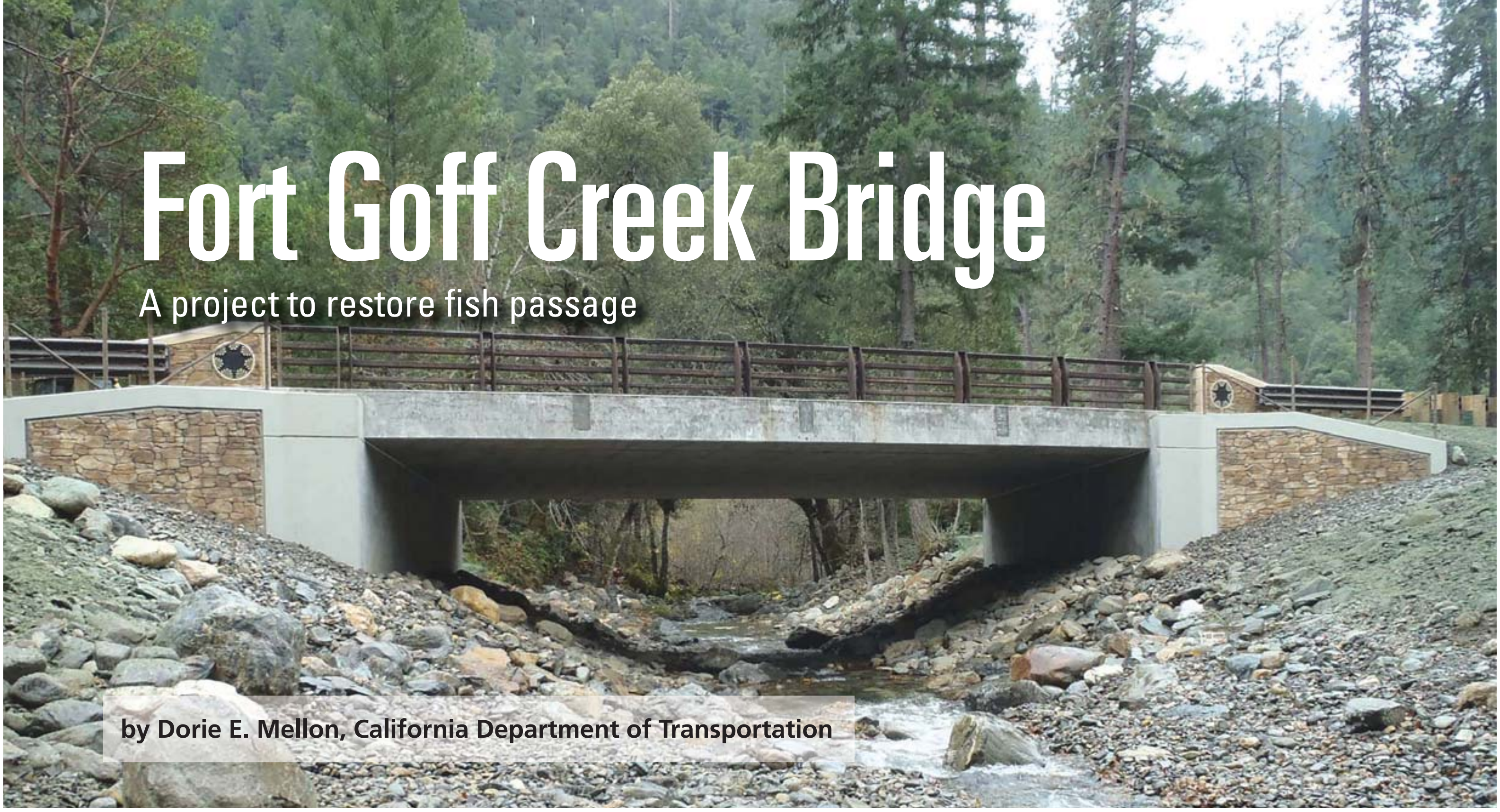
Fort Goff Creek Bridge

A project to restore fish passage



by Dorie E. Mellon, California Department of Transportation

Fort Goff Creek Bridge. All Photos: Caltrans.

During the construction of California's highway system, hundreds of culverts were installed to allow creeks to flow under roads. Many of these culverts acted as barriers to migrating fish, effectively cutting off upstream access. The Fort Goff Creek Bridge was proposed in response to the commitment by the California Department of Transportation (Caltrans) to restore fish passage in California. California Senate Bill 857 (Kehoe, Chapter 589, Statutes of 2006) and Article 3.5 of Chapter 1 of Division 2 of the California Streets and Highways Code require the removal of barriers to fish passage where highways cross anadromous fish-bearing streams. Anadromous fish are migratory fish that breed in fresh water and spend a portion of their lives in the ocean.

