Volume 3, Number 3
November 2016

Historic Bridge Bulletin

Historic Bridge Foundation

November is Historic Bridge Awareness Month!

From the Director's Desk

Dear Friends of Historic Bridges,

November is **Historic Bridge Awareness Month**. In recognition of this, the Historic Bridge Foundation offers this special edition of the *Historic Bridge Bulletin* featuring articles exclusively focused on railroad bridges. Historic railroad bridges are easily overlooked, since most are privately owned, may not be accessible to the public for viewing, and are not inventoried by states like highway bridges are.

Please also consider supporting historic bridges this month through a donation to the Historic Bridge Foundation. Your generous contributions will help us to publish the *Historic Bridge Bulletin*, to maintain *historicbridgefoundation.com*, and, most importantly, to continue our mission to actively promote the preservation of bridges. Donations to the Historic Bridge Foundation are tax deductible. You may visit our website to pay through PayPal or send a check to PO Box 66245, Austin, Texas 78766.

Kitty Henderson
Executive Director

In This Issue:

Built to carry highway traffic on a lower deck and Chicago "L" rail traffic on an upper deck, the Lake Street Bridge, a double-leaf bascule bridge in Chicago, celebrates the 100th anniversary of its opening on November 6, 2016. Click this link for details. *Photo by Nathan Holth.*

Intended and Unintended Design Uses of Open-Spandrel Reinforced Concrete Arches

By James L. Cooper

With revenue and prospects high, the executives of the Big Four Railroad (Cleveland, Cincinnati, Chicago & Saint Louis) decided at the beginning of the twentieth century to improve its "Chicago Division" across Indiana.[1] The improvement (1902-1909) from Dearborn through Vigo Counties would widen the line from a single to a double track, reduce curves and track grade levels, promote grade separations with intersecting roadways, and shift from timber and metal to concrete bridging. In short, the goal was to turn the line into an expressway.[2]

The railroad's engineers aimed to standardize their new bridge design, an aim worked easily for most grade separations. T-beam style roadway "overheads" or overpasses of the tracks (figs. 1, 2, 3) and semi-circular arches for where the roadway or small streams crossed below the rail-bed (figs. 4, 5) followed essentially standard plans.

The reduction of curves and track grade levels confronted designers with a number of valleys or depressions which in a previous era would either have been skirted or crossed with trestles. Besides long stretches of fill, the railroad engineers now introduced several forms of concrete arches for use, especially where large streams crossed the rail line. In the eastern part of Indiana, these arches tended to be of filled-spandrel design with old rails used for a significant part of the ring reinforcing (figs. 6, 7, 8).

Figs. 2, 3. These photos are an example from Putnam County in western Indiana of the plan for an "overhead." *Photo by James Cooper.*

W. M. Dunne, the chief engineer, relied on an open-spandrel arch form for four structures he designed for construction in Hendricks and Putnam Counties in 1906 (figs. 9, 10, 11, 12). H. G. Tyrrell called attention to Dunne's design by featuring it in his 1912 volume on artistic bridges.[3] Each of the four open-spandrel structures have solid rings with spandrel columns each extending upward to a

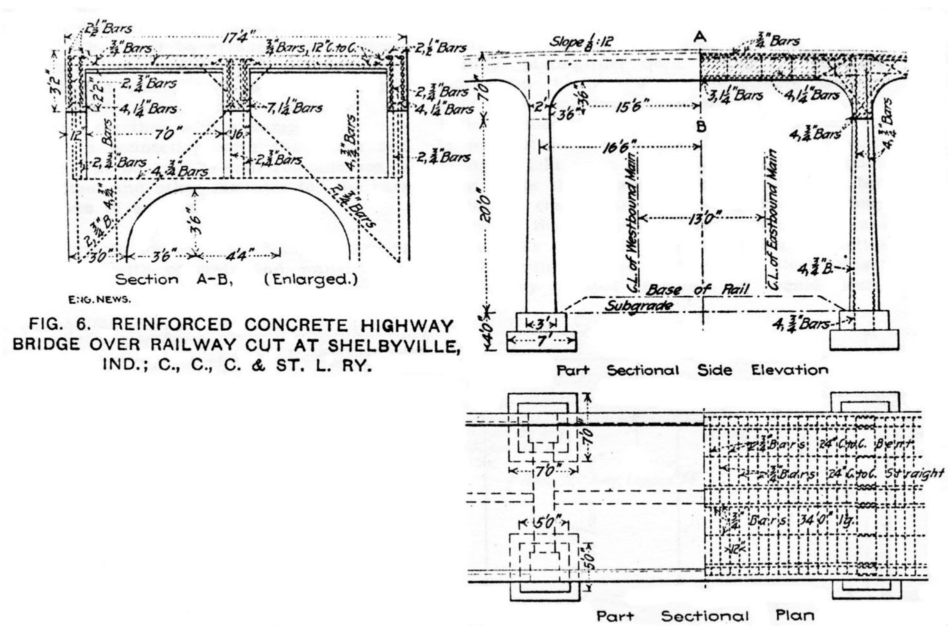


Fig. 1. The sample plan above is for Shelby County in the eastern part of the state. Note that the T-beam reinforcing is continuous over the spans. From *Engineering News-Record*, **16 May 1907: 538.**

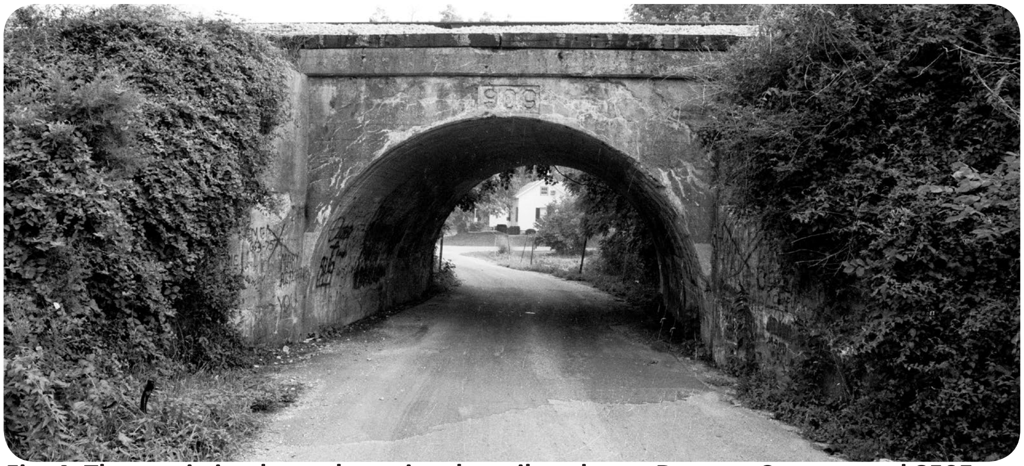


Fig. 4. The semi-circular arch carries the railroad over Decatur County road 850E. *Photo by James Cooper.*

