Replacement of the East River Bridge

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Abstract

There are few industries that can boast having infrastructure with the same longevity as the North American Railroads. Maintaining bridge infrastructure poses its own set of unique challenges that can be attributed to many factors including age, designed carrying capacity, and the geometry of the structure itself. In order to keep trains running at the optimal track speed and protect operations, it is necessary to identify structures for rehabilitation or replacement. Bridge structures that exhibit a history of geometry defects requiring slow orders and ongoing structural concerns are ideal candidates for replacement.

The following project description will discuss the overall scope of work, challenges, and construction techniques utilized while replacing the bridge located at N-340.68. This bridge is located just west of the Virginia/West Virginia state line and is a double main two span open deck structure comprised of two 62-foot-long riveted steel plate girder spans with skewed back walls in a 7-1/2 degree curve carrying 3 inches of super elevation originally erected in 1899. The replacement bridge was a double main three span ballast deck structure measuring 221 feet long built along the same alignment supported by two new intermediate piers and two precast abutments that were all supported by 42 inch diameter drilled shafts. Both of the existing bridges remained in service until two separate 80 hour outages removed the existing superstructure and replaced it with the new bridge. At the end 1.4 million pounds of steel had been erected, 735 cubic yards of concrete poured, 514 cubic yards of precast concrete set, 271,000 pounds of rebar tied together, and the total duration was 1 year and 9 months.

The line of road on which the subject bridge is located dates from late 1881, when our predecessor Norfolk & Western Railroad (later Norfolk & Western Railway) commenced building westward from what is now Radford, Virginia, through the sinuous New River valley and into the Flat Top Coal Fields of Tazewell County, Virginia, and Mercer County, West Virginia. Coal mining operations in this region had begun in anticipation of the N&W’s arrival, and the first car of coal was loaded at Pocahontas Mine near Laurel Creek, Virginia on March 12, 1883, bound for tidewater at Norfolk. The following year, N&W built the first in a series of ever-larger piers and storage facilities at Lambert’s Point in Norfolk, culminating in our present Coal Pier 6.

The bridge we replaced at milepost N-340.68 was constructed by the N&W in 1903, with American Bridge Company’s plant at Edgemoor, Delaware, performing the steel fabrication. Historically known as Bridge No. 819, this double-track, two-span structure consisted of four open-deck, 62-foot-long, riveted plate girder spans on substructure of stone masonry. Both abutments and the middle pier were skewed at an angle of approximately 50 degrees relative to the span chords. Originally the middle pier was topped by four pairs of 15’ high steel columns supporting the span ends. In 1926 these steel columns were encased in unreinforced concrete, resulting in a pier stem measuring about 37’ tall and 78” wide. The inadequacy of this pier to resist modern longitudinal forces was among the primary considerations in our desire to replace the bridge.
During the 1930s the N&W undertook additional modifications to raise the elevation of the abutment masonry, employing a new type of cement known as Luminite. This cement was apparently marketed as having the ability to set rapidly with high strength. Our records state that this was the first N&W bridge at which Luminite was used. For unknown reasons, the Luminite cement proved unsatisfactory at this location, and the bridge seats and backwalls had to be reconstructed in 1942. In 1952, to accommodate the heavier tonnage of the loaded coal trains moving toward Norfolk, the N&W replaced the spans beneath the eastbound track with new plate girders fabricated by the Mount Vernon Steel Company. With only tie deck renewals and minor steel repairs occurring throughout the ensuing decades, this span renewal was the bridge’s last major rehabilitation work prior its replacement.

In order to reduce the overall material costs for tie decks the N&W predecessor railroad put super elevation into the steel superstructure. On Bridge No. 819 the steel was over rotated with the main one and two both having 2-3/8” super elevation for 1-13/16” super elevation at the rail. Raising blocks were attached to the bottom of the ties to give the deck the final 3” super elevation that the curvature required.

As the structure aged through the years the cast shoes began to cut into the masonry on both the high and low side of the bridge. This consequently showed surface defects at the rail and required continual maintenance to achieve the correct rail profile.

