Sauk River Bridge #414

Snohomish County, Washington

Sauk River Bridge spans a federally-designated Wild and Scenic River in north Snohomish County, and at 479 feet is the county's longest two-span, steel truss bridge. It replaces an old bridge that was built in 1930 and had become both func¬tionally obsolete and structurally deficient. The bridge was too narrow at only 18 feet curb to curb, the deck was deteriorating and there were scour problems at the piers. It needed to be replaced.

Highlights

Safety Enhancements of the New Bridge

- The old under height, under width bridge was replaced with one that is twice as wide at 36-feet. It accommodates logging trucks and includes generous shoulders for pedestrians and bicyclists
- Scour critical pilings were replaced with a wider span foundation planted up to 125 feet deep to avoid scour
- The hazard of lead base coating was removed with removal of the old bridge

Unique Challenges

- The river's force and migration patterns severely limited placement and construction options for a new bridge
- Environmental regulations disallowed temporary supports in the river
- The fish window for in-water workwas unusually tight
- Traffic and lumber mill access had to be maintained
- The existing bridge qualified for National Register of Historic Places (NRHP) which complicated the removal process

Construction Excellence

★ The new bridge was built in one piece on the one side of the river and successfully rolled above the river to its foundation on the other side

- It is the first steel bridge in the Pacific NW to be both hot-dip galvanized and powder-coated for superior paint adhesion over the life of the bridge
- A protective work platform was hung under the bridge to keep debris from entering the river during the work

Innovative Design

- Advanced, three-dimensional modeling resulted in geometric precision during fabrication of the steel structure and its successful launch over the river
- Designed an educational kiosk using portion of the old bridge to highlight its importance in the history and economy of the region

Highlights

Environmental Compatibility

- All components were treated, painted and heat sealed before arriving at the site to avoid environmental contamination
- High clearance under bridge will withstand 100-year flood and avoid logs and other flooding debris from upstream
- Longer pier spans will accommodate river migration
- Foundations are planted between 110 and 125-feet deep to withstand migration and extreme floods

Effective Project Administration

- Completed 5 months ahead of time and $509,000 under budget
- There were no claims
- Proactive cost reduction management by Construction Manager Bob Morrison, including a $60,000 CRIP change order, saved the County more than $400,000
- Final CE/CN: 9%
- Final Engineering: $1,189,735
- Final construction: $13,592,219

Cost Effectiveness

- Saved time and approximately $1 million in construction costs by building in one piece
- 3-D modeling provided accurate information for ordering bridge elements
- Passed both FHWA and WSDOT audit with flying colors

Enhancement of Regional Transportation System

- The bridge serves as a gateway to the Mt. Baker-Snoqualmie National Forest and the scenic Mountain Loop Highway
- Traffic averages 750 vehicles daily, 25 percent of which are heavy logging trucks

Timeliness in Completing the Project

- Completed 5 months ahead of schedule, fortuitously avoiding subsequent flooding that eroded land that had been used for staging cranes

Public Satisfaction/Acceptance

- Darrington residents and Mayor came out to celebrate the opening of the bridge with the project team and provided Blue Grass music and a parade of antique vehicles

The community helped plan the ribbon-cutting celebration. They played blue grass music and brought a parade of antique vehicles to be the first to cross the newly dedicated bridge.

Awards

★ 2009 Merit Award, Iconic Bridge Category, from National Steel Bridge Alliance (NSBA)

★ 2010 Silver Award from the American Council of Engineering Companies (ACEC)

★ 2010 American Public Works Association (APWA) National Project of the Year Award

★ 2010 APWA Washington State Chapter Project of the Year Award

Sauk River Bridge

Engineers often use precast concrete as a bridge building material to keep initial capital costs low and minimize future maintenance. In this case, however, a conventional concrete bridge, with a relatively deep superstructure, would have required the roadway to be raised to maintain clearance above the 100-year flood elevation. This also would have required the roadway approaches to be raised, encroaching on the adjacent lumber mill and making access and drainage features much more costly.

"The power of steel makes it possible to do heroic things, including building bridges in very problematic locations," said the principal in charge. "By keeping the structure light during construction, we could minimize the profile of the roadway, keep the bridge surface relatively low, and provide adequate clearance during extreme high water flows."

The old bridge built in 1930, was only 18 feet wide from curb to curb.

The new bridge is twice as wide as the old, at 36 feet, from curb to curb.

The Roller Launch

Historically, bridge engineers have built a temporary structure on driven piles to provide local traffic with unimpeded and continuous travel. Also, they would have erected falsework in the water to support the new bridge while under construction. However, this was not permitted in the pristine, untamed Sauk River, where construction noise and related activities could harm endangered salmon species and disturb their habitat.

The bridge was originally designed to be assembled on shore in two pieces and placed in position with a special heavy lift crane. Connection of the two pieces into a single continuous truss would be the only assembling activities to occur over water. The team secured environmental permits to clear the land required for this, and the contract included provisions for preparing the river bank for the anticipated crane weight. However, the contractor for the project took advantage of the continuous truss design and worked with the County to implement an alternative method.

