

Using steel for replacement bridges to yield cost savings and environmental benefits.

Trading UP

BY STEVE NARKIEWICZ, P.E.

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SINCE 2003, the Oregon Department of Transportation has repaired or replaced hundreds of aging bridges around the state as part of the \$1.3 billion OTIA III State Bridge Delivery Program (see sidebar). Most of these are straightforward highway bridges and, from a motorist's point of view, hard to distinguish from the roadway itself. But for those charged with bringing the state's surface transportation system back up to capacity, some upgrades are proving to be more challenging than others.

From a fiscal, technical, environmental and aesthetic standpoint, replacing the two 60-year-old, seismically vulnerable, narrow bridges that carry Interstate 84 across the Sandy River near Troutdale, Ore., posed some very distinct challenges for the project team.

Located at the mouth of the world-renowned Columbia River Gorge National Scenic Area, the new bridges initially were designed as post-tensioned concrete structures each with four 200-ft spans and a total length of 800 ft. In February 2009, their estimated total

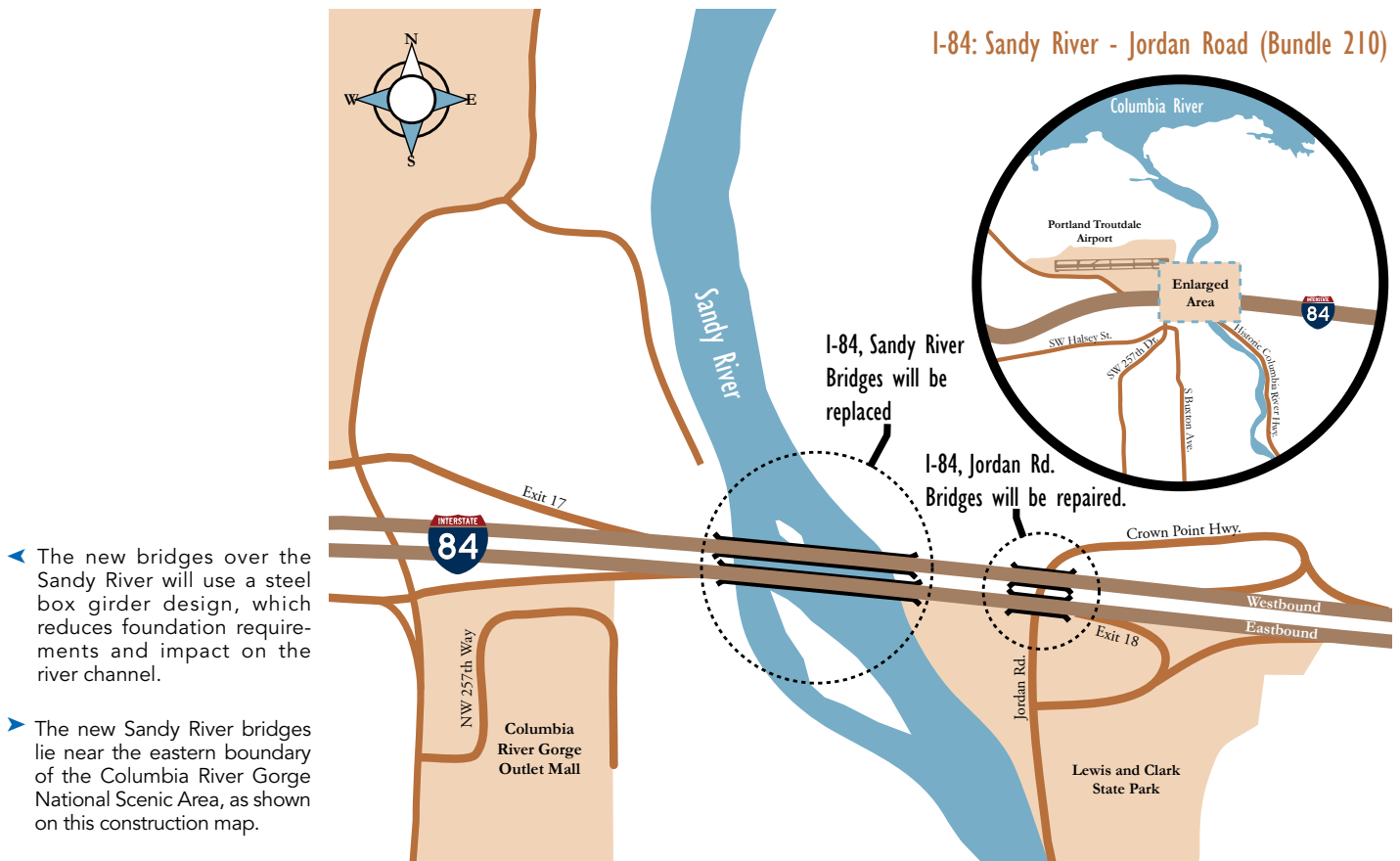
cost of more than \$90 million, well over the budget, triggered a complete re-evaluation of the project. An analysis of the estimate for the Sandy River bridges revealed that a large, expensive substructure would be required to support the heavy concrete superstructure.

