PROJECT

PUEBLO'S NEW 4TH STREET BRIDGE

Bridge aesthetics selected by the Pueblo community complement the bridge theme, which blends contemporary sculpture, natural environment, and Pueblo heritage. Rendering: © FIGG.

by Karen Rowe, Colorado Department of Transportation, and John Dvorak and Steve Fultz, FIGG

A record-setting concrete segmental bridge for Colorado focused on efficient construction and community involvement

The Colorado Department of Transportation's (CDOT) new 4th Street Bridge in Pueblo, Colo., features twin concrete segmental bridges built utilizing balanced cantilever construction over 28 active rail tracks and the Arkansas River. Bridge construction began in December 2007 and is scheduled to be completed in early 2011.

The existing seven-span 4th Street Bridge opened in 1958 and carries two lanes of traffic in each direction, linking historic downtown with the western residential neighborhoods of Pueblo. The existing bridge consists of a non-composite reinforced concrete deck on steel plate girders, which are supported on concrete multicolumn pier bents. Options to replace and repair the existing bridge were evaluated prior to design, but the condition of the aging substructure drove the decision to replace the existing bridge.

After evaluating several structure types, a concrete segmental solution with long, open spans and a minimal footprint proved to be the best option. Tight yard constraints and closely spaced railroad tracks eliminated conventional structure types, which required expensive track closures and potential track realignments to meet current railroad clearance requirements. According to Dean Sandoval, CDOT project manager for the 4th Street Bridge replacement, "Balanced cantilever construction provided the least impact to the railroads and was the most cost effective."

Using the existing track layout, a 378-ft-long main span over 23 Union Pacific Railroad (UPRR) tracks was developed, which is a record for the longest highway bridge span in the state of Colorado. Once the main-span lengths for the twin bridges were established, the side-spans were proportioned to

profile

4TH STREET BRIDGE / PUEBLO, COLORADO

BRIDGE DESIGN ENGINEER: FIGG, Denver, Colo.
PRIME CONTRACTOR: Flatiron Constructors Inc.—Intermountain Division, Longmont, Colo.
POST-TENSIONING CONTRACTOR: VSL, Grand Prairie, Tex.
CONCRETE SUPPLIER: Transit Mix Inc., Pueblo, Colo.
PIER TABLE AND TRAVELER FORMWORK: DOKA, Los Angeles, Calif.
PIER FORMWORK: EFCO, Phoenix, Ariz.
STEEL REINFORCEMENT: Banner Rebar, Denver, Colo.
POT BEARINGS: DS Brown, North Baltimore, Ohio
MODULAR EXPANSION JOINTS: Watson Bowman Acme, Amherst, N.Y.
POST-TENSIONING GROUT: Sika, Lyndhurst, N.J.

balance the superstructure loads and maintain adequate clearance above the Burlington Northern Santa Fe Railway Company (BNSF) tracks to the east and the Arkansas River to the west. End spans were designed to be cast-in-place concrete on falsework, since ground access is readily available in these locations.

