McKinley Bridge Inspection and Design

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ABSTRACT

This article describes the inspection philosophy for the McKinley Bridge and the methodology used for its rehabilitation, both of which kept public safety as the highest priority while maximizing the limited funding available. The bridge was owned and operated by the City of Venice, IL, and is now under the jurisdictional control of the State of Illinois, Department of Transportation. The inspection methodology followed the National Bridge Inspection Standards (NBIS) requirements; however, the inspection philosophy emphasized concentrating inspection time and resources into those portions of the bridge that were most likely to fail or most likely to become a hazard to the traveling public. The existing bridge includes a variety of common construction materials and methods, including the use of steel girders, steel trusses, timber trestles, reinforced concrete viaducts, reinforced concrete decks, wooden decks, and concrete-filled steel grid deck, which were open and closed to the traveling public at various times. The inspection resources given to each portion of the bridge were weighted based upon their structural importance, usage, and degree of deterioration. Due to the targeted use of resources, the bridge was kept operational for many years past its normal useful life.

Eventually, with limited maintenance funding, it could no longer be kept in operating service, and the State of Illinois closed it to public use. Realizing that the McKinley Bridge was needed as a vital link in the St. Louis Metropolitan area, especially until the new downtown bridge is built, the State of Illinois decided to fund the rehabilitation of the bridge. All of the approach spans and deck trusses are being replaced; however, the main through trusses will remain, with the exception of the cantilever roadways. This was all based on keeping public safety as the highest priority while still making the best use of the funds available for rehabilitation.

INTRODUCTION

This presentation, and the article on which it is based, describes the inspection philosophy for the existing McKinley Bridge and the methodology for the redesign of the rehabilitated McKinley Bridge. The purposes of the article are to convey the history of an interesting structure and a challenging project, and to possibly aid those who have the responsibility of maintaining and rehabilitating venerable long-span steel truss bridges and extensive steel girder viaducts.

HISTORY AND CONFIGURATION OF THE BRIDGE

The 5,798' long McKinley Bridge, designed by the great bridge engineer Ralph Modjeski, was opened November 10, 1910. He was apparently proud of this significant design, as a hardcover booklet composed of photographs and engineering drawings of the bridge was produced soon after construction was completed. The bridge connected the cities of St. Louis, Missouri and Venice, Illinois, to permit the passenger trolley cars of the St. Louis Electric Bridge Company to cross over the Mississippi River. It originally carried two lanes for vehicles and two railroad tracks, which carried both trolleys and freight trains.

The three main river spans of the bridge are each supported by two 520' long simple-span camelback through trusses, 80' high (max), 29'-8" apart (center to center). The top chords and the verticals are riveted steel box sections, and the bottom chords consist of 6 to 10 steel eye bars, except for the last two panels at each end, which are double box sections. The diagonal members are a mixture of riveted box sections and eye bars. Riveted I-section floorbeams with north and south cantilever brackets frame into each truss panel point. Four stringers, each under the location of the rail of the original tracks, span between floorbeams inboard of the trusses. The original deck between trusses consisted of wooden ties spanning between and cantilevering over the four stringers. The vehicular roadways run outboard of each truss. The original outboard roadway framing consisted of five wooden beams continuous over two spans. The center floorbeam of the cantilever roadway was supported at each end by an interior and an exterior roadway girder. In turn, the interior and exterior girders were supported by the cantilever brackets. The through truss spans are seated upon steel grillage bearings, which are supported on four tapered granite and concrete piers, roughly oval in cross-section. These piers are founded on caissons which extend down to bedrock.

Flanking the through truss spans were two simple-span deck trusses in Illinois and three simple-span deck trusses in St. Louis, varying in length from 150' to 250'. The top chords, verticals, and compression diagonals consisted of riveted steel box sections, while the bottom chords and the tension diagonals consisted of steel eye bars. Floorbeams ran continuously from south to north fascia, and were supported atop the panel points of the top chords. Supporting the truss bearings were either solid tapered concrete plinths or individual concrete pedestals. Both the track and roadway stringers and the railway and vehicular decks were similar to the original through truss spans.

