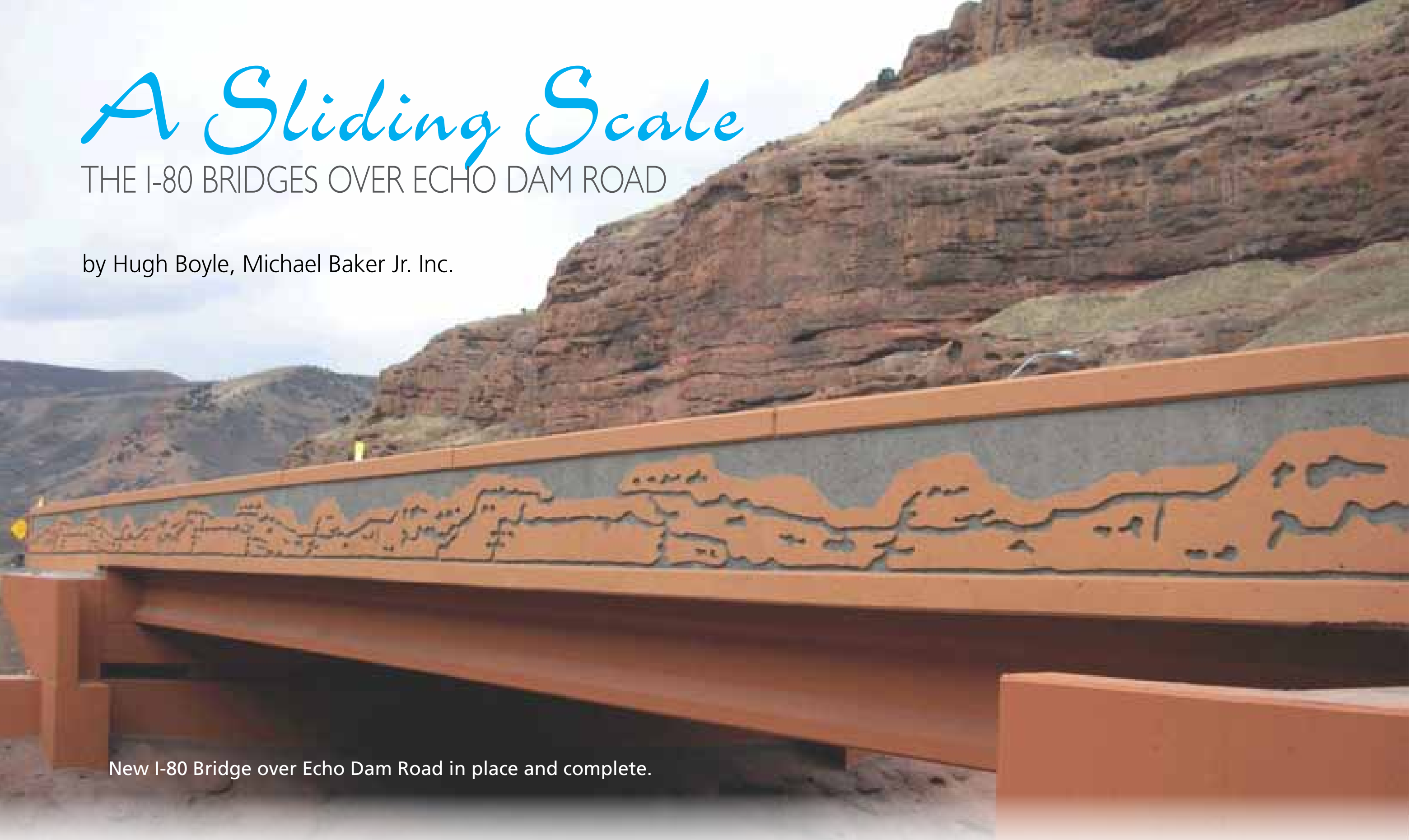
A Sliding Scale

THE I-80 BRIDGES OVER ECHO DAM ROAD

by Hugh Boyle, Michael Baker Jr. Inc.



New I-80 Bridge over Echo Dam Road in place and complete.