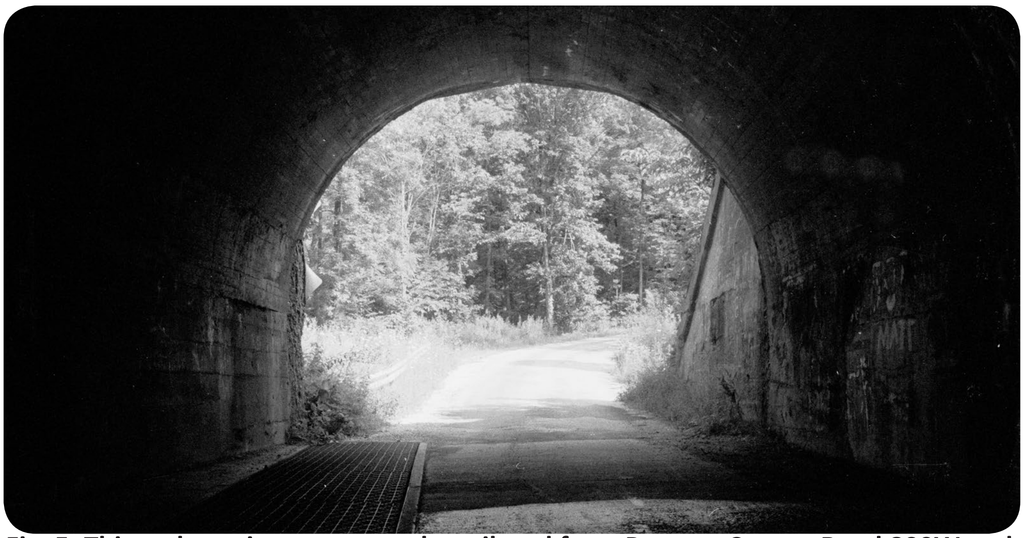


Fig. 5. This arch carries separates the railroad from Putnam County Road 800W and (under the metal grate) Snake Creek. *Photo by James Cooper.*

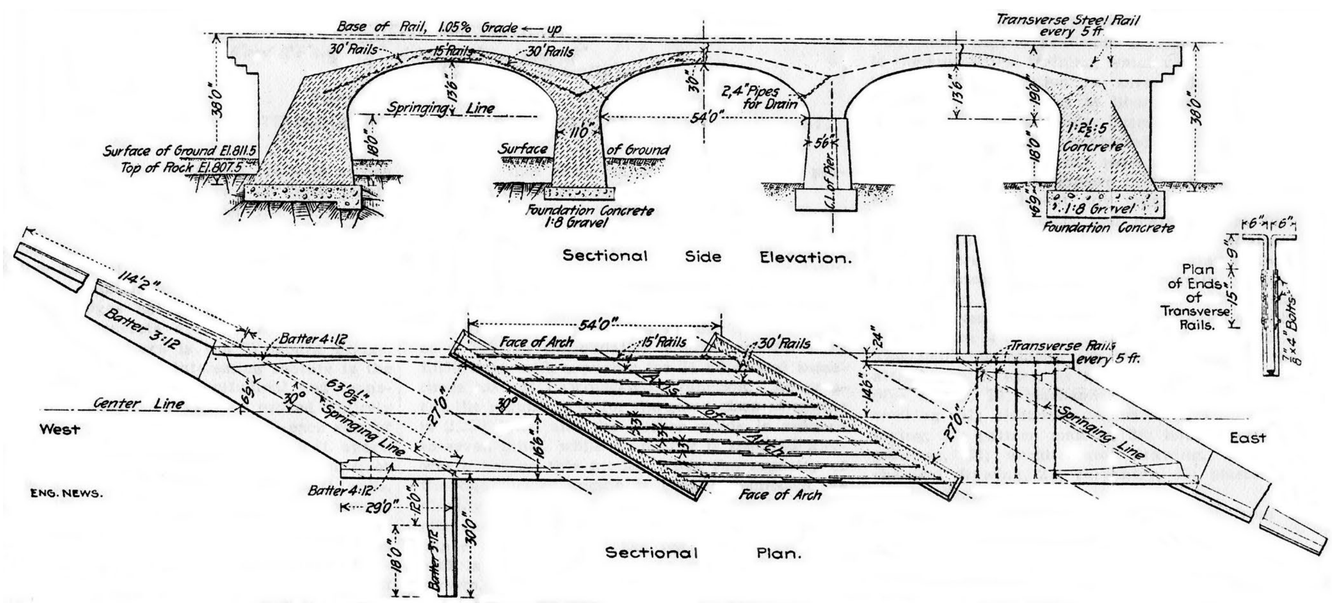
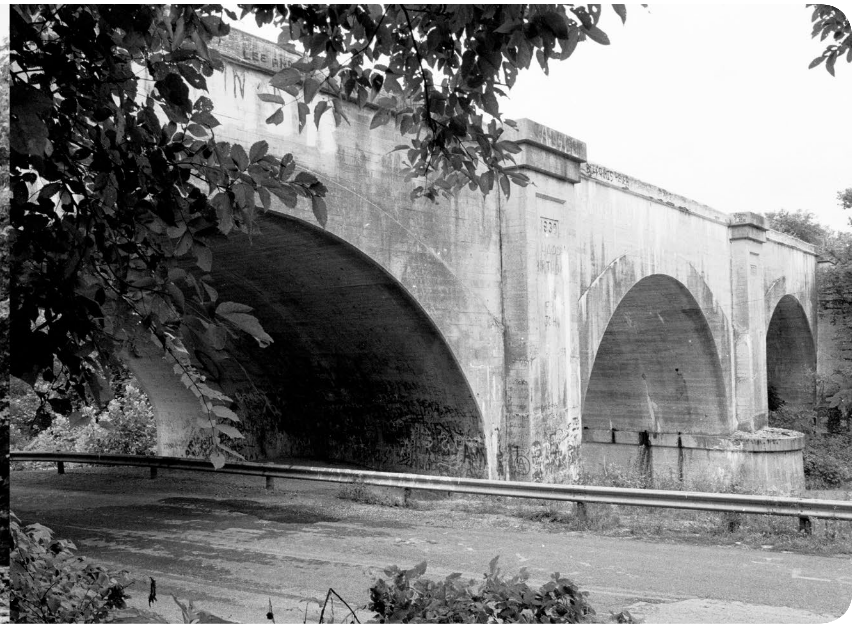


FIG. 7. REINFORCED CONCRETE ARCH BRIDGE AT WEISBERG, IND.; C., C., C. & ST. L. RY.

Fig 6. Plan for crossing Tanner's Creek at Weisberg in Dearborn County. From Engineering News-Record, 16 May 1907: 538.



Left: Fig. 7. Filled-spandrel arches over Tanner's Creek and Konradi Road in Dearborn County. Right: Fig. 8. Filled-spandrel arch over Tanner's Creek and Bonnell Road in Dearborn County. *Photos by James Cooper.*

concrete deck which carries fill for the tracks above. The substantial piers are hollow above the springing line, or bearing area, of the arch rings, thus reducing the quantity of concrete required by tens of tons per structure. The chambers also connect from one span to the next the segments of an interior central passageway which crosses atop the arch rings (figs. 13,14).

These four artistically-designed structures are now more than a century old, and their uses are by no means limited to carrying today's CSX rail freight. Three of the four open-spandrels cross a roadway and a creek. The other crosses a creek only. Where there is informal on-site parking as well as relatively easy access to the interior arch passages, a considerable number of adolescents amongst others have climbed through the arches over the years, and many have experienced the howling reverberations which occur when trains pass overhead. The reverberations have generated a variety of responses.

The Hendricks County open-spandrels - primarily the one at Avon and secondarily at Danville - received extended public notice as "Haunted Bridges." Reports of the various haunts would ultimately spread widely enough to enter the more formal realm of Indiana Folklore and Hoosier Folk Legends.[4] One story-line follows a construction worker who reportedly fell into and was buried in the wet concrete. Reportedly his spirit can now be heard crying out in pain when a train crosses overhead. Other story-lines concern the screams of a young man or of a mother and baby who jumped or were thrown off the bridge to their

Fig. 9. Avon Bridge over White Lick Creek and Hendricks County 625E. From H. G. Tyrrell, *Artistic Bridge Design* (1912), 208-209.