Simple span steel viaducts extended from the deck trusses to the abutments. The majority of the viaduct length consisted of two separate framing systems: The structure carrying rail consisted of four simple span track girders framing into steel cap beams, supported on steel columns. The vehicular structure consisted of two-span continuous stringers supported by a floorbeam, which in turn was supported by two simple-span girders. The interior girders framed into a cap beam supported at the piers by steel columns, while the fascia girders framed directly into the columns. Both railway structures and vehicular structures had open expansion joints at every third bent.

Columns were supported on individual concrete pedestal footings. There were four spans over roadways or railroad tracks that consisted of stringers, floorbeams, and through girders. There were originally 60 approach spans on the west side of the bridge, and 13 steel approach spans on the east side. The east approach track and roadway were similar to those on the main span, with two tracks located between vehicular roadways. The eastern section of the west approach had a similar configuration to the St. Louis deck trusses. Due to the presence of an original spur track and a theoretical mapped street below, at Bent W28 in St. Louis the alignment shifted so that the south roadway crossed the tracks and created a two lane roadway on the north side of the structure. The south side of the structure carried both railway tracks west of Bent W28. These structures west of Bent W28 were known as the "EB Chute" and the "WB Chute". Due to this crossover, the horizontal geometry of the bridge was very poor, with some changes in direction lacking appropriate horizontal curvature for modern vehicular traffic. The railway approach spans were built with heavy primary members and transverse and longitudinal bracing of the superstructure and the steel substructure. The primary members for the roadway were built with light framing, with light superstructure bracing. The columns supporting the track structure consisted of built-up box shapes, while roadway columns consisted of a two channels connected with lacing. Some of the columns extended to 40' (+/-) in height. The total length of approach spans equaled 2564' on the St. Louis side and approximately 665' on the Illinois side, all built with timber deck.

In 1928, the Illinois Traction System expanded services and became known as the Illinois Terminal Railroad. In 1935, a railway line named the Branch Street Viaduct was constructed in St. Louis, and this line was connected to the McKinley Bridge at the easternmost deck truss span in St. Louis. An additional deck truss was added to this span, and additional structural and track modifications were made in order to permit the Branch Street Viaduct trains to switch onto the main tracks. In the mid 1950s, all the north and south exterior wooden roadways were replaced with 3" deep concrete-filled steel grating. On the truss spans, wooden stringers were replaced with six 14" WF beams per cross-section.

The east abutment was unusual. Because the bridge had been designed to carry both rail and vehicular traffic, and because major renovation work had occurred to parts of the structure at different times, the centerlines of bearing for the eastbound and westbound roadways of the east abutments were offset longitudinally by approximately 55'. The last four spans of the eastbound roadway were rebuilt in the mid-1960s. They consisted of a reinforced concrete deck supported by five wide-flange stringers in cross section. These stringers were salvaged from another project. These simple spans were supported by concrete cap beams on concrete pile bent piers and a concrete stub abutment. The last seven spans of the westbound roadway consisted of a timber deck supported by timber beams, which were supported by a timber trestle substructure, including a timber breast wall bearing seat abutment.

In 1958, the railroad sold the bridge to the City of Venice. Funds for the purchase were obtained by bonding, to be repaid by tolls. As part of the bond document, Hardesty & Hanover was responsible for performing an annual bridge inspection and reporting the inspection findings to the bondholders.

In 1961, the rails were removed from the west approach spans and west deck truss spans, and replaced with a 6" deep reinforced concrete deck. The trolleys were removed from the bridge, and the trolley station located on the structure near the west abutment was demolished. All freight trains now entered and exited on the St. Louis side of the bridge from the Branch Street Viaduct, and one track was removed from the interior roadway of the through trusses and the east deck truss spans and approach spans, leaving one remaining track.