Other bids in the OTIA III bridge program had shown that structural steel prices were declining. An economic analysis indicated that this trend was likely to continue. Faced with the conflicting goals of reducing cost and using longer spans that would protect the ecologically valuable Sandy River, which is home to threatened species such as chinook salmon, coho salmon and steelhead trout, the project team redesigned the bridges using steel box girders, abandoning the concrete design to take advantage of favorable steel prices and reduce superstructure weight.

To minimize delays to the project letting, the redesign focused on using simple repetitive details and a balance between steel weight and fabrication cost.



I-84: Sandy River - Jordan Road (Bundle 210)



- ▶ The new bridges over the Sandy River will use a steel box girder design, which reduces foundation requirements and impact on the river channel.
- ▶ The new Sandy River bridges lie near the eastern boundary of the Columbia River Gorge National Scenic Area, as shown on this construction map.

Due to the project complexity and sensitive location, ODOT used best-value bid selection criteria for this project rather than simply awarding the project to the lowest bidder. Price, qualifications and technical approach were all factors included in the scoring to determine the best value bid and selection of the contractor. Hamilton Construction Co.'s bid of \$48.5 million was not the lowest bid; however, the quality of its technical proposal gave the company the best value score.

In addition to typical budget constraints, the Sandy River Bridge project had cultural, aesthetic and technical challenges. These highly visible structures attracted interest from a number of stakeholders in the design phase.

One of the most important considerations for this project is its location in the Columbia River Gorge National Scenic Area. The CRGNSA was established by Congress to protect and provide for the enhancement of the scenic, cultural, recreational and natural resources of the gorge. ODOT worked with the Columbia River Gorge Commission, U.S. Forest Service, Federal Highway Administration, Oregon Department of Fish and Wildlife, and the three counties within the CRGNSA to develop an Interstate 84 Corridor Strategy that

would allow it to meet public safety and transportation needs while also meeting the National Scenic Area provisions.

The I-84 Corridor Strategy required the bridges to blend in with the surrounding natural environment. The final modified-contemporary design for the Sandy River bridges includes steel box girders with a rock facade on the bridge piers and abutment, and decorative pylons in dark earth-tone colors. A sleek, trim profile with a rough, rocky texture and an irregular pattern will minimize distraction and the reflectivity of various highway features. The steel box girder depths vary from 5 ft, 6 in. to 11 ft. In total, the two bridges require more than 8 million pounds of AASHTO M270 Grade 50 steel, which will be painted to comply with aesthetic guidelines.

Both eastbound and westbound bridges have spans of 200 ft, 220 ft, 220 ft and 200 ft. Proportionally shorter end spans and longer interior spans

- ▶ Redesigned from concrete to steel in late 2009 and rebid in early 2010, the Sandy River bridge construction is expected to be completed in 2013.

