Maroon Creek Bridge Replacement

by Thomas W. Stelmack, Parsons

A rendering of the completed project was prepared for approval by the CDOT and local agencies.

The residents and visitors at the world-class ski resort of Aspen, Colorado, have waited years for the 'Entrance to Aspen' project to be completed. This consists of the reconstruction of State Highway 82 as the primary access road and one of only two routes into the town from the west. The highway crosses the wide and deep Maroon Creek basin at the town limits on the oldest bridge in service on the Colorado state highway system. Due to its historical significance, the existing bridge is listed on the National Register of Historic Places.

Originally constructed as a railroad trestle bridge in 1888, the Colorado Midland Railroad Bridge became the property of what was then called the Colorado Department of Highways in 1927. The Maroon Creek Bridge was converted for highway use in 1929 and widened in 1963 to its current width of 30 ft by adding outrigger struts to the original A-frame trestles. Since then, the timber bridge deck with asphalt has been replaced once and repaired several times. To this day, the structure continues to require high maintenance

profile

MAROON CREEK BRIDGE REPLACEMENT / STATE HIGHWAY 82, ASPEN, COLORADO

ENGINEER: Parsons Transportation Group, Denver, Colo.

PRIME CONTRACTOR: BTE Concrete/Atkinson Construction JV, Glenwood Springs, Colo.

CONTRACTOR'S ENGINEER: McNary Bergeron & Associates, Denver, Colo.

CONSTRUCTION INSPECTION: Carter Burgess, Denver, Colo.

CONCRETE SUPPLIER: Lafarge North America, Carbondale, Colo.

A view of the nearly completed first cantilever shows the wide deck overhangs, deck ribs, and the adjacent existing historic bridge.

by the Colorado Department of Transportation (CDOT), which lowered the sufficiency rating to 24 because of substructure repairs to arrest scour and damaged pier foundations. This forced heavy trucks to be detoured around the bridge via the secondary route while repairs were made.

In 1990, the CDOT recognized the need to replace the existing bridge and completed the design of twin, three-span steel box girder bridges. The twin-bridge concept, however, was never built due to public concerns regarding the number of lanes, alignment, and impact the construction and resulting traffic would have on the environment.

Critical Issues and Project Goals

After extensive study, several requirements were identified and considered in the design of the replacement bridge. The primary issues were environmental impact, aesthetics, and impact on the traveling public using SH 82. These were added to CDOT's original project goals of cost,

CAST-IN-PLACE, CONCRETE, SEGMENTAL BOX GIRDER BRIDGE CROSSING MAROON CREEK / COLORADO DEPARTMENT OF TRANSPORTATION, REGION 3, OWNER

POST-TENSIONING SUPPLIER: VSL, Hanover, Md.

FORM TRAVELER SUPPLIER: Mexpressa, Xochimilco, D.F., Mexico

BRIDGE DESCRIPTION: Three-span, cast-in-place, balanced cantilever segmental box girder with a main span of 270 ft, end spans of 170 ft, and a width of 73 ft

BRIDGE CONSTRUCTION COST: $13.97 million

‘It’s also going to be a very durable and long-lasting bridge.’

maintenance, and durability in the evaluation of the alternative structures.

During preliminary design, several bridge types were identified that could achieve the aesthetic goals of the project, have estimated construction costs within an acceptable range, and meet the maintenance and durability requirements. Therefore, constructibility became the differentiating factor in selection of the bridge type.

