

THREE SISTERS BRIDGES

(Trinity of Bridges)

Pennsylvania Historic Bridges Recording Project - II

Spanning Allegheny River at Sixth, Seventh, and Ninth streets

Pittsburgh

Allegheny County

Pennsylvania

HAER No. PA-490

HAER
PA
2-PITBY
78-

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD

National Park Service

1849 C Street, NW

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Location: Spanning Allegheny River at Sixth, Seventh, and Ninth streets, Pittsburgh, Allegheny County, Pennsylvania.

USGS Quadrangles: Pittsburgh West, Pennsylvania (7.5-minute series, 1993), Sixth and Seventh Street bridges; Pittsburgh East, Pennsylvania (7.5-minute series, 1993), Ninth Street Bridge.

UTM Coordinates: 17/584520/4477650 (Sixth Street Bridge)
17/584700/4477750 (Seventh Street Bridge)
17/584840/4477785 (Ninth Street Bridge)

Dates of Construction: 1926-28 (Sixth Street Bridge)
1924-26 (Seventh Street Bridge)
1924-26 (Ninth Street Bridge)

Designers: Allegheny Department of Public Works: T. J. Wilkerson, consulting engineer; Vernon R. Covell, chief engineer; A. D. Nutter, design engineer; and Stanley L. Roush, architect.

Builders: American Bridge Company (Ambridge, Pennsylvania), superstructure; Foundation Company (Pittsburgh), substructure.

Present Owner: Allegheny County.

Present Use: Vehicular bridges.

Significance: These structures are the only trio of nearly identical bridges, as well as the first self-anchored suspension spans, built in the United States. They are among the only surviving examples of large eye-bar chain suspension bridges in America, and furthermore unusual for having been erected using cantilever methods. The bridges' design was a creative response to the political, commercial, and aesthetic concerns of Pittsburgh in the 1920s.

Historian: Haven Hawley, August 1998.

Project Description: The Pennsylvania Historic Bridges Recording Project II was co-sponsored during the summer of 1998 by HABS/HAER under the general direction of E. Blaine Cliver, Chief, the Pennsylvania Department of Transportation, Bureau of Environmental Quality, Wayne W. Kober, Director; and the Pennsylvania Historical and Museum Commission, Brent D. Glass, Executive Director and State Historic Preservation Officer. The fieldwork, measured drawings, historical reports and photographs were prepared under the direction of Eric DeLony, Chief of HAER.

Introduction

Pittsburgh, founded in 1794 and incorporated in 1816, developed rapidly on the basis of its mineral deposits, location at the entry to the western U.S., and abundant navigable waters. Throughout the nineteenth and twentieth centuries, Pittsburgh annexed neighboring boroughs and townships, climaxing in consolidation with Allegheny City in 1907. Annexation joined the two cities' commercial interests, following paths first laid out by bridges across the Allegheny River flowing between them.¹ Chiefly through annexation, Pittsburgh's population increased from 86,000 in 1870 to 190,000 in the mid-1870s. By that decade, the Allegheny River had proved to be a major transportation route for barges filled with coal, oil, lumber, and miscellaneous river traffic.²

The Monongahela River had Pittsburgh's first ferry and bridge connections, but efforts to cross the Allegheny quickly followed. Prominent Allegheny City resident William Robinson, whose son was not only the first non-Indian child born in the North Side but also became the city's first mayor, owned the Allegheny-Pittsburgh ferry. His service took passengers back and forth between Franklin Road (later Federal Street) in Allegheny and St. Clair Street (later Sixth Street) in Pittsburgh.³

The first petitioners to build bridges across the Allegheny and Monongahela rivers received charters on 20 March 1810. After a delay in constructing the bridges, their charters lapsed. Lack of funding, related to problems chartering of banks within the state, caused the bridge companies' inaction. The legislature refused a charter application from the Bank of Pittsburgh in 1810, which had promised to fund the proposed bridge projects with \$20,000. With

¹ G. M. Hopkins, *Atlas of the County of Allegheny, Penna., from Official Records, Private Plans and Actual Surveys* (Philadelphia: G. M. Hopkins, 1876), 4; City of Pittsburgh, "Incorporation of Boroughs and Townships Now Annexed to City," 1936, in Closed Reference Map Files, State Library of Pennsylvania, Harrisburg, Pa.

² L. H. Everts, *A History of Allegheny County, Pennsylvania* (Philadelphia: J. B. Lippincott & Co., 1876), 136.

³ Adrian J. Briggs, comp., *A Chronological History of Old Allegheny City Penna.* (Pittsburgh: Don Kuhl Printing Co., 1969).

the Bank of Pittsburgh out of the picture, the companies faced the difficult prospect of acquiring funding without the bank's assistance, delaying construction efforts until new charters could be obtained on 17 February 1816.⁴

The First Sixth Street (St. Clair) Bridge, circa 1819

The St. Clair Bridge at first endured a reputation as a second sister to the Smithfield Street Bridge over the Monongahela. The latter, an eight-span structure designed by nationally known bridge-builder Lewis Wernwag, opened in 1818 at a cost of \$102,000. At a lesser price of \$80,000, the St. Clair Bridge was built by a local contractor named Lothrop. It opened to traffic in late 1819, as shown by toll records for the bridge company. Although the Monongahela crossing was initially more important because of larger settlement south of the river, the St. Clair Bridge eventually became the better-known and more-used crossing as Allegheny City outgrew the South Side.⁵

Although no detailed physical descriptions or illustrations of the St. Clair Bridge remain, its design can be compared to other early Pittsburgh bridges. A nineteenth-century historian noted similarities between the later Mechanic (Sixteenth) Street Bridge and the first covered wooden structures over the Allegheny and Monongahela, suggesting that a local style or a single bridge builder — perhaps Lothrop — predominated in projects of the period.⁶ It is known that Lothrop used an arch-reinforced wooden truss design pioneered by Theodore Burr (the Burr arch-truss) on the nearby Hand (Ninth) Street Bridge. He quite possibly used this truss form on the St. Clair Bridge as well. Both bridges employed similar construction methods, incorporating iron elements into the wooden trusses, which were carried on substantial masonry abutments and piers.⁷

⁴ Everts, *History of Allegheny County*, 135. For dates of all early charters for bridge companies in Pennsylvania, see "Bridges: List of the Bridges, Authorized by the Legislature of Pennsylvania, to Be Erected by Companies, in the Order in the Several Acts of Incorporation Were Passed," in Bridge Company Accounts, 1809-1859, General Administrative and Financial Records, Record Group 2: Department of the Auditor General, Pennsylvania State Archives, Harrisburg, Pa. [hereinafter cited as Bridge Company Accounts].

⁵ Frank C. Harper, *Pittsburgh of Today: Its Resources and People*, vol. 1 (New York: The American Historical Society, Inc., 1931), 206. David Plowden, *Bridges: The Spans of North America* (New York: W. W. Norton & Co., 1974), 74, 239, gives 1821 as the St. Clair Bridge's opening date. In 1819, the bridge company collected just less than one-quarter of its 1820 revenues. This indicates that the bridge opened to traffic in late 1819, but does not provide a definitive completion date. See "State of the Allegheny Bridge Co., from the Date of Organization, 8th July, 1816, until January 1st, 1851, Inclusive," in Bridge Company Accounts. A. Warner & Co., *History of Allegheny County, Pennsylvania*, vol. 1 (Chicago: A. Warner & Co., 1889), 570, notes the actual name on the charter was "A Company for Erecting a Bridge over the Allegheny River Opposite Pittsburgh in the County of Allegheny."

⁶ Everts, *History of Allegheny County*, 135.

⁷ Harper, *Pittsburgh of Today*, 206.

In the St. Clair Bridge, Lothorp used wooden truss spans of varying lengths to achieve a total length of 1037'-0". The wooden superstructure included four spans each 185'-0" long, one 170'-0" long, and one 137'-0" long. Iron bars 1" in diameter provided vertical ties between the floor system and the arches above. Stone piers supported the spans, which were joined to each other by removable iron bolts in case a particular span needed repairs.⁸ (Some of the masonry, in fact, remained in use through the third bridge on the Sixth Street site.)

The St. Clair Bridge's opening was celebrated with a banquet eaten across virtually the entire length of the structure.⁹ The bridge was known as a promenade for young people, a social event that enhanced its popularity during daylight hours. Lit by oil lights extinguished at midnight, it was considered a safe passage by day but not hospitable for night-time crossings. The bridge company charged two cents for pedestrians. As its backers had hoped, trans-Allegheny traffic soon preferred the St. Clair Bridge over the ferry, forcing the latter into obsolescence.¹⁰

Despite the success of land transportation crossing area rivers, alternative methods continued to find use in the mid-nineteenth century. The state-constructed Pennsylvania Canal spanned the Allegheny on a wooden aqueduct at Eleventh Street built in 1829, but in 1843 weakness in a fire-damaged pier forced its closing. The city of Pittsburgh could not persuade the state to repair the structure, but instead received authorization to charge tolls to finance the work locally. John A. Roebling designed a cost-effective reconstruction using wire cables to carry the roadway, finishing the work in 1845. Roebling's reputation for suspension bridge design and his ability to finish a bridge within its original budget of \$62,000 impressed local observers.¹¹

The suspension aqueduct charted a potentially lucrative innovation for the region. It was the first such structure in the country, carrying a wooden flume over seven spans of 162'-0" each. Accounts vary, but the aqueduct seems to have continued in service until at least the mid-1850s, and perhaps as late as 1860. One local historian recorded that the city lost money despite the tolls, helping to precipitate the canal's demise. A bridge enthusiast commented on the structure's success, however, and noted its use until 1860.¹² Regardless of the precise date of abandonment and degree of success, the aqueduct began to deteriorate soon thereafter.

