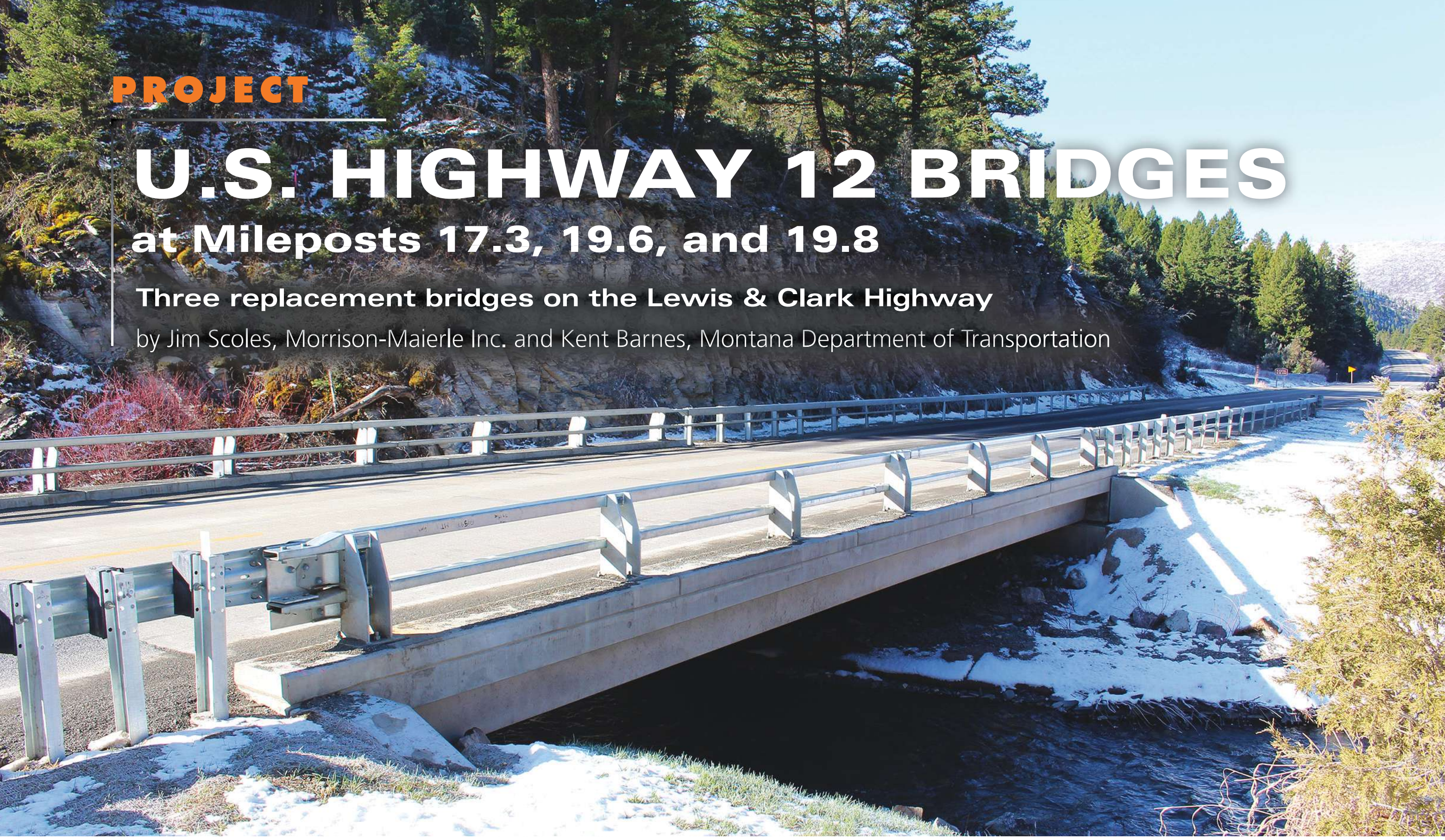


PROJECT

U.S. HIGHWAY 12 BRIDGES
at Mileposts 17.3, 19.6, and 19.8

Three replacement bridges on the Lewis & Clark Highway

by Jim Scoles, Morrison-Maierle Inc. and Kent Barnes, Montana Department of Transportation

U.S. Highway 12 runs along the narrow floor of Deep Creek Canyon in Montana. Three bridges were replaced due to significant scour and severe erosion of the highway embankment. Photo: Sheila Habeck.