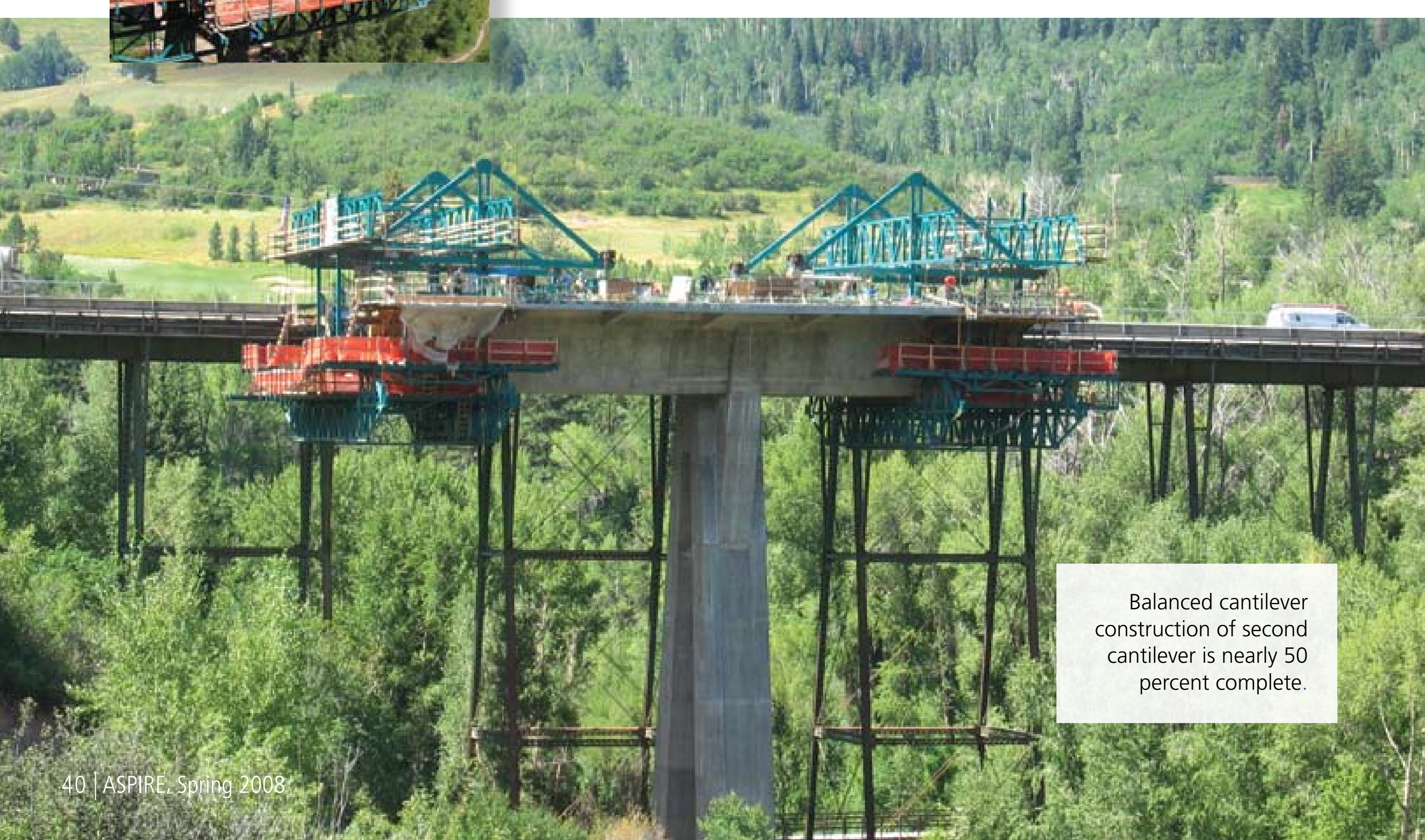
Recommended Alternative—Cast-in-Place Segmental Concrete

After careful evaluation of several alternative bridge types and construction methods, a cast-in-place (CIP), segmental concrete box girder bridge to be built using a pair of form travelers and the balanced cantilever method of construction was selected.

Superstructure—The final span configuration is a 270-ft-long main span flanked by equal 170-ft-long side spans. The single cell box girder is 73 ft wide and is a constant 13 ft 6 in. deep, with 19-ft-long long deck overhangs, using ribbed elements for support of the long slab spans. The typical segments are 15 ft long, with one deck rib in each segment placed 5 ft from the leading edge of the segment. The segment layout consists of a 25-ft-long pier table with eight segments in the main span cantilever and 10 segments in the side span, the last connecting directly to the abutment segment. The two cantilevers are connected with a 5-ft-long closure segment at the center of the main span.

Piers and Foundation—The piers form an ‘A’ shape with a capital section at the top of the pier that is flared at the same angle as the outriggers on the existing bridge. The flared section provides the required connection to the wide box girder section, while reflecting the shape of the existing trestles. As the lines of the capital flow into the pier legs, the outside face of the pier

Form travelers were used to construct the superstructure segments from above to minimize impacts to the environmentally sensitive creek basin and wetlands below the bridge.



Balanced cantilever construction of second cantilever is nearly 50 percent complete.

An 'Environmentally Friendly' Bridge

The new Maroon Creek Bridge has been a successful project for many reasons, but none more important than its utilization of a 'from the top' construction method. The wetlands in the Maroon Creek basin have been subjected to serious environmental impacts since the area was first settled in the 1800s. Recently completed wetlands restoration projects include eradicating non-native plants, re-grading, re-planting, and improving drainage to create a thriving riparian complex. Therefore, one of the major goals of the project was to design an economical bridge that could be constructed with minimal impact to the basin. The Entrance to Aspen documents required that the new bridge be constructed with a maximum temporary disturbance to wetlands of 0.2 acres, and maximum permanent displacement for piers of 0.1 acres.

The balanced cantilever, cast-in-place concrete, segmental bridge construction technique using overhead form travelers minimized the need for heavy cranes and allowed the majority of the superstructure construction work to be done from above.

Detailed constructibility studies of all viable alternatives were done to determine the size and location of the cranes and other equipment for both substructure and superstructure construction, laydown areas for materials and girders, and access roads to both pier locations. While all the alternatives could be carried out within the allowable impact limits, the segmental alternative impacted less than half the area impacted by the girder alternatives. Also, the area impacted for the segmental structure is constrained to the area below the bridge and around the piers—the area previously disturbed during construction of a pedestrian bridge that was removed as part of this project. Based primarily on the results of this study, the segmental scheme was deemed to be preferable by all of the stakeholders, including CDOT, Pitkin County, the City of Aspen, and the public. The final plans included detailed limits for the disturbance areas and also included details for a temporary construction crossing of Maroon Creek, with a narrow footprint in order to minimize in-stream construction activities.

