PROJECT

DAVEY'S BRIDGE PROJECT

A super simple span

by Samir Sidhom and Greg May, Central Federal Lands Highway Division of the Federal Highway Administration

The Banks-Lowman Highway, also known as Forest Highway 24, is 35 miles north of Boise, Idaho. It is a vital 25-mile-long residential and commercial artery, and a state-designated Scenic Byway. It meanders along the South Fork of the Payette River in the Boise National Forest. Between the towns of Banks and Garden Valley, and south of the town of Crouch, the highway crossed the South Fork on the 54-year-old Davey's Bridge.

Constructed in 1960, the old Davey's Bridge was a 150-ft-long, five-span bridge with two 12-ft-wide lanes and 2-ft-wide shoulders with a 30-ft 6-in.-wide concrete deck supported by cast-in-place concrete girders. Each of the bridge bents was supported on six 13-in.-diameter treated timber piles with unknown lengths. The bridge was considered functionally obsolete and had a sufficiency rating of 46.9.

In July of 2010, the Western Federal Lands Highway Division (WFLHD) Office, in coordination with a consulting firm, completed a study to replace Davey's Bridge.

A single-span bridge was used as the replacement for the original five-span bridge. All Photos: Western Federal Lands.

Replacement Study

The study recommended that the new bridge had to be widened to facilitate the complete reconfiguration of the Banks-Lowman and Middle Folk Road "T" intersection to improve traffic flow and safety. The "T" intersection is located about 100 ft west of the bridge. The reconfigured intersection has both designated right and left hand turn lanes.

The study also concluded that to improve channel hydraulics it was desirable to reduce or eliminate the number of support piers in the river and evaluated several span arrangement options with different superstructure types.

In March of 2011, the WFLHD assigned the design of the bridge project to the Central Federal Lands Highway Division (CFLHD) bridge design team located in Lakewood, Colo.

Single Span, Best Design

After careful review of the study report, the design team decided, early on, that a single-span bridge was the best alternative for the bridge. This eliminated the two-span option presented in the study. A single-span bridge avoided the need for, significant cost of, and environmental degradation inherent in pier construction in the stream bed. A single-span bridge also shortened the construction schedule, and eliminated problems associated with dewatering, cofferdam construction, and equipment access.

profile

DAVEY'S BRIDGE / GARDEN VALLEY, BOISE COUNTY, IDAHO

BRIDGE DESIGN ENGINEER: Central Federal Lands Bridge Office of Bridges and Structures, part of the Federal Highway Administration's Office of Federal Lands Highway, Lakewood, Colo.

PRIME CONTRACTOR: Legacy Contracting Inc., Stayton, Ore.

PRECASTER: Hansen Structural Precast, Caldwell, Idaho—a PCI-certified producer

Upstream view of the bridge.

The single-span option improved seismic resistance, and simplified the seismic design analysis, compared to that required for a multi-span structure. From a sustainability standpoint, a single-span bridge, with no piers, optimizes flow capacity and hydraulic efficiency of the bridge opening. It prevents the need for costly maintenance and repair due to the snagging and retention of flow debris, and the potential for scour at the piers.

Design

The design team had to overcome a number of challenges. These included

- dealing with the location of the bridge, which is in seismic zone 2; the closest active fault contributing to the seismic hazard at the project site is the Squaw Creek Fault located about 18 miles to the west,
- designing the bridge deck with variable fillet (haunch) thickness to accommodate a partial vertical curve on the bridge,
- using staged construction to maintain existing two lane traffic at all times as requested by the county,
- environmental recommendation to eliminate piers in the river,
- ensuring that the unusually long precast concrete girders could actually be delivered to the site,
- completing the two designs of the project in a timely manner, and
- yielding the most economical structure.

The design team looked at three design options. The first option was a 160 ft plus-long precast, prestressed concrete girder that would have to be transported up the narrow canyon of the Banks-Lowman Highway. The second option was a precast, pretensioned and post-tensioned concrete spliced girder that would be shipped in three pieces and spliced together in the field using one stage or two-stage post-tensioning. Finally, a steel plate girder that could be shipped in two or three pieces and field spliced using high strength bolts. The first and third options were selected for competitive bidding.

Technologically, the design of 161-ft-long prestressed girders spaced at 8 ft 10 in. could readily be accomplished. To transport the girders, which were over 7 ft deep, from the casting bed to abutment bearings, was another matter. Any sharp bend in an access highway could, for a very long transporter, nullify the single-girder option. However, input from a concrete girder precaster in the area, a full 50 miles away, indicated that highway geometry would allow the girder's delivery.

Accordingly, the second option was dropped by the design team and a type, size, and location plan for a single-span, 162-ft 4-in.-long and 69-ft 7-in.-wide bridge was developed by the design team for final approval by WFLHD, Forest Services, and the county.