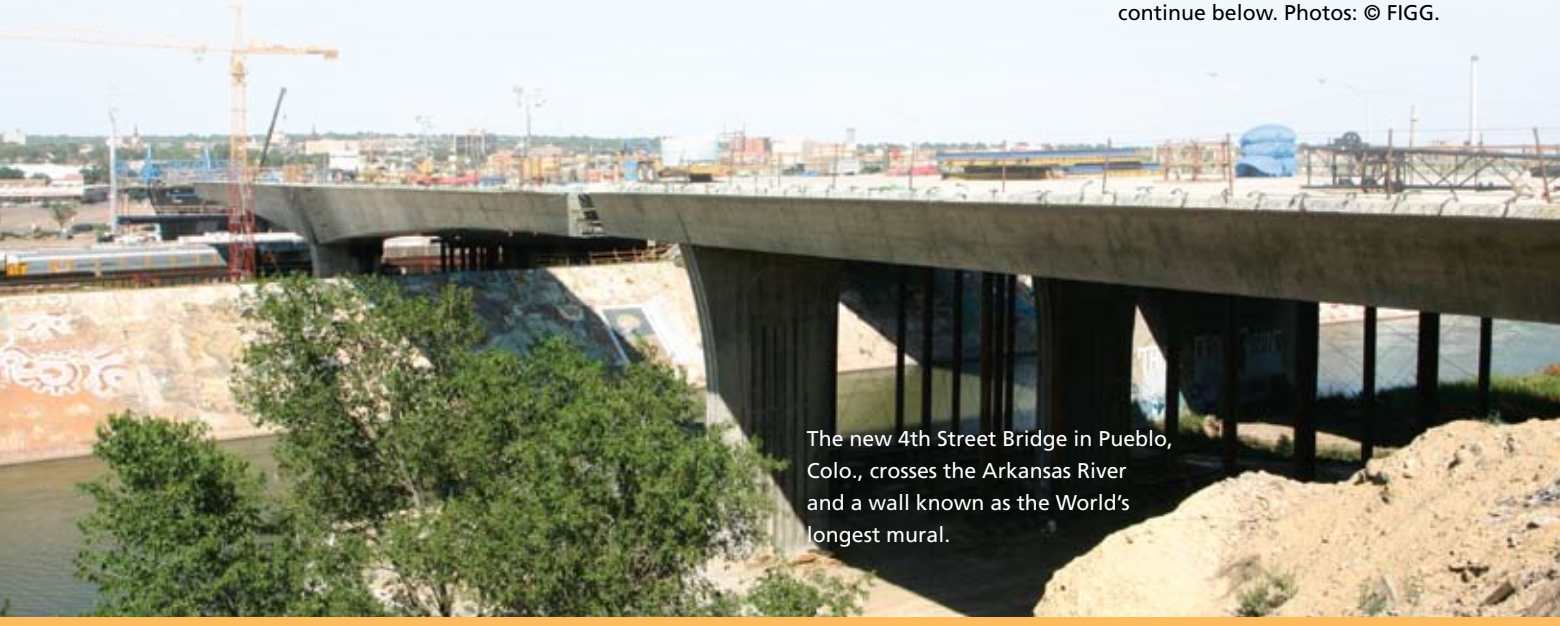
The New Bridge

The new bridge consists of two 1137-ft-long, five-span, single cell, parallel structures for eastbound and westbound traffic with a 6-ft-wide gap between bridges for future access and inspection. The 53-ft-wide variable-depth box girder accommodates two lanes of traffic with 6-ft-wide inside shoulders, 10-ft-wide outside shoulders, and a 10-ft-wide multiuse path for pedestrians and cyclists, with the option for future expansion to three traffic lanes.

The new bridges are parallel to the existing bridge and outside the current alignment, with the exception of the easternmost span of the new eastbound bridge. To keep traffic moving, the westbound bridge is being completed first and all four lanes of traffic will be transferred on to this structure temporarily. Following demolition of the eastern spans of the existing bridge, the new eastbound structure will be completed and traffic reconfigured to the final two lanes per structure.

The cantilevers are 18 ft deep at the main-span piers and decrease to the typical section depth of 8 ft at the end spans, as well as at the center of the main-span. Traveling forms are used to construct the cantilevers in the balanced cantilever construction method from above, allowing for continuous railroad operations. Two cantilevers for each

Form traveler removal begins by back launching to the pier, while railroad operations in the Pueblo Rail Yard continue below. Photos: © FIGG.



The new 4th Street Bridge in Pueblo, Colo., crosses the Arkansas River and a wall known as the World's longest mural.