⁸ W. G. Wilkins, "The Reconstruction of the Sixth Street Bridge at Pittsburgh, Pa.," *Proceedings of the Engineers' Society of Western Pennsylvania* 9 (1895): 144; Warner, *History of Allegheny County*, 206.

⁹ Leland D. Baldwin, *Pittsburgh: The Story of a City* (Pittsburgh: Univ. of Pittsburgh Press, 1937), 205.

¹⁰ Everts, *History of Allegheny County*, 135; Wilkins, "Reconstruction of the Sixth Street Bridge," 143-44; and Warner, *History of Allegheny County*, 570.

¹¹ Plowden, *Bridges*, 74.

¹² Warner, *History of Allegheny County*, 571, claimed that financial hardship caused the canal's closure while Plowden, *Bridges*, 74, called it a great success.

The First Ninth (Hand) Street Bridge, 1840

In 1835, the St. Clair Bridge and the aqueduct provided the only Allegheny River crossings. As the cities of Allegheny and Pittsburgh continued to grow, leading citizens obtained a charter for constructing a third structure. The 1836 charter permitted the Pittsburg & Allegheny Bridge Company to build a bridge joining Hand Street (later Ninth Street) in Pittsburgh with Chestnut Street (also known as Greyasoto Lane; later Anderson Street) in Allegheny. The company chose Pagan, Alston & Company to construct stone work for \$37,000, paid an unknown contractor \$10,000 to construct approaches, and hired Le Baron & Lothrop for the superstructure, paying \$33,000. It appears that Lothrop was the same contractor who constructed the St. Clair Bridge.¹³

The Allegheny's fast-moving current presented a difficult problem for bridge builders. Although the original drawings had been lost when the bridge was reconstructed in 1890, Gustave Kaufman, an engineer involved in replacing the structure, found exceptionally good alignments and elevations but poor masonry work. The four piers measured 9'-0" by 35'-0", with sides battered 1:12, semi-circular nosings on their upstream and downstream faces, and arch skewbacks 4'-0" longer than the pier tops. The masonry price of \$7 per cubic yard might be considered fairly expensive given the poor workmanship. The lime mortar deteriorated rapidly, and the Freeport sandstone suffered from exposure to the river's current. Areas of masonry not exposed to water and ice remained in better condition than the piers.¹⁴

The Panic of 1837 slowed construction, but the company continued foundation work and waited for an economic recovery. Local opposition, perhaps because residents feared that another cross-river construction would initiate a repeat of the powerful flood of 1832, delayed work. The 1832 flood was thought to have been intensified by obstructions put in place to protect structures erected by bridge interests. The Pittsburg & Allegheny Bridge Company temporarily lost permission to build a Hand Street abutment until the company guaranteed in 1838 that its structures would not impede river flows.¹⁵

The company abandoned its plan to sell stock in the venture and borrowed money to complete the bridge. In 1840, the firm began recording toll collections for passage. To gain authorization for the Hand Street project, the bridge company paid half of the cost for a bridge that carried the West Pennsylvania Railroad over a canal on the Allegheny side, near what became Canal Street. The company also paved a road from the canal to the bridge. A tunnel through the Allegheny approach had to be bored to make way for the Pittsburg & Western Railway's tracks. The railroad gained a 12'-0" by 16'-0" opening about 20'-0" from the northern

¹³ Gustave Kaufman, "The Reconstruction of Ninth Street Bridge, Pittsburg, Pa.," *Proceedings of the Engineers' Society of Western Pennsylvania* 8 (1892): 189, 192.

¹⁴ Kaufman, "Reconstruction of Ninth Street Bridge," 190-92.

¹⁵ Kaufman, "Reconstruction of Ninth Street Bridge," 191.

abutment, and the bridge's roadway was reinforced with buckle plates, iron beams, and iron plates for smoke protection.¹⁶

At the time of its construction, the Hand Street Bridge was the third-largest Burr arch-truss in the United States, according to Kaufman. The combination of two structural systems used in a Burr arch-truss presented problems in determining which component carried load at a given time. Despite these calculation difficulties, the Burr arch-truss remained a popular design during the second and third quarters of the nineteenth century. Only Wernwag's "Colossus" across the Schuylkill River and another structure on the Merrimac River surpassed the Hand Street Bridge in span lengths.¹⁷

The Hand Street Bridge combined a single span of 190'-0" with four spans each 200'-0" long. Three lines of arch-trusses divided the roadway into two sections each 11'-0" wide. Each arch contained two layers of timber 2'-4" deep and 7" thick, with timbers in the middle arch twice the thickness of those in the outer arches. Cantilever sidewalks added 7'-0" more to each side of the bridge, which measured about 28'-6" across. Howe trusses, consisting of white pine diagonals and transverse iron rods, provided lateral bracing. When workers removed the exterior sheathing to build the replacement bridge, some pedestrians were scared of crossing because of visible strains in the arches and floor beams. Nonetheless, the high-quality pine allowed the bridge to remain sound and mostly free of rot during its entire use.¹⁸

With a clear interior height of 11'-0", the wooden structure later faced the clearance problems of Burr arch-trusses adapted for street railways. An additional dilemma of navigational clearance arose when constructing a replacement in 1890. Engineers considered the vertical tension members extending 18" below the roadway surface to be the limit for the height of craft moving under the bridge. They found that the protuberances were a steering challenge rather than a lower limit for expert boatmen on the river below. "Such precision in steering was almost an incredible revelation" to Kaufman.¹⁹

Ice presented a constant danger to structures across Pittsburgh's rivers. Ice damaged a pier on the Hand Street Bridge in 1857 so severely that traffic had to be shut off while repairs could be made. Despite having insurance against ice damage, the company could not collect on its policy — a difficulty which may have encouraged other bridge companies to forego spending money on policies thereafter.

¹⁶ Kaufman, "Reconstruction of Ninth Street Bridge," 192-93.

¹⁷ Kaufman, "Reconstruction of Ninth Street Bridge," 192-94.

¹⁸ Kaufman, "Reconstruction of Ninth Street Bridge," 192-95.

¹⁹ Kaufman, "Reconstruction of Ninth Street Bridge," 192-94.

The Second Sixth Street (St. Clair) Bridge, 1859

Roebling's introduction to Pittsburgh gained him other jobs in the city. He designed a replacement for the Smithfield Street Bridge, destroyed by fire in 1845, and then a new structure for the profitable St. Clair Bridge, which was completely reconstructed from 1857 to 1859.²⁰ Although covered bridges were constructed as late as the 1876 Union Street Bridge over the Allegheny River at the Point, the suspension type became more popular after Roebling's structures were completed.²¹

The Allegheny Bridge Company, owner of the St. Clair Bridge, showed consistent profits from 1819, the first year in which it collected tolls, through 1860, when the new suspension bridge was finished. The rate of dividends increased steadily from 3 percent in 1823, when first paid, to a steady 15-percent rate in the mid-1840s.²² A charter supplement in 1857 allowed the bridge to be replaced. John Harper, director of the bridge company, advocated a suspension bridge over the objections that such an expensive venture would not be profitable. The entire structure, from piers and abutments to superstructure, was razed prior to starting work on Roebling's design, although the stone was saved for reuse.²³

Subsequent to reconstruction, the company became known as the Suspension Bridge Company. Harper aggressively marketed investments in the new structure, assuring prospective buyers of the value of their stock purchases — which indeed came to pay solid dividends. Harper also reduced the toll to a penny for male pedestrians and gave women free passage, while also publicizing incentives rewarding companies and local organizations whose members committed to use the crossing. Fascination with the suspension form encouraged more intense use of the crossing, proving Harper's investment and strategies to have been a savvy business decision.²⁴

Roebling's ornate design for the replacement nearly doubled the largest span lengths of the previous structure and used the elegant suspension form for which he was so well known, at a cost of just less than \$300,000. One local history described Roebling's St. Clair Bridge as "the first great bridge to span a navigable stream in the United States."²⁵ The design called for two

²⁰ Warner, *History of Allegheny County*, 570-71; Plowden, *Bridges*, 119; and Wilkins, "Reconstruction of the Sixth Street Bridge," 145.

²¹ Warner, *History of Allegheny County*, 571.

²² Pennsylvania State Archives, "State of the Allegheny Bridge Co."

²³ Everts, *History of Allegheny County*, 135-36; Pennsylvania State Archives, "State of the Allegheny Bridge Co." Harper also served as president of the Bank of Pittsburgh.

²⁴ Everts, *History of Allegheny County*, 136.

²⁵ Everts, *History of Allegheny County*, 135-36.

main spans of 344'-0" between the shore spans of 177'-0" and 171'-0".²⁶ The bridge was 40'-0" wide, with a 20'-0" roadway and two 8'-0" sidewalks, which decreased to 7'-0" at towers. Four cables ran over the cast-iron towers. Two large main cables attached to the structure between the roadway and sidewalk, and two smaller cables were affixed to the bridge outside of the sidewalks and handrails.²⁷

The suspension system required 7-1/2"-diameter main cables, each containing seven bundles of 100 wires, spaced 22'-0" apart the crown and flaring out 5'-0" wider at the towers. The 4-1/2"-diameter, 300-wire sidewalk cables, hung between 35'-0" and 42'-0" apart at the same points. Four cast-iron column towers, approximately 27'-0" high and 22" in diameter, supported saddles for the cables. Wire-rope stays crossed from the deck beams at one side of the structure, over the saddles, and back to the opposite beams. The iron floor beams, spaced 5'-0" on center, hung from 1"-diameter wire rope suspenders affixed to the cables with wrought-iron collars. A system of timber stringers, with iron rods providing lateral bracing, carried a wooden deck.²⁸

The St. Clair Bridge became more popular after Roebling's design was constructed, and rail traffic soon joined those on foot. By the 1870s, two street railway tracks used the structure for taking passengers across the river.²⁹ With the advent of electric streetcars in 1890, the structure could not bear the greater load and width required by the newer vehicles. Taken down later for replacement, the once-repaired and once-oiled wire cables were found nearly as strong as when installed, excepting the exterior strands. The change in traffic technologies and loads, however, made the narrower cable-supported structure obsolete. Tests on the iron components also showed corrosion from steamboat smoke.³⁰

The First Seventh Street Bridge, 1884

In 1868, Pittsburgh annexed the East End and renamed city streets. Names recalling founders or landmarks disappeared into numbered sequences. The St. Clair Bridge took on a new identity as the Sixth Street Bridge; Irwin Street became Seventh Street; and Hand Street two blocks away became Ninth Street. Historic monikers and denotations such as Pitt, Hancock,

²⁶ Wilkins, "Reconstruction of the Sixth Street Bridge," 145.