Fig. 10. Twin or Danville Bridge over W. Fork of White Lick Creek and Hendricks County 150E. Note, in front of the arch, the stone abutments which had carried a through metal-truss superstructure when the railroad was single-tracked. *Period post card in possession of author.*

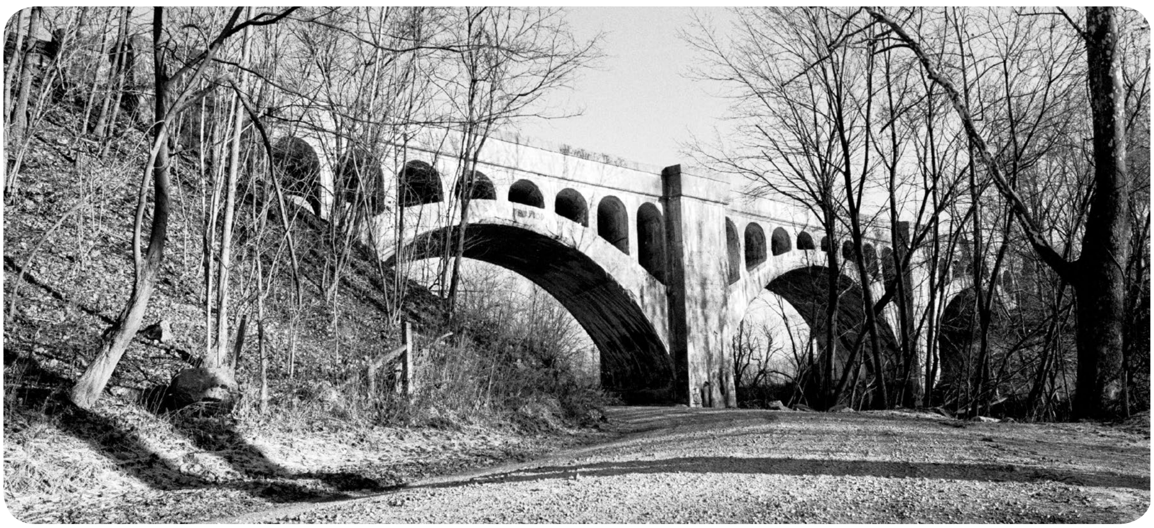


Fig. 11. Big Four Arch over Little Walnut Creek and Putnam County 500W. *Photo by James Cooper.*

Fig. 12. Big Walnut Creek Bridge. Note that this crossing in Putnam County did not include a roadway. *Photo by James Cooper.*

Fig 13. Interior passage. Big Four Arch. *Photo by James Cooper.*

Fig. 14. View from arch ring and spandrel column. Twin Bridge, Danville. *Photo by James Cooper.*

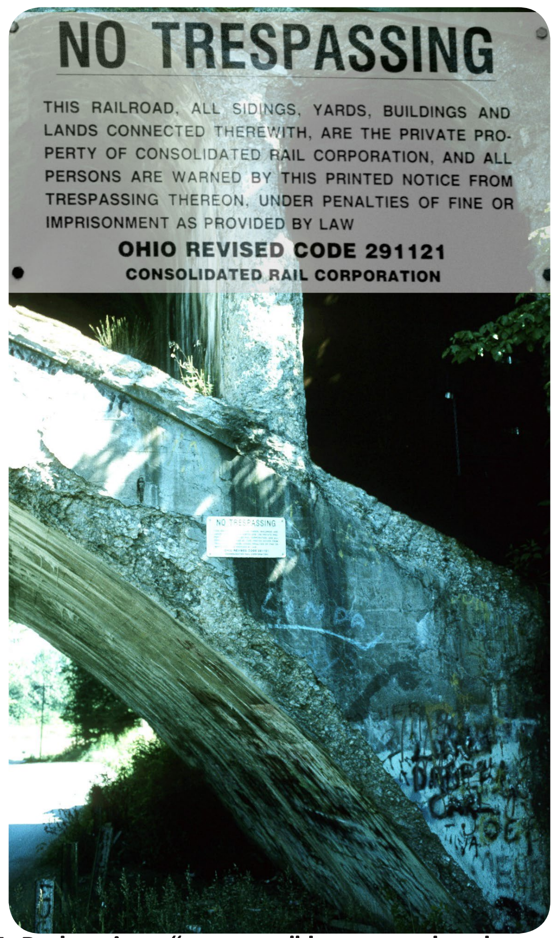


Fig. 15. Pedestrians "entrance" between the abutment and the first spandrel column fenced off on the Avon Bridge. *Photo by James Cooper.*

Fig. 16. A collage of some of the art found on the Big Four Arch, including some on the outside of the southwest pier, which required the artist to crawl through the interior passage over two spans. *Photos by James Cooper.*

Fig. 17. Art on a spandrel column of the Twin Bridge, Danville. *Photo by James Cooper.*

deaths when a train caught them at mid-structure while crossing. The number of young folk climbing through the Avon arches to witness a haunt became so pronounced that the successors to the Big Four Railroad authorities, worried about their liability, fenced off the main "entrance" area adjacent to the county roadway (fig. 15).

Countless teenagers continue to climb through the"Big Four Arch" in Putnam County and memorialize their visits in different ways. Reports of haunting have been limited here to riders in vehicles claiming to have seen a "goat man" in one of the spandrel arches over the roadway. More often, visitors - mostly teenagers - have created mural-like, often macabre, or ethereal art inside and outside the structure (fig. 16). The Danville bridge has also served as a gallery for this youthful visual expression (fig. 17).

While W. M. Dunne must have been pleased to have seen his open-spandrel design recognized nationally as artistic, he undoubtedly did not anticipate that his arches would also become homes for other-worldly spirits or function as youthful art galleries. The stately structures continue these collateral services while meeting the fundamental needs of more than one hundred years of rail transport.

Notes

1. The CCC&StL became a part of the New York Central system by 1900, although it continued to operate separately until about 1930.

2. "Line Improvements Between Indianapolis and Cincinnati, C.C.C. & St. L. R. R.," Engineering News-Record,

16 March 1905: 275; “Improvements on the Chicago Division of the Cleveland, Cincinnati, Chicago & St. Louis Ry,” Engineering News-Record, 16 May 1907, 57: 535-539.

3. Henry Grattan Tyrrell, Artistic Bridge Design (Myron C. Clark Publishing, Chicago, 1912), 105, 208-209.

4. Linda Degh, “The Haunted Bridges Near Avon and Danville and Their Role in Legend Formation,” Indiana Folklore, II (1969), 54-89; Ronald L. Baker, Hoosier Folk Legends (Indiana University Press, Bloomington, 1982), 62-66; Larry L. Hanson, “Hoosier ghosts who haunt Halloween,” Indiana Rural News, October 1975: 6-7; “Halloween sparks talks of supernatural,” The Guide, 29 October 1980: 9; Robin Bland, “Avon’s Famous Bridge Has Haunted Generations of Youth,” Hendricks County Flyer, 20 October 1991; J. W. Williams, “Downtown Diary,” Nuvo, 6-16 March 2005: 7.