They decided to assemble the structure on shore, in one piece, and then "launch" the assembled structure out over the river. An innovative cantilever/roller system was used to accomplish this complex task. The trusses and framing elements were first constructed on the east roadway approach.

After assembling the nearly complete truss superstructure, launching it over the river required intricate and precise control. Advance 3-dimensional modeling provided the calculations needed to plan the precision work. Winches on either side of the trusses, designed for 25,000 pounds of line pull, guided the bridge over high-capacity, low-profile, Hillman Roller dollies. Tiny deviations or irregularities in the tracks would have produced dangerous internal friction in the rollers. Careful planning and monitoring, however, limited the line pulls to only 5,000 pounds, and the bridge moved smoothly forward into position without a hitch — a masterpiece of precision.

To limit deflections and forces in the trusses while the bridge was being launched, the launching method employed also required a nose piece add-on to successfully reach the west abutment. The project team designed the nose piece, something like the prow of a ship, which was then removed after final positioning of the truss.

Galvanizing and Powder-Coating

The Sauk River Bridge is the first steel bridge in the Pacific Northwest to be both hot-dip galvanized and powder-coated, a technique that provides much better paint adhesion over the life of the bridge. All steel members were submerged in a zinc bath at 850 degrees, using zinc as a sacrificial anode. Then a top coat of paint was applied, and steel components were baked in a huge oven to cure the paint.

The dual-system process is considered to be very "green," as it requires no solvents. Top coating prevents the zinc used during galvanization from leaching into the pristine river below, addressing concerns from the National Marine Fisheries Service. All rebar was galvanized as well, a highly unusual step, providing protection and inhibiting rust. Shop coating bridge components prior to shipping them to the job site further minimized any possible environmental dangers associated with applying paint in the field.

Firm Foundations

The project team drilled deep foundations to support the bridge to protect against scour, and because some of the riverbank's sub layers had a potential for liquefaction. These were 8 feet in diameter, and 110 to 125 feet deep. They had to be inserted by the use of a special oscillator, which was too heavy to go across the existing bridge for placement. The oscillators had to be taken apart and reassembled on the other side of the river, a condition that was clearly identified in bid documents.

> "This was the first time we'd ever launched a bridge in this fashion, and it was fascinating," said the contractor's construction manager. "In fact, the challenge was one of the main reasons we went after the job. The creative approach resulted in a safer, faster and more effective project."

3-D Modeling

When calculating deflections for the new bridge, the design consultants introduced a three- dimensional model. It illustrated stiffness of the structure, including lateral bracing of both the top and bottom. This proved to be much more accurate than a conventional two-dimensional analysis of just the truss itself, and confirmed greater strength and rigidity than was indicated by older techniques. "This was the first time I had seen three-dimensional modeling in actual use, and I was really surprised at what a big difference it made in accuracy," said the construction engineer.

Economic Benefits

The project's contractor has indicated that the decision to launch the Sauk River Bridge, as previously described, resulted in an estimated construction savings of $1 million. In the end, the construction of the project was completed a full five months ahead of the initial completion date. Construction administration staff managing the contractor's activities have stated, "The bottom line is that the County, with good defensible plans and specs, a creative and organized contractor and good construction management was able complete this project ahead of schedule and nearly $500,000 under the original bid price. There were only three change orders. One was for a minor item of $1,900, another resulted in a cost reduction of about $60,000, and a third was a no-cost change order to correct a minor contractual condition.

All of this was made possible by innovative engineering practices, primarily the cantilevered launch, and coordinated permitting through close collaboration between the project team, Snohomish County, and the:

- Sauk-Suiattle Tribe (SST)
- Skagit River System Cooperative (SRSC)
- Town of Darrington
- Washington State Department of Transportation (WSDOT)
- Washington Department of Fish and Wildlife (WDFW)
- Federal Highway Administration (FHWA)
- Federal Emergency Management Administration (FEMA)
- National Marine Fisheries Service (NMFS)
- U.S. Forest Service (USFS)

Sauk River Bridge

Financial support from a Conservation Futures grant helped pay for purchases of properties upstream from the bridge, which are being maintained as a passive park by the Town of Darrington. Federal bridge Replacement funds (BROS) and County Road Fund dollars paid for construction of the bridge.

No one could have anticipated another odd source of financial savings. Right after the bridge was finished, major flooding occurred. The rushing waters eroded land that had been used for staging cranes while removing the old bridge. If the new bridge had not been finished early, and therefore the old one also demolished early, the County would have faced considerable additional expense.

Aesthetic Considerations

The original Sauk River Bridge was one of a select type of steel bridge, and very few of its age remain in the state. When replacement became inevitable, the County completed initial Historic American Engineering Record (HAER) documentation on the bridge, in accordance with National Historic Preservation Act Section 106 requirements and designed an educational kiosk that highlights the bridge's place in the history and economy of the region.

The New Sauk River Bridge

A tribute to its breathtaking natural surroundings, the new Sauk River Bridge has achieved one of its toughest challenges: to be an aesthetic match to the beautiful scenery and its inhabitants

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John Koster, Councilman, District #1

Snohomish County Public Works Administration
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Owen Carter, County Engineer
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