PROJECT

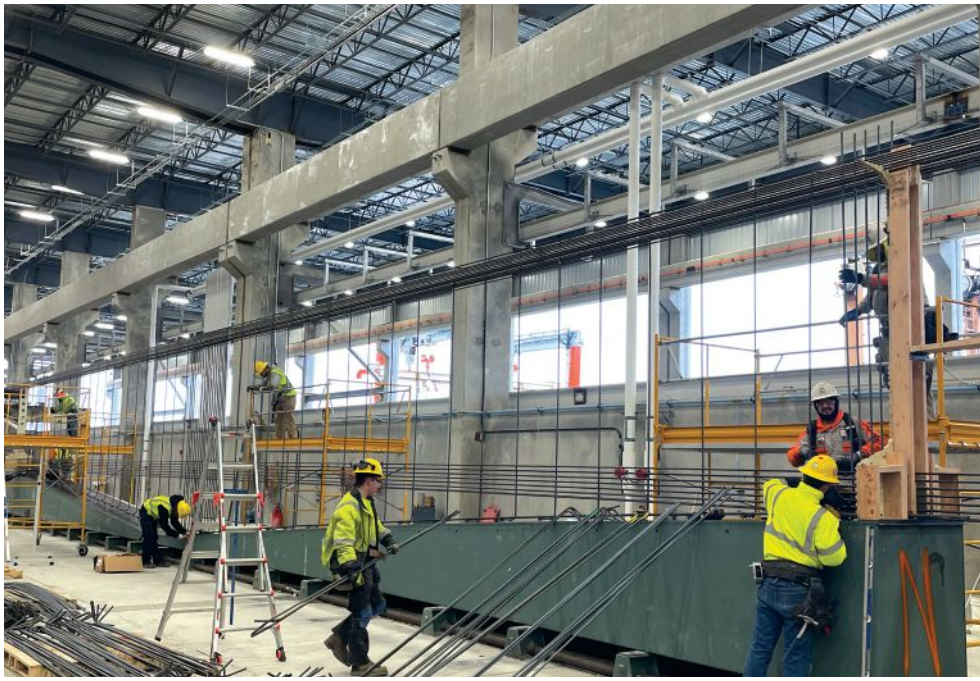
U.S. Route 395 North Spokane Corridor Spokane River Crossing

Connecting Washington One Segment at a Time

by Jordan Pelphrey, Pelphrey Prestress Partners; Dusty Andrews, Knife River Prestress; and Mathew Rochon, Washington State Department of Transportation

The 10.5-mile U.S. Route 395 (U.S. 395) North Spokane Corridor (NSC) is part of the Washington state highway system. When completed, it will be a north/south limited-access highway with a dedicated pedestrian and bike path that connects Interstate 90 on the south end to U.S. Route 2 and U.S. 395 on the north end.[1] The highway is expected to significantly improve safety and traffic flow through north Spokane. This project has been in the works for more than 50 years. Substantial research planning, legislation, and public input were required to gain approval for the corridor.

As part of the overall NSC project, the U.S. 395 NSC Spokane River Crossing project includes construction of two bridges that cross the Spokane River and connect two other NSC projects together: the Sprague Avenue to Spokane River Phase 1 project, which is located to the south of the Spokane River and is adjacent to Spokane Community College, and the Spokane River to Columbia project, which is located north of the Spokane River.



Reinforcement is being installed at the precasting facility for the prestressed concrete variable-depth girder segment. The 98-ft-long, lightweight prestressed (pretensioned and post-tensioned), haunched concrete girder segments weigh 198,400 lb and vary in depth from 8 ft 8½ in. at the ends to 12 ft at the center. Photo: Knife River Prestress.

The Washington State Department of Transportation (WSDOT) has committed to a community engagement process for the entirety of the NSC project. Early stages in the process established a corridor theme unique to the Spokane area. In addition, neighborhood-specific aesthetics were established where

profile

U.S. ROUTE 395 NORTH SPOKANE CORRIDOR SPOKANE RIVER CROSSING / SPOKANE, WASHINGTON

BRIDGE DESIGN ENGINEER: Washington State Department of Transportation Bridge and Structures Office, Olympia, Wash.

OTHER CONSULTANTS: Precast concrete specialty engineers: Pelphrey Prestress Partners, Grandville, Mich., and Williams & Works, Grand Rapids, Mich.

PRIME CONTRACTOR: Kuney Construction, Spokane, Wash.

READY-MIXED CONCRETE SUPPLIER: Central Pre-Mix, Spokane Valley, Wash.