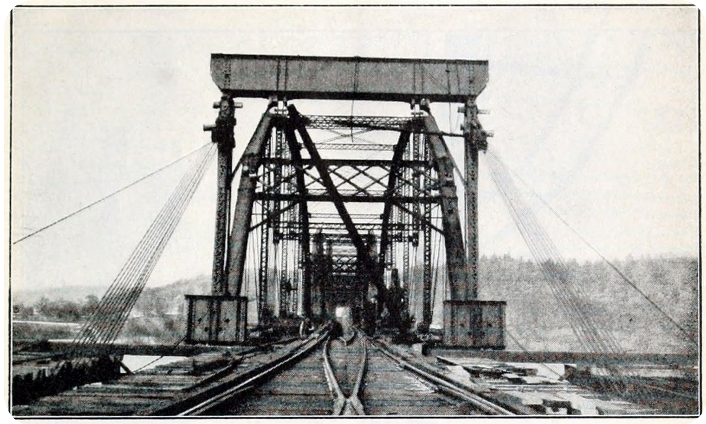
James L. Cooper, professor emeritus of history at DePauw University, is a bridge historian who specializes in the history of Indiana’s bridges. He is the author of several books about historic bridges, and has been a consultant for the Indiana Division of Historic Preservation and Archaeology, Historic Landmarks Foundation of Indiana, and past board president for the Historic Bridge Foundation.

Yeah, We Can Do That!

Heavy Steel Fabrication and Accelerated Construction on Early 20th Century Railroads

By Nathan Holth

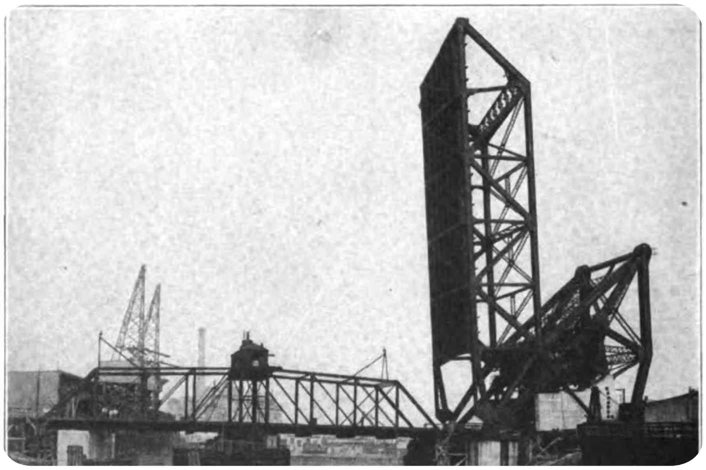
Railroad bridges constructed in the early 20th century in America were built to handle extremely heavy loads on busy railroad lines. During this time, railroads were experiencing rapidly changing needs in terms of loading and traffic requirements and, as a result, even existing bridges that were only a couple decades old might face replacement. The heavy loads dictated massive, heavy materials in construction and the importance of the railroad itself dictated complex construction sequences designed to minimize railroad line closure. Closing a railroad line might be compared to closing an Interstate Highway or an airport today. In the time before airports and Interstate Highways, railroads were critically important travel corridors, and were also difficult (if not impossible) to arrange



The 1892 Kenova Railroad Bridge over the Ohio River is shown here as replacement work begins ca. 1913. Originally built as a single-track truss bridge with provisions for later conversion to a double-track bridge, the decision was made instead to replace the 1892 trusses completely after only 21 years of service. *Photo from American Society of Civil Engineers.*

detours for. Many of the impressive railroad bridges built in the early 20th century remain standing today and some are among the most impressive bridges in the country. In simply visiting and viewing these bridges, however, the amount of effort and creativity that went into their fabrication and construction may not be readily apparent. Fortunately, engineering periodicals of the time documented these projects in considerable detail. In fact, railroad bridges received far more coverage in these periodicals than highway bridges of the same period, largely because the construction of the much lighter-weight highway bridges, often with less restrictions on closure to traffic, simply did not require as much in the way of groundbreaking engineering, fabrication, and

Note the heavy design of the 1913 Kenova Railroad Bridge, in comparison to the 1892 span. *Photo by Nathan Holth.*



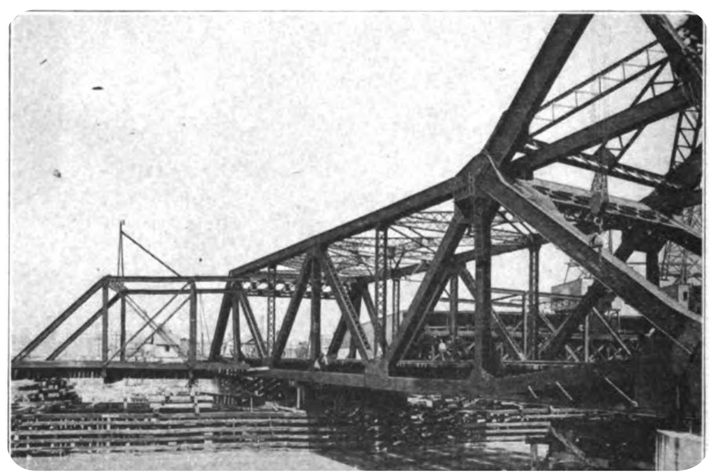
The Deering Bridge shown under construction, before the swing bridge (left) was cut in half and the new bascule span (right) was lowered. *Photo from Journal of the Western Society of Engineers.*

construction sequencing. What follows is a brief survey of some of the more interesting and well-documented railroad bridge projects.

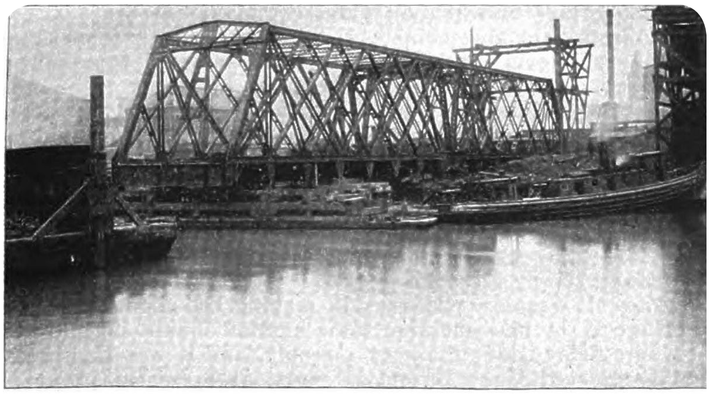
The replacement of the Deering Bridge in Chicago illustrates the unusual effort that railroads made to minimize closure time on their lines. A detailed article in the Journal of the Western Society of Engineers describes the replacement of a center pier swing bridge with a single-leaf bascule bridge. The new bascule span was erected in the raised position, which allowed for nearly the entire structure to be erected while trains continued using the swing span immediately below. Only a few portions of the truss and deck could not be erected without interrupting trains. During a short closure to trains, the remaining portion of the bridge was completed. During this closure, the old swing bridge was moved to the open position and the members and chords of the center panels of the truss were cut out, which made room to lower the bascule into place for the first time. Once lowered, trains could travel on the bascule bridge, and workers could then continue to demolish the swing bridge without disruption to rail traffic. This unusual sequence of construction would be noteworthy on its own, but what is even more impressive is how this process was pre-scheduled right down to the minute. Some of the schedule follows:

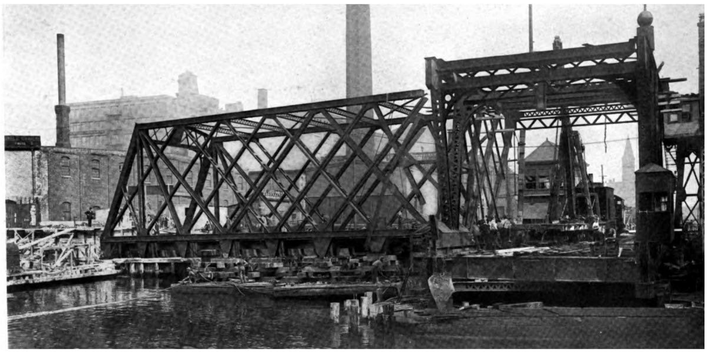
Railway traffic was suspended on July 30, 1916 at 12:23 AM after a northbound train passed. Immediately, the swing span was opened, and crews began to cut apart the center section. The center section needed to be cut out and loaded onto a scow by 7:30 AM. Simultaneously, the old approach spans were removed and new spans installed. The southern approach needed to be ready for decking by 5:00 AM, and the northern approach by 6:00 AM. By 7:00 AM, crews would also be working on the approaching trackage. The 5:00 AM completion of the southern approach span allowed for crews to move in and erect the final portion of the steel on the bascule span, which needed to be complete by 8:00 AM. Then, the bascule span was to be lowered only 15 minutes later, 8:15AM. After lowering the bascule span, the remaining deck was installed. The remainder of the day was spent making miscellaneous mechanical adjustments and completing other remaining structural work. The goal was to have the new bridge open to traffic on the same day at 4:07 PM to enable a southbound train to pass, a closure time of only about 16 hours. However, the final part of the work, which was to include minor realignments and grade changes to the approaching railroad, could not be completed on time and the bridge did not open for nearly two hours later, at 6:00 PM. In other words, even with a delay, the entire closure to railroad traffic was less than 18 hours!