²⁷ "The New Sixth Street Bridge, Pittsburgh, Pa.," *Railroad Gazette* (28 July 1893): 560.

²⁸ Wilkins, "Reconstruction of the Sixth Street Bridge," 145-47.

²⁹ Everts, *History of Allegheny County*, 136.

³⁰ Wilkins, "Reconstruction of the Sixth Street Bridge," 144, 147-49.

Canal, Factory, and Mechanic streets were lost along the way of rationalizing the municipal layout.³¹

Commodore William J. Kountz led the group operating the Pittsburgh, Allegheny & Manchester Passenger Railway over the St. Clair Bridge. The route joined downtown Pittsburgh to Allegheny City, running from Market and Liberty streets in the former to Federal Street and on to Woods Run in the latter. Rail passengers endured sharp turns on the mule- or horse-pulled vehicles, as well as exposure to winter air. Rail companies provided straw during cold weather to help keep customers' feet warm. Cars traveled at most three to five miles per hour, and passengers paid six cents for a ride.³²

In a bid to compete with the popular crossings at Sixth and Ninth streets, the North Side Bridge Company hired famous bridge builder Gustav Lindenthal to design the Seventh Street Bridge. Lindenthal's 1884 structure used a stiffened-chain suspension design. Three towers carried chains supporting two main spans of 320'-0" and two side spans of 165'-0". Rather than calling his design a suspension bridge, Lindenthal referred to it as a "suspended arch bridge" because of the unusual web bracing he specified for placement between the top and bottom chains.³³

Moreover, eye-bars and not wire comprised the chains, which hung as pairs with the bracing connecting the two cables. Eye-bars provided a stiffness lacking in wire suspension bridges. Lindenthal also designed the Smithfield Bridge which stands today in Pittsburgh, albeit with a more modest portal than first constructed. Historian Henry Petroski notes that the pair were among "the major structures erected in the 1880s in America."³⁴ When discussions about tearing down the trio of downtown bridges proceeded in the 1920s, journalists and residents of Pittsburgh noted the Seventh Street Bridge as a historic site because of Lindenthal's contribution. Despite being an older crossing, the much less attractive Ninth Street Bridge received much less attention.

Lindenthal's Seventh Street Bridge also gave warning about the anchoring problems that structures at the downtown sites faced. After construction had been completed, the north anchorage proceeded to slip. A repair shoring up the anchorage with additional masonry joined to the structure's first anchor chain resolved the problem, however. Hermann Laub, who had experience working with Lindenthal, completed the repairs.³⁵

³¹ "Life in Pittsburgh Over Fifty Years Ago," *Pittsburgh First*, 6 Dec. 1924, 56, in Pennsylvania Room, Carnegie Library, Pittsburgh, Pa. Everts' map in *History of Allegheny County*, 1876, uses "Irvine" instead of "Irwin."

³² *Pittsburgh First*, "Life in Pittsburgh," 57.

³³ Plowden, *Bridges*, 238.

³⁴ Henry Petroski, *Engineers of Dreams: Great Bridge Builders and the Spanning of America* (New York: Alfred A. Knopf, 1995), 129.

³⁵ Plowden, *Bridges*, 238.

In the mid-1890s, a city directory listed railways crossing the Sixth and Ninth street bridges but none over Lindenthal's structure. Railway consolidations brought the Sixth Street line under control of the Pittsburgh, Allegheny & Manchester Traction Company. The Federal Street & Pleasant Valley Passenger Railway Company controlled the Ninth Street Bridge. Each firm ran two streetcar tracks on each of the structures, carrying passengers in both directions between Allegheny and Pittsburgh.³⁶ The added weight of the electric cars made alterations of the Sixth and Ninth Street bridges necessary.

The Second Ninth Street Bridge, 1890

The Pleasant Valley Electric Street Railway Company purchased controlling stock in the Pittsburgh & Allegheny Bridge Company in 1889, allowing the railway to dictate a new Ninth Street Bridge design to meet its specifications. The profitability of electric railways encouraged the Pleasant Valley company to undertake the venture.³⁷ Engineers Ferris and Kaufman directed construction of a second bridge out of steel to make the crossing sufficiently strong for rapid transit vehicles.³⁸

The railway provided funds to construct a four-track roadway with 5'-2-1/2" gauge rails. Three river spans, measuring 205'-0" each, were flanked by side spans of 152'-6", and an 80'-0" viaduct on the Allegheny approach. The work was started in 1889 and completed by the fall of 1890. Specifications called for a Pratt truss design built of rivet steel and wrought iron. The bridge company also specified stringers of either iron or steel, and the widest roadway possible on the existing piers, showing a concern with economizing wherever possible.³⁹ The railway company selected the Iron City Bridge Company's proposal as best meeting the specifications. The Iron City Bridge Company built bridges in the Pittsburgh area from 1876 to 1896, according to a directory of nineteenth-century bridge-building companies. The same directory indicated that engineers Ferris and Kaufman ran a joint operation named Ferris, Kaufman & Company in 1896; their association likely extended earlier to the Ninth Street Bridge replacement.⁴⁰

The contractor immediately took off the roof and wall coverings of the bridge so that the railway's cars could pass. New wooden towers provided lateral support after overhead bracing was torn down. Even with a mild winter, the engineers noted, the Allegheny River's level fluctuated so much that other work was difficult. Contractors removed the sidewalks and erected the new bridge around the wooden one. The poor condition of the masonry made the work

³⁶ J. M. Kelly, *Handbook of Greater Pittsburgh* (Pittsburgh: J. M. Kelly, 1895), 58.

³⁷ Kaufman, "Reconstruction of Ninth Street Bridge," 195.

³⁸ Wilkins, "Reconstruction of the Sixth Street Bridge," 144.

³⁹ Kaufman, "Reconstruction of Ninth Street Bridge," 200-01, 215, 196.

⁴⁰ Victor C. Darnell, *A Directory of American Bridge-Building Companies, 1840-1900*, Occasional Publication No. 4 (Washington, D.C.: Society for Industrial Archaeology, 1984), 65, 67.

difficult, because old grout had to be removed and new mortar injected to keep piers sturdy. Workers took apart the skewbacks, constructed new tops on the piers, and used falsework to construct the new trusses outside of the existing arches, span by span.⁴¹

Kaufman reported that navigation concerns arose during the bridge's construction. The engineer was aware of federal jurisdiction over navigable waterways such as the Allegheny. With increasing discussion about a future height requirement on American rivers, Kaufman's firm tried to anticipate higher clearances that might affect the bridge owners. Midway through construction, the company decided to place 12"-high granite blocks under the span shoes in the channel and 7"-high blocks on adjacent piers, providing additional clearance.⁴²

The new design included a number of improvements for rail traffic. On the Pittsburgh approach, the contractor moved the abutment 40'-0", decreasing the length of the span adjacent to Duquesne Way (present-day Fort Duquesne Boulevard). This modification made turning from the bridge onto the street easier. On the bridge itself, the designers increased the vertical clearance to 20'-0" and boosted the number of stringers from eight to twelve. The roadway was designed to carry an engine somewhat heavier than that used by the Pleasant Valley Railway. Kaufman's firm used an Aveling & Porter engine weighing 15 tons for calculations because the railway's cars weighed close to 13 tons when full. Changes to the Allegheny City abutment benefitted the Pittsburg & Western Railroad operating on the river bank below. The rebuilt approach included five 16'-0" stone arch spans each accommodating one track, with an additional 1'-0" of vertical clearance. The passage was made expandable in case Anderson Street was moved and more space for railroad operations became available.⁴³

The Third Sixth Street Bridge, 1892

Steel trusses provided the strength necessary for the greater load of electric streetcars at the Sixth Street crossing as well. The main route between the two cities, the Sixth Street Bridge constructed by Roebling, proved unequal to the task of carrying greater passenger and vehicular loads. Streetcars' speeds were restricted on the two tracks of the roadway, and the number of light vehicles continued to increase. Pittsburgh needed "a structure capable of carrying the heavy loads customary in an iron city," reported the *Railroad Gazette*.⁴⁴ The design of those trusses became a matter of public interest because of the longevity of the two previous bridges at the site.

⁴¹ Kaufman, "Reconstruction of Ninth Street Bridge," 202-03, 205-11.

⁴² Kaufman, "Reconstruction of Ninth Street Bridge," 213.

⁴³ Kaufman, "Reconstruction of Ninth Street Bridge," 196-201. According to a story related by an engineer who helped take down the wooden bridge, a violin maker asked to procure wood from the first Hand Street Bridge, speculating that the continual vibration would condition the wood as if it had been played already. He formed three violins from a wood chosen from the disassembled wooden structure and was very satisfied with the outcome of his handiwork (*ibid.*, 218).

⁴⁴ *Railroad Gazette*, "New Sixth Street Bridge," 560.

