Replacement of the BNSF Truss 66.4 – A Multi-Level Approach to Accelerated Bridge Construction - Fabrication to Roll-On to Float-In

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ABSTRACT: The Burlington Northern Santa-Fe (BNSF) Railroad Bridge No. 66-4, is located along the Northern bank of the Columbia River Gorge between Portland and Hood Mountain Oregon. As part of BNSF's continued rail improvements throughout the Pacific Northwest, the circa 1900's 150 ft thru pin style truss bridge over the conflux of the Little White Salmon River was replaced with a new 336 ft ballasted thru truss bridge. This presentation will focus on the unique construction methods utilized to minimize the environmental impact to the river and the surrounding wildlife and go into depth regarding the accelerated bridge construction techniques used during the project, most notably the truss fabrication and complete truss assembly by the Fabricator at their fabrication facility, the transfer (SPMT) of the truss from land onto a barge for transport, repositioning the truss on the travel barge for float in and ultimately the float in and setting of the truss onto its new bearings. The presentation will also highlight the coordination and planning required between multiple entities including the owner, engineer of record, the U.S. Army Corps of Engineers and Bonneville Power Administration.

INTRODUCTION

The BNSF Railway Bridge No 66.4 was a 150ft thru pin style truss bridge spanning the conflux of Salmon River into the Columbia River joined with two 50ft Deep Plate Girder (DPG) spans on each approach. The bridge is part of the BNSF rail line located along the Northern bank of the Columbia River and services approximately 50 trains per day. As part of BNSF continued rail improvements, this direct fixation bridge was replaced by a new 336ft ballasted thru truss bridge and 2 ballasted precast box girder spans.

Due to the high train volume and importance of the rail line to the surrounding industry, replacement of the bridge needed to take place with minimal disruption to the rail traffic. Accelerated bridge construction (ABC) techniques were employed in the design of the new structure and in the construction means and methods for the bridge. HNTB designed the new bridge and supporting pier structures to allow construction of the foundation elements around the existing structure.

Advanced American Construction (AAC) was awarded the project and managed all of the construction activities. AAC self-performed all marine aspects of this project and worked closely with industry partners to subcontract key scopes such as: Micropile Foundation, Bridge Fabrication and Erection as well as Site-Civil. Genesis Structures was brought on board to provide engineering support to AAC for the float-out, roll-on and float-in work items.

JOBSITE CONSTRAINTS

The rail line is located along the north bank of the Columbia River and south of the Lewis and Clark Oregon Highway 14. The close proximity of the bridge to the bank line as well as Highway 14 required the use of barge mounted cranes to provide the required hoisting operations and was also the catalyst for the design modification from large diameter drilled shafts to micropile supported foundations. This allowed for much smaller drilling equipment to be operated on the small foot print around the existing bridge.

Due to these tight jobsite constraints, truss erection off alignment with a lateral slide installation proved unfeasible and therefore a full float-out and float-in concept was utilized.

The bodies of water surrounding the 66.4 site presented fixed and dynamic hazards to personnel and equipment. The existing pier wingwalls were submerged underwater and created blind hazards for barges and boats. Over the course of 2-hours, wind conditions would rise 20-30 mph and turn the water into white caps with large swells capable of capsizing boats. The project location was open and unprotected exposing crews to a very unsafe environment when the wind speeds increased. Our team monitored 6 weather channels daily for the duration of the project. We transitioned every possible task to not be exclusively tied to a barge move or crane pick. We made all barge moves and crane picks during times when winds were below 20-25mph and transitioned all ground/service work to times of high winds sometimes with gusts reaching 45-60mph.

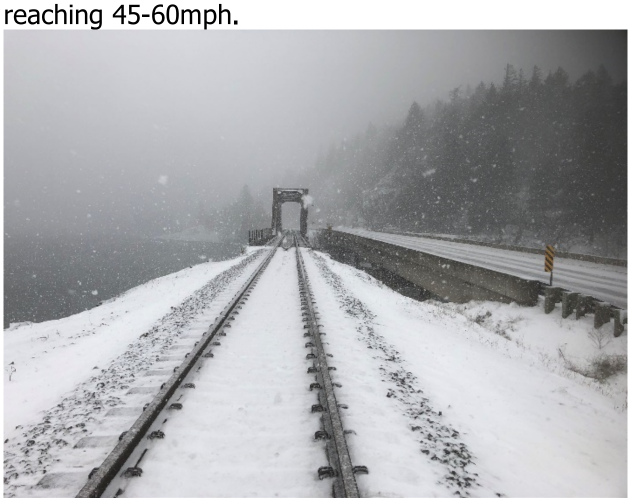

Figure 1 – Site Conditions

EXISTING TRUSS

The existing bridge was built circa 1900 and received numerous retrofits and upgrades thru its life span. The bridge sat upon large abutment style gravity retaining walls that were retrofitted to support approach DPG spans on either side.