In 1977, the last train crossed the McKinley Bridge. The remaining track and the wooden deck remained on the inner roadway of the through trusses and on the east deck spans. The wooden deck consisted of long wooden railroad ties covered with asphalt, but rotting and splitting of the ties had caused potholes to form, which in turn permitted leakage onto the superstructure and created an extremely poor riding surface. The inner roadway on the through trusses was in such poor shape that most trucks chose to use the outer cantilever roadways. Although the cantilever roadways did have sufficient deck and superstructure capacity for these trucks, overuse accelerated deterioration. Fortunately, traffic was at a reduced level due to the inferior nature of the deck and the presence of the toll-free bridge downstream.

Due to the condition of the bridge, Congressman Jerry Costello was able to obtain Federal funding for rehabilitation as a Demonstration Project. These funds were administered through the Illinois Department of Transportation (IDOT). In 1994, the Norfolk & Western Railroad officially vacated the bridge, and replacement of the wooden deck with an 8" thick reinforced concrete deck was performed, along with railing replacement and minor structural steel work. This was the last major rehabilitation before it was finally closed to traffic.

DEFECTS AND COUNTERMEASURES DURING SERVICE LIFE

The advancement of the Interstate Highway Act during the mid-20th Century inadvertently had an adverse effect on the ability of the McKinley Bridge to generate sufficient toll revenue to maintain the bridge in good repair. Most riders now used the free Poplar Street Bridge downstream, which carries several interstate highways. The number of vehicles crossing the McKinley Bridge fell significantly in the 1960s, reducing the toll income. A high percentage of the remaining traffic consisted of heavy trucks, because McKinley provided a faster trip across the river to North St. Louis, MO, than the Poplar Street Bridge, which was often crowded with traffic. Although they paid higher tolls than passenger vehicles, these trucks caused a significant amount of deterioration, especially to the reinforced concrete deck. Plowing and salting the roadway caused further damage and deterioration to joints, decks, and the underlying superstructure and substructure at the joints. The original configuration of the bridge, combined with various deck replacements, created open longitudinal deck joints. There were also numerous transverse deck joints in various states of disrepair. Due to concrete creep and to corrosion exfoliation growth of the bars in the steel grid, concrete-filled grid decks have a tendency to expand over time. This growth is increased in the warmer months by thermal expansion. The skews and poor horizontal geometry exacerbated the movement of the concrete-filled steel grid deck.

The bridge is located in an old industrial area of St. Louis, and often the owner had difficulty enforcing its right-of-way boundaries, creating additional problems. Trucks would often park beneath the bridge, sometimes impacting and bending the columns.

The business that had the largest impact, literally, on the bridge was a scrap metal business. Their trucks would often strike the columns, and heavy pieces or piles of scrap metal would be stored against the columns. This would be noted during the inspection, and the pieces would be taken away, but new scrap would often be placed there after the old scrap was removed.

There were three mitigating factors, however, that permitted the bridge to remain in service as long as it did. The first was its origin as a railroad bridge designed for Cooper E-60 locomotive loads. Despite corrosion losses, the truck load ratings of many of the original railroad structure members were still more than adequate. The second was the direction of the Hardesty & Hanover (H&H) inspection crews, who located problem areas during the inspection, listed them in the annual reports, and designed emergency repairs. The third was the ironworker crews from Alberici Inc. that were kept on semi-permanent retainer. A crew, consisting of a foreman and two ironworkers, became quite familiar with the different bridge repair conditions. The repair funds were limited for the tasks required, and the ironworkers would make very efficient use of whatever funds were available. These crews would take the emergency repair sketches and drawings made by H&H, order material, and erect it themselves. They often performed repair steel fabrication themselves. Often these ironworkers would obtain material needed for steel repairs from the scrap yard located beneath the bridge. The repair work done by the ironworkers was overseen by Juneau Associates, Inc. (JAI), the local liaison firm.