The Allegheny Bridge Company deemed the project important enough to announce a design competition, selecting aesthetics and strength as two critical features.⁴⁵

The Lohse system of inverted arches, which had been featured recently in a German bridge at Hamburg, served as the model for the specifications. C. L. Strobel submitted three designs closely following the announced guidelines, and the company selected one that featured a three-hinged inverted arch in the lower chords. The project proceeded far enough for Strobel to submit and have published in a major engineering journal the designs he had prepared for the structure. Before work began, however, the bridge company changed its mind about the design to be used.⁴⁶

An entirely different design by Theodore Cooper, who had been named the bridge company's engineer, received final acceptance. His simpler design featured a pair of pin-connected 440'-0"-long bowstring trusses erected around the old bridge, which was then demolished upon completion in 1892. The Drake & Stratton Company, Limited, received a contract for foundations and masonry; the Union Bridge Company for the superstructure; and Baird Brothers of Pittsburgh for erection. All work cost \$560,000. The contract included a 105'-0" approach on the Pittsburgh side with a pair of 28'-0" archways; the two main spans; a 48'-6" approach span on the northern side traversing the Pittsburgh & Western Railroad right-of-way; and new coping for the old Allegheny approach. The trusses were spaced 44'-6" apart, accommodating a roadway 40'-0" wide from curb to curb, and stood 79'-0" high at mid-span. Sidewalks measured 10'-0" wide on the approaches and 9'-0" between posts. The design moved the center line on the Pittsburgh shore downstream approximately 6'-0" for better alignment with Duquesne Way.⁴⁷

Engineer W. G. Wilkins discussed foundation work for the third Sixth Street Bridge at a meeting of the Engineers' Society of Western Pennsylvania. Abutments were completed in halves in order to maintain cable strain in the old bridge. The new piers incorporated rock-faced Beaver County sandstone, with coping and cornice stone from Berea, Ohio. Wilkins noted one of the original piers was found to have been widened and reinforced with two rows of piles, extending the pier 3'-0" over the piles while the original remained on timber footings. Also, the third pier had a location identical to that of the first St. Clair Bridge abutment. Contractors discovered "two courses of twelve inch timbers with the sap sides riveted together with oak pins" from the 1819 bridge, which provided material for blocking up the old floor.⁴⁸

With bedrock about 60'-0" under river bottom in the area where the Monongahela and Allegheny rivers meet, only one bridge in the vicinity had foundations on rock, most opting

⁴⁵ C. L. Strobel, "A New Truss Design And Its Analysis," *Engineering News* 38 (1897): 51.

⁴⁶ Wilkins, "Reconstruction of the Sixth Street Bridge," 149.

⁴⁷ Wilkins, "Reconstruction of the Sixth Street Bridge," 150-51, 161-62; *Railroad Gazette*, "New Sixth Street Bridge," 560.

⁴⁸ Wilkins, "Reconstruction of the Sixth Street Bridge," 152-57.

instead for pier foundations at whatever depths were deemed appropriate to the bridge structures above. All of the piers for the new Sixth Street Bridge, except for the second one, were constructed in open cuts protected by sheet piling. For the second pier, the contractor first set a breakwater in place 80'-0" upstream to shield the new pier site. The next step was to build an open coffer-dam on a wooden grillage, sinking the grillage to gravel without piling. This avoided the former bridge's problem of having timber footings out of water during low river flow and allowed the footings to be set on gravel with enough bearing capacity to avoid unnecessary excavation. With the new pier 7'-7" lower and offset 10'-6", the old pier could be maintained in place for temporary support. During dredging, additional sheet piling had to be driven to stop erosion under the old pier. As pier masonry was added, the cofferdam settled out of plumb, requiring that each successive course be adjusted to provide a level coping. The entire process, from breakwater to coping, took four months and finished in November. As a final step, workers dredged the river after the old piers had been removed.⁴⁹

Workers began constructing the new bridge's floor after raising the old floor to accommodate the procedure. Temporary piles were topped with timber bents to allow the old floor to be jacked, blocked, and supported by the stringers. Other bents carried traveling crane tracks on either side of the structure. Bridge company directors decided to halt horse traffic across the bridge during construction because of liability for accidents if the animals became frightened, but pedestrian and non-animal vehicles were able to use the structure. To allow continued streetcar traffic, the tracks were repositioned on three occasions by installing buckle plates and stringers.⁵⁰ The Union Bridge Company prepared a cable conduit for streetcars as requested by the transit company, but the firm ultimately decided to continue using overhead trolley wires.⁵¹

Greater Pittsburgh, Navigation, and Free Bridges

Pittsburgh continued to build bridges to the North Side in the 1880s and 1890s, and the physical connections paralleled administrative efforts to create a Greater Pittsburgh. The vision of a metropolitan area united under one city government reflected consolidation and annexation movements beginning in the mid-nineteenth century, but the Pittsburgh Chamber of Commerce dated Greater Pittsburgh to 1894, when state legislators approved Pittsburgh's proposed annexation of Allegheny City. Allegheny City fought the proposal, forcing Greater Pittsburgh proponents to endure numerous state-level committee meetings, to power three bills through the

⁴⁹ Wilkins, "Reconstruction of the Sixth Street Bridge," 152-57.

⁵⁰ Wilkins, "Reconstruction of the Sixth Street Bridge," 151-52.

⁵¹ *Railroad Gazette*, "New Sixth Street Bridge," 560.

legislature, and to procure judicial approval for the annexation procedures. Pittsburgh's Chamber of Commerce claimed responsibility for the proposal's success.⁵²

A committee of the Chamber of Commerce requested select councils of each city to meet to discuss the issue, setting the issue in motion. After numerous delays, including revising state law to lower the number of petitioners required to initiate annexation of an adjacent municipality from one-fifth to one-twentieth of the population, the state legislature passed a bill allowing the process to begin. After the last hurdle of approval by the State Supreme Court allowed the vote to proceed, citizens in the two cities at last voted in 1906 for consolidation.⁵³ Pittsburgh had maneuvered for legislative approval that required a majority of the combined vote of the municipalities instead of a clear majority of the area to be annexed, and the measure passed easily. A pithy history of Allegheny City noted the "end of the wrangling that started back in 1846. Pittsburgh, the larger city, annexed itself to Allegheny by outvoting the smaller city, and retained its own name."⁵⁴

The Chamber of Commerce also promoted federal improvements to waterways in the area. Just ten days after its chartering in 1876, the Chamber lobbied Allegheny County to encourage congressional action on a bill to dam the Ohio River and improve harborage for the city. By 1880 the organization was calling for Congress to implement "radical improvements" along the entire Allegheny River. Members consistently opposed giving bridge companies rights-of-way or concessions to make profits from control over riverfront access. The Chamber sent representatives to congressional committee meetings that focused on navigation issues in the mid-1890s, and in the following decade began actively participating in regional and national river and harbor conferences.⁵⁵ Congress authorized new surveys of waterways across the nation in the 1913 River and Harbor Act, and the Chamber continued to press for more attention to area navigation, hoping to link Pittsburgh to a national waterway integrating the Ohio River and the Lake Erie Canal into an system encompassing the Mississippi Valley and eastern United States.⁵⁶

An earlier River and Harbor Act, passed by Congress on 3 March 1899, required the Secretary of War to declare highway or railroad bridges over navigable bodies of water in violation if they posed "an unreasonable obstruction to the free navigation of such waters on account of insufficient height, width of span, or otherwise." In the course of investigations to

⁵² "The Chamber and Greater Pittsburgh," *Pittsburgh First*, 6 Dec. 1924, 49.

⁵³ *Pittsburgh First*, "The Chamber and Greater Pittsburgh," 49.

⁵⁴ Briggs, *Chronological History*, entry under 1907.

⁵⁵ "The Chamber and Ohio, Monongahela and Allegheny River Improvements," *Pittsburgh First*, 6 Dec. 1924, 38-39.

⁵⁶ *Pittsburgh First*, "The Chamber and ... River Improvements," 39.

determine whether a structure posed such a blockage, the secretary's task entailed setting deadlines and clearances for modifications.⁵⁷

Although river interests had agitated for higher clearances long before the Secretary of War became involved, the War Department first held hearings about Allegheny obstructions in 1903 after a local district engineer, Capt. William L. Sibert, reported that Pittsburgh bridges were not in compliance with the 1899 act. Secretary of War Elihu Root ruled in 1904 after lengthy investigations that the structures posed no unreasonable problem for shipping as it existed at that time. Four years later his successor, William Howard Taft, upheld the decision because he was unwilling to overturn the decision without new evidence, although he conceded that he favored a 47'-0" clearance for all new cases he would be called upon to judge.⁵⁸

The matter resurfaced in 1909, resulting in a recommendation by the Bixby Board, a War Department committee, generally to follow Sibert's advice. Timing proved crucial in the outcome. When a new Secretary of War, J. M. Dickinson, finally acted on the recommendation, he rejected the petition instead of approving it. The ruling that Allegheny bridges would not have to be razed to meet height requirements came on 6 March 1911, and influenced Allegheny County's decision to purchase the bridges from their private owners. Dickinson, like Taft, refused to overrule a predecessor without material alteration in the circumstances of the case.⁵⁹

Yet again proponents of increased clearances sought a positive ruling on their petition in 1915 with acting secretary Lindley M. Garrison. Garrison agreed to review the case for new information, and Lt. Col. Shunk, serving in the same capacity as Capt. Sibert as district engineer, provided a detailed report. Like Sibert, Shunk advised that the bridges obstructed river traffic. After holding hearings, visiting the site, and digesting immense amounts of information in the case, Secretary of War Newton D. Baker agreed with the district engineer.⁶⁰

Shunk reported that the existing clearances of the Sixth, Seventh, and Ninth Street bridges were respectively 33.4', 35.0', and 33.6' above the Davis Island pool (elevation 703.0'). He recommended additional clearances of 8.1' to 9.7' in 1916. Baker revised the order for even greater heights and set firm deadlines, requiring 47.0' in the clear over the Davis Island pool for the Sixth Street Bridge, 47.1' for the Seventh Street Bridge and 47.3' for Ninth Street Bridge. Work on the latter two bridges was to begin by 28 September 1918, and on the Sixth Street Bridge in 1919. The deadline for compliance was two years after commencement of work.⁶¹

⁵⁷ U.S. War Department, *Opinion of the Secretary of War in re Elevation of Bridges over the Allegheny River at Pittsburgh* (Washington, D.C.: U.S. Government Printing Office, 1917), 3.