Just outside the tiny community of Echo, in Summit County, Utah, thousands of motorists drive by on I-80 every day. In this area, I-80 is a smooth, easy route—a portion of one of the longest interstate highways in the country carrying people and products coast-to-coast for 2900 miles.

Two deteriorating bridges on I-80 in this area threatened to shut down this important corridor as the Utah Department of Transportation (UDOT) needed to replace the structures. The agency estimated that any disruption to I-80 would detour the high volume of interstate truck traffic for 90 miles.

UDOT is recognized as a leader in innovative accelerated bridge construction (ABC). They challenged the consulting and construction industry to find a way to minimize impact to the traveling public as part of the replacement of the I-80 bridges over Echo Dam Road. The agency stipulated that the design-build team must remove existing bridges and approach ramps and construct new bridges within 135 calendar days after the notice to proceed. Additionally, the closure of I-80 at Echo Dam Road was limited to 16 hours. To receive the full incentive, the road needed to be open to traffic in less than 11 hours. The contract also stipulated incentive/disincentive pay for every 15 minutes that I-80 was opened or closed as measured against the allowable time window.

The design-build (D-B) contract was awarded in April 2009. The team then developed the first project in the United States to move a bridge span into place, including the approach slabs, in just a matter of hours using hydraulic rams and slide rails. This resulted in another new first for UDOT and their innovative methods for ABC, and for a cost of approximately 60% of the state's estimate.

Design Basics

The original three-span, I-80 twin bridges over Echo Dam Road were approximately 40 ft wide and 101 ft long including fill slopes under the approach spans that rested on stub abutments. The span lengths were 30.5, 44, and 26.5 ft.

The new twin bridges are each 44 ft 10 in. wide with a single 80-ft-long main span and 25-ft-long approach slabs at either end. The approach slabs are designed to span their full length to allow for bridge settlement at the abutments. After reaching their final location, flowable fill was used beneath the approach slabs. There is a special joint between the deck and approach slabs that allows rotation if the approach slabs settle.

To meet the tight timeline and vertical clearance requirements, the D-B team opted to use economical, single-span

profile

I-80 BRIDGES OVER ECHO DAM ROAD / ECHO, UTAH

BRIDGE DESIGN ENGINEER: Michael Baker Jr. Inc., Midvale, Utah

PRIME CONTRACTOR: Ralph L. Wadsworth Construction Company, Draper, Utah

PRECASTER: EnCon Utah LLC, Tooele, Utah, a PCI-certified producer

CONCRETE SUPPLIER: Geneva Concrete, Park City, Utah

AASHTO Type II precast, prestressed concrete beams for the main span. The beams use 8500 psi compressive strength, normal weight concrete and contain prestressing strand and epoxy-coated reinforcement as required by the UDOT standard specifications. The beams are spaced at 6 ft 8 in. on center. Cast-in-place, lightweight concrete with a unit weight of 113 pcf is used in the 8-in.-thick deck, approach slabs, and 42-in.-tall parapets. The lightweight concrete reduced the sliding weight and temporary shoring cost. It allowed the Type II beams to reach the required 80-ft span, some 10 ft more than typically used.

The bridge foundations incorporate 16-in.-diameter, high-capacity pipe piles driven into the bedrock. These piles are located outside the footprint of the existing structure to allow them to be driven without affecting the existing structure.

The ABCs of the Slide

During design, the project team evaluated several proven ABC techniques.

Self-propelled modular transporters (SPMTs) were investigated. But, at this location, SPMTs would have required extensive soil nail walls and grading to accommodate access. Further, it would have been necessary to shorten the new bridge and move the new abutments closer to the road, or the abutment slopes and approach slopes would have had to be cut out and soil nailed to allow the SPMTs to support the bridge closer to its ends.

Shortening the bridge and moving the new abutments was not a viable option. After the new bridge was moved into place, a large amount of backfill, approach slab construction, and paving would need to be done—too much work to complete in 16 hours.