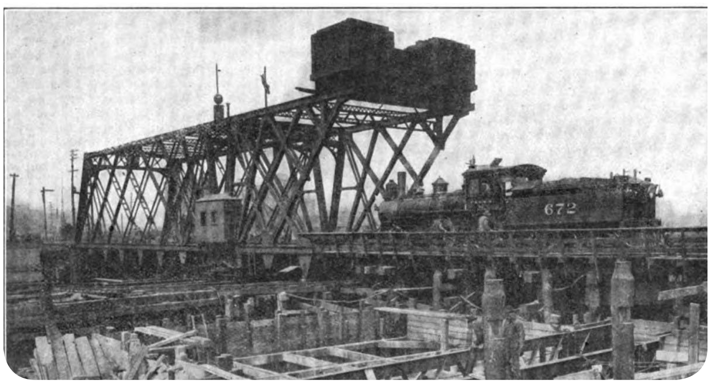
Another bizarre construction project took place in Chicago in 1907 with the Chicago NorthWestern Railroad Bridge replacement. The scope of work was the same as the Deering Bridge. An existing center pier swing bridge was to be replaced by a single leaf bascule bridge. However, rather than replace this



The Deering Bridge shown immediately after the swing bridge was cut in half and the new bascule span was lowered. Note the end portions of the severed swing span to the left and right of the bascule span *Photo from Journal of the Western Society of Engineers.*

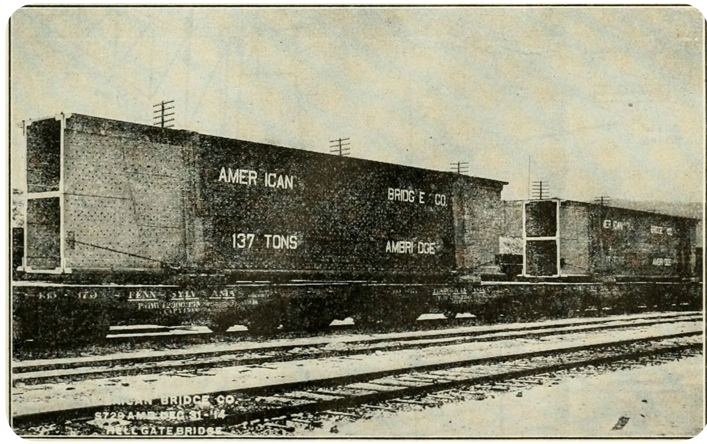






This series of photos shows the Chicago NorthWestern swing bridge before construction, half of the swing span cut off, and completed conversion into a bobtail design. In the bottom photo, note the counterweights on top of the truss, and bascule bridge construction visible in the foreground. *Photo from Journal of the Western Society of Engineers.*

bridge on the exact same alignment, the plan was to construct the new bascule bridge right next to the swing span. However, the swing bridge needed to be able to continue to swing open for boats. This was a bit of a problem, because when it swung open, the trusses of the swing span would have moved right into the construction zone. To solve this problem, the portion of the swing truss that would have interfered with the new bridge construction was cut right off! To keep the span in balance, a massive counterweight was set on top of this shortened end of the bridge. In



Bottom chord sections of the Hell Gate Bridge, each weighing 137 tons, are shipped to the construction site by rail. *Photo from American Society of Civil Engineers.*

short, the center-pier swing span was turned into a bobtail swing bridge for the construction project!

While movable bridges were often a source of impressive construction sequencing, large, high-level fixed bridges had their own claim to fame: incredibly massive steel fabrications. The Hell Gate Bridge in New York City was completed in 1917 to the design of Gustav Lindenthal and is a sprawling chain of railroad bridge spans over 17,000 feet in total length, with the most famous span being the steel arch span over the East River. The size of this span is staggering. Each steel bearing of this arch span weighs 250 tons! These bearings are hidden within a decorative riveted enclosure. The arch's bottom chord, which springs from the bearings, was fabricated and shipped by railcar in 137 ton segments.

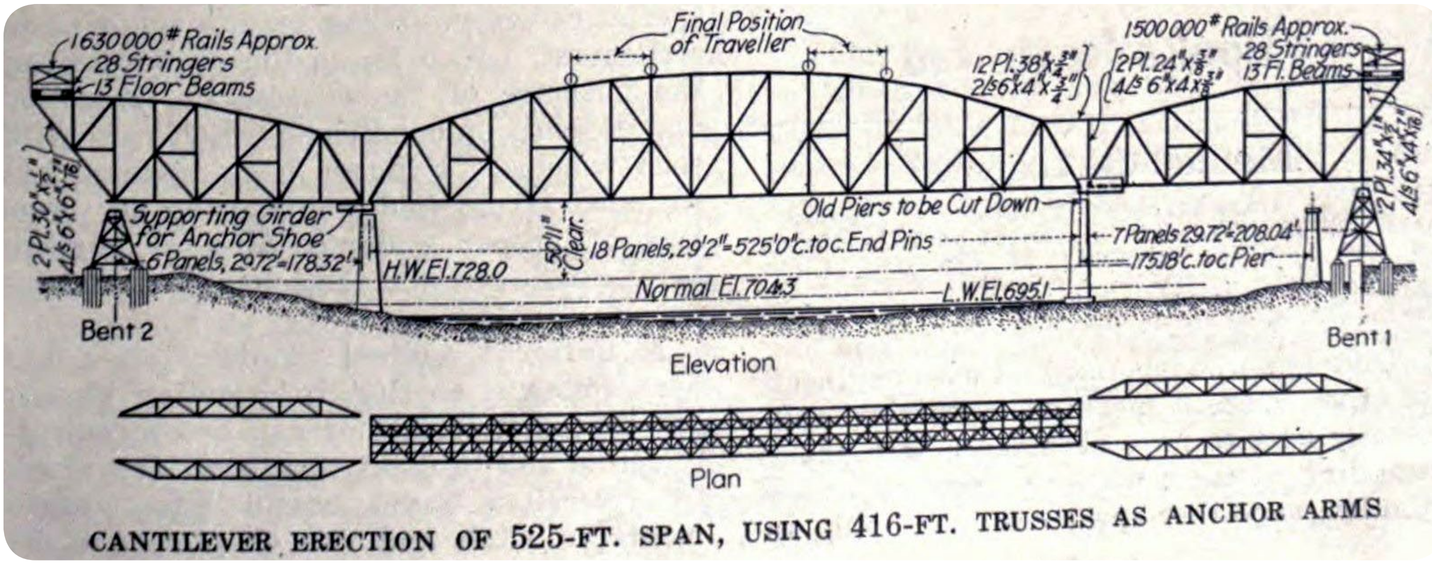
The Sciotoville Railroad Bridge over the Ohio River is a double-track bridge with a heavy-duty appearance.

