



Historic Bridge Bulletin

From the Director's Desk

November is Historic Bridge Awareness Month. Bridge enthusiasts promote November as the month to raise awareness and to give special recognition to historic bridges. We urge you to think of ways during the month to support historic bridges and spread the word about their importance to our heritage. Your donations to HBF can help. Along with our desire to share information with you about historic bridges through our newsletter, your donations will help support of our mission. Your generous contributions will help us to publish the Historic Bridge Bulletin, to continue to maintain historicbridgefoundation.com, and, most importantly, to continue to actively promote the preservation of bridges. Without your help, the loss of these cultural and engineering landmarks threatens to change the face of our nation. Donations to the Historic Bridge Foundation are tax deductible. You may visit our website to donate through PayPal or send your donation to PO Box 66245, Austin, Texas 78766.

Kitty Henderson
Executive Director

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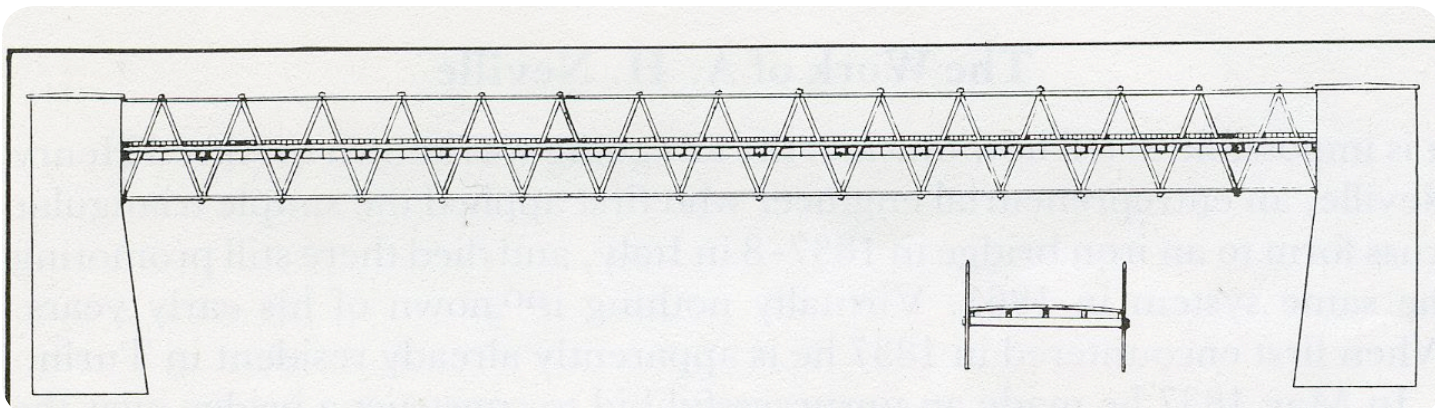
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The Waldshut-Koblentz Rhine Bridge was built in 1859 over the Rhine River between Switzerland and Germany. This rare lattice deck truss bridge survived wartime damage, and is the only unaltered pre-war bridge on the river. *Photo by Nathan Holth.*



Alfred Neville built an iron prototype for the Warren truss, shown in elevation and cross-section views, in Italy in 1837. Credit: J.G. James, "Origin and Worldwide Spread of Warren-truss Bridges" *History of Technology*, 1986.

Confusion Over a Truss Type

By David A. Simmons

For years the Salt Creek Covered Bridge, or Johnson's Mill Covered Bridge, in Muskingum County, Ohio, has been identified as a Warren truss. Today, it is the county's only remaining covered bridge. The Southern Ohio Covered Bridge Association—now the Ohio Historic Bridge Association—was founded in 1960 specifically to preserve this bridge.

The first-known Warren trusses were not wood but iron. And they were not in America but in Europe, Italy to be specific. We are fortunate for the research into the background of the Warren truss conducted by the late British historian John G. James and published in volume 11 of *History of Technology* in 1986.

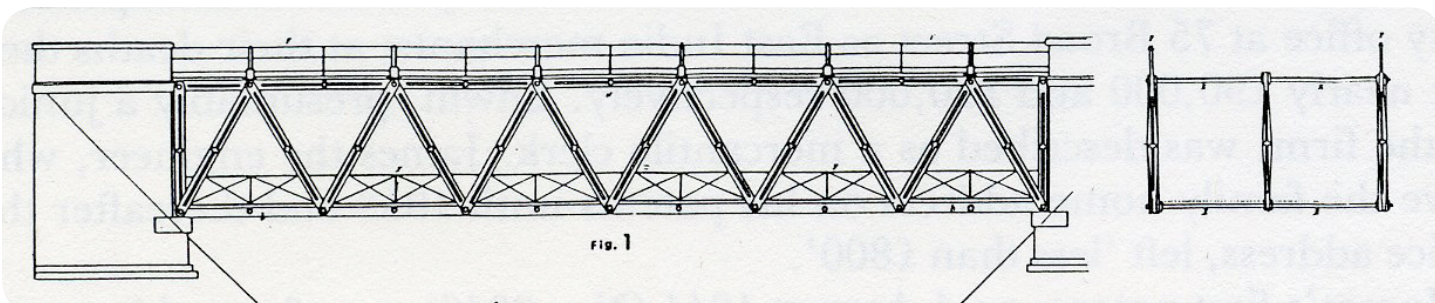
An Englishman named Alfred Neville built a wrought-iron bridge with isosceles triangles in 1837 near Turin, Italy. He filed for and received a patent for his design in France in 1838 and in England the following year. Neville's first bridge was too weak and was soon replaced. So in 1840 he beefed up his design—essentially by adding more components in parallel—and built some bridges in France, where he received a gold medal at the Paris Exposition in