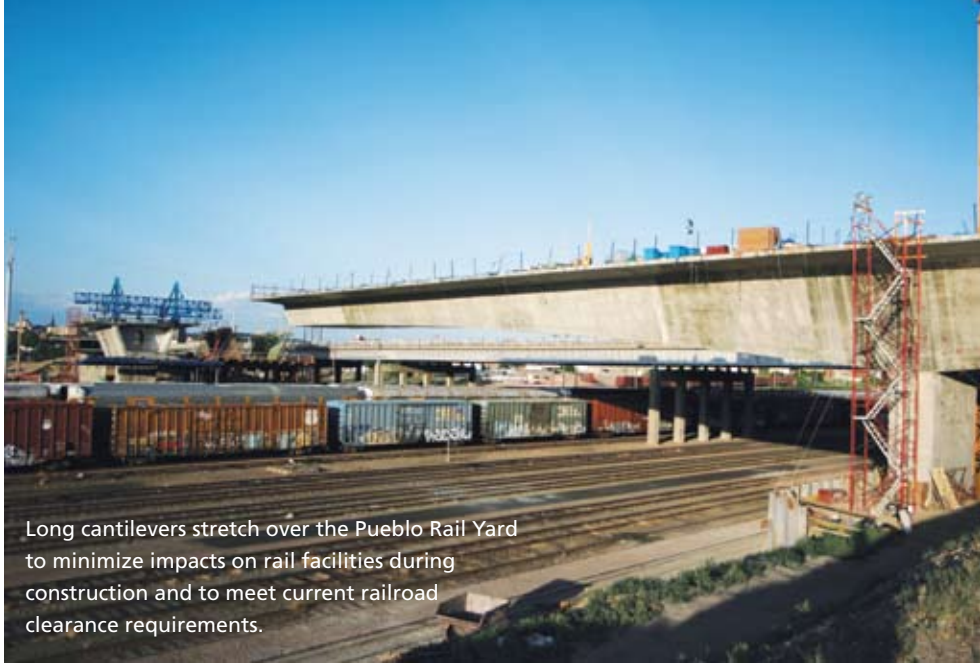
CAST-IN-PLACE, POST-TENSIONED, SEGMENTAL BOX GIRDER BRIDGES / COLORADO DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTION: Twin, 1137-ft-long, concrete segmental box girder bridges built from above in balanced cantilever, with 378-ft-long main spans over the Arkansas River and 23 Union Pacific and 5 Burlington Northern Santa Fe railroad tracks.

STRUCTURAL COMPONENTS: Cast-in-place drilled shafts, footings, columns, and superstructure segments

BRIDGE CONSTRUCTION COST: $20.3 million

Building from above using concrete segmental balanced cantilever construction accommodates unique site constraints and allows rail traffic to keep moving.



Long cantilevers stretch over the Pueblo Rail Yard to minimize impacts on rail facilities during construction and to meet current railroad clearance requirements.

structure result in two side spans of approximately 230 ft and a main span of 378 ft. The 150-ft-long end spans cantilever approximately 30 ft into the side spans and connect to the main-span cantilevers with 8-ft-long closure joints.

With the extensive level of deterioration of the existing bridge's substructure, CDOT was interested in long-term durability. Several levels of protection are provided, including a 3-in.-thick sacrificial asphalt wearing surface with an elastomeric waterproofing membrane, epoxy-coated superstructure reinforcement, and integral piers. Expansion joints are located only at the abutments. With these levels of protection, along with bidirectional compression of the superstructure deck from the application of post-tensioning, the concrete segmental solution provides a low maintenance, durable, and sustainable structure.

Unique Site Conditions

The Pueblo Railroad Yard is jointly operated by the UPRR and the BNSF and is a major switching yard and hub for western railroad operations. Coal and freight moving along the front range of the Rocky Mountains is stacked and redirected from this point. One BNSF and two UPRR mainlines are among the 28 continuously operating tracks at the crossing. Because of the constant activity, neither closure nor track removal was feasible during construction or as a long-term solution.

The existing bridge does not meet current railroad clearance envelopes, with piers as close as 8 ft 3 in. to adjacent tracks. The new bridge accommodates current railroad design requirements, including temporary and permanent clearance envelopes. In addition, the bridge solution had to minimize temporary and permanent impacts to tracks, yard roads, utilities, railroad operations, and facilities.

Previous bridges at this location followed an alignment parallel to and north of the existing bridge. Following this same alignment, the new bridge minimizes right-of-way acquisition requirements, satisfies maintenance of traffic demands, and provides the best opportunity for geometric improvements.

Construction Schedule

The 4th Street Bridge contract was awarded in October 2007. The $27.7 million bid for the segmental alternate saved CDOT approximately $5 million against the steel alternate and was less than the engineer's estimate. Construction is progressing on schedule with the completion of the first cantilever in mid-June 2009 and casting of the second cantilever now underway.

Construction is currently proceeding across both the rail yard and Arkansas River. The majority of substructure work was completed as of September 30, 2008, and once the existing bridge is removed, the remaining substructure for the eastbound bridge will be completed by June 2010. During construction of the first main span cantilevers the contractor was able to achieve a production rate of approximately two segments per week. Once the first pair of cantilevers was complete, operations moved to the adjacent cantilevers to complete the new westbound bridge. Following this, travelers will be relocated for construction of the eastbound bridge.