The truss was constructed with common riveted structural elements with eye bars and pins for the lower cord elements. The truss was evaluated for being lifted from the first two lower panel points (L1 and L2) and it was found that no significant reinforcing was required on the existing members. The first two bays of the bottom chord was made with double channels laced together which afforded some amount of compression capacity which was needed when the truss was lifted due to the cantilevered bay on each end. The vertical members of the truss, including the first hangers, were also built with laced elements that provided adequate compression capacity for the lifting forces.

Figure 2 - Bridge Site

TRUSS ASSEMBLY & ROLL ON

The new truss was fabricated and assembled by Vigor Industrial LLC at their river front facility located in Vancouver, Washington. The truss was built in large units inside the fabrication facility and then brought outside with self-propelled motorized transports (SPMT) and assembled adjacent to the Columbia River.

Figure 3 - Truss Assembly

After the truss was assembled at the Vigor fabrication facility, the truss was hoisted by 4-10 axle SPMTs and walked approximately 1/4 mile to a loading dock. The truss was then loaded onto a 315ftx58ftx18ft deck barge. A detailed roll on plan was required that accounted for the changes in river elevation due to tidal effects, the ballasting of the barge tanks to help keep the barge as level as possible and to control the slope of the ramp from the dock to the barge. Four 2000 gpm pumps were used to move approximately 800,000 gals of ballast water during the roll on; pumping water into the tanks as the first set of SPMTs rolled onto the barge, removing that water as the SPMT reached midship, and then pumping water back onboard as the second set of SPMTs rolled onto the barge. The total roll on took approximately 3.5 hrs to complete.

Figure 4 - Truss Roll On

FLOAT-OUT BARGE

The float out barge system was made of two 150ft x 40ft x 10ft flat deck material barges. A steel grillage system was built on top of the barge to distribute the weight of the hoisted truss to the barge and to create elevated bearing points to lift the existing truss at elevation. To provide the vertical lift necessary to lift the 700kip truss, a total of 12 open top 21,000 gallon capacity tanker trailers, also known as Baker Tanks, were placed on the barges and then filled with a total of 1.8 million lbs of water. This ballast, once released from the tanks, provided enough lift to take the weight of the truss plus raise the truss approximately 1.5 ft.

The grillage structure and Baker tanks were shimmed at strategic locations on the deck of the barge. Inside the barge, these areas were also shimmed to the barge structural elements to eliminate local crushing or failures within the barge.

This same float-out system was previously used for the float-out of BNSF Br 58.8 in 2019 located just 10 miles west of Br 66.4. The addition of upper grillage beams allowed the two barges to be lashed together and still reach out to support L1 & L2 panel points.

Figure 5- Removal Barges

TRANSPORT OF TRUSS

After the roll on, the truss was prepared for transport to the bridge site up the Columbia River. The truss remained on the SPMTs and was lashed to the barge for transport. Two tug boats were used to transport the truss. The SDS Klickitat, a 1000 horse power tug, was in a tow configuration and the SDS Dauby, a 2200 horse power tug, was in a push configuration.

The tow navigated up the Columbia River thru the Bonneville Lock and Dam and arrived at the project site. The truss was transferred to a pair of temporary transfer bents located 200 ft south of the existing truss further out into the river but not blocking navigation. The barge was positioned between the temporary bents and was ballasted down to set the bridge onto the bents. This allowed the SPMTs to be removed and additional support grillage to be installed on the float in barge.

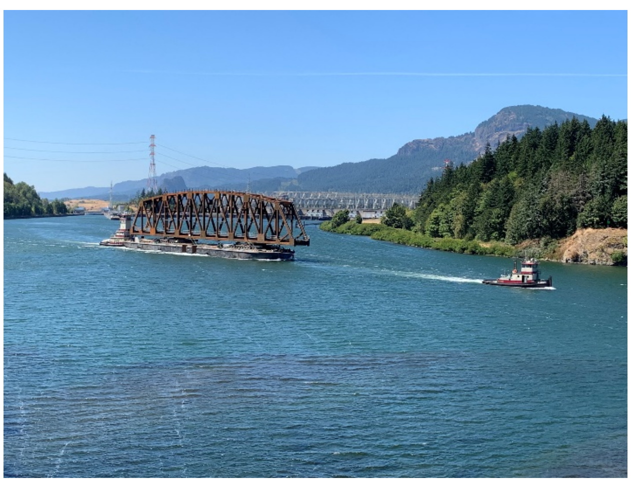

Figure 6 - Truss Transportation

FLOAT-IN BARGE CONFIGURATION

The float in configuration of the 315ftx58ft barge required the truss be oriented across the width of the barge transversely. Structural columns were welded to the sides of the barge near midship and 68ft long triple pack grillage beams were set on top of the columns. Timber blocking stacks (6ft x 6ft) were built on top of the beams to elevate the truss approximately 16ft above the deck of the barge.