1844. Examples were then built in Belgium, Austria, Bohemia, and back in Italy during the 1850s. All of these bridges were iron.

A self-educated engineer in Great Britain named James Warren learned of Neville's British patent and decided to improve it, receiving a patent for it in 1848. Warren predominately used equilateral triangles, but the language of his patent laid claim to all types of triangular trusses—whether equilateral or isosceles. Warren's eldest brother was a member of multiple boards of directors for railway companies, so the Warren truss quickly became a popular truss for British railroads.

Another Englishman—T. W. Kennard, the chief engineer of the Atlantic & Great Western Railway—apparently brought the Warren truss to America. This railroad was established in the 1860s to run from western New York to Dayton, Ohio. Passing through, Warren, Pennsylvania, it eventually became a part of the famed Erie Railroad. Again, all these bridges were iron.

There are vague historic references to all-wood Warren trusses in America, but the record is less than clear. What is clear is that by the 1880s, the all-iron Warren truss was a mainstay of American railroads.



Alfred Neville built an iron prototype for the Warren truss, shown in elevation and cross-section views, in Italy in 1837. Credit: J.G. James, "Origin and Worldwide Spread of Warren-truss Bridges" *History of Technology*, 1986.



The Jasper Road Bridge, built in 1870 in Greene County but later moved to the Germantown area, incorporated Smith's distinctive compression diagonals in the end panels. Although documentation has not been found, it is likely a formal agreement existed between John McLane, its builder, and Robert Smith. Salt Creek's builder omitted this feature. Photo by David Simmons.

Their popularity was based on their repetitive components that helped keep production costs down.

American covered bridge historians like Richard Sanders Allen, Miriam Wood, and myself have labeled three all-wood trusses in Ohio as Warren trusses. These bridges are the only known examples in the United States. The Jasper Road Covered Bridge was built in Greene County and moved to Germantown and placed over Mud Lick Creek. The Feedwire Road Covered Bridge was also built in Greene County and

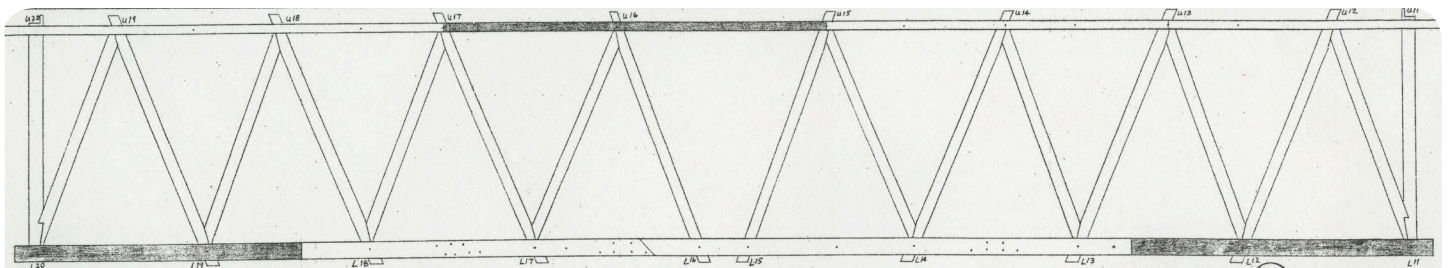
was relocated to Dayton's Historical Carillon Park. The Salt Creek Covered Bridge still stands on its original site.

All three of these Ohio bridges cannot be Warren trusses for one simple reason. The two tension diagonals in the center panel do not meet, as would be required in a Warren truss design. The trusses do not function like a Warren truss. They do, however, match the basic characteristics of a Smith truss.