Two people sitting next to the bearing of the Hell Gate Bridge help provide a sense of scale for this enormous structure. *Photo by Nathan Holth.*

The Sciotoville Railroad Bridge. *Photo by Nathan Holth.*

One of the shop-fabricated lower chord connections over a bearing of the Sciotoville Railroad Bridge. This single detail weighed 40 tons. *Photo by McClintic-Marshall Company.*

For comparison, the entire superstructure of this 113 foot lenticular highway truss (built 1881) weighs 27 tons, or only 67% of the weight of the single lower chord connection of the Sciotoville Railroad Bridge. *Photo by Nathan Holth.*



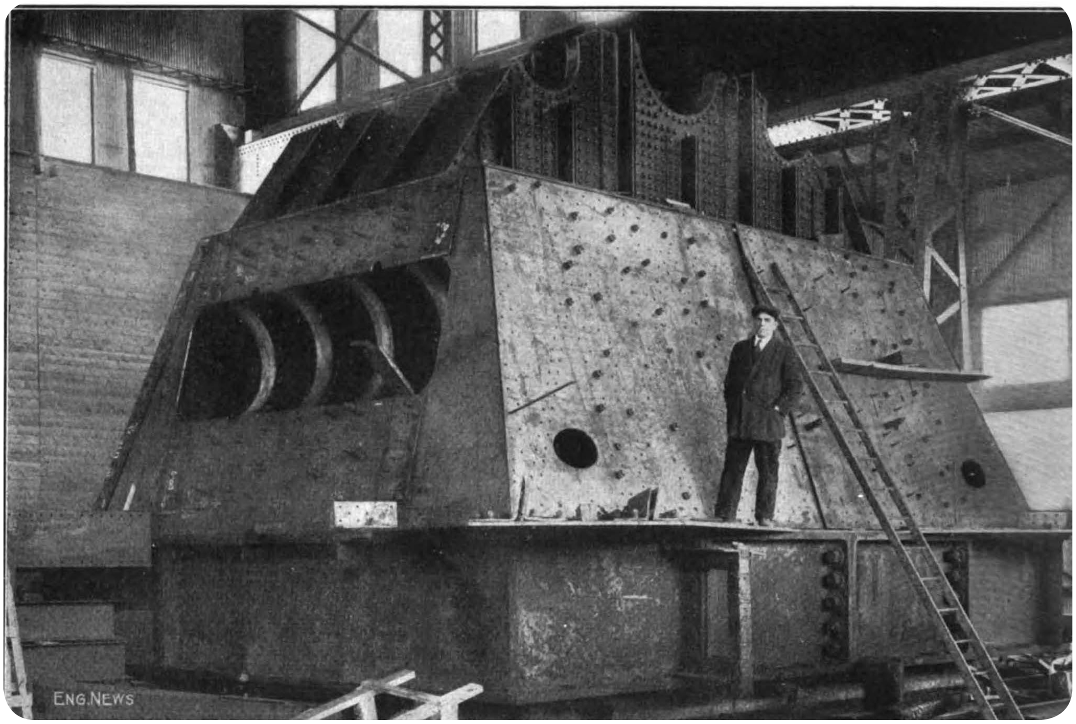
This diagram from the *Engineering Record* shows how the trusses for the 416 foot span of the Ohio Connecting Railroad Bridge were temporarily used to construct the 525 foot span of the bridge.

Another Lindenthal-designed bridge, and completed in 1917, the bridge was the first modern large-scale continuous truss bridge. The fabrication details are no less impressive. A single pre-fabricated lower chord connection and associated gusset plates weighed 40 tons. Each of the bearings at the center pier were fabricated with base dimensions of 14 feet square and weighed 71 tons.

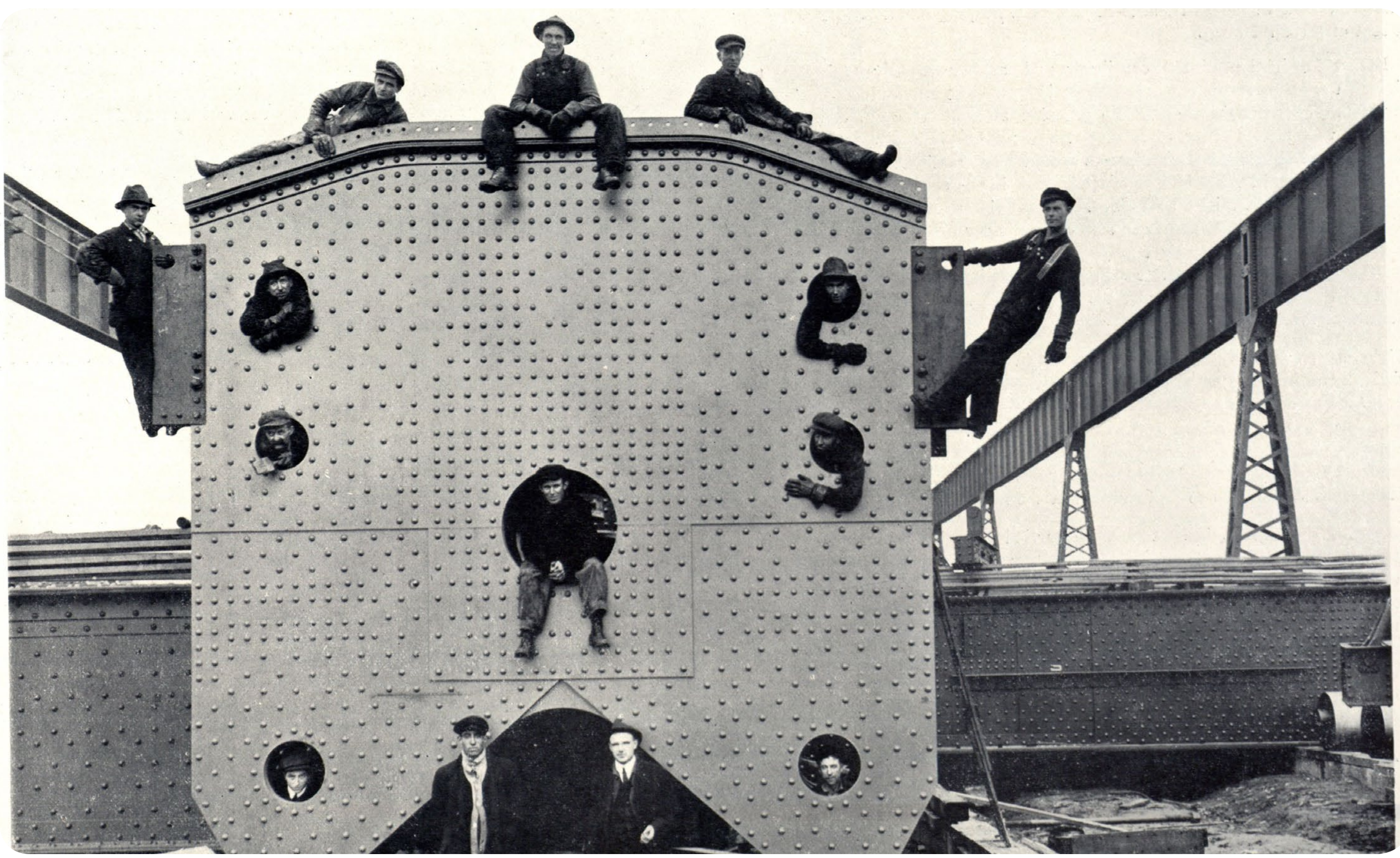
The 1915 Ohio Connecting Railroad Bridge in Pittsburgh utilized a rather creative construction sequence. The bridge extends over Brunot Island and the main and back channels of the Ohio River. The 525 foot main channel through truss span is separated from the 416 foot through truss span by over 1900 feet of shorter deck truss spans. During construction, in order to eliminate the need for falsework in the navigable main channel, it was decided to erect each half of the main channel span outward from the piers using the cantilever method, which required temporary counterbalancing of each truss half. In order to accomplish this, half of the 416 foot truss span was erected on the far side of the main channel piers and connected to the 525 foot span during construction. In addition, 13 floor beams, 28 deck stringers, and a bunch of rails were piled up on top of these temporary anchors. All of this material was removed and used on the new bridge after the 525 foot span was erected. Likewise, the 416 foot span halves were re-erected in their final position over the back channel. To add to this impressive construction story, all this work was completed around the narrower previous truss span which continued to carry railroad traffic during construction. This previous bridge, built in 1890, included stone piers which had been designed extra-wide, anticipating a replacement project such as this one.