During 43 years of inspections, H&H had the difficult task of prioritizing repairs due to funding limitations while maintaining public safety for the users of the bridge. The early years of the inspections occurred before the NBIS requirements had become law. After NBIS regulations went into effect, inspection and reporting requirements for IDOT were completed every two years. Over time, the inspection crew grew to four-to-six people, who were aided by a 60' manlift truck and an underbridge inspection vehicle. Later, two engineers would inspect for an additional week. In two of those years the additional week of inspection was performed in January and in one year the additional week was performed in July, which allowed documentation of how the bridge functioned at the extreme service temperatures.

H&H concentrated most of its inspection effort at the areas beneath the badly leaking transverse and longitudinal joints. At expansion joints there were expansion saddles for interior girders and expansion seats for the exterior girders on one side of the cap beam or column. The expansion seats consisted of sliding plates bearing on steel seat brackets that were part of exterior columns. The sliding plates were connected to their seats with anchor bolts that passed through slotted holes in the plates. The saddles consisted of two triangular plates riveted to the cap beam web via vertical connection angles. Horizontal angles were riveted to the bottom of the triangular plates, and a plate would be bolted between the outstanding legs of the angles and the bottom flange of the girders, using slotted holes. The deck joints located above the seats usually leaked badly. The faying surfaces between plates and angles would provide numerous places for dirt and moisture to become trapped, creating perfect conditions for corrosion. Severe section loss occurred next, so much so that a few hammer blows would create holes throughout the bottom of the vertical triangular plates. Several saddles had to be replaced twice, so saddles were redesigned to have fewer surfaces that would trap dirt and moisture.

At one location, not only did the interior girder saddle have severe deterioration, so did the end of the girder and the bottom flange of the end cap beam at the interior girder connection. Therefore, traffic was diverted from the lane above the connection, while a temporary repair was designed and detailed. The repair called for replacement of the bottom flange of the cap beam, and a sling support for the interior girder. This support consisted of a longitudinal beam that was bolted to the interior girder on the fixed end side of the cap beam. The other end of the longitudinal beam supported the end of the interior girder on the longitudinal side of the cap beam. Expansion was accommodated by bolts placed in horizontal longitudinal slotted holes.

The longitudinal joints between deck sections permitted leakage onto the girders below. The configuration of the framing caused most of the deterioration to occur on the interior girders of the vehicular roadways. These lattice girders usually were composed of pairs of top and bottom angles connected by laced web bars and full-depth end web plates. The outstanding leg of the bottom flange would become severely corroded. H&H called for either replacement of bottom flange, or for replacement of the entire girder, as needed.

The tendency of the concrete-filled steel grid deck to expand caused a dangerous condition where there were no expansion joints between piers in long spans. During rapid temperature rise, this expansion would frequently occur quickly in a violent movement that would cause the deck to buckle upward, as much as 12 inches. When this happened, portions of the deck would be sawcut and removed, and the remaining deck in the location of the removed section would be welded to the top flanges of the supporting stringers. If a section of deck appeared ready to buckle, it would also be sawcut and removed.

Due to expansion, the grid deck would arch upward if it were oriented transversely. If the stringers on the cantilever roadways were still welded to the deck, the deck would lift the stringers up off their seats and above the floorbeam. If the beams were misaligned, they would be reset and shimmed. If they were aligned, they would be left alone. The arching action was so strong that a 30' underbridge inspection vehicle was not heavy enough to force the stringers back on their seats.

In Span B-C, the deck truss spanned 150', and crossed over the St. Louis side levee. The levee at this location consisted of a reinforced concrete wall. However, the height of the levee required at this point was higher than the elevation of the bottom chord of the truss. Therefore, at the chords four steel plates 6' high and 2' wide replaced reinforced concrete. Each plate had a space for a rubber gasket that fit around the four bottom chord eyebars. Each year, the distance between the gasket and the bottom chords was inspected so as to ensure that the levee was not sinking and therefore not adding load to the bridge.