Environmental Challenge

Restoring Natural Environment

The City of Pueblo and Corps of Engineers recently completed the Arkansas River Restoration Project with the goal of restoring the natural riverine environment in this region. Among other features, this included construction of a white water kayak park just downstream of the bridge. Maintaining recreation through the project site both during and after construction was an important consideration. Building from above and utilizing long open spans supported by slender piers—a minimal bridge footprint—created many benefits for this recreational area.

Substructure Design and Construction

All piers are supported on two drilled shafts, providing the necessary flexibility, minimizing the bridge's footprint, and greatly reducing the number of construction operations. This is especially advantageous in the railroad yard. Abutments and end span piers utilize 4-ft- and 5-ft-diameter drilled shafts, respectively, while main-span piers are supported on 8-ft-diameter shafts. Shafts are drilled through an alluvial sand layer and socketed 25 to 43 ft into hard rock. Overexposure of the shale bedrock layers found along Colorado's Front Range can lead to a loss in capacity over time. To minimize this potential, the contractor chose to drill the larger 8-ft-diameter shafts in stages, first drilling smaller pilot holes followed by the final required diameter. Tip elevation was not drilled until the contractor was satisfied that concrete could be placed within the required CDOT timeframe.

Footing and column construction followed completion of drilled shafts at each pier location. Careful design and close coordination with the railroads during construction ensured efficient movement of materials, forming, and concrete placement. At Pier 4, adjacent to both the UPRR and BNSF mainline tracks, substructure construction occurred without any track closures.

Superstructure Design and Construction

The end spans are cast-in-place on ground-based falsework. To speed construction and minimize materials, falsework is removed once the spans are completed and all post-tensioning stressed. Once the adjacent cast-in-place cantilevers are complete, they are joined to the end spans with closure placements.

Pier tables on top of the main span piers are cast-in-place on temporary falsework that has been designed to maintain the required railroad clearances. Tracks remain open while pier table construction occurs overhead.

Another challenge from the rail yard constraints was overcoming the large out-of-balance forces induced from the balanced cantilever construction. Typical twin wall pier construction could not be used because of the large footings required and the need to remove tracks from service. Therefore, a temporary support prop is used during cantilever construction. This prop shares construction loads with the permanent pier and provides added rigidity for better geometry control. This allows the bridge piers to maintain a slender shape and minimal footprint.

Concrete segmental balanced cantilever construction has proven to be an efficient and economical option for the new 4th Street Bridge in Pueblo, Colo.—allowing vehicular and rail traffic to remain operational while delivering an aesthetically pleasing design for the community.

Karen Rowe is resident engineer, Colorado Department of Transportation, Pueblo, Colo. Steve Fultz is assistant regional director for FIGG, Denver, Colo., and John Dvorak is the resident engineer/lead inspector for FIGG, Pueblo, Colo.

For more information on this or other projects, visit www.aspirebridge.org.

The new 4th Street Bridge in Pueblo, Colo., spans 28 active rail tracks in the Pueblo Rail Yard. Rendering courtesy of FIGG.

Access is limited in the Pueblo Rail Yard, but balanced cantilever construction easily solves this with overhead construction. Photo: FIGG.

Community Selects Bridge Aesthetics

Community members in Pueblo, Colo., had a hand in selecting the aesthetic features for the new bridge. In the FIGG Bridge Design Charette™ process, they first selected a theme that blends the clean simple and timeless lines of contemporary sculpture with the natural environment and stylistic aspects of Pueblo heritage.

Earth tone staining was selected for the bridge color to blend the bridge into its environment along the river. Specific features of aesthetic treatments will honor Pueblo's history, heritage, and artistic focus. Artistic pier medallions and tile work on the barriers and monument will include the theme at a pedestrian level. CDOT will advertise a request for proposals for the final details for the medallions and tile work.

Other elements selected by the community include vertical monuments to mark the ends of the bridge, overlooks on the bridge deck at the river piers, a plaza overlook on the southwest approach, and open pedestrian railings. Aesthetic light poles were also selected to reflect the bridge theme and provide roadway and sidewalk illumination.