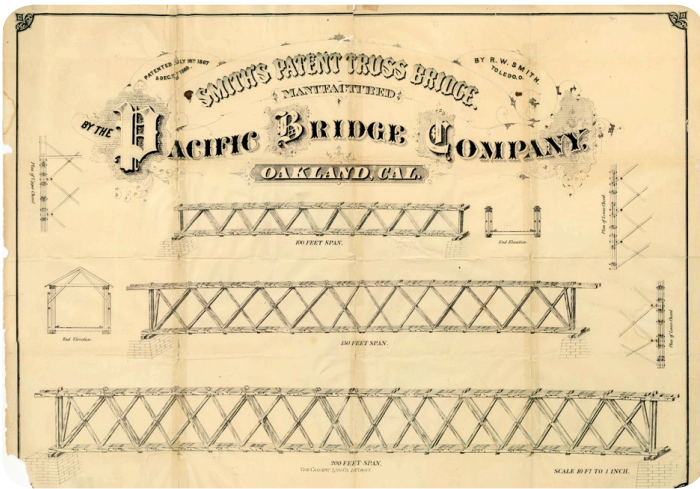
Robert Smith—first from Tipp City and then Toledo—worked towards fabricating covered bridges on an industrial scale. His goal was to speed the production, reduce the need for highly skilled workers, and minimize fabrication and construction errors. In short, he wanted to industrialize covered bridges. His 1867 and 1869 patents seem to have been a modification of a multiple kingpost. The vertical tension members in a kingpost—right-angle triangles—were changed to 60° diagonals. It provided an inherent savings in materials, which was important in the highly competitive world of late-nineteenth-century bridge building. The Smith truss could be a single, doubled, or even tripled, depending on the span requirements at a site. Smith's patent claimed lightness and cheapness while still being strong, ideal aspirations for any nineteenth-century bridge builder.

The Smith Bridge Company built the Carillon Park Bridge near Bellbrook, and a John McLane built the Jasper Road Bridge near Jamestown, both in 1870. Thomas Fisher built the Salt Creek in 1876. So how would someone get away with building a Smith truss who wasn't Robert Smith or affiliated with his company, since Smith's patents did not expire until 1884 and 1886?

Actually, Smith built it into his corporate structure. He would sell you a bridge and build it for you, or he would sell you the parts and let you build it, or he



Drawings prepared for a 1995 rehabilitation of the Salt Creek Bridge highlighted the elements to be replaced. But they also demonstrate how the central panel of the bridge does not meet as in a true Warren truss. Photo by David Simmons.



An ad prepared by the Pacific Bridge Company in the 1870s exemplifies the single, double, and triple forms of the Smith truss, dependent on length requirements.
Credit: Ohio History Connection.

would simply sell you the plans and let it otherwise be your project. All he cared about was getting paid. The existence of an elaborate advertising lithograph for the Pacific Bridge Company shows that Smith formalized his arrangements with bridge builders all across the nation. But in the absence of more specific corporate records, we can only speculate on what arrangements—if any—existed between Smith and John McLane or with Thomas Fisher. The fact that both Greene County bridges were built the same year, strongly suggests that there must have been a formalized relationship between Smith and McLane.

But because the Salt Creek Bridge was completed six years after the other two, there may be another explanation for its existence. A publication on covered bridges in Coshocton County, Ohio, by Terry Miller demonstrates that the Smith Bridge Company was very active in that county during the 1870s. Unpublished research by Miriam Wood on Muskingum County indicates the firm was equally known in that county during that decade. But the types of bridges the company aggressively pursued were almost exclusively long, major river crossings of multiple spans, quite unlike the bridge Fisher built on Salt Creek. In addition, there was a wide gap between the bid prices of Smith's bridges in both counties—generally around \$15 per lineal foot—and the more modest \$8 that Fisher received. Fisher is documented as building at least five other bridges in the Muskingum County, but might Smith simply have not seen Fisher's small-time operation as serious competition?

Another possibility is reflected in the Salt Creek Bridge itself. While the truss built by Fisher—he called it his “plan #3”—follows the Smith truss in its overall configuration, it omits an important element. Smith's 1869 patent text emphasized the distinctive compression diagonals in the end panels of his longest trusses intended to help carry loads into the abutments. Smith claimed that they stiffened the truss and prevented “sagging.” Fisher omitted them



Thomas Fisher built the Salt Creek Covered Bridge near a gristmill in eastern Muskingum County, Ohio, in 1876. *Photo by David Simmons.*

entirely, so Smith may have reasoned that if no one saw the Salt Creek Bridge as a Smith truss, it wasn't really a threat to his corporate empire. So why make a legal fuss about it? If true, given the long confusion by bridge historians, it seems like sound reasoning by Smith.

David A. Simmons is president of the Ohio Historic Bridge Association, which promotes the study and protection of historic bridges in Ohio, and is the Senior Editor for the Ohio Connection's (formerly the Ohio Historical Society) popular history magazine Timeline.

From Browns to Grays: Evolution of the Homestead Grays Bridge

By Helen Wilson and Todd Wilson, PE

In the late 1800s, the steel industry burgeoned in the Monongahela River Valley around Pittsburgh. The bustling steel town of Homestead was just seven miles upstream from the Point—but it was on the other side of the river. A bridge connecting Homestead and Pittsburgh was desperately needed.