The locations at which horizontal alignment changed were carefully inspected for unusual movements or conditions. One location was at the expansion bent at Bent W45. Three non-redundant through girders carried the eastbound (vehicular structure), and the westbound (railroad structure) roadways. During one inspection, the south girder was found to have moved southward by approximately 8" from its original location, so that only 50% of the bearing area was supported on the cap beam. A cap beam extension was designed that was braced by a strut to the south column. In order to transfer horizontal force from the cap beam extension through the column, a brace was added to the opposite side of the column, connected to the cap beam bottom flange.

The reinforced concrete deck from 1961 was only 6" thick, and damage done by heavy trucks caused severe deterioration. By the mid-1990s, truck traffic resulted full-depth holes in sections of the deck, which had to be repaired.

REHABILITATION PROCESS

In 2000, IDOT assembled a team of in-house and outside consultant engineers for the McKinley Bridge Rehabilitation design process. Teng Engineers performed four independent inspections over a period of 18 months. H&H was the lead design firm, designing the structure and horizontal and vertical geometry layout. For the design team, H&H chose the firms of Geotechnology, Inc., for subsurface exploration and preparation of the geotechnical report, and KAM Engineering, Inc., for highway and utility plans. Juneau Associates continued their role as the local liaison for H&H. Louis Berger, Inc prepared the BCR and the required environmental documents. During the design process, public involvement meetings were held in both Illinois and St. Louis.

Once rehabilitation had been chosen, deciding how much of the existing structure should be salvaged was next. Various options were considered. While traffic on the bridge was still allowed, all options utilized staged construction with no trucks permitted, including:

- Rehabilitating the EB "Chute"; Demolishing and rebuilding the WB "Chute" offline
- Rehabilitating the WB "Chute"; Demolishing and rebuilding the EB "Chute" offline
- Replacing the entire west end of the St. Louis Approach with no offset
- Replacing the deck and repairing superstructure, and encasing steel columns in concrete on the east end of the St. Louis Approach and the entire Venice Approach
- Replacing the east end of the St. Louis Approach and the entire Venice Approach
- Rebuilding some of the St. Louis approach spans on structure and some on grade using MSE retaining walls

By the end of 2001, despite an earlier weight restriction of 8 tons, the bridge condition continued to deteriorate. Therefore, IDOT decided that the bridge should be shut down. Since the bridge was now closed, there was no need for staged construction. The cost of rehabilitating the approach spans to present-day seismic and structural capacity standards was close to the cost of demolishing and replacing them. The approach spans did not have the same historical significance as the deck or through truss spans. Therefore, the decision was made to choose replacement of the approach structures.

Whether to keep the deck trusses in place was a more difficult decision. IDOT considered keeping them in place, partially due to their historical significance, and partially to reduce costs by decreasing the amount of approach structure required. However, there were disadvantages in re-using the deck trusses. As simple span trusses, they are globally non-redundant structures that have Fracture-Critical bottom chords. Since the chords consist of eyebars connected by steel pins, both eyebars and pins are Fracture-Critical members, which require hands-on inspection during each biennial NBIS inspection, and some of the individual bottom chords consisted of two eyebars only, one on each end of the pin, which made them internally non-redundant. The existing eyebars have forged heads, which are known to be susceptible to fatigue, brittle fracture, stress corrosion, and internal flaws brought on by the forging process. Finally, the Mississippi River rises to the level of the bottom chord every 10 to 20 years. Flood water and debris in the water cause severe lateral load on the bottom chord. For these reasons, it was decided to demolish the deck trusses, and extend the new approach structure to the existing river piers.

