NATIONAL STEEL BRIDGE ALLIANCE
Steel Bridge NEWS

Using steel offered economic and scheduling advantages, as well as the opportunity to reuse salvaged materials.

New Spans Over Two Oregon Rivers

BY PETER PAGTER, S.E., P.E., AND XIQIN LONG, P.E.

DOUGLAS COUNTY, OREGON, had a unique opportunity to replace two long-span bridges just 20 miles apart over the very environmentally-sensitive South Umpqua and North Umpqua rivers with locally-fabricated weathering structural steel plate girders. This was an unusual opportunity because most highway bridges in the state are constructed with prestressed concrete elements.

South Umpqua River (Pruner Road) Bridge

The old South Umpqua (Pruner Road) Bridge, constructed in 1957, was a cast-in-place concrete bridge with a longitudinally and transversely post-tensioned main span. The superstructure showed signs of severe deterioration, and both Douglas County and the Oregon Department of Transportation (ODOT) decided it was critical to replace the old bridge.

Replacement design efforts had to account for both traffic and seismic demands. The average daily traffic (ADT) was estimated to be 6,850 vehicles per day in 2008 and is forecasted to be 9,180 by 2027. The seismic site peak acceleration coefficients (A) are 0.13g and 0.22g for the 500-year and 1,000-year return periods, respectively. It is interesting to note that the acceleration coefficients increase by a factor of three just 45 miles to the west along the Oregon coast.

The new Pruner Road Bridge is a 588-ft-long three-span bridge composed of four weathering structural steel plate girder lines. The unbalanced spans of 200 ft, 218 ft, and 170 ft were chosen to avoid the existing footings of the old bridge. In order to find the most efficient use of steel, the designer analyzed several girder configurations. The final girder spacing is 12 ft—well within the ODOT guidelines of 11 ft to 14 ft for spans longer than 140 ft. The four lines of weathering steel girders, conforming to ASTM Specification A709 Grade 50W, are 80 in. deep.

The interior piers are supported on 7-ft-diameter drilled shafts to minimize the substructure excavations in the environmentally sensitive river. The concrete bridge rails incorporated ashlar stone architectural treatment, and the steel top railings were powder-coated brown to provide increased aesthetic appeal.

The advantages of selecting a structural steel bridge over the precast post-tensioned segmental concrete alternative were:


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- Smaller foundations due to a lighter superstructure
- Future widening is more constructible
- Shorter construction time, reducing temporary impacts to the river
- Less disruption to the traveling public due to shorter construction time

The projected costs during the preliminary design phase for the three structure alternatives were:

- Structural steel bridge with detour bridge: $8,828,000
- Post-tensioned concrete bridge with detour bridge: $8,223,000
- Staged structural steel bridge (no detour bridge): $9,967,000

Douglas County chose the unstaged structural steel alternative with the detour bridge because of lower project costs, as well as the items listed above.

The new 588-ft-long South Umpqua River (Pruner Road) Bridge uses four weathering structural steel girders spaced 12 ft apart.

The new South Umpqua River (Pruner Road) Bridge features aesthetic treatments including a brown powder-coating on the steel top railings.


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On-Site Concerns

The site of the old South Umpqua River Bridge is well known as an archaeological hot spot for Native American artifacts. There are known Native American archaeological sites along the North Umpqua River as well, so the entire project required close monitoring by local tribes during construction.

Additionally, the North Umpqua River is very environmentally-sensitive, with some of the most productive coho and steelhead salmon runs within the state. The coho salmon that frequent these waters became federally-listed as an endangered species during construction. That further complicated the environmental documentation and required an emergency consultation with the National Marine Fisheries Service.

Peter Pagter, S.E., P.E., and Xiqin Long, P.E., are senior project engineers with OBEC Consulting Engineers, Eugene, Ore., and Professional Members of AISC. Pagter has more than 27 years of experience designing bridges of all types in Oregon. Long also is a member of the Society of Women Engineers and has more than 16 years of experience designing bridges and other structures.

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▲ Douglas County and the Oregon Department of Transportation considered concrete and steel alternatives for the permanent North Umpqua River (Brown) Bridge, but ultimately chose the structural steel option. To increase the structure's aesthetics, OBEC Consulting Engineers designed the bridge to utilize haunched steel girders at its interior piers.

▼ This artist's rendering was used during preliminary design to demonstrate what the final North Umpqua River (Brown) Bridge would look like.

◀ To give the new highly-visible North Umpqua River (Brown) Bridge more visual appeal, the structure features haunched weathering structural steel girders and an ashlar stone architectural treatment at the interior pier. In addition, all visible concrete surfaces are stained with three different colors.

The Detour Bridge

The existing 627-ft-long, seven-span North Umpqua River (Brown) Bridge, constructed in 1965, had a cast-in-place concrete box girder main span with prestressed concrete deck girder approach spans. The bridge had developed several structural deficiencies in recent years, including extensive shear cracks up to 0.06 in. and flexure cracks up to 0.07 in. in the main span. Furthermore, the bridge had developed negative camber over the past decade.

As a result, the existing bridge was load-restricted and required monthly inspection monitoring. The condition of the bridge was so deteriorated that the geotechnical drilling equipment was not allowed on the center spans to provide exploratory investigation in the main part of the channel.

When the structural condition worsened in 2008, Douglas County declared the replacement of the bridge an emergency. OBEC Consulting Engineers quickly designed a 760-ft-long temporary detour bridge to be constructed adjacent to the permanent replacement bridge. The project was designed in two months and bid in April of 2008. The successful bidder's total contract was for $1,247,000.