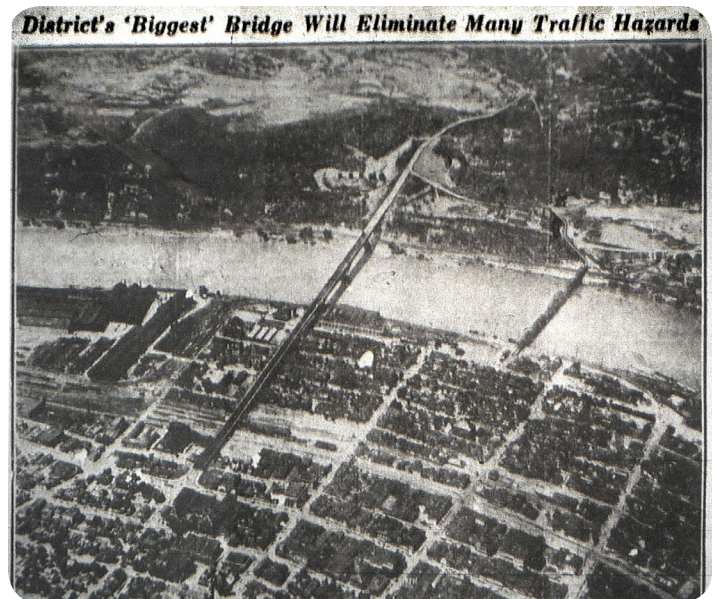
Enter wealthy entrepreneur Captain Samuel S. Brown, who owned coal mines, steamboats, banks, racetracks—and a trolley company. He also happened to own the land on the Pittsburgh side of the river across from Homestead. He assembled a group of investors and formed the Homestead and Pittsburgh Bridge Company to secure a charter to build the Homestead & Highland Bridge, commonly called Brown's Bridge, to carry his trolley line across the river. The bridge, which opened in 1895, was a five-span Parker through truss bridge with a 370-foot main span and four 232.5-foot truss approach spans, two on either side of the main span. The bridge was about 1,300 feet long and 19 feet wide. It was designed and built by consulting engineer E. J. Taylor under supervisor C. B. Waddell and was constructed by the Phoenix Bridge Company. Captain Brown's company reaped the profits from tolls paid by vehicles, pedestrians, and, by the early 1900s, automobiles. Tolls also paid for maintenance of the bridge.

To solve the problem of the difference in height between the 180-foot bluffs on the Pittsburgh side and the low flood plain on the Homestead side, the

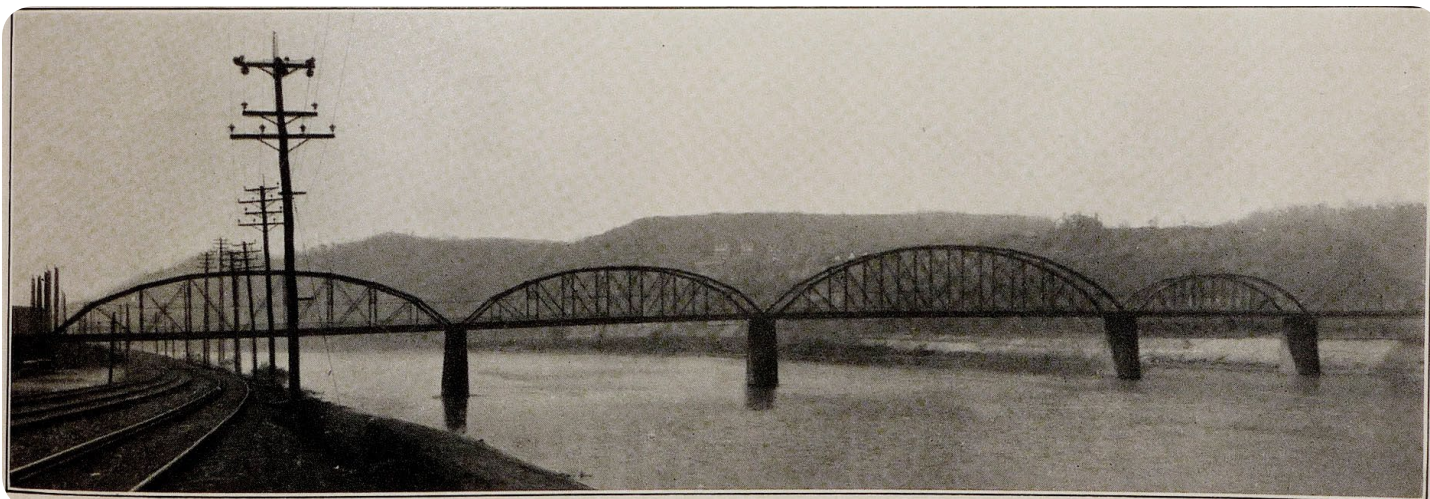
road on the Pittsburgh side took advantage of the Squirrel Hill slope above Nine Mile Run Valley. The steep and winding route down from the top must have given riders some heart-stopping moments. Along the riverbank ran the B&O railroad. Brown's Bridge had to span the tracks as well as the river, so it was 54 feet above water level.