3 days prior to the bridge closure, the float in barge was floated under the truss and the truss was lifted off the temporary bents. The barge with the truss was then relocated slightly downstream to allow the demolition barge to be positioned under the truss and prepared for the closure period.

Figure 7- Float In Configuration

CLOSURE PERIOD

The bridge closure period started the evening of Friday September 11th 2020 and was completed on Sunday September 13th 2020. During this track closure, the existing truss was removed, the existing DPG approach spans were removed, the new 336ft truss span was installed, new precast abutments were installed, existing abutments were demolished, new precast box girder approach spans installed and ballast placement and track installation and alignment performed.

3 days ahead of the track closure period, the float-out barges were positioned under the existing truss and moored for position. Hours before the track closure started, the final blocking between the float–

out grillage and the truss was placed, a small portion of the water ballast removed to hold position of the barge and truss and lashing installed between the truss and the grillage.

Bonneville Power Administration and the U.S. Army Corp of Engineers controlled the pool elevation above the Bonneville Dam which helped to control the river elevations at the project site. This allowed the float-out and float-in to be detailed and executed around a controlled river elevation range and assured the successful float-out and float-in of the bridges.

During the closure, to complete the required aspects of work, crane operations as well as movement of the barges, particularly the truss float in barge, are highly dependent on the jobsite wind speeds. The area is known for its persistent high winds with numerous times throughout the construction of the new piers, crane operations were ceased due to high winds. Monitoring of the current and predicted wind speeds was performed as well as matching them against collected historic wind data. Mother Nature cooperated as the winds lowered to near zero wind conditions during the bridge change out.

Once the track closure period began, the rails were cut. Ballast water was then released from the tanks on the float-out barge, tracking water levels in each tank to provide even lift on the truss. In approximately 1 hour, the existing bridge was lifted from its bearings and the float-out barge with the truss was moved aside and stored temporarily. Once the truss was removed, the two DPG approach spans were removed; one by a crane behind the West abutment and the other by a barge mounted crane.

Figure 8 - Existing Truss Removal

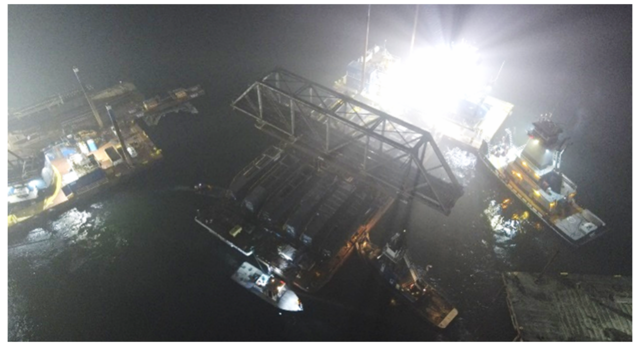

Figure 9 - Existing Truss Removal

With the float out barge now out away from the bridge envelope, the float in barge could be positioned for the float in. Multiple spud barges were joined to the float in barge and then the flotilla was positioned south of the bridge location but in alignment for pushing into the envelope.

The flotilla was pushed northward, using the spud barges as needed to help control movement and position. Because of the narrow opening between the existing piers, the spud barges could not be advanced all the way forward with the float in barge. They remained on the South side of the bridge while the tugs continued to push the float in barge northward, using the spud barges as guides and leverage. As the float in barge bow extended under the highway bridge, winch lines were run port and starboard to help control the position of the bow.

The float in barge was advanced until the truss bearings were within a few feet of final station and offset and come-a-longs were connected at the piers to help with the small adjustments to gain final position. Ballast was then added to the float in barge until we touched down on the bearings. Ballast was continued to be added to unload the barge of the truss weight and the cribbing stacks were partially removed and the float in barge was removed from the bridge envelope.

Figure 10 - New Truss Float In

Figure 11 - New Truss Float In

DEMOLITION OF EXISTING TRUSS

After the track closure was complete, the truss end segments from L0 back to L2 were removed along with a portion of the upper grillage that extended beyond the width of the float out barges. Once completed the remaining portion of the truss was lashed down and the system was sent back towards Portland and delivered to a river based recycling center for processing.

Figure 12 - Existing Truss Demolition

ACKNOWLEDGEMENT

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