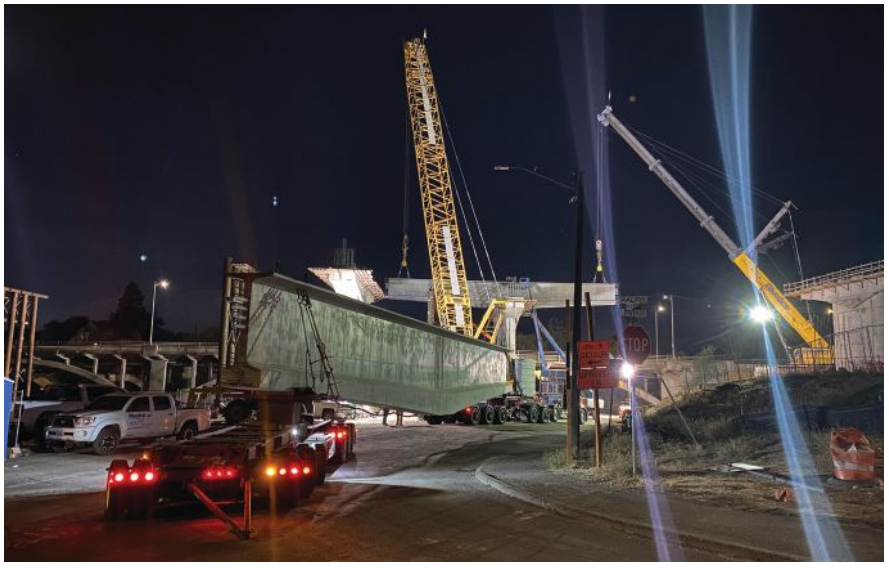
PRECASTER: Knife River Prestress, Newman Lake, Wash.—a PCI-certified producer

POST-TENSIONING CONTRACTOR: Structural Technologies/VSL, Wheat Ridge, Colo.

The cast-in-place concrete pier is a two-column structure with decorative precast concrete panels to give the illusion of a single-column pier. The panels will receive a base coat of gray pigmented sealer, and some areas of the concrete texture will be enhanced with accent colors. Photo: Kuney Construction.

adjacent communities expressed an interest in unique local themes, as well as discrete locales for all respective projects. The Spokane River Crossing project received considerable attention because of the river's significance throughout Spokane's history. The structure's aesthetics and design needed to reflect its importance and context in relation to that of other river crossings throughout the city. At this site in particular, the adjacent Greene Street Bridge's historic spandrel arch design was relevant. Because the new bridge was to be significantly elevated relative to Greene Street, the intent was to provide a form that would complement the Greene Street Bridge's spandrel arch without overshadowing it.

View from beneath the erected WF83G pretensioned concrete girders. Photo: Kuney Construction.



Delivery of a prestressed concrete girder segment. Photo: Knife River Prestress.

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION, OWNER

OTHER MATERIAL SUPPLIERS: Formwork (new for variable-depth segments): Helser Industries, Tualatin, Ore.; lightweight aggregate: Stalite, Salisbury, N.C.

BRIDGE DESCRIPTION: Two 1211-ft-long precast, prestressed, and post-tensioned concrete girder vehicular bridges

STRUCTURAL COMPONENTS: 70 WF83G bulb-tee precast, pretensioned concrete girders; 28 WF83PTG precast, post-tensioned concrete end segments; 14 WF83PTG precast, post-tensioned concrete drop-in center segments; 28 WF83PTG precast, post-tensioned lightweight concrete haunched girder segments; 8-in.-thick cast-in-place concrete deck; cast-in-place concrete pier caps, crossbeams, closure pours, columns, drilled shafts, and footings

BRIDGE CONSTRUCTION COST: $91 million

Erection of the haunched girder segments. Photo: Knife River Prestress.

An extensive type, size, and location study was performed in conjunction with the community engagement process. Several structure types were considered. A haunched, precast concrete bridge option provided the form and function needed for the crossing and was ultimately chosen as the solution. Additionally, other creative precast concrete components—including decorative panels for the faux pier walls, end caps, and column medallions—were used in the project. The cast-in-place (CIP) concrete piers comprise a two-column structure with decorative precast concrete infill panels, precast in the field by the contractor, that give the illusion of a single-column pier. Aesthetic treatments on these surfaces consist of standardized items from the NSC aesthetic theme, such as the sunburst pattern, nature themes near the Spokane River, and other custom concrete finishes developed through community engagement by a local artist.