The bridge was busy not only because it connected Homestead with the upscale Pittsburgh neighborhood of Squirrel Hill, where many middle managers of the Homestead steel mills lived, but also because it gave people living in the smaller towns and cities in the Monongahela Valley access to the large commercial centers of Pittsburgh as well as to Pittsburgh's parks, especially Schenley, where various events and celebrations took place. On evenings and weekends the bridge carried Pittsburghers out to small amusement parks called trolley parks, since they were built around the end of the lines by trolley companies to spur off-peak use. Kennywood Park, which is still operating and has been named a National Historic Landmark, was built a few years after Brown's Bridge opened in 1895. It is less than four miles from the bridge.

From the start, the main drawback of Brown's Bridge was that on the Homestead side, traffic was let out close to the riverbank, and only a few blocks away were several busy railroad crossings (still there and



District's 'Biggest' Bridge Will Eliminate Many Traffic Hazards
Illustration from the *Daily Messenger*, Homestead, PA, November 19, 1927, clearly showing the difference in size and location of Brown's Bridge and the Homestead Grays Bridge.



Brown's Bridge in the 1920s. Illustration in *Bridges of Pittsburgh* by Joseph White.

still busy). It was estimated that trains stopped traffic for more than two hours a day, causing traffic jams and accidents.

With the advent of automobiles in the early 1900s, motorists found it difficult to negotiate the bridge's narrow nine-foot lanes, and the bridge became dangerous from overuse and poor maintenance. Newspapers reported on trolley cars jumping the tracks and automobile wheels sinking through holes in the wooden planks of the deck. The problems worsened when the bridge was purchased by Allegheny County and freed of tolls in 1915. A long parade of automobiles celebrated the event, but the county didn't maintain the bridge, and it deteriorated even more. Demands for a new bridge began as early as 1919. Reports in newspapers over the next sixteen years detail the blow-by-blow, excruciatingly slow process of getting a new bridge financed and built. The problem became more critical because

Pittsburgh's early airfields—Bettis Field and the Allegheny County Airport, both located about four miles south of the bridge—were built in 1924 and 1931 respectively, and the bridge was the conduit from the East End of Pittsburgh.

The Great Depression gave Allegheny County access to funds from the Works Progress Administration to help finance a new bridge. The county's former Department of Public Works (DPW), which in the 1920s employed a design staff of up to a hundred engineers and draftsmen, was downsized after elections in 1932 but was reorganized and reinvigorated to be the Department of Works (DOW) to take advantage of the new federal funds. The DOW hired former chief DPW engineer George S. Richardson to design the bridge. Richardson had a hand in the majority of the large Pittsburgh bridges built from the late 1920s through the early 1980s.



George S. Richardson



Homestead Grays Bridge seen from the north shore of the Monongahela River. Photo by Helen Wilson.



Homestead Grays Bridge from Desdemona Avenue in Squirrel Hill. *Photo by Helen Wilson.*

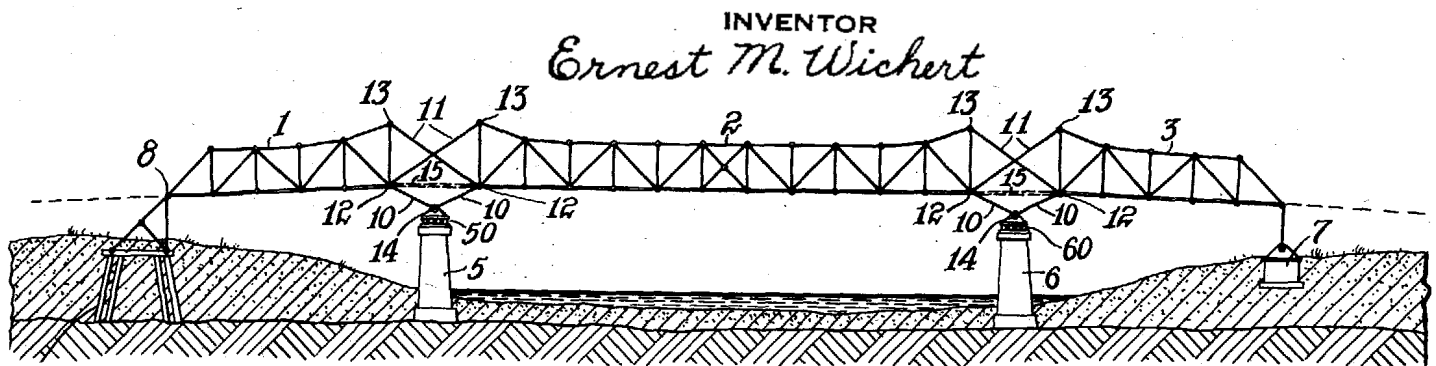
The county-owned Homestead-Pittsburgh High Level Bridge opened in 1937, and what a bridge it turned out to be! It was a marvel of bridge engineering, state-of-the-art for its time. In an era when many bridges had two lanes, it had four. It was built of carbon and silicon steel and weighed 8,351 tons. The bridge was high enough to cross both the river and the busy railroad lines and streets in lower Homestead and to eliminate the need for the winding road down to the river on the Squirrel Hill side. The bridge rises about three feet for every 100 feet in length as it heads toward Pittsburgh.