The temporary detour bridge was designed as a 12-span structural steel bridge with 40- to 60-ft-long approach spans and one 125-ft-long main span. During the design phase of the detour bridge, the county provided several ideas to promote the concept of sustainability. The main steel girder spans of the detour bridge were salvaged and modified from an earlier local bridge replacement, and several approach spans incorporated salvaged beams from the county's bridge maintenance yard stockpile, saving the county from having to purchase new beams. The design included locally fabricated precast concrete deck panels and steel bridge rail, all of which are planned to be disassembled and used at different sites after the permanent bridge has been constructed.

For a county with more than 300 bridges, there are numerous benefits that result from designing reusable, sustainable bridge elements. Many of Douglas County's bridges are nearing the end of their useful life, and the county anticipates reusing all

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of the deck panels and steel girders from the temporary bridge on future bridge replacement projects. The salvaged structural elements can be easily stockpiled and take up much less room in the county storage yard than concrete girders. With the lighter overall weight, they also are more easily handled by smaller equipment, which frees up the county to deploy them more rapidly, especially in the event of an emergency repair. The steel elements in particular represent a built-in cost savings that will help the county make the most of limited resources because the engineering details can be easily transferred to another site.

Because hard pile-driving conditions were anticipated during construction, OBEC designed the substructure with a four-pile braced bent system with inside-fitting cutting shoes and 24-in.-diameter steel pipe piles. One-in.-diameter high-strength rock anchors were planned, but the piles were sufficiently embedded into the alternating layers of sandstone and siltstone that the rock anchors were not necessary.

To speed up construction, the contractor employed two cranes at opposite ends of the river to drive piling and erect the superstructure. As each span was constructed, the cranes moved across the completed span to start construction on the next span. The contractor used this "trestle" construction method to eventually meet in the middle of the bridge.

North Umpqua River (Brown) Bridge

The design of the replacement North Umpqua River (Brown) Bridge was completed during construction of the South Umpqua River (Pruner Road) Bridge and the temporary North Umpqua River (Brown) Detour Bridge. The two new bridges are similarly configured, with three spans and four lines of weathering steel girders. Whereas the South Umpqua River Bridge has straight (unhaunched) girders, the North Umpqua River Bridge has haunched girders at the interior piers. The 646-ft-long bridge has asymmetrical spans of 200 ft, 250 ft, and 196 ft in part to avoid existing footings and also to allow the contractor to use the existing substructure to help erect the new superstructure.

A precast post-tensioned segmental concrete alternative was studied during the pre-

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▲ The North Umpqua River detour bridge being constructed adjacent to the existing bridge. The steel girders for the 120-ft main span were salvaged and modified from a local bridge replacement.

▲ Workers install the precast concrete panels that make up the deck of the temporary North Umpqua River detour bridge. Douglas County plans to reuse the deck panels and steel bridge rail at different sites after the permanent bridge is complete.

liminary design phase, and the estimated cost of construction for the two alternatives was:

- Structural steel bridge: $13,079,000
- Post-tensioned concrete bridge: $13,425,000

These estimates included construction engineering and contingencies. Douglas County and ODOT decided to pursue the structural steel alternative for several reasons. First, they determined that the concrete alternative required two 8-ft-diameter drilled shafts to resist the calculated seismic forces, while the steel alternative required 7-ft-diameter shafts, reducing the environmental impact. Second, any future widening of the bridge would be easier with a steel bridge.

In 2008, the ADT was measured to be 5,459 vehicles per day, but is anticipated to be 12,090 by the year 2031. The seismic site peak acceleration coefficients (A) are only slightly higher than they are for the South Umpqua River Bridge: 0.14g and 0.24g for the 500-year and 1,000-year return periods, respectively.

The girder spacing is 13 ft 6 in., just within the ODOT-recommended maximum girder spacing of 14 ft. The roadway widens from 40 ft to 50 ft in Span 3 to allow traffic storage for turning movements on Old Garden Valley Road north of the bridge.

Because of the North Umpqua River Bridge's high visibility, the county wished to add aesthetic features. Haunched girders and arched interior piers give the new bridge an attractive appearance, while all visible concrete surfaces are stained with three different colors and incorporate an ashlar stone appearance.

The project was bid in May 2009. The total cost of construction was $5,362,000. Steel prices for weathering structural steel were relatively low during the design and construction of both Umpqua Basin bridges, providing substantial cost savings for the county. For the South Umpqua River (Pruner Road) Bridge, the price for the structural steel was $1.58 per pound, and $1.40 per pound for the North Umpqua River (Brown) Bridge, including fabrication, transportation, and erection.

Conclusion

Douglas County was looking for cost-effective, low-maintenance long-span bridges to replace two of its aging structures over the South and North Umpqua rivers. Weathering structural steel bridge replacements provided all the answers in the environmentally sensitive Umpqua Basin. The new South Umpqua (Pruner Road) Bridge and North Umpqua River (Brown) Bridge will maintain these vital transportation links for county residents and others for many years to come. MSC

Owner
Douglas County, Oregon

Structural Engineer
OBEC Consulting Engineers, Eugene, Ore.

Steel Detailer and Fabricator (Pruner Road and Brown Bridges)
Fought & Company, Inc., Tigard, Ore. (AISC and NSBA Member)

Steel Erector (Pruner Road and Brown Bridges)
REFA Erection, Inc., Tigard, Ore. (IMPACT Member)

General Contractor — South Umpqua (Pruner Road) Bridge
Ross Bros. & Co., Inc., Salem, Ore.

General Contractor — North Umpqua (Brown) Bridge
Concrete Enterprises, Stayton, Ore.

General Contractor — North Umpqua River Detour Bridge
Carter & Co., Salem, Ore.