The 525 foot span of the Ohio Connecting Railroad Bridge is barely visible in the distance in this photo taken next to the 416 foot span of the bridge. *Photo by Nathan Holth.*

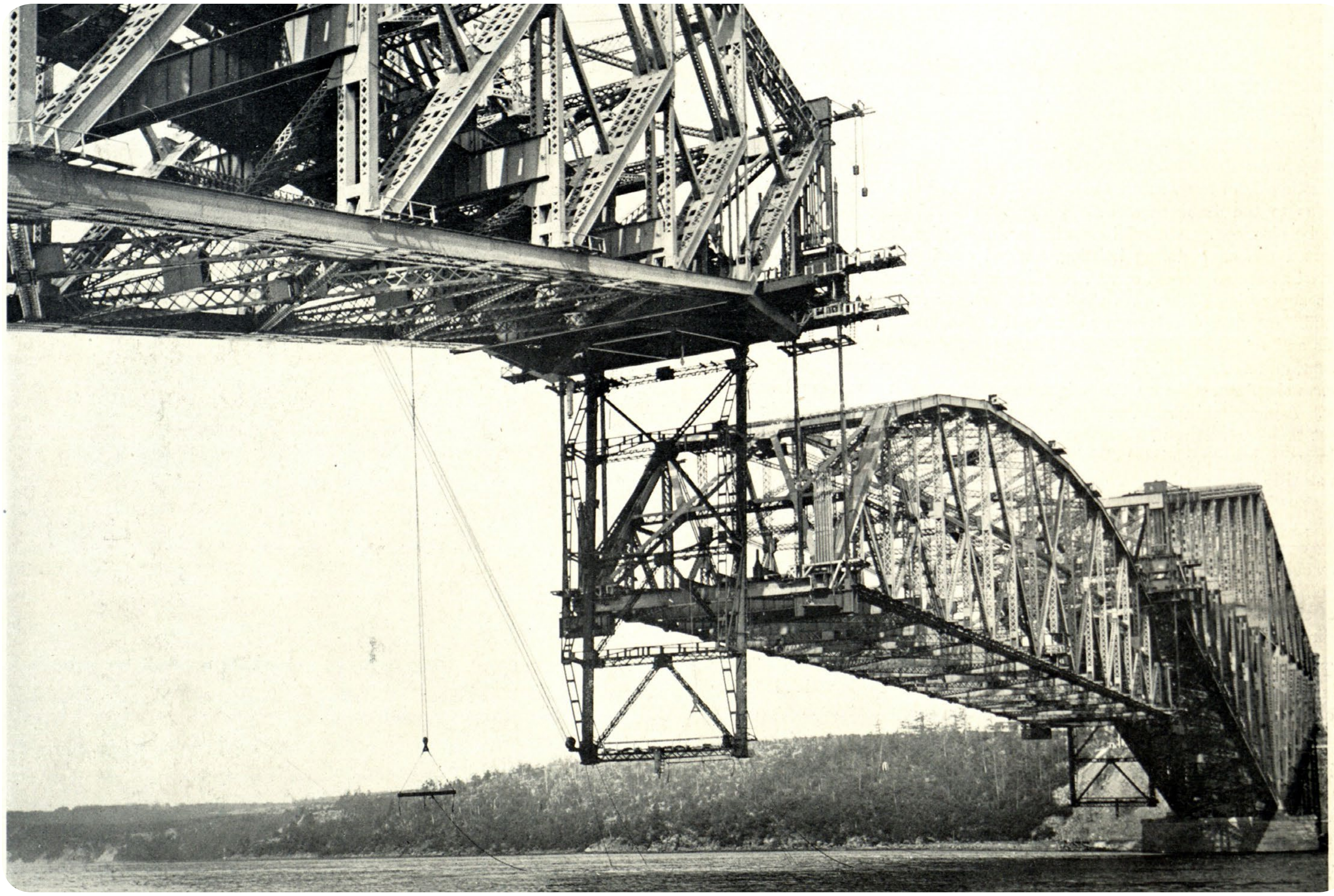
The 1917 Quebec Bridge, originally built for two sets of railroad tracks, set numerous world records and entire books have been written about its fascinating and dramatic history. Rather than retell this well-documented history here, a few lesser-known, but impressive details about this bridge follow. This is a bridge so enormous that a special all-new bridge shop had to be constructed to fabricate the bridge's enormous parts. These parts had dimensions that dwarf those of the other bridges discussed here. The main vertical posts at the towers



The size of the parts for the Quebec Bridge were so large that no existing shop could fabricate them, so new shops were built just for this bridge. This photo showing one of the bridge's enormous shoes test-assembled in the shop helps illustrate why new shops were needed. *Photo from Report of the Government Board of Engineers.*



Shown assembled in the bridge shop yard, this enormous upper chord connection link weighed 145 tons and its smallest pin holes were so large these men could comfortably fit their heads through them for this photo. *Photo from Report of the Government Board of Engineers.*



After being fabricated off-site and barged to this location, this photo shows the suspended span of the Quebec Bridge being lifted into place 150 feet above high water level. Measuring 640 feet long and over 88 feet wide, lifting such a large structure would grab news headlines even today. *Photo from Report of the Government Board of Engineers.*

of the cantilever truss bridge had two impressive shop-fabricated details. The main post shoes, which were fully test-assembled in the shop, were 20 feet by 26 feet at the base, and 23 feet tall, and were composed of an intricate honeycomb of riveted steel. At the top of the main post was a "link" for the top chord connections. The weight of each link alone (fully preassembled in the shop) was 145 tons. As impressive as the shop fabrications were, the hoisting of the central 640 foot suspended span was no less so, especially considering the 94 foot roadway width of the bridge. The suspended span, on its own one of the longest simple-span trusses ever constructed, was assembled on-shore and barged out to the center of the bridge. Even in the 21st century, structures with such impressive dimensions and weights are rarely moved in a single piece, let alone lifted up into position.

Fast-forward to the 21st century, and it is not even clear if it would be possible to fabricate some of these bridges discussed using existing all-American companies and facilities. For example, fabrication of several parts of the new eastern spans of the San Francisco Oakland Bay Bridge were outsourced to China and Japan, partly because equivalent fabrication facilities for such a large bridge project were not to be found in the United States. Existing Buy America laws had to be suspended for this project. This irony is only made greater by the company that built the new Oakland Bay Bridge: the American Bridge Company. This company, which originally was part of the United States Steel Corporation and built many of the bridges discussed in this article, is today owned by the Continental Engineering Corporation of Taiwan.