⁵⁸ War Department, *Opinion*, 3-4; and V. R. Covell, "The Bridge-Raising Program on the Allegheny River in Allegheny County," in *Proceedings of the Engineers' Society of Western Pennsylvania* 41 (1925): 83.

⁵⁹ War Department, *Opinion*, 4.

⁶⁰ War Department, *Opinion*, 5.

⁶¹ Covell, "Bridge-Raising Program," 84.

Baker's upward revision of Shunk's recommendations posed serious grading problems, requiring the county either to buy more private property for longer approaches, or to increase the bridges' grade by about one percent.⁶² Crucial in Baker's decision was the fact that Pittsburgh led the nation in steel production, an industry whose fate affected enterprises and commercial development across the nation. Both river and rail distribution played an important role in making the abundant iron ore and rich coal deposits of the area available to producers both local and outside of the area. Improvements along the Monongahela had made that river a better transportation route, especially for craft relying on stern-wheel equipment that often found its sister river unnavigable.⁶³

Allegheny County owned six of the seven Allegheny bridges considered not in compliance: the Sixth, Seventh, Ninth, Sixteenth, Thirtieth, and Forty-third Street bridges. A seventh bridge, for the Pittsburgh, Fort Wayne & Chicago Railway, was owned by a subsidiary of the Pennsylvania Railroad Company.⁶⁴ For boats needing 32'-6" clearance (with lowered stacks), navigation was impossible for periods varying from 14 days at Thirtieth Street; 82 days at Seventh Street and the Fort Wayne bridge; 105 days at Sixth and Ninth streets; and for the entire year at Sixteenth and Forty-third streets. Baker rejected the suggestion that boat manufacturers be encouraged to build craft to meet available bridge heights, as well as the observation that certain bridges obstructed traffic for relatively few days. The Secretary of War asserted that the government's responsibility was to ensure navigation of current waters, using craft available locally, and to ensure reliable transportation for resources vital to the nation's industrial growth as well as to the local economy.⁶⁵

The uneven pier locations along the river, particularly on the downtown structures within such close proximity, made for dangerous conditions because of the Allegheny's swift currents and frequent fluctuations in water level.⁶⁶ The Sixth, Seventh and Ninth Street bridges were 0.6, 0.7, and 0.8 miles from where the Allegheny flowed into the Ohio. The Sixth Street Bridge's main span of 430'-0" lay on the left of the river, while the other two structures had spans of 422'-0" and 410'-0" over the center channels. Clearances were, respectively, 33.3', 47.1', and

⁶² Covell, "Bridge-Raising Program," 86.

⁶³ War Department, *Opinion*, 5-6.

⁶⁴ War Department, *Opinion*, 6. Warren and Wetmore and H. G. Balcom designed the Sixteenth Street Bridge, completed in 1923. The Forty-Third Street Bridge was razed and replaced in 1924 by one at Fortieth Street, designed by Benno Janssen and Charles S. Davis. See "Three New Allegheny River Bridges To Be of Unusual Type," in *Engineering News-Record* 93 (1924): 995.

⁶⁵ War Department, *Opinion*, 6-7.

⁶⁶ War Department, *Opinion*, 7-8.

47.3' at the lowest portion of the superstructure during low water, and 3.5', 17.3', and 17.4' during high water.⁶⁷

Baker's final ruling noted that raising the clearances would maintain cheaper river transportation as a vital component of the nation's transportation infrastructure and strengthen the country's commerce by not favoring land-based highways over water routes. He dismissed charges that the government's interest be dictated by the river's use at that time, asserting that the federal role was to help achieve the potential of a resource and not merely to sustain its current level of use. As a vital portion of the city's harbor, the downtown sites alone could justify clearance modifications on those bridges, regardless of whether the resources of the Allegheny river basin matched those of the slower-moving and more profitable Monongahela River. Finally, he asserted that waiting to make changes in the structures merely would increase the cost and inconvenience of the process.⁶⁸

Focusing on the potential shipping load of the Allegheny River, rather than its second-class status compared to the Monongahela, proved an important point. Monthly freight records from the period just before construction began on the three downtown bridges reveals a large disparity in the shipping along the two rivers. Freight carried on the Allegheny in October 1924 paled in comparison to loads transported on the Monongahela and comprised only half of that on the Ohio. While commerce on the Allegheny totaled just more than 370,000 short tons, the Monongahela supported a robust trade of more than 2 million short tons. The Allegheny carried proportionately more coke and gasoline than the other rivers, nearly as much gravel as either of the other two bodies of water, and more sand than either. The location of steel mills along the Monongahela and Ohio rivers provided their heavy coal and steel cargoes.⁶⁹

In separate notices to the county commissioners on 23 March 1917, the Secretary of War outlined specifications that the new bridges would be required to meet. The Sixth Street crossing needed three spans between present abutments, with at least 400.0' clearance between piers, the south end of the main span 416.0' from the building line of Duquesne Way at Federal Street. A 47.0' clearance above the Davis Island pool had to be maintained for at least 180.0' near mid-span, with clearances not less than 32.0' at abutments. At the Seventh Street location, the middle channel of a three-span structure needed at least a 350.0' clear width between piers, with the middle span's left pier 407.0' from the building line of Duquesne Way at Sandusky Street. The clearance had to be at least 47.1' over the middle 180.0' and could drop no lower than 27.5' toward the south abutment, or 31.7' at the north abutment. The Ninth Street Bridge had to provide the same 350.0' clear width, with its left pier 400.0' from building line at Anderson Street. The middle 180.0' needed a minimum clearance of at least 47.5', and the structure could

⁶⁷ U.S. Army Corps of Engineers, *List of Bridges over the Navigable Waters of the United States* (Washington, D.C.: U.S. Government Printing Office, 1926), 6-7.

⁶⁸ War Department, *Opinion*, 8-10.

⁶⁹ Norman F. Brown, "Allegheny County Improvements Started in 1928 Total \$43,680,000," *Greater Pittsburgh*, 22 Dec. 1928.

drop no lower than 26.4' at the south abutment, or 27.4' at the city wharf to the north. All rip-rap within 10.0' of the water line had to be removed, forcing contractors to build piers deep enough to anchor the bridge without relying on significant rubble bracing the channel masonry.⁷⁰

With the issue decided, the county bore responsibility for implementing the order to raise bridge clearances, move piers to ensure clear channel navigation, and make the changes as palatable to the bridge customers as possible.⁷¹ World War I intervened to delay the 28 March 1917 order, which was suspended until one year later. After the armistice, the War Department renewed its demand in April 1919, revising the start date for work on the Seventh and Ninth Street bridges to 2 April 1920, with work on the Sixth Street Bridge to be started exactly one year later. All projects received another two-year extension.⁷²

The county and bridge interests tried several tactics to convince the War Department to make the project easier to complete. In 1921 the department refused to allow changes along the lines of Shunk's lower clearances, and a Bridge Raising Board comprised of representatives from federal and municipal departments split over a 1922 report about grades. The majority supported increasing grades on the Sixth Street Bridge up to a total of 4.25 percent while maintaining approach grades, on the Seventh Street Bridge up to 4.5 percent with a 4.36' rise on Duquesne Way, and on the Ninth Street Bridge up to 4.5 percent while elevating Duquesne Way 2.63'. A 1922 meeting failed to present enough fresh evidence for yet another commander, Secretary of War J. W. Weeks, to reopen the case, and serious design efforts to meet the ultimatum began soon thereafter.⁷³

Anti-toll sentiment emerged long before the fight between bridge companies and navigation interests erupted. State legislators debated parameters for allowing bridge companies to charge tolls on the Sixth Street Bridge as early as the original charter in 1810, and public support for free bridges grew significantly in the 1850s.⁷⁴ In 1907, the still-popular idea of freeing the Allegheny River bridges fueled a *quid pro quo* arrangement between consolidation supporters on either side of the waterway. The Chamber of Commerce formed a Special Committee on Free Bridges to lobby for purchase or condemnation of all toll bridges in Pittsburgh. In what the committee reported as a "promise" to consolidation supporters, the

⁷⁰ U.S. War Department, to Allegheny County Commissioners, 23 Mar. 1917, in Bridge Files: AL 02 (Sixth Street), Records Department, Allegheny County Department of Public Works, Pittsburgh, Pa. (hereinafter cited as ACDPW).

⁷¹ War Department, *Opinion*, 11.

⁷² Covell, "Bridge-Raising Program," 84-85.

⁷³ Covell, "Bridge-Raising Program," 86-87.

⁷⁴ Pittsburgh Chamber of Commerce, Special Committee on Free Bridges, *Report of Committee on Free Bridges* (Pittsburgh, 1911), 3; and Baldwin, *Pittsburgh: Story of a City*, 206.