The bridge is 3,109 feet long and 129 feet high (the piers go down 47 feet below water level for a total height of 176 feet). It was notable for its length when it opened, and today it is still the longest bridge on the Monongahela River. It has 17 spans in three distinct sections from the Pittsburgh side to the Homestead side, consisting of four large continuous deck trusses with Pratt webbing over the river, six smaller continuous Warren deck trusses over the streets of lower Homestead, and six girder spans terminating into a steel rigid frame span over the rail lines and other streets. The two main spans are each 534 feet flanked by 291-foot spans. There is also a ramp off the bridge to lower Homestead, connecting to the last of the truss spans.

Forces on continuous truss bridges were difficult to calculate before the advent of computers because they are not statically determinate. At the fiftieth anniversary celebration of the Homestead High Level Bridge in 1987, William Conwell, an engineer who worked on the bridge, reminisced that engineers struggled for two years with never-tested theories and never-before-used procedures to build the structure. The bridge utilized a new type of truss invented by Pittsburgh engineer E. M. Wichert, aptly called the Wichert Self-Adjusting Truss, an open rhomboid-shaped assembly with hinges at each angle. The truss, used to connect spans at pier points, let each span flex independently, a way of allowing a continuous truss to have statically determinate spans.



One of the Wichert trusses on the Homestead Grays Bridge. Wichert trusses lack a vertical member in the rhomboid-shaped interior support at piers. *Photo by Helen Wilson.*



Drawing and signature as seen on Ernest M. Wichert's truss patent (# 1,842,136) with the rhomboid-shaped detail shown over the piers of a through truss bridge.

Only around ten bridges with the patented Wichert Truss were ever built, mainly in Pittsburgh and Maryland, the largest of which is the 1940 Harry W. Nice Memorial Bridge, which carries U.S. 301 over the Potomac River. Pittsburgh's only other example is the Charles Anderson Bridge, which carries the Boulevard of the Allies into Schenley Park a few miles away. Because the Homestead Grays Bridge was the first to use Wichert trusses, it was placed on the National Register of Historic Places in 1986 and was awarded

a Historic Landmark plaque by the Pittsburgh History and Landmarks Foundation in 2001.

The new bridge solved the problem of railroad crossing delays by soaring over them—hence the name Homestead-Pittsburgh High-Level Bridge, commonly called the Homestead High-Level Bridge. In 2002, the bridge's name was officially changed to the Homestead Grays Bridge to honor the famous Negro League Baseball Team that originated in Homestead.

Around the beginning of World War II, the residential part of Homestead beneath the bridge was demolished to make room for US Steel's Homestead Works expansion, but in the 1980s, the steel mills closed and were later demolished, devastating the economies of surrounding communities. In 1999, the brownfield (an abandoned steel mill site) became The Waterfront, a mixed-use development with apartments, businesses, stores, restaurants, hotels, a multiplex theater, medical facilities, and several



View of the trusses of the Homestead Grays Bridge at The Waterfront in Homestead. Photo by Helen Wilson.



View on the Homestead Grays Bridge sidewalk facing north, with one of the ramps to The Waterfront to the right. Photo by Nathan Holth.



View of the Homestead Grays Bridge from along the north bank of the Monongahela River. Photo by Nathan Holth.

corporate headquarters, including an engineering company. A second ramp was built opposite the original one on the bridge to allow vehicles to exit into The Waterfront without having to make a dangerous left turn onto the old ramp.

The bridge was repainted and updated in 1979 and given a more extensive \$35 million rehabilitation in 2006-7. The roadway was widened from 40 to 46 feet and both sidewalks were replaced, with 42-inch high concrete and steel barriers put along curbs. Attention was paid to preserving the historic look of the bridge. The existing pedestrian railings were restored, and new light poles were reproductions of historic models. The true complexity of the bridge isn't seen from the deck, however, because its pale gray trusses are below it. Now that The Waterfront shines multicolored spotlights on the trusses every evening, the glory of that magnificent bridge is evident day and night.

Bibliography

Baughn, James. Website, Bridgehunter.com.

Cridlebaugh, Bruce. Website: Bridges and Tunnels of Allegheny County. pghbridges.com.