Advanced Historic Bridges Crossword

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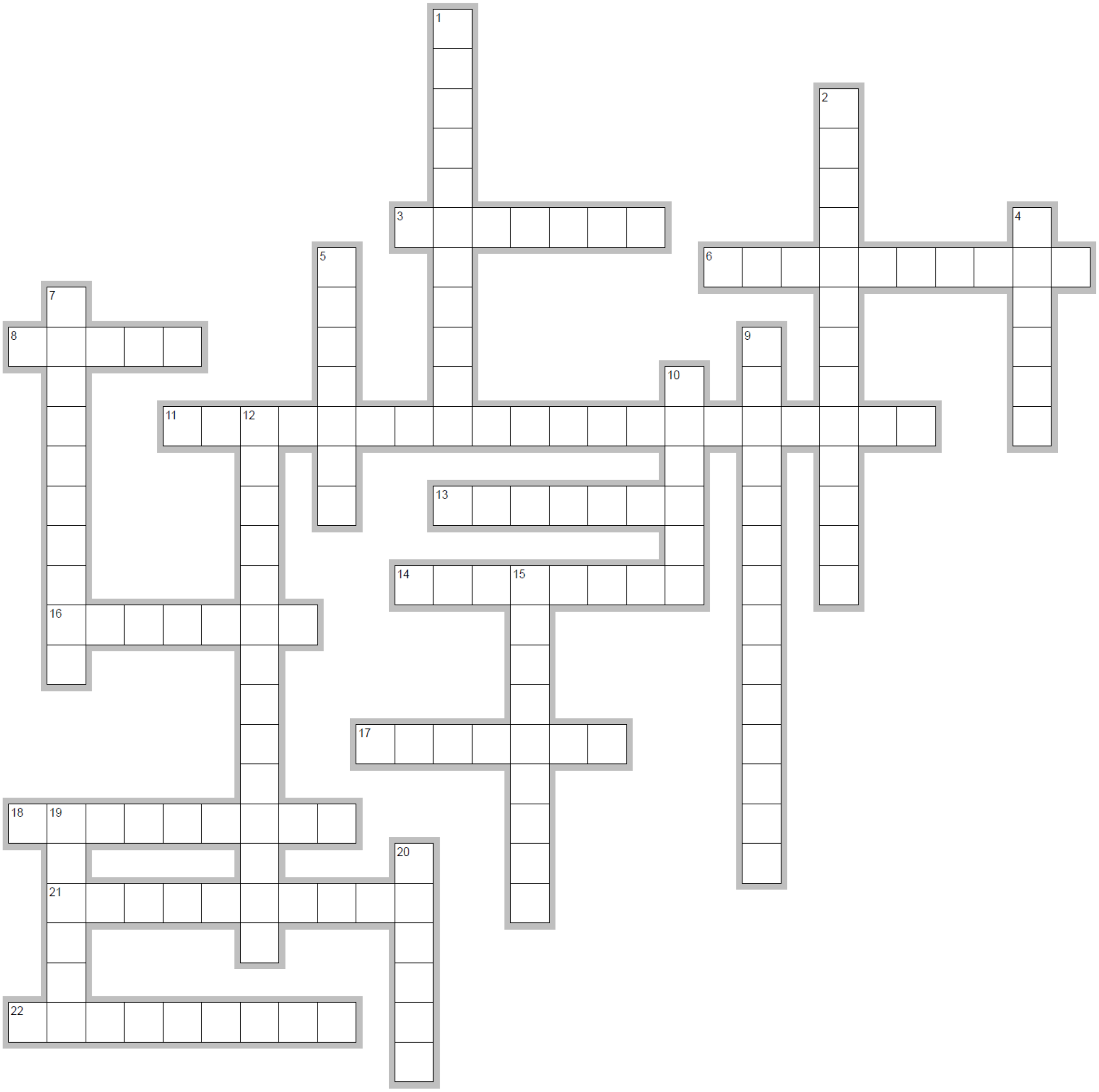


Across

3. This support structure transfers loads from the superstructure to the substructure while providing for limited movement.
6. A variety of this truss bridge configuration was patented and built by the Berlin Iron Bridge Company of East Berlin.
8. The portion of truss between the points where the web members and chord members intersect.
11. Term for a traditional rolled i-beam with an "I" shape and sloped flanges.
13. Term for masonry that is lined up in rows.
14. The wedge-like stone at the crown of a masonry arch which is the last stone placed to close the arch.
16. The end compression member of a truss. Can be vertical or inclined.

17. Rolled beam that has a U-like shape.
18. A temporary structure that is built under a bridge during construction to support the bridge until the bridge is self-supporting.

21. A bridge with spans that are connected to each other without joints over one or more interior supports.
22. Alternate name for a special rolled structural iron/steel element that was also known as star iron.

Down

1. Type of stress that involves bridge parts being pushed together.
2. A weight used to provide balance in movable bridges.
4. A small piece of plate that ties together two sections of metal in a built-up beam.
5. Type of stress that involves bridge parts being pulled apart.
7. A structure that has a free end extending beyond a support, like holding your arm straight out from your body.
9. Modern type of rolled i-beam that lacks sloped flanges and often has a more H-like cross-section.
10. The structure at the top of a suspension bridge tower where the cable bears.
12. Small gaps in the deck that allow for expansion and contraction of the bridge and its deck. Two words.
15. Longitudinal beams that support the deck.
19. This span provides balance for a cantilever span in a bridge.
20. Term for cut stone that is finely worked into shaped blocks.

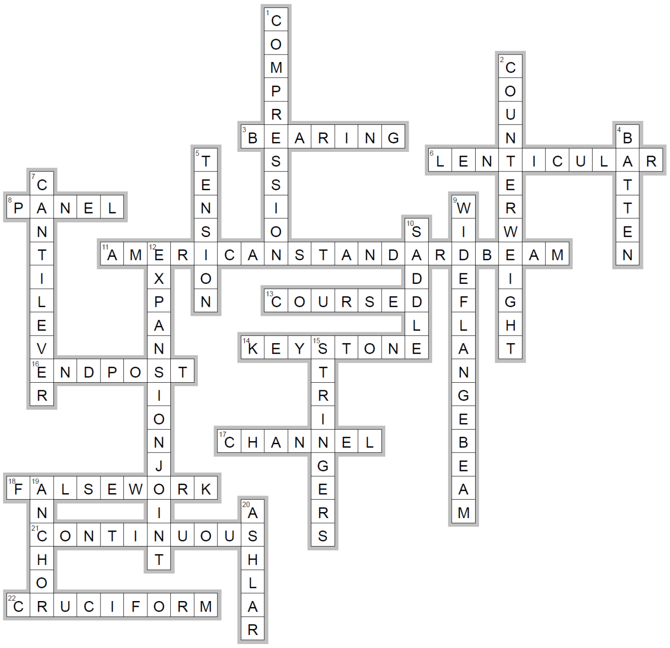
Upcoming Conferences

National Preservation Conference

Location: Houston, TX
Date: November 15-18, 2016
Website: http://savingplaces.org/conference
Details: PastForward is the premier educational and networking event for historic preservation professionals, volunteer leaders, and advocates. Expert practitioners lead learning labs and field studies, all designed to provide tools that participants can use to improve their own communities. Preservation Studio offers attendees the chance to explore exhibits, see live demonstrations and watch films. In addition, the live streaming TrustLive engages new audiences as they explore preservation through new lenses.

English Center Bridge, Lycoming County, Pennsylvania.
Photo by Nathan Holth.

Crossword Solution



Upper Slate Run Bridge, Lycoming County, Pennsylvania. *Photo by Nathan Holth.*