Chamber supported efforts to provide filtered water to the North Side and to eliminate tolls on Allegheny River crossings.⁷⁵

The process entailed long discussions about whether Pittsburgh had the right to force bridge companies to sell their property, the limits of each company's charter for collecting tolls past the time the structures had been paid for, and whether condemnation proceedings were limited to only the municipal entities party to the original charter (in which case Pittsburgh would only have been able to condemn its half of the structures).⁷⁶ The city passed an ordinance arranging an offer to purchase the structures and a threat to commence condemnation proceedings if the offer was not accepted within thirty days. After rejecting buying the bridges outright in order to avoid charges of corrupt secret deals with the bridge owners, the city commenced a jury trial to condemn the Seventh Street Bridge. The sitting judge ruled that a state law would have to be passed allowing the city to condemn a structure not totally within its jurisdiction when chartered, however. City officials then lobbied successfully for a state law allowing municipalities many options, including condemnation or purchase, in order to free bridges.⁷⁷

When the War Department declared height specifications for the Allegheny River structures, the Chamber proposed that the county or city condemn and purchase the bridges from private companies. In 1909, the city's new mayor, William A. Magee, persuaded Allegheny County to become sole purchaser of the structures. The War Department's decision about navigational clearances encouraged some hesitation about purchasing the structures rather than waiting for the federal government to force the bridge companies to raze their own bridges. In 1911, Secretary of War Jacob M. Dickinson ruled bridges would not have to be raised, and ten days later on 16 March 1911, Allegheny County commissioners finalized the deal.⁷⁸

The county commissioners enforced the legislative act allowing the county to take the bridges for fair market value, financing the purchase of the Sixth, Seventh, Ninth, and Thirtieth Street bridges with a bond issue.⁷⁹ When the War Department ordered action in 1917 and again in 1919, the county — and not the Bridge Company (Sixth Street), North Side Bridge Company (Seventh Street) or the Pittsburgh & Allegheny Bridge Company (Ninth Street) — faced the dilemma of how to pay for the project.

Raising funds for the project proved as daunting as raising the bridges themselves. Municipal government had gained a reputation for corruption, leaving voters suspicious of undesignated allocations for public works projects such as a last-minute bond proposal initiated

⁷⁵ Special Committee, *Report on Free Bridges*, 3.

⁷⁶ Special Committee, *Report on Free Bridges*.

⁷⁷ Special Committee, *Report on Free Bridges*, 4-7.

⁷⁸ Special Committee, *Report on Free Bridges*, 7-8.

⁷⁹ "The Chamber and the Bridges," *Pittsburgh First*, 6 Dec. 1924, 88.

by the county in 1920. The Chamber of Commerce recommended that the commissioners delay the \$35 million bond election until the following spring to make more details available to the public and allow more time for advertising its merits.⁸⁰

While Pittsburgh's voters strongly approved of a state bond issue for state-built highways in the 1920s, they refused to support county funding to demolish and rebuild the free bridges. Voters commonly believed massive public works projects to be byways of corruption. They rejected the 1921 bond issue that would have supplied \$35 million for altering the three bridges, among other projects.⁸¹ The Chamber supported the 1924 county bond issue that focused on bridge reconstruction and highway improvements after its leadership negotiated proposed wording for the bond election with county commissioners.⁸²

In 1924, voters finally approved a \$29.2 million bond issue to finance construction of new bridges, municipal buildings, and roadways. Allegheny County commissioners restructured public works-related offices to form a Department of Public Works that could work more closely with the commissioners in planning and completing bond-related projects. The organizational change aided in coordinating a massive infrastructural improvement plan focusing on bridge construction. Between those bridges funded by the bond issue and those constructed as part of the regular budget, forty-one new bridges costing more than \$21 million were built in the county from 1924 to 1928.⁸³ Construction continued when a second bond issue focusing on infrastructure such as roads and an airport was passed on 26 June 1928, for \$43.7 million.⁸⁴

Civic boosters noted that the building program funded by the 1924 bond election allowed work that was "in essence a defensive maneuver rather than advance." Much of the work done during the program reconstructed existing transportation routes and structures that had not been updated in the previous two decades due to the war and a lack of local support.⁸⁵ Politicians and planners also argued that constructing the three bridges during a period of low construction prices gave an added cost advantage, making full use of the funds authorized by voters. Selecting construction plans that allowed contractors to complete work more quickly also proved a source of "savings" for the area's citizens, who then could gain transportation advantages even faster.⁸⁶

⁸⁰ "The Chamber and Road Improvements," *Pittsburgh First*, 6 Dec. 1924, 41.

⁸¹ Covell, "Bridge-Raising Program," 86.

⁸² *Pittsburgh First*, "The Chamber and Road Improvements," 41.

⁸³ Brown, "Allegheny County Improvements," 19.

⁸⁴ Brown notes in "Allegheny County Improvements," 21, that the second bond issue of this construction period in 1928 authorized \$43,680,000. It funded projects such as an airport, park improvements, road construction, and erecting bridges at sites that had not before had a crossing structure.

⁸⁵ Brown, "Allegheny County Improvements," 21.

⁸⁶ Brown, "Allegheny County Improvements," 20.

Allegheny County Government and Public Works

Popular mistrust of municipal government resulted in reform candidates being elected just when the bond issues arose, but the men who had promised to clean up city and county government lacked the connections and experience to force the bond issues through. Ironically, a return to the machine politics provided the push needed to convince voters that raising the bridges would benefit all of Pittsburgh's citizens.⁸⁷

In 1924, three new members won elections for positions as city commissioners. Joseph G. Armstrong and E. V. Babcock earned seats as majority party commissioners, and James Houlahan took the seat apportioned by county law for the minority party representative. "Joe Armstrong was one of the old political czars who had spent his life in politics in Allegheny County," noted George S. Richardson, whose invaluable interview memories of the county building program during the 1920s provide insight into the politics and personalities crucial to building the Three Sisters Bridges. What Armstrong lacked in formal education he made up for in drive and decisiveness.⁸⁸ Although controversial because of his connections to political patronage and machine politics in Pittsburgh, Armstrong's ambition to leave a lasting mark on the municipality gave impetus to the county's building program.⁸⁹

The three commissioners were a main reason that the 1924 bond issue passed. Even before approval of funds for bridge and road work, they began restructuring county engineering offices, hiring Norman F. Brown to head the new Department of Public Works. Brown promptly brought the engineering- and design-related offices under the umbrella of a centralized public works agency, so that long-term heads of independent offices became leaders of subordinate sections. Vernon R. Covell moved from County Engineer to chief engineer of the Bureau of Bridges, and A. D. Nutter became the chief design engineer.⁹⁰

⁸⁷ P. M. Farrington, S. J. Fenves, and J. A. Tarr, *The Allegheny County Highway and Bridge Program 1924-1932*, Report No. R-82-132 (master's thesis, Carnegie-Mellon Univ., 1982), 43. Farrington et al. provide much information about the bridge program during this period, particularly the effect of political maneuvering on the process of proposing designs. The bibliography is helpful for indicating source material, but the lack of footnotes in the text makes tracing citations to original sources difficult.

⁸⁸ George S. Richardson, "History of Allegheny County Bridges: An Oral History of the Bridge Construction Program from April 1924 to March 1937 Inclusive," interview by Steven J. Fenves, 2, in File 54: File 54: Bridges — 1 — Lists, Collected Descriptions, Pictures, Drawer 1, Cabinet IV, Print Collection, James D. van Trump Library, Pittsburgh History and Landmarks Foundation, Pittsburgh, Pa. (hereafter cited as Richardson, "Oral History").

⁸⁹ Although Armstrong did indeed appoint political friends to engineering posts, he made sure that the operations of the department were not encumbered by the presence of non-engineering employees. One story Richardson related was that Armstrong gave Brown *carte blanche* for employment decisions and merely added absentee appointees to the payroll — an account similar to gossip reported in local newspapers at the time.

⁹⁰ Richardson, "Oral History," 2.

Initial Bridge Designs

Four formal proposals preceded the self-anchored suspension form finally selected.⁹¹ A 1910 design by F. A. Glafey, former chief designing engineer of the Keystone Bridge Company and of the American Bridge Company, shows a grade of just under 3 percent — less than half the grade then on Seventh Street Bridge's north approach and slightly less than that on the Sixth Street Bridge. In 1917, Thomas M. Rees, owner of a stern-wheel boat operated on the Allegheny River, publicized the design, which had not been accepted by the War Department engineers or the County Commissioners. Rees' flyer showed a two-humped bridge, higher at its center point, with current and proposed elevations.⁹²

A more seriously considered plan originated from within the county engineer's office. A. A. Henderson designed a continuous-traffic lift bridge, proposing to raise the existing bridge during the navigation season with jacks placed on piers. By using the existing bridge, the cost could be minimized, making the plan more attractive. The War Department rejected the jacking scheme, pointing out that a single jack's malfunction would make the entire bridge inoperable. At maximum height, the bridge would have had a 5.7 percent grade, nearly twice the maximum 3 percent the city wanted. On other hand, for nearly half of the year the structure's grade would be only 1.5 percent.⁹³

In order to avoid fines for noncompliance, the county commissioners had to act, regardless of the funding dilemma. With the success of the 1924 bond election and the reorganization of the Department of Public Works under the dynamic Brown, work at last began on the third plan. The county began preparing plans in 1923 and by the next year began razing the Seventh Street Bridge. The War Department forced the county to begin work on the Ninth Street Bridge while the first was torn down, despite local opposition to the inconvenience and pleas for time extensions by the county.⁹⁴

Engineers prepared several options using steel trusses to meet the military's clearance requirement. In 1923, engineers recommended a continuous-traffic lift design with a variable top chord. The main span of 400'-0" had a 33'-0" clearance, to be raised by action at two trussed towers on piers two and three. A hydraulic lift or similar equipment would have been required at each tower to change the main span's elevation for river traffic below. A platform nestled under

⁹¹ For a breakdown of plan sets that groups proposals and final drawings, see "List of Available Drawings," in Appendix A of Allegheny County Department of Engineering and Construction, "Report on In-Depth Structural Inspection and Analysis of the Sixth Street Bridge," vol. 1, Aug. 1985, in File AL 02-1307.

⁹² "Do Not Be Deceived by the Anti Bridge Organization So Called 'Hump,'" flyer (26 Jan. 1917), in File AL 02, ACDPW.

⁹³ Farrington, *Highway and Bridge Program*, 84-84; and "Alternate Plan & Elevation, Continuous-Traffic Lift Bridge," Drawing No. 5867 (12 Apr. 1923), ACDPW.