"First Rumblings of Unrest Over Bridge Situation Came as far Back as '80's." The Daily Messenger, Homestead, Pa. November 19, 1937, 15-19. Also, a file of newspaper clippings from the Daily Messenger detailing the progress of building both Brown's Bridge and the Homestead Grays Bridge.

Kane, Mary. "Spanning time, Homestead High-Level Bridge marks 50 years." Pittsburgh Press, November 19, 1987, S4, 69.

Kidney, Walter C. Pittsburgh's Bridges, Architecture and Engineering. Pittsburgh: Pittsburgh History & Landmarks Foundation, 1999. 132-35.

Pennsylvania Historic Resource Survey Form, Office of Historic Preservation. March 20, 1980.

White, Joseph. The Bridges of Pittsburgh. Pittsburgh: Cramer Printing and Publishing Co., 1928. 39.

Wills, Dan, PE. "The Homestead Grays Bridge and Pittsburgh's Steel Industry." Pittsburgh Engineer. Summer, 2009, 25-6.

Wilson, Todd, PE., and Helen Wilson. Images of America, Pittsburgh's Bridges. Charleston, SC: Arcadia Publishing, 2015. 63-64.

Todd M. Wilson, P.E., is a civil engineer whose passion for bridges has spanned his whole life and led him on quests to photograph bridges in all 50 states and 21 countries. He is especially interested in the history of bridge building in Pittsburgh, with its cast of monumental engineers such as John A. Roebling, Gustav Lindenthal, and George S. Richardson. He and his mother, Helen, are co-authors of Pittsburgh's Bridges in the Images of America series published by Arcadia.

Helen Wilson worked for the Pittsburgh Public Schools as an art teacher and curriculum writer, editor and illustrator. She is currently vice-president of the Squirrel Hill Historical Society and has been researching the history of Squirrel Hill for over ten years. One focus of her research is the Brown family and Brown's Hill, the Pittsburgh-side terminus for both bridges in this article. She was editor and one of the authors of Squirrel Hill, A Neighborhood History, published by The History Press.



The Cheboygan Bridge in 2017 after the rehabilitation was completed. Photo by Nathan Holth.

Rehabilitation of a Michigan Bascule Bridge Using Rivets

By Nels Raynor

The US-23 Cheboygan River Bascule Bridge is located in Cheboygan, Michigan, which is located along the Lake Huron shoreline in the northern Lower Peninsula. US-23 is the primary north-south route along Lake Huron in this region. Located over a Coast Guard regulated waterway, the historic bridge continues to operate for boats, primarily recreational.

The previous bridge at this location was a through truss swing bridge. A historical photo shows that the Canton Bridge Company of Canton, Ohio, built the

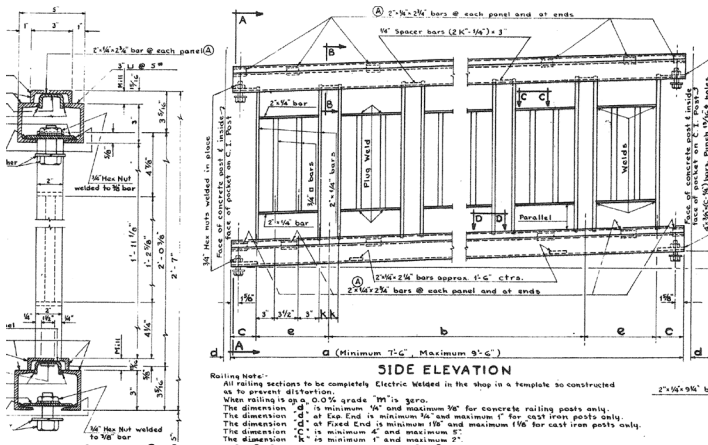
swing bridge at a cost of \$6,500. The existing bascule bridge replaced the swing bridge in 1940. This bascule bridge is a Scherzer rolling lift bascule bridge, with a double-leaf deck plate girder configuration. Hazelet and Erdal of Chicago were the consulting engineers for the project. This firm was the successor to the Scherzer Rolling Lift Bridge Company, which invented this type of bascule bridge where the leaves roll backward on a track. This contrasts with trunnion type bascule bridges, which rotate around a fixed axle called a trunnion. The Cheboygan Bridge's two bascule leaves provide a 70 foot span (short for a bascule span) and there is also a 42 foot fixed deck plate girder approach span at each end of the bridge providing a 155 foot overall bridge length. The bridge



A historical photo showing the previous bridge at Cheboygan, a swing bridge. Photo Source: Cheboygan County History Center.