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▲ The new Sandy River bridges will feature rock facade treatments on the bridge piers, abutments and decorative pylons consistent with the Interstate 84 Corridor Strategy aesthetic design guidelines.

would have been preferable from a structural perspective, but the span arrangements chosen keep the substructures out of the low-flow channel and avoid the existing bridge foundations.

The eastbound bridge includes a 16-ft-wide multi-use path. This feature, unusual for an interstate highway bridge, was included to allow pedestrians and bicyclists to safely gain access to popular recreation areas in the Columbia River Gorge. Both bridges have three 12-ft lanes and two 12-ft shoulders.

Environmental and seismic issues were a challenge regardless of the materials selected, but changing the design of the superstructure to steel girders provided a number of benefits in these areas.

Because the Sandy River is home to chinook salmon, coho salmon and steelhead trout, all of which are threatened species, ODOT was required to reduce the environmental impact of the project both during and after construction. One of the team's design goals was to open the channel so that the fluvial geomorphology could return to a more natural state.

Environmental regulatory agencies requested longer bridges without additional substructures, which would further open the channel to provide better fish habitat. Piles placed to support falsework were a concern because completely removing the long piles located below the new bridges would be impractical. Leaving the piles in place would conflict with the goal of restoring the channel to a more natural condition. By building with steel, the amount of falsework the bridge crew will develop for the bridge structure will be notably less than

- ▶ The eastbound bridge over the Sandy River will include a combined bicycle and pedestrian crossing that will accommodate users traveling in both directions.

what would have been used for concrete, because only one tower will be needed on each side to erect the girders.

During construction, strict limits will also be imposed on the volume of material, including fill and concrete, that can be placed in the channel. Construction activities within the area of the ordinary high water are limited to a six-week period each year.

Foundation conditions at the site can only be described as challenging from a design perspective. The bridge rests in a seismically active area with more than 100 ft of loose, saturated sand overlying the bedrock at the site. Because lateral forces that develop during an earthquake increase with the mass of the superstructure, the potential for soil liquefaction during a seismic event was analyzed extensively during design. Reducing the superstructure mass and weight not only helped to reduce potential seismic impacts, but also shrank the drilled-shaft size from the 10 ft diameter required for the concrete design to 8 ft for the steel bridges. Building smaller shafts also helped meet the environmental requirement to reduce the volume of material removed and replaced



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within the channel. These reductions lowered costs as well.

In the end, our reworking of the design plans included only two visible differences between the steel and concrete versions of the bridges. The first is that with concrete there would have been two box surfaces underneath the bridge, and with steel there will be three or four. The new steel bridges will also be 40 ft longer to the east to widen

the channel, which helps diminish environmental impacts.

With all of these reductions in environmental impact, construction cost and overall bridge load, the decision to redesign the bridges with steel girders has proven to be very beneficial to the agency. With a completion date slated for 2013, we look forward to seeing travelers through the Columbia River Gorge benefit from the bridges' replacement for decades to come.

MSC

Oregon's Big Investment

The 10-year, \$3 billion Oregon Transportation Investment Act (OTIA) marked the largest construction investment in the state's highway and bridge system since creation of the interstate highway system began in the 1950s.

OTIA I and II, passed in 2001 and 2002, respectively, resulted in \$500 million in improvements to state transportation infrastructure. Most projects in these programs were opened to traffic by 2009.

The third phase of the program, OTIA III, was enacted in 2003. The \$2.46 billion package allocated \$1.3 billion to repair or replace Oregon's aging state highway bridges and \$1.16 billion to fund county and city maintenance projects, local bridge repair and replacement work, and modernization projects statewide.

The majority of the OTIA III bridges are now complete and open to traffic. All but two of the remaining bridges will be in construction by 2011.



Project Owner

Oregon Department of Transportation

Designer and Structural Engineer

David Evans and Associates, Inc., Portland, Ore.

Steel Fabricator

Mountain States Steel, Lindon, Utah (AISC and NSBA Member)

Contractor

Hamilton Construction Company, Springfield, Ore. (AISC and NSBA Member)