⁹⁴ "Action Follows County Rule That Bridge Must Go," 21 Nov. 1924, *Pittsburgh Post*, in Pittsburgh Bridges — Ninth Street file, Pennsylvania Room, Carnegie Library, Pittsburgh, Pa.

the northern span provided the railroad right-of-way for the Baltimore & Ohio Railroad below street traffic at the River Avenue and Federal Street intersection.⁹⁵

A second option, for a fixed bridge, received War Department approval. In 1924 engineers designed a structure with a parabolic top chord, its 410'-0" main span meeting the 47'-0" clearance for the required 180'-0". In addition to the three main spans, two side spans without trussing extended to the approaches, with the B&O access under the pier and embankment anchoring the northern side span. The bridge's grade of 4.175 percent exceeded the 3 percent desired, but would have meant less entanglement in procuring property or altering streets on either side of the structure.⁹⁶

The third proposal included continuous truss bridges at Sixth and Ninth streets, designed by the city Bureau of Architecture, and a cantilever bridge at Seventh Street, designed by local architects Rutan, Russel & Wood.⁹⁷ The plans were the culmination of a long process of compromise between a dozen organizations involved in the approval process. The grades did not exceed 4 percent, but the approaches were narrower than the roadways. After clearing the fixed bridge proposal with the War Department, city and county planning departments, the state's Public Service Commission, the Citizens Committee on City Plan, as well as securing support from powerful local organizations such as the Chamber of Commerce, the county submitted the drawings to the little-known Art Commission "for suggestion and approval." The commission, an advisory body created by the state in 1911 to approve Pittsburgh bridges costing more than \$25,000, was expected to rubber-stamp the project.⁹⁸ While waiting for approval, the county printed specifications and opened the bidding process. The commission faced pressure for quick approval as demolition of the Seventh Street Bridge proceeded and the Ninth Street's imminent razing loomed.⁹⁹

The commission's veto of the final plans shocked engineers and city leaders. The commission sent engineers back to the drawing board with instructions for a more attractive bridge that would not mar the downtown skyline with metal structures above the deck. The

⁹⁵ "Alternate Plan and Elevation, Continuous Traffic Lift," Drawing No. 5866 (12 Apr. 1923), ACDPW.

⁹⁶ "Bridge No. 2 Allegheny River, Plan & Elevation," Drawing No. 6106 (15 May 1924), ACDPW.

⁹⁷ "Pushing Plans for New Bridges," *Pittsburgh Telegraph*, 6 June 1929, in File AL 03, ACDPW.

⁹⁸ Stanley L. Roush, "The Sixth, Seventh and Ninth Street Bridges, Pittsburgh, Pa.," *American Architect* (5 Feb. 1928): 194.

⁹⁹ Allegheny County Department of Public Works, "Specifications for the Construction of the New Sixth Street Bridge, Pittsburgh, Pa." (New York: Evening Post Job Printing House, n.d.), in File AL 02, ACDPW; Brown, "Allegheny County Improvements," 20; "Bridge Plans Approved By Planning Body," *Pittsburgh Gazette*, 17 May 1924, in File AL 03, ACDPW; Allegheny County Department of Public Works, "Application Docket No. 11, 747-24," to Public Service Commission regarding authority to reconstruct and operate a structure crossing the Baltimore & Ohio Railroad Company's right-of-way, n.d., in File AL 02, ACDPW; and "Report of the Grand Jury," 19 June 1924, regarding authority to take down existing Sixth Street Bridge, in File AL 02, ACDPW.

requirement forced the department to reevaluate unusual ways of meeting the aesthetic mandate. Architects supplied a variety of sketches, including simple trusses, tied arches, cantilevers, and ordinary suspension bridges to the Art Commission; members had favored the last, despite known difficulties in using suspension forms at the downtown locations. After the truss design's rejection, architects again prepared a view of existing and proposed suspension bridges to help engineers visualize their task.

The architectural renderings depicted a bridge type that "would have fallen down had it been built as that particular drawing showed," noted John Lyle Harrington, a Kansas City engineer who had seen the proposals.¹⁰⁰ Architects played little role in the decision-making processes of the newly-organized department when their advice differed with that of the design engineers, according to Richardson. The new hierarchy within the Department of Public Works integrated architects into engineering projects, but all conflicting advice was resolved by the director, who was an engineer. Thus, while architects and engineers both presented designs, final internal department decisions favored engineering concerns.¹⁰¹

With the B&O right-of-way on the northern shore and a boulevard development anticipated by the Pittsburgh Planning Commission on the southern wharf, engineers lacked adequate anchorages. The two existing suspension bridges had suffered from anchorage movements. The county declined to take the controversial step of asking Pittsburgh to condemn businesses adjacent to the approaches. With only adumbrated approaches thus available, engineers considered more unusual anchorages and suspension systems. By thinking of the bridge as a unit, engineers deliberated whether the bridge's own forces could provide a system of support, with the piers bearing all vertical forces.¹⁰²

Self-Anchored Suspension: Technological Diffusion

The only precedent that matched the specifications thrown back at the county's engineers was a single bridge constructed over the Rhine at Cologne, Germany, in 1915. Although the entire Department of Public Works has been credited with the design that finally succeeded in pacifying all organizations involved in the decision, and Covell has generally received main credit for his leadership, exactly who suggested the design presents a puzzling aspect of the Sixth Street Bridge's history.

City planners must have been aware of European engineering and architecture because prominent municipal reports during the first decades of the twentieth century featured examples from around the world. Frederick Law Olmsted's 1910 report about improvements necessary to

¹⁰⁰ John Lyle Harrington, "Recent Developments in Bridge Superstructures," *Proceedings of the Engineers' Society of Western Pennsylvania* 46, No. 3 (1930): 68.

¹⁰¹ Wilbur J. Watson, "Bridge Architecture," *Proceedings of the Engineers' Society of Western Pennsylvania* 46, No. 3 (1930): 84, 87.

¹⁰² Harrington, "Recent Developments," 68.

keep Pittsburgh's downtown transportation systems efficient and attractive included numerous examples of European structures, from municipal buildings to various bridge types.¹⁰³

News of the self-anchored structure successfully built in Germany became available in English-language engineering literature just as the county's first truss drawings were rejected as unsuitable. George A. Hool and W. S. Kinne made an oblique reference in their book, *Movable and Long-Span Steel Bridges*. The authors noted that "modern suspension bridge construction is principally confined to the suspended stiffening truss type," but their broad secondary category of "suspension trusses, or braced chain bridges" included exceptions — one of which was the 1915 Cologne bridge. Hool and Kinne included a photo of the structure that clearly showed the eye-bar chains attached to the bridge deck. Whether their picture might have conveyed the possibilities of self-anchored design is debatable. The text accompanying their description of this second category of bridges never referred to the structure as self-anchoring.¹⁰⁴

By 1922 one of the better known advisors on cantilever and suspension bridge structures noted the peculiar strengths represented in the Cologne bridge's design.¹⁰⁵ David B. Steinman's running dispute with J. A. L. Waddell about the relative costs of suspension and cantilever forms continued a debate with roots in the Quebec Bridge collapse. The 1907 construction disaster, accompanied by the 1916 accident during a second attempt, heightened a growing preference for suspension bridges.¹⁰⁶ In light of the popular and engineering support for suspension structures, Steinman's first edition of *A Practical Treatise on Suspension Bridges* fed a growing demand for technical information about components such as eye-bars and stiffening systems. Steinman's notoriety and the fact that his book was reviewed in the engineering press make it likely that Allegheny County's engineers could have examined the first edition of this book.¹⁰⁷

¹⁰³ Frederick Law Olmsted, *Pittsburgh: Main Thoroughfares and the Down Town District* (Pittsburgh: Committee on City Planning, 1910).

¹⁰⁴ George A. Hool and W. S. Kinne, *Movable and Long-Span Steel Bridges* (New York: McGraw-Hill, 1923), 324-33.

¹⁰⁵ D. B. Steinman, *A Practical Treatise on Suspension Bridges: Their Design, Construction and Erection*, 1st ed. (New York: John Wiley & Sons, 1922), 53 et passim.

¹⁰⁶ Petroski, *Engineers of Dreams*, 101-18. For Petroski's analysis of the cantilever-suspension bridge debate, see *ibid.*, 111.

¹⁰⁷ Waddell and Steinman waged a turf war in professional literature during the 1910s, arguing that comparative cost of the two bridge types indicated different uses. Waddell complimented the less established Steinman on attempting to calculate costs — primarily as a way of setting his opponent up for criticism in using approximations of weights when calculating the span lengths at which both types proved equally economical. J. A. L. Waddell, *Economics of Bridgework: A Sequel to Bridge Engineering* (New York: John Wiley & Sons, 1921), see especially 8-9, 104-106, 268; D. B. Steinman, *Suspension Bridges and Cantilevers: Their Economic Proportions and Limiting Spans*, 2nd ed. (New York: D. Van Nostrand Co., 1913); see also C. B. McCullough, *Economics of Highway Bridge Types* (Chicago: Gillette Publishing Co., 1929).

Despite Waddell's attack, Steinman may have had the last laugh. He proved more open than Waddell to

With potential routes of technological diffusion established, the question remaining is that of who identified the Cologne bridge from available literature. Despite credit usually given to Covell, consulting engineer T. J. Wilkerson directly took credit for the design at least once. During a discussion about whether the structures could best be classified as cantilever or suspension bridges, Wilkerson added that he had credentials, "... as I proposed the type of bridge used and am responsible for the design."¹⁰⁸ While Covell indeed must be credited with leading the team that transformed an idea into reality, his role in initiating the concept must be reassessed. Wilkerson's announcement to fellow engineers was not challenged at the meeting. Additionally, the recollections of an engineer intimately familiar with the bridge construction efforts of the period increases doubt about Covell's authorship and perhaps even initiation of the self-anchoring design.