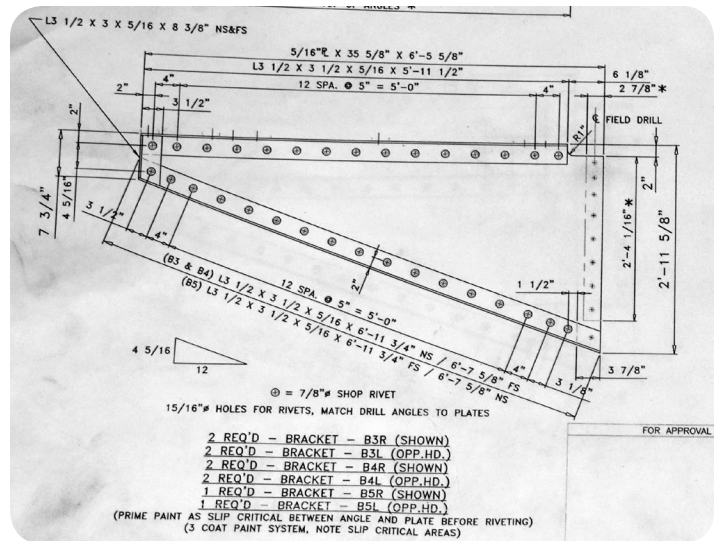
View of the bridge in 2006 showing the original riveted sidewalk cantilevers which were replaced in-kind in 2016. Photo by Nathan Holth.



A portion of the Michigan State Highway Department Type R4 standard railing drawing.

originally only had a single bridge tender house at the north corner of the bridge, but a second, larger bridge tender house has recently been constructed at the south corner of the bridge. The old house remains in place, and the new one is styled with matching architectural features.

The bridge design included the Michigan State Highway Department's standard metal railings, usually referred to by the Highway Department as Type R4. The Type R4 railing was used in Michigan from 1932 until about 1963 and is unique because it is a more ornate design than the standard railings adopted by most other state highway departments during this period. The railing design was used widely on everything from small stream crossings of less than 20 feet to bascule bridges such as the Cheboygan Bridge to expressway overpasses.



A portion of the shop drawings for the 2017 replication of the riveted sidewalk cantilever brackets.

As both a historic bridge and an important functional bascule bridge for both highway traffic and boats, the Michigan Department of Transportation (MDOT) has sought to both keep this bridge in good condition for continued use, while also maintaining the features of the bridge that make it eligible for listing in the National Register of Historic Places. The 2017 rehabilitation of the bascule bridge is the latest example of this effort, and the project is noteworthy as one of the first two bascule bridge rehabilitations in Michigan to include hot riveting as part of the contract. The other bascule bridge project was the US-31 Bridge in Charlevoix, which received a minor repair involving rivets in the same year. Michigan



The Cheboygan Bridge in 2012 shown in the raised position for the Bois Blanc Island ferry. Photo by C. Hanchey.



One of the fully heated 7/8 inch rivets being removed from the gas forge. Photo by Bach Steel.

already has been a nationwide leader for many years in specifying in-kind restoration with use of rivets for historic bridge projects.

Bach Steel was subcontracted to install rivets on this project. The largest and most visible portion of this project was replacement of the riveted sidewalk cantilever brackets. These were replaced in entirety with replica brackets of the same riveted construction as the originals. Each sidewalk cantilever was riveted together in a shop setting. Rivets were heated in a gas forge and driven using a pneumatic rivet hammer and pneumatic holder-on. The completed cantilever brackets were then shipped to the job site and riveted onto the bascule bridge in the field. Additional rivet replacements were completed in the field on deteriorated areas of the approach spans. These repairs ensured the continuity of the riveted appearance and design of the bridge. Replacement of sidewalk cantilever brackets on bascule bridges is not uncommon, but typically riveted brackets are



Driving a 7/8 inch rivet in the shop for one of the sidewalk cantilever brackets. Photo by Bach Steel.

replaced with modern welded or bolted brackets. Although these might seem like an insignificant part of the bridge, their location on the outside of a superstructure that is frequently viewed from below by boaters and people walking or fishing along the river makes them a very visible part of the bridge. Welded or bolted brackets would have contrasted negatively with the original riveted girders on the bridge.

The bascule leaves themselves did not require significant repair because the bridge has been maintained by MDOT, with a prior rehabilitation completed in 2003. The 2003 rehabilitation was noteworthy for its renovation of the railing system, which retained the original Type R4 railings while also adding a two tube railing system that provides a better guardrail function.

Carrying heavy truck traffic on the regionally important US-23 highway, the Cheboygan Bascule Bridge project shows that hot riveting can meet the needs of 21st century rehabilitation of historic bridges, including movable bridges and those serving major highways that carry full legal loads.

Nels Raynor is president of Bach Steel, a steel fabricator and contractor located in Holt, Michigan, that specializes in hot riveting, heat straightening, and relocation and restoration of historic metal bridges. Raynor has several decades of experience working on historic bridges, is a certified welder, and has been working with steel since he was 19 years old.



This photo shows the replicated sidewalk brackets riveted to the original bascule girders on the bridge. Photo by Nathan Holth.