Due to the grade, curvature, and tonnage across the bridge maintaining proper gage, curvature, and replacing broken fasteners proved to be a constant struggle. An exotic tie deck comprised of azobe ties was installed in 1994 with pandrol plates. The deck was installed on the main one at East River as a potential solution to the countless man hours spent trying to maintain the bridge yearly. The azobe tie solution worked for over a decade and a half. However, the challenge of maintaining the bridge ends was only aggravated further by the presence of skewed backwalls and the ties began to show the average wear and tear. The main indicator of wear was plate cut caused by the interaction of the steel plate on the
exotic hardwood. Pandrol plates also have a smaller surface area than normal plates which only aggravated the plate cut condition of the ties. Lag screws holding the plates began to break and as the plate cut condition continued to deteriorate company forces had to constantly change plates on the deck due to the plates breaking in half along the e-clip shoulder. Rail cant and eventually rail roll over became a serious concern in the later stages of the tie decks life.

Access to the bridge was extremely limited. The nearest road crossing was almost a half mile to the east of the bridge and the ability to drive down the right of way from the east road crossing to the bridge proved to be impossible. To the west of the bridge was a rock cut measuring over 80’ tall. Protected by slide fences on the north and south side of the tracks, access from the west was virtually impossible as well. Before the merger of the Norfolk and Western and the Virginian, the Virginian had a viaduct bridge that spanned over the N&W just east of the N-340.68. After the merger with the Virginian, traffic was consolidated onto the original N&W mainline. The consolidation of traffic allowed the Virginian viaduct and track to be removed. The roadbed and east abutment remained. A maintenance road was established utilizing the former Virginian roadbed that came down the ridge from their east abutment to access the control point at Glen Lyn, just west of the old Virginia viaduct. This road came in on the south side of the main one track. The first phase of the project required the construction of a road that would allow equipment to access the east abutment of the East River Bridge. The road was constructed south of the main one track to eliminate the need to cross the tracks with trucks and heavy equipment. The construction road was over 425’ long and required going through solid rock. A hydraulic hoe ram mounted to an excavator working in tandem with an excavator with a bucket working over several weeks fought the road from the side of the mountain. At the completion of the road approximately 1,500 cubic yards of rock had been removed giving access to the east end of the bridge. The construction road was later extended down the embankment to the East River, crossed under the main one and two of the bridge and came back up the hill of the west abutment to grant heavy equipment access to the other side of the bridge.

The environmental permitting for this project involved complications related to Section 106 of the National Historic Preservation Act (NHPA) of 1966. This line segment was part of our Heartland Corridor Clearance Improvement Project, an initiative to improve vertical and horizontal clearances to accommodate double-stack container traffic between Walton, Virginia, and Columbus, Ohio. Through the Federal Highway Administration’s Eastern Federal Lands Highway Division (EFLHD), the federal government contributed funding for the Heartland Corridor project.

Pursuant to Section 106 of the NHPA, the FHWA and the various State Historic Preservation Officers (SHPOs) considered the potential effects of this corridor project on cultural resources. Ultimately, a memorandum of agreement (MOA) was developed stating that “the Norfolk Southern mainline railroad corridor between Walton, Virginia, and Columbus, Ohio, is eligible for listing in the National Register of Historic Places.” The entire corridor is considered a single property, and the bridge at Milepost N-340.68 was identified as a “contributing element” by this MOA, along with 111 other bridges and tunnels between Cowan, Virginia, and Bull, West Virginia. As a consequence of this blanket eligibility determination, we have experienced rather lengthy permitting phases for all bridge projects in this corridor where the U.S. Army Corps of Engineers, as a federal agency, has been involved in the review process, thereby triggering the NHPA Section 106 requirements. Each of these permitting endeavors has
eventually culminated in its own memorandum of agreement (MOA) among Norfolk Southern and the respective SHPO and USACE district regulatory branch.

For the subject bridge replacement project, the USACE Huntington District and the West Virginia Division of Culture and History (WVDCH) were signatories to the MOA, which stipulated that NS furnish Historic American Engineering Record (HAER) recordation photographs of the existing structure, provide reproductions of the original construction drawings, and complete a West Virginia Historic Property form for this structure. Copies of this documentation were made available to the WVDCH, the USACE Huntington District, the Mercer County Historical Society, the Eastern Regional Coal Archives, and the Norfolk & Western Historical Society.

Due to the engineering decision to lengthen the existing bridge by approximately 96’, new end bents had to be constructed 48’ behind the existing abutments. A new multi-piece precast abutment weighing over 233 tons would be sitting on four-48” drilled shafts. The bridge carries over 35 trains per day. The amount of traffic, building on the existing alignment, and the depth of the proposed bridge set created a challenging construction environment. The excavation was shored using sheet piling. The track was supported over the excavation by jump spans. The jump spans were specially constructed for this project having an overall length of 30’ and an unsupported span length of 19’. These would support the rail vertically and laterally allowing the excavation and drilling of the four-48” caissons. False work consisting of interlocked 25’ Z-27 sheets were driven prior to the installation of the jump spans to minimize the window required for installation. Outages were obtained that allowed the track panel to be removed as well as the ballast section and fill between the sets of sheets. Walers and bracing comprised of W 12X53 were installed according the engineer’s design.