In July 1805, the Lewis and Clark expedition passed by the confluence of Deep Creek and the Missouri River in what is now Broadwater County, Mont. Less than two river miles upstream, William Clark mapped the area as "Yorks 8 Islands," and Meriwether Lewis noted the beavers' role in creating the islands. The mouth of the steep, rocky canyon through the Big Belt Mountains lies 12 miles due east as the raven flies.

The Lewis & Clark Highway—also known as U.S. Highway 12—runs along the narrow floor of Deep Creek Canyon. The 24-ft-wide, two-lane highway between Townsend and White Sulphur Springs was constructed in the 1930s with timber bridges at eight locations where the creek and the highway intersect. High flows during spring runoff in 2011 resulted in significant scour of the bridges and severe erosion of the highway embankment. The flooding required emergency response to prevent structural loss and ultimately triggered a project to replace the bridges in this rural area of southwestern Montana.

In the first phase of the project, the Montana Department of Transportation (MDT) replaced three timber bridges with new 54-ft-long, single-span, precast concrete structures using accelerated bridge construction (ABC) techniques. Initially, even with ABC, complete road closures were not considered an option because of the required two-hour, 120-mile detour around the Big Belt and Bridger mountain ranges.

Limited space through the Deep Creek Canyon required staging materials and equipment on the roadway during the weekend closures. Photo: Andy Cullison.

profile

U.S. HIGHWAY 12 BRIDGES AT MILEPOSTS 17.3, 19.6, AND 19.8 / BROADWATER COUNTY, MONTANA

BRIDGE DESIGN ENGINEER: Morrison-Maierle Inc., Helena, Mont.

PRIME CONTRACTOR: Dick Anderson Construction, Helena, Mont.

PRECASTER: Oldcastle Precast, Spokane, Wash.—a PCI-certified producer

GEOTECHNICAL CONSULTANT: SK Geotechnical, Billings, Mont.

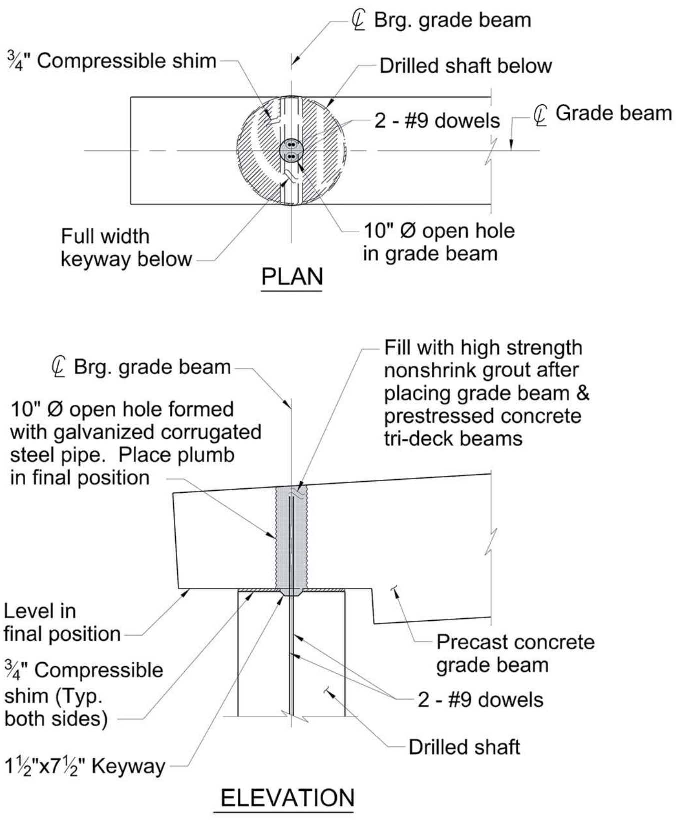
Following preliminary layout of temporary detours, and further consideration of all project elements, ABC construction began to emerge as the favorite for the design team. Several reasons were identified for this shift:

