Steel Bridge Uses Simple-Span-Made-Continuous Construction

The Colorado DOT has designed and built its first new steel bridge using simple-span-made-continuous construction. Using this technique, workers connected in-line steel girders together at the piers. Conventionally, a welded or bolted steel splice of girder segments is located some distance out between piers, adding labor and construction complexity. CDOT engineering estimates indicated that this technique, combined with rolled steel beams, was especially cost-effective. In fact, the cost of the erected steel bridge superstructure was just $1.1 million. ($53.2/sq ft of deck or $.97/lb erected.)

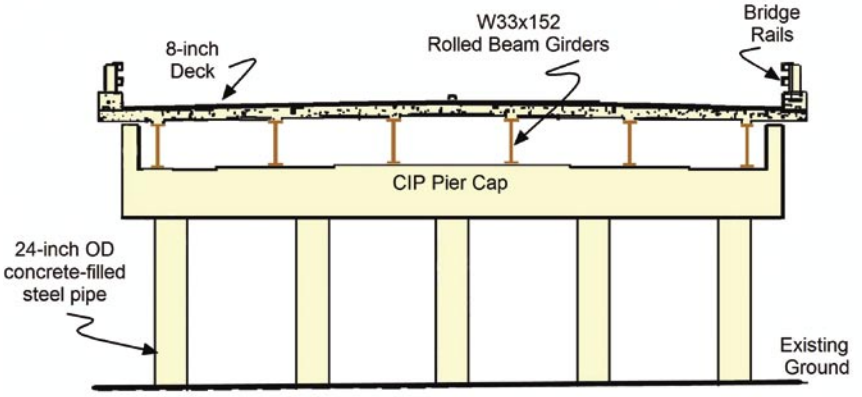
"The simple-span-made-continuous design is common with concrete beams," says Mark Leonard, State Bridge Engineer. "What we've done with this bridge is apply the same technique to structural steel, greatly simplifying design and construction. The end result is a steel bridge superstructure that's highly competitive with concrete beam alternatives," he says.

The new bridge crosses Box Elder Creek on U.S. Route 36 just east of Denver. For about four months during its construction, CDOT diverted all traffic to Interstate 70, which parallels U.S. 36 in this area. The new bridge replaces one built in 1930 and widened in 1950, but considered functionally obsolete.

Designer Teddy Meshesha, CDOT Structural Project Engineer, notes that the new 470-ft bridge is straight with six equal spans. "Its overall width is 44 ft, leaving 41 ft curb to curb for two 12 ft traffic lanes bordered by 8.5 ft shoulders," says Meshesha.

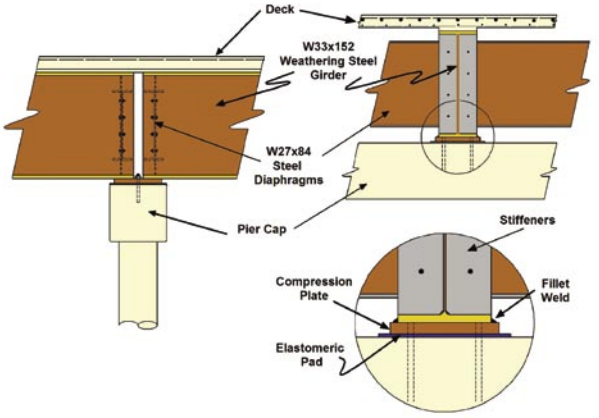
"Five 24-in. diameter steel pipe piles filled with concrete extend to a concrete cap to form the substructure for each pier and the abutments," he says. "The bridge has no expansion joints, which is a CDOT requirement for bridges of this size. The piers and abutments accommodate expansion and contraction of the superstructure."

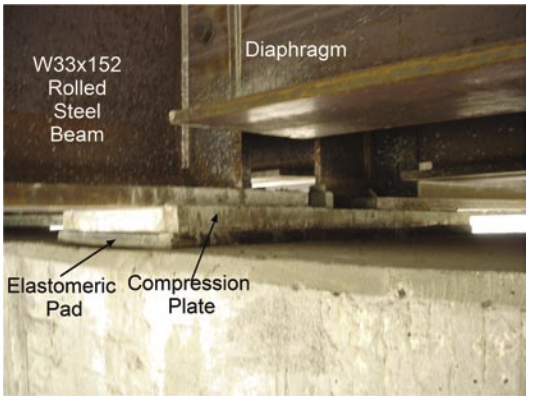
During the design stage, Meshesha considered three possible superstructures: rolled steel beams, precast prestressed bulb-t (BT) concrete beams, and precast prestressed concrete box beams. "High-water restrictions eliminated the bulb-t beams," says Meshesha. "While Box Elder creek is generally dry, it can carry fast-moving water seasonally or after heavy rains. CDOT requires a 2 ft clearance between the high water and



Typical section of Box Elder Creek bridge.

Rolled beam girders and diaphragms form the steel superstructure for the bridge.





Workers weld the bottom flanges of in-line girders to a compression plate bolted to the pier, creating a continuous connection for live loads.

the bottom of the beams to permit passage of debris," he says. "The 42 in. depth of the concrete BT beams provided insufficient clearance." He adds that cost ruled out the precast concrete box superstructure. "By our estimate, the steel beam design came in 18 percent under the cost of concrete box beams," says Meshesha.

The depth of W33x152 rolled steel beam girders (33 in.) offered sufficient clearance from high water. The bridge has six lines of these grade 50 weathering steel girders across its width. Weathering steel eliminated the need for initial painting and minimized future maintenance. Each girder is about 77 ft long. The lateral spacing between girder centerlines is 7 ft 4 in.

Meshesha says that the steel superstructure follows LRFD guidelines. Making the girders continuous shares the live loads between spans, requiring a less robust girder section. The fabricator, Big R Manufacturing LLC in Greeley, CO, added a slight camber to the steel beams. "Big R supplied the girders to the site in pairs, connected by a series of W27x84 rolled steel diaphragms, for stability during erection," says Meshesha. During construction, a crane lifted a pair of girders, placing the girder ends on the piers."

The steel diaphragms that create a girder pair bolt to 0.5-in.-thick stiffeners. The diaphragms are spaced at 12 ft 8 in. for the two external girder pairs and about 19 ft for the internal pair. Similar diaphragms laterally connect the three pairs of girders at the piers.

The ends of two in-line girders are 6 in. apart and sit on a 30x14x1 in. steel compression plate bolted to the pier concrete cap. The cap has a 36-in.-wide cross section. A 0.75-in. elastomeric pad lies between the plate and the cap. To make the steel girders continuous, a worker welds the bottom flanges of the two girders to the compression plate. Tension rebar within the 8 in. concrete deck handles the tensile component of the negative moment load of the continuous connection.

Total project cost was $2.1 million, including removal of the old bridge, asphalt paving, new guardrails, fencing, striping, and seeding. The bridge opened for traffic in early July.

Design
Colorado Department of Transportation

Contractor
Structures, Inc., of Englewood, Colo.

Steel fabrication
Big R Manufacturing LLC (AISC and NSBA member), Greeley, Colo.