Plan view of the west abutment
The jump spans were not manufactured to carry the super elevation required by the curve. Consequently, the sub grade underneath the bearings had to be graded and maintained to carry the prescribed super elevation. Another problem encountered was that the jump spans were in service in signaled territory and therefore had to be insulated in order to prevent the accidental shunting of the track. All bolts tying the spans together at the diaphragms were placed through specialty collars and washers that prevented the exterior of the bolt from contacting the diaphragm. This effectively insulated the jump span. Additional precautions were taken by placing thick rubber pads under the base of the rail and around the base of rail clamps on each rail to act as a redundant method of insulation. Daily inspections were performed to ensure that all fasteners held tight.
The construction road was too narrow and steep to allow mobilization of a crane of sufficient size to set the spans. An alternative means of mobilizing a crane had to be found. The middle span, span two, was the heaviest lift requiring the longest reach. It was determined that two Manitowoc 888 crawler cranes would be the appropriate pieces of equipment to make this lift. Each crane required its own fleet of tractor trailers to carry the tracks, machine housing, counterweights, lattice booms, and rigging equipment. Both cranes had a footprint of 24’ x 30’. It was determined that the best method of bringing the cranes in would be to partially construct them in the lay down area by the road crossing, walk them on to flat cars, and then walk them off on site. Due to an overhead walkway clearance issue a temporary ramp had to be constructed on the field side of a 9.3 degree left hand curve with 4” of super elevation.
Double track outages were obtained due to the issue of fouling the adjacent track by the tread on the crane (10’ overhang from the car). The cranes were loaded onto a heavy duty flat car with a 400,000 pound capacity and brought out to the bridge via work train. The crane had to be moved on the car multiple times due to navigating the curves and encountering different super elevation in each curve. Blocks were stacked and the crane offloaded by walking down the blocks on site.
Tramming west with the first crane

Offloading crane on the east end of the bridge
At 5:00 AM on Monday, September 2\textsuperscript{nd} a safety briefing was performed with over 50 contractors and Norfolk Southern personnel. Shortly thereafter an 80 hour outage that was coordinated with the Transportation Department to allow the replacement of the main two bridge was granted. Adjacent track outages were also coordinated to allow the demolition of the main two from the main one track. For the entire length of the 80 hour window conditional stops were in place to provide protection on the adjacent track. At the end of the first window of track time the main two was finished in its entirety. The same planned outages were also coordinated for the demolition and construction of the main one track.

On the morning of Tuesday, September 10\textsuperscript{th} the countless hours of hard work and sweat poured into this project culminated. The final pull was made on the main one track panels and trains made their way across the deck. The ability to replace a bridge in an inaccessible area under the requirement of maintaining the train service that our customers demand is a testament to Norfolk Southern, L C Whitford, and all the sub-contractors involved in this project.
East River Bridge Replacement Virginia
Division Milepost N-340.68
Excessively Steep End Slopes & Highly Sensitive Hydraulics

Embankment Erosion at Abutments

Tie Arrangement at Skewed Backwalls

Access Road from the Former Virginian Ry. Roadbed

Historical Significance of Existing Bridge

Site Geology Map

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Drilled Shaft Load Summary

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Plan & Elevation Views

Layout of Temporary Shoring for Drilled Shaft Installation

Section of Temporary Jump Span for Abutment Construction

Installation of Sheet Piling for Abutment Construction

Insulation on Jump Spans
Excavation for Installation of Jump Spans

Completed Jump Span

Waler and Bracing Complete

Excavation Complete

Jump Span Under Load

Drill Rig
Drilling of Caisson

Cobbles Encountered

Advancing Steel Casing Pipe

Installation of Rebar

Caissons Being Drilled in the Creek

New Abutment Cap
Installation of Precast Cap at East Abutment

Completed East Abutment

Walking Mantis Crane to West End

Installation of Precast Cap at West Abutment

Continuation of Railway Operations

Stem Walls and Caps Taking Shape

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Living in the Present

While Celebrating our Past

Main One Outage

Main One Outage

Main One Outage

Main One Outage
Main One Outage

Completion

Questions?