Superstructure

The project features two 1211-ft-long precast, prestressed spliced concrete girder vehicular bridges, with one carrying northbound traffic and the other carrying southbound traffic. The precast, prestressed concrete girders are a combination of pretensioned and post-tensioned elements. Each bridge consists of eight spans of concrete girders. Spans 1, 2, 3, 7, and 8 consist of seven lines of precast, pretensioned concrete wide-flange bulb-tee girders (WF83Gs). These girders are 83 in. deep and weigh up to 163,000 lb, with spans ranging from 113 ft 4 in. to 148 ft 4 in. Spans 4, 5, and 6 consist of seven lines of girder segments, with each line composed of five precast, post-tensioned concrete girder segments (WF83PTGs): two end segments, two haunched concrete girder segments, and one center drop-in segment. Spans 4, 5, and 6 comprise 540 ft of the total bridge length, with end spans 4 and 6 measuring 155 ft each and center span 5 measuring 230 ft.

The overall bridge width for each bridge is 55 ft 9 in., with a roadway width of 50 ft. The superstructure includes three

AESTHETICS **COMMENTARY**

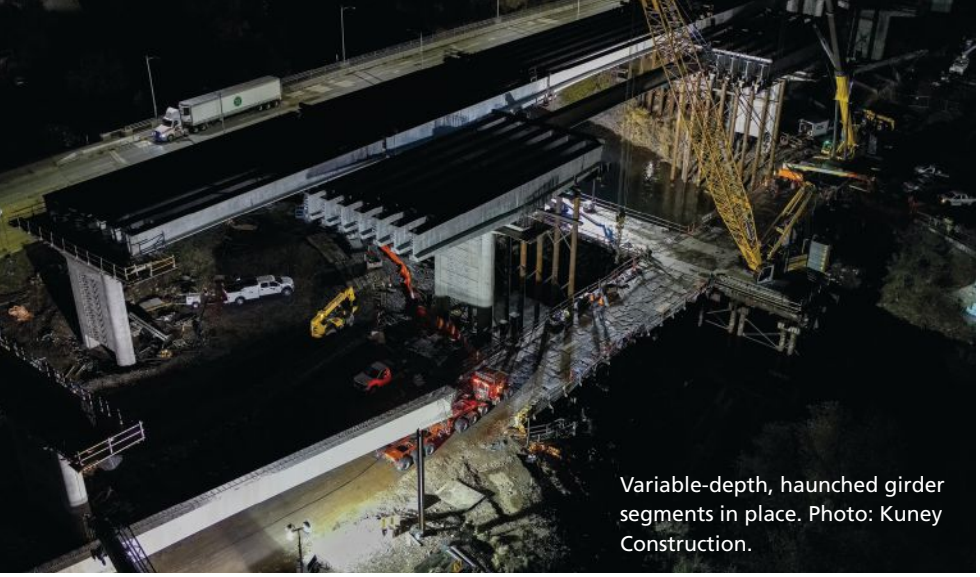
by Frederick Gottemoeller

The designers of the U.S. Route 395 North Spokane Corridor Spokane River Crossing were wise enough to recognize that they already had in hand a rare asset, a tradition of community stewardship for the river. That tradition meant that the community had already decided how to treat public structures that affect the river. So, the designers set up a dialogue with the community to work out exactly how that tradition would affect the new Spokane River Bridge.

Other designers worry that these kinds of efforts could increase costs. In fact, such efforts usually decrease costs. They head off community controversies and the resulting delays. If a project is delayed, especially a large project such as the Spokane River Bridge, the inflationary cost increase of even a few months' delay can eat up the supposed savings gained by a more conventional solution.

One decision that resulted from the community-outreach effort was to respect the adjacent historic Greene Street Bridge. That prompted the selection of longer-than-usual main spans that open views to the Greene Street Bridge and the river itself. Then, for structural reasons, the use of long spans prompted the designers to deepen the continuous girders using variable-depth, haunched girder segments over the piers. That creates visual evidence of where the forces are concentrated and how the structure is responding. Most observers appreciate that understanding. Finally, putting the soffits of the girders and haunched girder segments on continuous parabolic curves gives the bridge graceful, curved lines that complement the arches of the Greene Street Bridge.

But the designers didn't stop there. They also took advantage of the community's tradition in the design of the details, such as the pier wall panels, end caps, and column medallions. That gives the structure a consistent aesthetic theme that matches the aesthetic theme of the rest of the corridor. It also creates additional visual interest, which nearby observers will certainly enjoy. With the Spokane River Crossing, the designers and builders have created a civic asset that Spokane will long appreciate.



Variable-depth, haunched girder segments in place. Photo: Kuney Construction.

12-ft-wide lanes, a 4-ft-wide shoulder on one side, and a 10-ft-wide shoulder on the other. Other bridge components include an 8-in.-thick CIP concrete deck, CIP concrete pier caps with radiused bottoms, and CIP crossbeams, closure pours, columns, drilled shafts, and footings. The bridge exteriors include specialized finishes, with the exterior face of the girder, the CIP deck, and part of the CIP railing receiving a pigmented sealer, and the other part of the CIP railing receiving a fractured basalt finish with a concrete-staining treatment. Utilities are carried across the river by means of a hanger support system located between adjacent girders.