The barrier caused by the culvert carrying the water of Fort Goff Creek under State Route 96 was identified by Caltrans as a top-priority fish-passage remediation project. The streambed restoration project replaced the 15-ft-diameter corrugated metal pipe culvert with the Fort Goff Creek Bridge, a 60-ft-long, single-span precast concrete structure. Construction of the bridge allowed for the channel section and the stream bed beneath the highway to be restored to a natural state, providing unimpaired passage for anadromous fish. Removal of the barrier opened miles of habitat for the migration, spawning, and rearing of threatened and endangered species including steelhead trout and Chinook and Coho salmon.

The existing culvert blocked fish passage due to the slope of the culvert and the vertical drop at the inlet and outlet.

Structure Selection

The project, in a remote part of Northern California along the Klamath River in Siskiyou County, presented a number of challenges to conventional cast-in-place concrete construction. The site is located in a severe climate area where freezing and thawing cycles and heavy salting occur frequently, and tire chain use is common. These conditions require special attention to the longevity of the bridge deck and the structure in general. The nearest ready-mixed concrete batch plant is located approximately 90 minutes away, which created a situation where cast-in-place concrete quality could be compromised by traffic delays. Traffic

profile

FORT GOFF CREEK BRIDGE / SISKIYOU COUNTY, CALIFORNIA

BRIDGE DESIGN ENGINEER: California Department of Transportation, Sacramento, Calif.

PRIME CONTRACTOR: Stewart Engineering, Redding, Calif.

PRECASTER: KIE-CON Inc., Antioch, Calif.—a PCI-certified producer

POST-TENSIONING CONTRACTOR: Schwager Davis Inc., San Jose, Calif.

and environmental constraints called for one season construction and minimized impacts to the stream bed and surrounding areas. In addition, this project had multiple funding sources and many stakeholders. Caltrans needed a bridge type that would address the interests of all parties involved.

Multiple structure types were evaluated during the planning phase of the project. A prefabricated bridge element system (PBES) was identified as the preferred construction method for the 36-ft-wide, 60-ft-long, single-span structure. The drivers for accelerated bridge construction (ABC) and use of a PBES included improved quality of concrete elements, reduced environmental impacts, and the single construction season restriction.

Structure Design

The PBES structure design utilized nine adjacent 2-ft 1-in.-deep, 4-ft 1-in.-wide precast, prestressed voided concrete slabs; precast concrete abutments; precast concrete wing walls; and prefabricated steel barrier rail (California ST-70 bridge rail). To further enhance durability, epoxy-coated steel reinforcing bars were used in the voided slabs and for the top layers of reinforcement in the abutment back wall and precast concrete wingwalls. The riding surface was provided by a 1½-in.-thick polyester concrete overlay. Concerns over constructability issues, associated schedule delays, and other challenges of implementing innovative methods were addressed through the use of the *ABC Toolkit*[1] and funding from the Strategic Highway Research Program 2 (SHRP2) Implementation Assistance Funds for Innovative Bridge Designs for Rapid Renewal. The *ABC Toolkit*, a SHRP2 product, "provides a series of design and construction concepts for prefabricated elements and their connections." Architectural treatment was provided on the precast concrete wingwalls and barrier end walls through formliners and on-site concrete staining.

Construction

The construction contract was awarded in the spring of 2014 by the design-bid-build/low-bidder method and detour construction began on May 30, 2014. Single-lane signalized traffic was carried on a detour over a temporary culvert for the duration of the project.

Precast concrete abutments were founded on a single row of 30-in.-diameter, cast-in-drilled-hole (CIDH) piles with permanent casing. Due to difficulties with drilling and drilling equipment, the pile installation was completed in early September. The precast concrete seat-type abutments were erected in segments to keep element weights below 100 kips for ease of transportation and placement. Each abutment consisted of three segments weighing 85 kips each. A 275-ton crane was used by the contractor to place the abutment elements in 2 days. Large voids formed with corrugated metal pipe fit over reinforcement cages extending from the piles. The abutment elements were connected by grouted keyways using 14 ksi grout and post-tensioning with 1⅜-in.-diameter high-strength tie rods

Reinforcement in the skewed section of the girder, rail hardware, prestressing ducts, and voids caused significant congestion at the voided slab girder ends. Future designs will aim to reduce congestion and improve constructability.

Preassembly of abutment elements at the fabricating yard ensured fit up with piles and tie rod ducts in the field.

with a post-tensioning force of 100 kips per tie rod. Abutment voids were filled with 6 ksi grout.