- Poor sight distance at two of the sites raised safety concerns for construction workers and the traveling public.
- One site had only enough room for a single-lane detour.
- Geometric constraints in the canyon provided little room to stage equipment.
- The construction of detour bridges increased the project duration 4 to 5 weeks per bridge.
- Riparian habitat would have to be cleared and even filled in some places to provide the temporary detours.
- Conventional construction with detour was estimated to cost $610,000 per bridge, nearly twice as much as the ABC at $370,000 per bridge, without consideration of user costs.

Minimizing construction time required each bridge to be designed as a complete, modular concrete system. Precast concrete bridge superstructure elements consisting of three stem units with integral deck (known locally as tri-deck) were chosen to achieve project objectives. The five tri-deck prestressed beam lines were longitudinally jointed to create the superstructure and riding surface. The new bridges are simple spans of 54 ft and match the roadway approaches with two 12-ft-wide lanes and 2-ft-wide shoulders.

Two of the bridges are located on tangent roadway alignments. One of these bridges has a normal crown cross section, while the other maintains a 2% transverse slope because of its proximity to a superelevation transition. The third bridge is located on a 1280-ft-radius horizontal curve with a constant 6%

Construction workers set the first precast concrete tri-deck. A vertical rock face on the left and the pristine habitat on the right would have been the only available area for a detour bridge if accelerated bridge construction methods were not used. Photo: Andy Cullison.



This pin connection allows live load rotation about the longitudinal axis of the structure and provides resistance to rotation about the transverse axis. Figure: Morrison-Maierle.

MONTANA DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTION: Three single-span, 54-ft-long, 31-ft 8-in.-wide, modular bridges with prestressed concrete superstructure

STRUCTURAL COMPONENTS: Five prestressed concrete tri-deck beams per bridge; precast concrete grade beams, wingwalls, and backwalls; and 36-in.-diameter drilled shafts

BRIDGE CONSTRUCTION COST: $203/ft^2

AWARDS: 2015 Project of the Year by the Rocky Mountain Chapter of the American Public Works Association, and 2015 Engineering Excellence Award, Structural Systems Category, by the American Council of Engineering Companies of Montana

Due to critical road closure time limitations, all bridge components were assembled at the precasting plant to check for fit prior to shipment. Photo: Andy Cullison.

Crews work through the night preparing for bridge end backfill placement and compaction. Photo: Andy Cullison.

transverse slope. An extra 4 in. was added to the width to provide the minimum shoulder width along the full length of the bridge while maintaining a tangent bridge alignment to facilitate ABC construction. The extra width was also added to the other structures to simplify design and fabrication.

Drilled shafts were selected for the foundation over piles or spread footings because of the sloping bedrock at each bridge site. The 3-ft-diameter drilled shafts were socketed into the bedrock on each side of the road just beyond the existing shoulder. Placing the drilled shafts just off the shoulders allowed the construction to occur under single-lane traffic during the day several weeks in advance. When the road was closed, the contractor quickly excavated to the buried drilled shafts, cleaned the surfaces, connected the steel reinforcing using embedded mechanical couplers, and placed shims before setting the transverse spanning, precast concrete drilled shaft cap beams, referred to as grade beams.

A design challenge was to create a drilled shaft-to-grade beam connection that added no construction time. The timeframe for bridge construction was not long enough to accommodate separate grout cure times for the grade beam connection and the superstructure keyway connection. Additionally, the connection had to handle the deflection and rotation of the grade beam cap under dead and live loads as the span between the drilled shafts was long.

A typical fixed-condition moment connection was considered with grouted bars extending into the cap. However, the dead load and live load from the beams on the transverse cap created a large moment that could not be taken through the drilled shafts without significantly increasing their size over what was needed for axial loads. Moreover, void sizes and time required for grouting the connection was determined to make a full moment connection impractical. Other options considered were pot or disc-type bearings, which were not preferred because the connection was buried.