The design of the structure was based on HL-93 loading in accordance with the ninth edition of the American Association of State Highway and Transportation Officials' *AASHTO LRFD Bridge Design Specifications*,[2] with an allowance for 35 lb/ft^2 of future wearing surface. All work on the project is in accordance with the project's special provisions and WSDOT's 2023 *Standard Specifications for Road, Bridge, and Municipal Construction* and amendments.[3]

Precast Concrete Segments and Post-Tensioning (Spans 4–6)

The haunched girder segments were designed using lightweight concrete to keep the weight below 200,000 lb, which was a target weight based on plant lifting capabilities and truck hauling limitations. The lightweight aggregate was readily available from the supplier but was procured months ahead of production to allow shipping to be a backhaul for the trucking company and save costs. The concrete mixture design was developed specifically for the project, and some initial testing was completed before the bid to confirm the required strengths and unit weight could be met. The maximum specified unit weight of the lightweight concrete, including reinforcement, was 138 lb/ft^3.

Prestressed concrete drop-in segments suspended from the haunched girder segments whose ends are temporarily supported by falsework before post-tensioning is installed. Photo: Kris Brown.

These haunched segments had a design length of 98 ft, and each weighs 198,400 lb. The segments vary in depth from 8 ft 8½ in. at the ends to 12 ft at the center. They include 32 permanent 0.6-in.-diameter pretensioning strands. Each strand in every segment was initially tensioned to 43,900 lb. To help control the stresses from hanging the center drop-in segments from the haunched girder segments during erection, 18 of the pretensioning strands were located in

The girder lines of the southbound bridge are erected and ready for installation of post-tensioning. Photo: Knife River Prestress.

the top flange. All segments had a design concrete compressive strength at transfer of 7 ksi. The haunched segments had a 28-day concrete strength of 9.8 ksi.

The end segments are 103 ft 3 in. long and use normalweight concrete; each weighs 155,000 lb. These segments vary in depth from 6 ft 10⅝ in. at the lower end to 8 ft 7¼ in. at the higher end. They include 18 permanent and 2 top temporary 0.6-in.-diameter pretensioning strands and have a 28-day concrete strength of 9.5 ksi. The end segments include the four post-tensioning anchorages located only at the lower, or 6 ft 10⅝-in.-deep, end.

The center drop-in segments are 128 ft long, use normalweight concrete, and weigh 190,100 lb. They vary in depth from 8 ft 7¼ in. at the ends to 6 ft 10⅝ in. at the center. They include 20 permanent and 2 top temporary 0.6-in.-diameter pretensioning strands. The 28-day concrete strength for the drop-in segments was 10.5 ksi.

The bottom flange of each of the segments follows a parabolic curve. The segments' design includes four post-tensioning ducts with fourteen 0.6-in.-diameter post-tensioning strands per duct, for a total of 56 post-tensioning strands in each segment line. Special reinforcing bar jigs were developed to ensure that the ducts were supported in the correct locations throughout the production process.

Each segment included pretensioning strands to control stresses during lifting, handling, shipping, and erection. In the center drop-in and end segments, the pretensioning strands were designed to follow the profile of the parabolic bottom flange. To achieve the parabolic shape, the bottom strands were chorded along the bottom form soffit at 12-ft intervals. To handle the force from chord points, special holdup devices were designed and installed in the bottoms of the segments.

Special formwork was designed to produce the parabolic shape. The formwork used to produce the haunched girder pieces was nearly 17 ft tall and needed a special form stand that was designed to support the pieces of the formwork's side rail. All girder segments were cast inside the precasting facility and transferred to outside storage when completed. This process helped ensure quality control during production, a period of more than nine months.

Construction

The project was advertised to bidders in December 2022 and awarded to the contractor in February 2023. Construction began in May 2023. Erection of the southbound post-tensioned prestressed concrete girder segments began on October 14, 2024, and was completed on October 24, 2024. The haunched segments were set first, followed by the end segments and then the drop-in segments. The same order was followed for the northbound girder lines, starting on October 27, 2024, and finishing on November 7, 2024. Initially, three or four girders were set each night; by the end of the project, seven girders were being set each night. The Spokane River Crossing phase of the NSC project is slated for completion in late 2025.

Conclusion

When construction is finished, this bridge will improve north/south travel in Spokane and bring the entire North-South Corridor project one step closer to completion. The structure will create the opportunity for adjacent commercial and industrial development, improve user safety, and reduce collisions.

References

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3. WSDOT. 2023. *Standard Specifications for Road, Bridge, and Municipal Construction*. M 41-10. Spokane, WA: WSDOT. https://wsdot.wa.gov/publications/manuals/fulltext/M41-10/SS2023.pdf.

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