Instead, the engineers opted to construct the new bridge adjacent to the existing bridge and then use hydraulic rams and slide rails to move the new bridge and approaches into place after demolishing the existing structures. New abutments were built between the existing abutments and the intermediate columns and just below the existing bridge superstructure. While this method required the construction of temporary abutments as an extension of the new abutments, it eliminated the need for extensive backfill after moving the new bridge into place.

The slide rail option would also work well for the approach slabs. The D-B team had considered precast concrete approach slabs, but realized that the time needed to install the slabs, align and grout them would be too long to meet the requirements of the contract. A key advantage of the slide option was the ability to slide the approach slabs with the bridge, thus eliminating the additional time associated with separate panels. This also eliminated additional joints and assured a smoother transition to the bridge.

Sliding Scheme

The slide rail system relies on two hydraulic rams, each mounted on a sliding rail to push the superstructure into final position. Each ram had a working capacity of 200 kips, which turned out to be more than twice the force necessary to move the structure. On this project, the new permanent abutments provided lateral stability to the temporary abutments, by anchoring them to the permanent abutments with cast-in anchor bolts.

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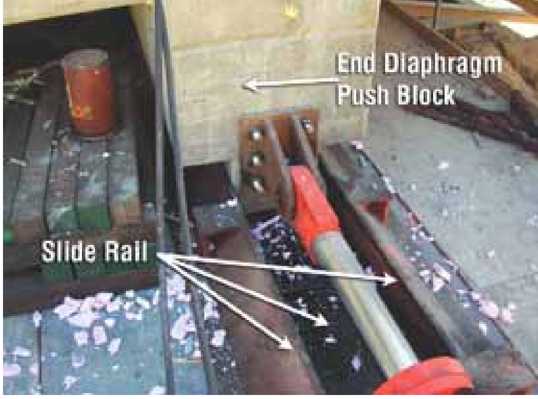

The hydraulic ram used to push the structure was mounted on the end diaphragm push block. Slide shoes rest on transfer plates in the slide rail.

The westbound bridge is in place as crews prepare for partial demolition of the eastbound bridge.

To facilitate sliding the superstructures, two concrete shoes surfaced with stainless steel were cast on the underside of each end diaphragm. In the final condition, the shoes transfer the vertical loads to the abutments. The temporary abutments were designed with a small platform in front of the end diaphragms at every other beam. At these locations, screw jacks were used to raise the superstructure.

With the superstructure raised just slightly, the slide rail, or "ladder beam," was inserted the length of the temporary abutment and connected to the abutments via link plates to the transfer plates. The transfer plates were attached to a base plate embedded and anchored to the concrete with

TWIN, PRECAST, PRESTRESSED CONCRETE BEAM BRIDGES WITH LIGHTWEIGHT CONCRETE DECKS AND APPROACH SLABS, SLID INTO FINAL POSITION ON NEW CONCRETE ABUTMENTS / UTAH DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTION: Twin Interstate bridges, 80 ft long and 44 ft 10 in. wide with Type II precast, prestressed concrete beams, lightweight concrete decks and 25-ft-long lightweight concrete approach slabs that rest on precast concrete sleeper slabs and cast-in-place concrete abutments

BRIDGE CONSTRUCTION COST: $3.1 million

AWARDS: 2011 PCI Design Award, Best Bridge with Main Span between 76 and 150 ft

Beam erection is complete on the temporary abutment.

shear studs. Once the slide rail was in place and connected to the abutment, elastomeric bearing pads with a polytetrafluoroethylene (PTFE) surface were placed evenly spaced along the slide rail and the superstructure was lowered onto the pads. The jack pushed the bridge about 3 ft, then a lock tab on the jack was lifted and the jack pulled itself along the "ladder;" the lock tab was set and the bridge pushed another 3 ft.

Precast concrete sleeper slabs were used at the roadway ends of the approach slabs; two sections per end, with one for each phase of the move. These act as grade beams to support the slabs. Shaped like an inverted "tee," the base is 5 ft wide and the upturned stem is 12 in. thick and varied in depth from 14 to 24 in. to accommodate a sloping roadway. The sleeper slabs used concrete with a specified compressive strength of 4000 psi. A weathering steel tee shape was embedded with about ¼ in. of the flange of the tee protruding above the top of the slab for a sliding surface.