The challenges of this connection were addressed by using a pin connection with a keyway at the top of the drilled shaft. This design allowed the tri-deck prestressed concrete beams to be set immediately after the grade beams were placed on the drilled shafts, and allows grouting after the system is fully assembled. The keyway allows live load rotation about the longitudinal axis of the structure and provides resistance to rotation about the transverse axis.

The precast, conventionally reinforced 3-ft-wide concrete grade beams step from a 4 ft depth between the drilled shafts to a 2 ft 8 in. depth above the drilled shafts. The step in the grade beam allowed the connection to be above the anticipated ground water level, eliminating the need to dewater for grout placement.

The grade beams contain a 10-in.-diameter through void at each of the drilled shaft locations. Four No. 9 steel reinforcing bars extend from the top of each of the drilled shafts into the void. The connection was designed to be grouted after the tri-deck beams were placed. This approach saved time by allowing the superstructure longitudinal keyway and grade beam connection grouting to be completed concurrently.

Once the tri-deck beams were in position, the connections between the concrete grade beams and drilled shafts were grouted with quick-setting, low exothermic epoxy grout as the tri-deck beams were leveled, welded, and painted to protect the steel ties at 5 ft on center and the continuous keyways between the beam flanges were grouted.

The top flange of the tri-deck beams was designed to be the wearing surface of the bridge deck. To avoid the need for asphalt overlay, the top flange thickness varied from 8.25 in. at midspan to 10 in. at the abutments to account for camber in the beams.

In order to help ensure the contractor's success, the project contract required assembly of all precast concrete components for each bridge at the precasting plant, after which they were checked for fit-up prior to shipment. During the dry-fit, the precast concrete grade beams were placed on temporary concrete footings to match the grades and cross slopes of their final positions. The exercise eliminated fit-up issues and greatly reduced the contractor's risk of exceeding the contract time requirements.

The contract schedule for the weekend closures of the Lewis & Clark Highway began at 6 p.m. on Friday for each bridge, and the road reopened at 7 a.m. the following Monday. A $38,000/day incentive/disincentive clause was included in the contract based on each hour. The ABC methods used required a detailed, step-by-step schedule for every hour of the allowable 61-hour period.

This carefully choreographed sequence of events was perfected as the project progressed. Each of the three bridges opened ahead of schedule, and actual closure times shortened as the contractor became more familiar with the process. The first structure was completed and the road opened to traffic at 3 a.m. on Monday, the second at 3 p.m. on Sunday; and the third at 1 p.m. on Sunday.

Jim Scoles is chief bridge engineer for Morrison-Maierle Inc. in Helena, Mont. Kent Barnes is Bridge Bureau chief for the Montana Department of Transportation in Helena.

For additional photographs or information on this or other projects, visit www.aspirebridge.org and open Current Issue.

Sustainability

Project activities are anticipated to enhance habitat characteristics, channel morphology, and general stream conditions through the installation of longer single-span bridges. Design elements were included to re-establish stream channel function through the crossings by providing access to overbank floodplain within the crossing and incorporating stream bank stabilization and re-vegetation.

Eliminating the need for temporary detours and the associated temporary fills resulted in significantly reduced impacts to the riparian environment and fisheries in the vicinity of each bridge. The impacted areas could have been rehabilitated, but it would have been years before pre-project conditions were again realized.

Project construction took place in the summer during low-flow conditions and a short window of time, that is, three consecutive 61-hour work periods. The contractor chose appropriate methods to isolate the areas where in-stream construction was required. These methods ensured that flowing water did not contact construction areas, and increased levels of sedimentation and turbidity were kept to a minimum.

Design elements were included to re-establish stream channel function through the crossings by providing access to overbank floodplain within the crossing and incorporating stream bank stabilization and re-vegetation. After a long Montana winter, these design decisions are already helping re-establish the native plants along the stream banks. Photo: Sheila Habeck.

EDITOR'S NOTE

This article was drawn from a presentation at the 2014 Accelerated Bridge Construction Conference. The Accelerated Bridge Construction-University Transportation Center has given permission to publish it in this periodical.