The bridge width of 69 ft 7 in. with an 8½-in-thick concrete deck, comfortably accommodated two, 12–ft-wide through-lanes and one 12-ft-wide right hand turn lane onto Middle Fork Road. In addition, it included an 11-ft 7-in.-wide median, 12-ft 3-in.- and 8-ft 3-in.-wide shoulders, and two 9-in.-wide, crash-tested, guardrail parapets. An 18-ft-long approach slab was also provided at each end of the bridge to alleviate any possible settlement of fill materials at the bridge approaches.

Girder delivery.

BOISE COUNTY, IDAHO, OWNER

BRIDGE DESCRIPTION: A single-span, 162-ft 4-in.-long and 69-ft 7-in.-wide bridge with a deck area that provided 12-ft 3-in.- and 8-ft 3-in.-wide shoulders; three, 12-ft-wide travel lanes; and an 11-ft 7-in.-wide median

STRUCTURAL COMPONENTS: Eight 85-in.-deep Idaho bulb-tee girders, 161 ft 2 in. long, with an 8½-in.-thick cast-in-place concrete deck; two 5.5-ft-deep cast-in-place concrete abutment caps each supported on seven 18-in.-diameter concrete filled pipe piles; and 24-ft long and 14-ft deep wingwalls also supported on concrete filled pipe piles

BRIDGE CONSTRUCTION COST: $1.67 million ($148/ft^2)

Setting girders for stage I (left) and stage II (right).

The girders in the final layout were longer (161 ft 2 in.) than half the length of a football field and stood 7 ft 1 in. tall. These prestressed concrete "bulb-tee" girders were the longest ever designed by any of the Federal Lands Highway (FLH) Bridge Offices. The girders were prestressed with fifty 0.6-in.-diameter, grade 270, seven-wire prestressing strands. Eighteen of those were harped, in 12- and 6-strand bundles, through the 7-in.-thick girder web. The stirrup spacing of 3 and 6 in. extended nearly 11 ft from girder ends to resist shear forces. The required final concrete compressive design strength was 9.0 ksi while the required strength at transfer was 7.6 ksi.

Substructure elements at each abutment included 72-ft 2-in.-long by 5-ft 6-in.-deep concrete caps supported by 14 closed-end, 18-in.-diameter, concrete-filled steel pipe piles at 5 ft 2 in. spacing. The four, 24-ft-long, 14-ft-deep, and 14-in.-thick wingwalls including 6 ft cheek walls were also supported by concrete-filled pipe piles. A mechanically stabilized earth wall was constructed off the northwest wingwall to keep project construction limits within the existing right-of-way.

Traffic Flow

To maintain uninterrupted traffic flow during construction, a two-stage construction strategy was incorporated into the design plans. Stage I retained traffic on the existing bridge while seven pipe piles were driven, the Stage I cap section built, and four girders were set on their bearings. Then, concrete for the 30-ft 8-in.-wide deck, with epoxy-coated reinforcement, was placed. The exposed, transverse reinforcement doweling out from the Stage I deck placement came within a few inches of the existing bridge.

Traffic was then diverted to the completed Stage I deck and the original bridge was demolished and removed. The remaining seven pipe piles were driven, the cap concrete placed, the four girders set, and the 38-ft 11-in.-wide Stage II deck completed including a 4-ft 6-in.-wide closure placement linking the Stage I and II deck sections with their overlapping transverse deck reinforcement. Mechanical couplers were used to connect the transverse reinforcement between the two pile cap sections because the close proximity of the two stages did not allow for lap splices.

The bridge was completed and partially opened to traffic in December 2013 pending minor works to be completed by the summer of 2014.

Summary

The use of precast, prestressed concrete girders contributed to building a structure that is simple, aesthetically pleasing, and blends nicely into the natural environment of the rural Idaho countryside. Prestressed concrete girders also provided the lowest overall cost, considering production and lifetime maintenance and reduced life-cycle costs.

Because of the extensive coordination between the CFLHD and WFLHD Bridge Offices, an optimal bridge solution was implemented. It satisfied the hydraulic requirements with a single span. It accommodated the need, created by the nearby "T" intersection, for an unusually wide bridge deck. It allowed for uninterrupted traffic flow with an efficient and innovative staged construction strategy.

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With no doubt, the new Davey's Bridge is one of the signature bridges of the FLH Bridge Office and a tacit tribute to the capabilities and efficiencies of modern bridge engineering.

Samir Sidhom is the project team leader and functional team lead and Greg May is a member of the design team and a structural engineer with the Central Federal Lands Bridge Office of Bridges and Structures, which is part of the Federal Highway Administration's Office of Federal Lands Highway, based in Lakewood, Colo.

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