At the ends of the approach slabs, a weathering steel tee shape was embedded in the bottom of the approach slab. The dead load reactions at the ends of the approach slabs were much less than at the end diaphragms. Block outs at each corner of the approach slabs under the parapet, allowed the contractor to jack the approach slab a few inches into the air, grease the steel-to-steel sliding surfaces and install the $^{1}/_{8}$-in.-thick PTFE pads to further reduce friction.

Let it Slide

The westbound bridge was moved into place on September 29, 2010, 4½ months after receiving the notice-to-proceed. On that day, crews closed one lane for the day while a section of the existing structure was demolished and the first section of the precast concrete sleeper slabs was moved into place at both ends of the bridge. During this single-lane closure, the bridge was pushed the first 10 to 12 ft to test the procedures and make necessary adjustments.

At 10:00 p.m. the same day, the entire westbound bridge was closed. Two hours later, the crews had demolished the remainder of the westbound structure. During this time, crews were installing guardrail and the last two pieces of the precast sleeper slabs. Once the precast sleeper slabs were in place, the hydraulic jacks began pushing the bridge into place. Approximately 3 hours later, the bridge was in its final location. When in motion, the bridge traveled at about 2 ft/min. Additional time was required to reset the jacks and align the bridge.

The approach slab compression seals were installed in the joint at the sleeper slab stem, the roadway approaches were paved, and the bridge was open to traffic by 4:47 a.m.—less than 7 hours later and 4 hours faster than required to receive full incentive. Several weeks later, the eastbound bridge was slid into place and opened to traffic 7 hours after full closure.

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Hugh Boyle is senior project manager—bridge services lead with Michael Baker Jr. Inc. in Midvale, Utah.

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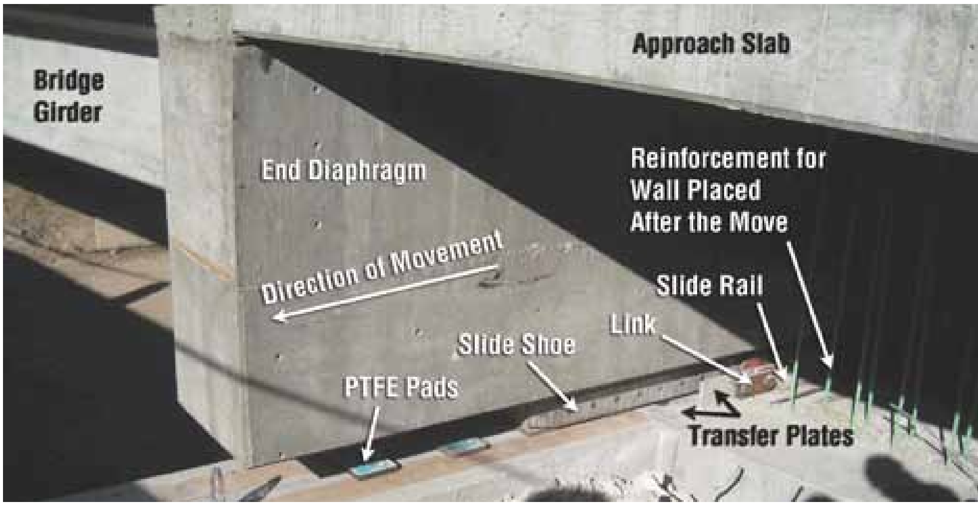

Seen during the move, the slide shoe on the bottom of the abutment wall glides across PTFE pads onto the permanent abutment.

New westbound structure in place and complete. The push block and slide shoes can be seen.

Placing AASHTO Type II beams on the temporary abutments.

I-80 at Echo Dam Road Bridge is constructed of 80-ft-long AASHTO Type II precast, prestressed concrete beams.

A workman monitors the slide operation to make sure the slide shoe moves cleanly onto the PTFE-coated bearing pads.

View of the completed I-80 Bridges over Echo Dam Road.

The aesthetic scheme for the new bridges was in keeping with the surrounding red rock cliffs and desert landscape.