Another challenge to the project design team was to provide extensive water-quality protection and a protected staging area, while still allowing for movement of wildlife in the basin. A wildlife movement study was conducted with a three-fold purpose to:

- Evaluate current large mammal movement through the proposed project area;
- Predict how the staging and construction of the bridge replacement could impact those movements; and
- Make recommendations on how to mitigate those impacts.

The results of this study, which were included in the project plans and implemented during construction, included requirements for special fencing, monitoring during and after construction, and limitations on night work to minimize disruptions during nocturnal wildlife movements. A special wetland-restoration seed mix was also developed to restore disturbed areas.

Additional environmentally sensitive features of the bridge include low-energy LED lighting of the pedestrian path and the accommodation of an 8-in.-diameter pipe inside the box girder to carry reclaimed water from a new city development for irrigation of the adjacent Aspen City golf course.

The project has already been the recipient of CDOT's own Environmental Award in 2007 and Pete Mertes, CDOT Resident Engineer, states, "it was an excellent choice of structure type to minimize the environmental footprint, as well as virtually avoiding the impacts to traffic and the traveling public."

leg is recessed. This recess, together with a change in concrete color within the recess, combines to reduce the visual mass of the very tall pier. The conventionally reinforced concrete pier legs are tapered in the direction transverse to the roadway centerline from 10 ft at the base to 6 ft at the top and have a constant 10 ft thickness in the longitudinal direction. The pier is founded on a footing supported by twelve 4-ft-diameter drilled shafts socketed into rock approximately 20 ft below the footing.

Construction Details

Construction began on the piers in late fall 2005 and continued throughout the winter. Once the pier was completed, the 25-ft-long pier table section was cast on falsework supported directly from the top section of the pier. The first form traveler was then erected on top of the pier table and the first typical segment cast in early fall 2006. The segments were cast alternately on either end of the cantilever until reaching the eighth segment in the main span and ninth on the side span. Although the site is located at an elevation of 7900 ft, the contractor controlled temperature in the segments throughout the winter by insulating the forms and running heated glycol through pipes on the exterior surface of the forms. Concrete for the segments was pumped from the creek basin with a pumper truck located near the pier. The entire superstructure was constructed from the top, with impacts to the creek basin limited to the areas designated during design with one exception. The path connecting the two work pier areas was relocated from the centerline of the structure to just outside the edge of the bridge. This was done to allow better crane access for lifting segment materials, while keeping the overall area of impact the same.

The second cantilever was completed in late 2007 and the main span closure connecting the cantilevers was cast in December 2007. Bottom slab tendons were then stressed to complete the main span. The final closure to the second abutment was made in January 2008, which completed the segment casting a little over a year after the first segment was cast. Joe Elsen, CDOT Region 3 East Program Engineer expressed his satisfaction with the project, "The bridge is an extremely elegant structure and the aesthetics are very pleasing. It's also going

Only the final closure segment to the abutment remains as the form travelers are lowered to the ground near the pier.

to be a very durable and long-lasting bridge due to the prestressing and high strength concrete." Local agencies and the public have also been receptive to the new structure and are looking forward to the day later in 2008 when the bridge will be opened to traffic completing the first phase of the 'Entrance to Aspen.'

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AESTHETICS **COMMENTARY**

by Frederick Gottemoeller

The new Maroon Creek Bridge and the former railroad trestle that it replaces present a fascinating contrast in bridge design philosophies. Happily, both will remain in place to remind engineers that there is always more than one way to bridge a gap. The original railroad bridge crosses the valley with 19 spans supported by multiple thin steel piers. It achieves transparency because the members are so thin that you can see right through them. The new bridge crosses the valley with three spans on two massive piers. It achieves transparency because you can see between them. Even non-engineers will find the differences between these bridges interesting and worth thinking about.

When the railroad bridge was converted to automobile use in 1929, diagonal struts were added at each pier line and gave the cross section a pinched-waist silhouette. The new bridge takes this silhouette as a point of departure for the design of the new piers. This very effectively provides a visual tie between the bridges in spite of the fact that they are otherwise quite different. The long deck overhangs are another successful feature of the new bridge. Their shadows on the girder webs reduce the apparent depth of the girder. At the same time, the deep setback of the girder webs from the edges of the deck reduces the shadow of the bridge on the ground. The piers themselves appear heavy, particularly when seen together with the thin steel members of the original bridge. They would have been improved with thinner proportions, especially at the "knuckle" just below the girder. However, overall this is a fine bridge. The crossing of the creek by State Highway 82 will continue to be a memorable feature of the Maroon Creek valley.

Construction of the second cantilever continues over the Maroon Creek Basin as work begins on the closure segment between the end of the first cantilever and the abutment.

Overhead construction using form travelers continues on the second cantilever.

After casting segments throughout the winter, the first cantilever is almost complete and grows closer to the abutment.