Once the abutment grout had reached a strength of 2.6 ksi, the 65-kip precast concrete voided slabs and 20-kip wing walls were set in a single day. Precast concrete wingwalls were connected to the abutment by closure placements with 4 ksi concrete. The voided slabs were connected to each other by 14 ksi grouted longitudinal keyways (5 ksi was required in 24 hours) and transverse post-tensioning of 1⅜-in.-diameter, high-strength tie rods with a post-tensioning force of 150 kips per tie rod.

A 1½-in.-thick riding surface of polyester concrete was placed on the precast concrete superstructure in mid-October followed by the barrier rail. By embedding anchorages in the precast concrete curb of the exterior girders, the barrier rail was installed in a matter of hours. Work was completed and the traffic was shifted to the permanent structure on November 12, 2014.

Lessons Learned

Best practices from the *ABC Toolkit* incorporated into the Fort Goff Creek Bridge project included

- using a single row of piles under the precast concrete abutment,
- using repeatable elements,
- keeping pick weights under 100 kips,
- pre-assembling substructure elements prior to shipping, and
- incorporating fabrication and erection tolerances in the plans and special provisions.

CALIFORNIA DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTION: A 60-ft-long, single-span, precast concrete voided slab bridge with precast concrete abutments and wingwalls

STRUCTURAL COMPONENTS: Nine precast/prestressed concrete voided slab girders, six precast concrete seat-type abutment segments, four precast concrete wingwalls, and 30-in.-diameter cast-in-drilled-hole piling with rock socket

BRIDGE CONSTRUCTION COST: $1,400,303 ($660/ft²)

AWARDS: 2015 PCI Design Awards Honorable Mention: Bridge with a Main Span Up to 75 Feet

Precast concrete elements at the jobsite ready for quick assembly.

A cement slurry provided an excellent leveling pad for quick and accurate placement of 85-kip abutment segments.

Precast concrete elements are connected by grouted keyways, post-tensioned tie rods, and closure placements.

Other items added for ease of implementation were

- using a cement slurry as a leveling pad for the abutment stems,
- using prefabricated rail,
- including the rail curb in the precast exterior slab elements,
- including a construction sequence on the plans, and
- providing extra overlay thickness to accommodate differential camber and fabrication tolerances.

An unexpected benefit of PBES construction was the mitigation of a 63-day schedule overrun due to foundation construction problems. Pile installation poses a significant schedule risk on any project, especially under conditions of wet and difficult drilling. The schedule delays introduced by the CIDH piling on the Fort Goff Creek Bridge were effectively offset by the rapid assembly of the PBES structure (71 days for foundation construction versus 23 days for bridge construction). The use of precast concrete elements removed the threat of the project extending into a second season, thereby avoiding additional cost, extended traffic delays, and a significant increase in environmental impacts.

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Improved Project Delivery

The Fort Goff Creek Bridge project provided several lessons learned that will allow Caltrans to improve ABC and PBES project delivery going forward. Engineers recognized several opportunities to improve the shop drawing review process, including the development of a review checklist, a longer review time to provide adequate time to review the increased number of shop plans, and concurrent shop plan submittal to identify conflicts between prefabricated components.

Going forward, Caltrans is considering the requirement of building information modelling (BIM) of precast concrete elements and connections to avoid reinforcement congestion and to improve constructability. BIM would be particularly helpful in identifying geometric complications introduced by skews, cross slopes, and horizontal and vertical curves. Lessons learned also include increasing resources for materials inspections and enforcement of quality control/quality assurance practices. ABC projects should be staffed with individuals that embrace innovation and continue outreach efforts to gain support for ABC construction. These should include Caltrans staff, as well as external partners from the construction industry, funding sources, and permitting agencies.

Fast-track Permits for ABC

Caltrans has identified over 500 fish passage barriers that must be addressed to provide unrestricted passage of anadromous fish. Because of the success and subsequent publicity about this fish passage project, our permitting partners (National Marine Fisheries Service and California Fish and Wildlife) would like to pursue a programmatic permitting process for accelerated bridge construction (ABC) structures that has the potential of reducing the permitting process from between 6 to 12 months to 30 days. This streamlining of the permitting process will yield big savings in time and support costs.

ABC and PBES construction successfully delivered a one-season solution for the Fort Goff Creek Bridge project. This type of construction was well received by the contractor and Caltrans construction staff. Project managers in northern California have identified several future projects that would benefit from a similar approach and envision widespread application in fish passage projects statewide. Caltrans continues to pursue ABC and PBES on a larger scale in order to effectively mainstream ABC in California.

References

1. Transportation Research Board (TRB). 2013. *Innovative Bridge Designs for Rapid Renewal ABC Toolkit*, SHRP 2 Report S2-R04-RR-2.

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