The final decision on what was to remain concerned the through truss spans. The trusses themselves were in surprisingly good condition. All members above the deck were in very good condition, despite not having been painted in over 40 years. Most of the paint was gone, but a patina of rust that appears somewhat similar to the patina of weathering steel has formed on the exterior of all truss members. Below deck, the eyebar members had pack rust forming at the pins where as many as 10 eyebars meet, but there was little to no section loss. Although the eyebars are subject to the same potential problems as those on the deck trusses, the great number of eyebar heads meeting at a single pin reduces greatly the effect of a crack in any one eyebar. The box beam members at the first two bottom chord panels at either end of the truss had significant longitudinal holes, but they did not constitute enough section loss to seriously lower the load rating. The holes are being repaired during the construction contract. The reinforced concrete deck of the interior roadway constructed in 1995 was retained. The two areas on the through truss spans that were in poor condition were the cantilever roadways. The bowed, cracked, and holed-through concrete-filled steel grid deck, stringers pulled upward away from their seat angles, and cantilever brackets and tension strap angles for the cantilever brackets having section losses made it an easy decision to replace both cantilever roadways.

NEW STRUCTURE

The rehabilitation / reconstruction of the McKinley Bridge had to be designed and built relatively quickly, with minimal funds expended and with IDOT standard construction techniques and products used, while still providing a safe structure for the public and meeting structural and roadway standards for IDOT state highway bridges. These were the criteria on which the design was based. The roadway cross-section chosen was two traffic lanes with two 4' wide shoulders on the approaches, and two interior lanes with full 12' wide lanes outboard of the through trusses. The typical curb-to-curb width on the approach structure was 32', with typical out-to-out width of 35'-2". Roadway width tapered outward as it met the through truss spans from either direction. The cantilever decks on the main spans will be used only by bridge inspection vehicles, pedestrians, and bicyclists.

SUPERSTRUCTURE

The superstructure of the new approach spans consists of steel multi-girder spans with a 7-1/2" thick reinforced concrete deck. Space considerations prevent further discussion.
The new main span cantilever roadways, while not designated for use by normal vehicular traffic, had to be able to support maintenance and inspection vehicles.

Therefore, the cantilever roadway deck and superstructure were designed for HS-20 trucks. Also, these spans were to be used as the bicycle lanes for the main through truss spans. The existing cantilever roadway had an exterior railing supported by posts bolted to the web of the fascia girder; the new cantilever roadway has a steel shell safety-shape parapet with a single railing atop it. The steel shell barrier was chosen for the parapet as it is lighter than a comparable concrete barrier. The new cantilever roadway deck is no wider than the existing roadway deck; however, the interior curbline is further from the centerline of truss than was the existing, and the new roadway exterior deck extends all the way to the back of the parapet. This brought the exterior edge of the deck to 17' from the centerline of truss, compared to the existing deck exterior edge at 15'-10" from centerline of truss, and with a relatively heavy line load at the edge of deck due to the parapet. Finally, the existing 3" grid deck was relatively light. It was thought desirable to limit the new dead load to be supported by through trusses and main span piers, in order to minimize cantilever bracket load and to limit the seismic demand on existing piers.

An analysis was performed in order to determine what type of deck would be the best choice on the main through truss cantilever roadways. The lightest deck would be an open steel grid deck. However, this would permit water to flow directly on the steel members below. Worse, it would be dangerous as a road surface for cyclists and vehicles, as open-steel grating is slippery when wet, and is jarring both on tires and the cyclists themselves. The usable choices were for a typical reinforced concrete deck, a steel grid deck partially filled with concrete, and a steel grid deck composite with a concrete deck. The lightest choice per square foot, including the weight of the steel framing below, was for the steel grid deck composite with concrete deck. The steel grid deck is also somewhat faster and safer to build, as the form work is added in the shop, and it requires less reinforcement than a typical reinforced concrete deck.

