The Cantilever Truss Shortcut

BY NATHAN BROWN, P.E., S.E.

Avoiding the need for several pesky permits also allowed the project to start much earlier.

Lyle Jansma, Jansma Design

THE NOOKSACK RIVER CROSSING is part of a widening project for Washington State Route 539. This section of highway is being converted from one lane each way to a four-lane divided highway. The river crossing is located near the town of Lynden, approximately six miles south of a border crossing to British Columbia.

The site provided numerous challenges. The foundation material is extremely poor, and the height of the roadway embankment is limited by settlement and existing profile grade. The superstructure depth was limited to about 6 ft based on clearance to high water. Environmental permitting restricted placement of piers within the river channel.

These site challenges dictated a clear span of about 340 ft, leaving the only reasonable option a truss to match the existing bridge. The right-of-way was extremely limited, and construction access would require a lengthy permitting process. It was anticipated obtaining permits for construction access within the river channel would take at least a year. Also, the river is too low during the construction season for barge cranes.

The design called for a truss span of 350 ft, with a roadway width of 40 ft. A cantilever method of construction was proposed to circumvent the year of permitting. Two configurations were considered in the preliminary planning phase: a three-span truss and a single-span truss with two concrete approach spans. The second option was selected to better match existing conditions. The concrete approach spans were to be used as anchors for a backstay system. This became a balancing act during design, because it was discovered that construction access for large land-based cranes was not available on the south shore. Tower cranes were cost-prohibitive for this application.

The backstay system, therefore, needed to accommodate crane access and weight, in addition to truss self weight. Fortunately, the approach spans provided enough counterweight. A launching option was studied, but the necessary apparatus was quickly determined to be much more cumbersome by comparison. The three-span construction option would have been patterned after a number of Columbia River crossings, albeit at a smaller scale. Very little modification was needed for truss member design based on the cantilever method of construction.

The contract included complete details for the backstay system, including attachments to the truss and anchorage to the approach spans, which is not common practice for a WSDOT design-bid-build contract. The usual WSDOT method is to ensure constructability and provide schematic construction information only, allowing a contractor to build as suited. The contract did allow for a contractor-designed system, but Max J. Kuney chose to erect the steel using the details provided, with modest changes in the jacking arrangement.

Opposite page: Cantilevering the new truss out from both sides of the crossing enabled construction to proceed much sooner than if the usual permits for construction access, including those needed to work in the river channel, would have been required.

The plans called for the truss to be assembled in the shop or yard to verify and record geometrics as-fabricated. The intent was to have a way to monitor geometry during fit-up in the field and make closure at midspan less prone to mismatch.

Procedures for closing and releasing the span were shown in the plans. Temporary construction pins were used in the last truss members installed to quickly provide joints with adequate strength and mobility. Once the truss halves were joined and geometry fixed, these last connections would be bolted. The plans called for closing the truss during stable thermal conditions, to avoid harmful movement of the steel.

Fortunately, a typical Puget Sound rainy day arrived when the time came to drive construction pins at midspan. Temperature during closure did not vary by more than a degree. After the truss connections were complete, jacks at thrust blocks and backstay anchorages were used to release the support system. These jacks were incorporated into the scheme for adjusting elevations and advancing or retracting the cantilevers at closure.

The contractor estimated it took an additional month to erect the steel, compared to using conventional shoring and work trestle. The steel erector thought it took closer to two months additional time. The crane access decking turned out to be tedious and time consuming to install and move. Also, there was down time waiting for completion of the north approach. Truss erection began in early May, and was completed by mid-September. All parties still favor conventional, contractor designed methods for erecting steel.

The steel fabricator proposed and used a less involved shop assembly. The truss was completed without the need to modify members or connections. Shop drawings for the bridge were created with Tekla 3D modeling software, to ensure proper fit-up. Gusset plates and splice plates were drilled on CNC drilling equipment using the downloaded Tekla data in order to maintain hole tolerances. Because most structural members were fabricated during the winter months, extra care was taken to maintain tolerances due to expansion and contraction as the temperature changed. Built up box members were welded in lengths longer than required due to some shrinkage in length of the member during welding. The members were then cut to length in Rainier Welding's environmentally controlled building, in order to maintain length tolerance.

The truss design was patterned after the Cooper River truss in South Carolina (see *Modern Steel Construction* October, 1996). The Nooksack River truss will have the same open appearance when complete. The usual portal and sway frames are absent, providing much higher vertical clearance from traffic.

The finished bridge consists of 705 tons of structural steel with an associated cost of $5.172 million, which includes a three-coat paint system and special erection. The roadway deck is expected to be completed late this year. MSC

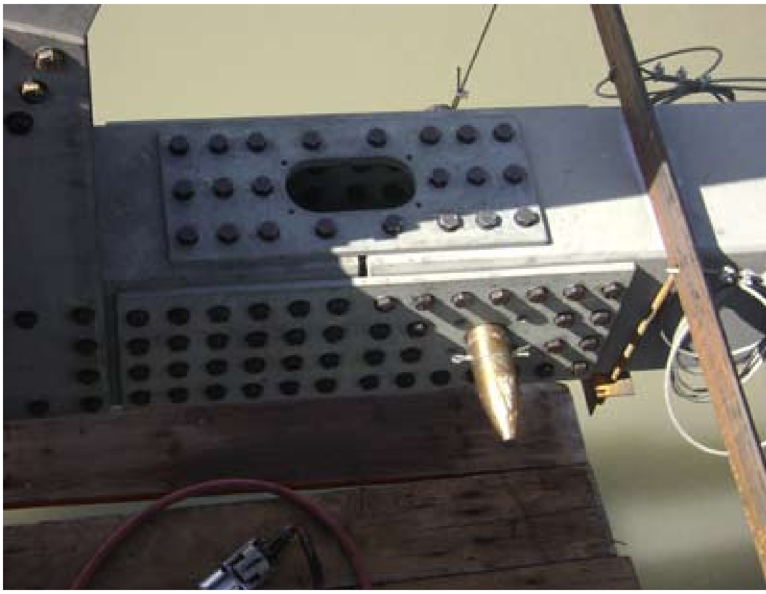
Owner/designer
Washington State Department of Transportation

Contractor
Max J. Kuney, Spokane, Wash.

Fabricator
Rainier Welding, Redmond, Wash. (AISC Member)

Erector
Schneider Up, Olympia, Wash. (IMPACT Member)

Because access for a large land-based crane was not available on the south shore of the Nooksack River crossing, the anchorage and backstay system had to support the weight of equipment as well as the truss weight.



Temporary construction pins were used in the last truss members installed to quickly provide joints with adequate strength and mobility. Once the truss halves were joined and geometry fixed, the last connections were bolted.

Nathan Brown, P.E., S.E., began his bridge design career in 1980 and since 1993 has been a steel specialist for the Washington Department of Transportation, Bridge and Structures Office, Tumwater, Wash.