For all the reasons noted above, a steel grid deck composite with a concrete slab was chosen for the deck of the new cantilever roadways on the main through truss spans. This composite steel-concrete deck consists of a steel grid made of T-section main bars, and transverse distribution bars. The concrete deck extends onto the top 1" of the steel grid, making the steel grid take tensile loads, and the concrete deck take the compressive loads. At McKinley, the concrete deck extended 3.375" above the top of the steel grid, ensuring that the concrete would be in compression in positive moment areas. In negative moment areas, steel reinforcement bars take negative moment tension above the stringers. The steel grid deck composite with concrete deck has a 49" center-to-center span. Main grid bars are WT 4x5's at 11-1/2" spacing, distribution grid bars are 1-1/2" by ¼" rectangular bars, and both main and longitudinal reinforcement bars are #5 bars at 6". Galvanized sheet steel was installed in the shop for use as bottom of slab formwork. Lightweight concrete was used in place of standard weight concrete, with compressive strength specified to be 4000 psi. As speed of construction on the cantilever spans is not a prime concern, the panels will be filled with concrete in the field. This provides panels that are lighter to transport and erect, while the sheet metal added in the shop eliminates most of the need to place formwork in the field. Galvanized sheet metal formwork added in the field permits creation of stringer haunches. The only other formwork pieces required to be field installed are 7" sections between panels that rest on the WT flanges. Cantilever roadway framing on the through truss spans consists of four stringers in cross section spanning 28'-9" between cantilever brackets. Shear studs extending through haunches and steel grid permit the stringers to act compositely with the concrete.

New cantilever bracket size, number, and location must match the original cantilever brackets, and maximum cantilever bracket depth must match the depth of interior roadway floorbeams. Tension created by the cantilever moment is transferred to the top flange of the inner roadway floorbeams by pairs of strap angles. So as to avoid interference with the truss verticals, strap angles are connected to new horizontal gusset plates on both cantilever bracket and on inner floorbeam sides. These gussets had to be wider than the truss verticals. In order to install new strap angles and new inner floorbeam gussets, known as "wing plates" due to their shape, a 4' by 4' section of the existing concrete deck and curb had to be removed at curblines at every inner roadway floorbeam. Mechanical couplers were used to splice new reinforcement into these areas. At the bottom flange of original interior cantilever brackets, compression generated by cantilever moment was taken by gusset plates riveted to the bracket bottom flanges, to the bottom of the truss verticals, and to the bottom flange of the inner roadway floorbeams. H&H believes that the rivets to the truss verticals should not be disturbed, as these gusset plates also connected to the bottom chord diagonal bracing. Instead, a thick fill plate containing several holes was placed over the gusset, the holes placed in order to avoid existing rivets. New gusset plates were bolted to both the cantilever bracket bottom flanges and inner roadway floorbeam bottom flanges. These gussets were connected by a T-shaped weldment.

As the new brackets had to connect to existing members, it was important that connection detailing be done as accurately as possible. Since the through truss joints have several different gusset plate connections, five different connection details had to be detailed for the connection between the brackets and the existing truss verticals and inner floorbeams. The original shop drawings were invaluable in performing this task. These shop drawings are available to the Contractor for use in erection and detailing. However, field measurements are still required for these purposes.

SUBSTRUCTURE

Space prevents much discussion of the new substructure. Most new piers consist of pile bents with reinforced concrete cap beams, while the remainder consists of solid stem reinforced concrete piers with reinforced concrete footings. Typically, the solid piers were built on top of the existing ground due to the contamination of the soils in the area. Several existing piers are being reused, with various degrees of modifications.

NEW BIKEWAY

After the construction contract was let, a decision was made to add a 12' wide pedestrian/bicycle lane to the south side of the bridge. Under a separate expedited contract, H&H redesigned the Illinois approach spans, 750' of Missouri approach spans, and designed 800' of new structure, all concurrent with preparation of shop details, ordering of material, and the start of construction. Proceeding westward and southward, the pedestrian/bicycle lane continues on the old Branch Street Viaduct, which is being rehabilitated for this purpose. HNTB designed the remainder of the bikeway project.

AR-039