George S. Richardson worked as a draftsman for the American Bridge Company before being hired in the spring of 1924 to work on Allegheny County's projects. He worked for the county for the next thirteen years. Richardson worked on bridges other than the Sixth, Seventh, and Ninth Street projects and did not know who actually proposed the self-anchored suspension design for the trio, but his knowledge of the staff's workings led him to presume that Wilkerson, the consulting engineer, was responsible.¹⁰⁹

In an interview he recalled that Covell and Nutter's performance in the new Department of Public Works was competent but not inspired. Richardson suggested in his recollection "that long years of employment without any engineering work except on very minor structures had dulled their ambitions to participate in any very active way in the major programs then under way."¹¹⁰ A contentious relationship with Brown may have exacerbated Covell's tendency to withdraw into bureaucratic duties.¹¹¹ Richardson's perspective suggests that the credit given Covell for the structures may refer to his ability to design the thousands of connections and parts required. Whether Covell introduced the idea of the self-anchoring system himself or supervised the project as designed by another remains in question.

Richardson said he was surprised that in his own work, which covered all major bridge structures except for the Three Sisters, Covell lacked any interest in choosing types of structures

new ways of categorizing bridge structures, noting in 1922 the existence of new technologies, such as eye-bars and self-anchored suspension spans, which eventually blurred the boundaries of the debate. (Steven J. Fennes of Carnegie-Mellon University's Department of Civil Engineering kindly noted Steinman's contributions to the technological diffusion discussed above.)

¹⁰⁸ Harrington, "Recent Developments," 68.

¹⁰⁹ Richardson, "Oral History," 1, 4.

¹¹⁰ Richardson, "Oral History," 1, 5; quote from *ibid.*, 6.

¹¹¹ Farrington, *Highway and Bridge Program*, 47, discusses inter-department tensions and provides insight into this situation. Farrington cites the *Controller's Report* of 1926, which records that Brown actually placed Covell's desk in a hallway and forced him to perform his duties without an office.

or in directing those who did. Covell's particular contribution to those projects was a concern with handrail design — a minimal portion of the bridge, albeit a difficult problem that covered making railings child-proof. Nutter showed interest in details such as expansion dams and curb types, but Richardson noted that he suggested no new designs himself, waiting instead for Richardson's advice on each matter before promoting a particular design.¹¹²

Wilkerson, who designed the California Avenue concrete arch bridge over Jack's Run for the county just before the 1924 construction program began, contributed more directly to the Three Sisters project. Brought on board as a consulting engineer for the concrete arch by Director of Public Works Norman S. Sprague, Wilkerson also figured prominently in decisions about the Three Sisters.¹¹³ Richardson did not recall having seen stress calculations for the design, but from his knowledge of structural analysis, he concluded that the bridges were designed as statically determinate structures. It was unlikely that Wilkerson, who often used graphical representations for stress analysis, or his assistant, H. K. Dodge, had the ability to analyze a statically indeterminate structure.¹¹⁴

Wilkerson worked on two bridge projects in neighboring Beaver County after his contribution to the Three Sisters project, using graphical methods and requesting that Richardson verify calculations for both. The downtown bridge designs would particularly have lent themselves to this method because the immense stiffening girders and adumbrated suspension spans would make a statically determinant analysis likely to produce workable results. Further, Richardson added, it would be quite possible to use this method with a design that anticipated greater stresses than actually were likely to exist.¹¹⁵

Regardless of the exact path by which the idea arrived at the Department of Public Works, implementing such a complex project brought deserved credit to the entire staff of engineers, especially Covell, chief engineer; Nutter, design engineer; Wilkerson, consulting engineer; and Stanley L. Roush, architect. Members of sections new to the public works department also contributed specific competencies to the program's design of the Three Sisters. Chief of the Bureau of Tests Freeman added a specialty in concrete testing. His assistant, Groh, had particular expertise in a wide range of metallurgy, with exceptional depth in structural steel.

¹¹² Richardson, "Oral History," 5.

¹¹³ Richardson, "Oral History," 1.

¹¹⁴ Richardson, "Oral History," 4-5. Richardson's comments provide one of the few clues available about design methods. The Allegheny County Department of Public Works no longer has information about the assumptions used. See ACDEC, "In-Depth Structural Inspection," 6:4. The report recommends for general reading about self-anchored suspension bridge theory D. B. Steinman, "A Generalized Deflection Theory for Suspension Bridges," *Proceedings of the American Society of Civil Engineers* 60 (1934): 323-60, and C. H. Gronquist, "Simplified Theory of the Self-anchored Suspension Bridge," *Transactions of the American Society of Civil Engineers* 107 (1942): 84-90.

¹¹⁵ Richardson, "Oral History," 5.

Roush headed the Department of Architecture, which consulted with engineers about bridge designs.¹¹⁶

Once the design for the self-anchored structure had been identified, the question of whether to vary bridge design solved itself: no other solution to the technical, political, and aesthetic dilemma could be found. A consensus formed among members of involved agencies that not only was the eye-bar suspension design for a self-anchored structure the only and best solution, but also that constructing a trio of bridges in such a close area would create a scenic attraction near downtown. Not to be forgotten was the potentially lower unit cost for each to be gained by awarding a single contract for all three projects.¹¹⁷

Design Issues

The crucial features of the Three Sisters' final design were the eye-bar chains, the deck-stiffening girders, and vertical hangers. An eye-bar chain, draped over steel towers on the river piers, carried the floor system's weight through vertical hangers. The deck contained a stiffening girder running the bridge's entire length. Engineers designed the components to work as a system, anchoring both ends of the eye-bar chain to the stiffening girder, which resisted vertical forces through horizontal thrust. This stood in contrast to conventional suspension bridges, which used heavy shore masonry to maintain tension in the catenary.¹¹⁸ The Three Sisters caused some debate within the engineering community because they confounded this aspect of the archetypal suspension form. Nonetheless, the design met the surest test of a suspension bridge: if the chains were cut, the entire structure would collapse.¹¹⁹

In a suspension bridge, catenary elements carry loads in tension rather than compression. Cables or chains are draped over towers and anchored at bridge ends. They function like inverted arches, with the roadway hung from the catenaries.¹²⁰ New materials like heat-treated eye-bars and drawn steel wire offered greater strength in suspension bridges. With the greater span lengths and elegant catenary lines, a suspension bridge would satisfy both navigational and aesthetic considerations. Calculating stress required in stiffening trusses was difficult, however. In 1930 this remained a point of contention among engineers who could not explain why some

¹¹⁶ Richardson, "Oral History," 3.

¹¹⁷ Roush, "Sixth, Seventh and Ninth Street," 196.

¹¹⁸ Watson, "Bridge Architecture," 91.

¹¹⁹ Watson, "Bridge Architecture," 94.

¹²⁰ Walter C. Kidney, "Bridge Anatomy for the Layman," in James D. Van Trump Library, Pennsylvania History and Landmarks Foundation, Pittsburgh, Pa.

stiffening trusses used in suspension bridges worked in practice while failing to meet theoretical stress thresholds.¹²¹

Although the Three Sisters essentially behaved as suspension bridges when complete, they were erected by cantilever methods. The 1889 Firth of Forth Bridge inspired renewed interest in cantilever erection, which had great application on long-span work. Generally, cantilever erection does not save money when used on spans less than 700'-0" in length if falsework can be contracted for without exceptional cost. When deciding whether to use cantilever erection, engineers had to consider the difficulty of using falsework, the length of the span, and whether navigation must be maintained under the structure. Cantilever methods made erection possible without falsework, for longer spans, and with free navigation.¹²²

Contractors

Erecting suspension bridges using cantilever methods was a complex job demanding only the most experienced of contractors. After advertising the bids, the county awarded the contract for the three bridges' superstructure to the American Bridge Company and the substructure to the Foundation Company of New York. County commissioners, anxious to assure the public that contracts were in no way marred by corrupt deals, publicized the savings provided by awarding the contracts to the same company. By building all three bridges at a single price, the county shaved about \$0.5 million off of the project budget.¹²³

The American Bridge Company, perhaps more than any other company in the world, was best qualified to work on a bridge with a continuous stiffening component. The company was then constructing the Florianopolis Bridge in Brazil, working from 1922 to 1926 on the longest eye-bar suspension span in existence at that time. The 1113'-0"-long design featured towers with rocker bearings. The company brought to that project its own experimental heat-treated eye-bars, and as project contractor pioneered stiffening techniques that saved materials and money while providing greater rigidity.¹²⁴

H. D. Robinson, who had worked with Steinman on the Florianopolis Bridge, had also consulted on towers for the Cologne bridge's design. Robinson used similar towers on the Rondout Bridge at Kingston, New York, which was constructed in 1922 and used a stiffening truss that functioned apart from the towers. By 1924, the American Bridge Company had many opportunities to acquire a base of knowledge that specifically would have helped in building a bridge such as that specified by Allegheny County engineers. Whether the firm advertised its

¹²¹ Harrington, "Recent Developments," 55; see *ibid.*, 64-65 for further information.

¹²² Harrington, "Recent Developments," 60.

¹²³ "Parade Marks Sixth Street Span Opening," *Pittsburgh Post-Gazette*, 20 Oct. 1928, in Clippings Files, Pittsburgh Bridges — Sixth Street, Pennsylvania Room, Carnegie Library, Pittsburgh, Pa.

¹²⁴ D. B. Steinman, *A Practical Treatise on Suspension Bridges: Their Design, Construction and Erection*, 2nd ed. (New York: John Wiley & Sons, 1929), 198-227.

services to the county before specifications were devised is not known. The American Bridge Company used its knowledge from the Florianopolis Bridge to prepare alternative designs for bridges over the Ohio River in Point Pleasant and in St. Marys, West Virginia, however, securing both projects.¹²⁵

The American Bridge Company also accumulated vast experience by company acquisition. In 1900, J. P. Morgan consolidated two dozen bridge-building companies under the umbrella of the American Bridge Company, which a year later became a subsidiary of Morgan's U.S. Steel. Thereby he created an industrial giant that controlled half of the country's bridge-building capacity. The acquisition united large Pittsburgh competitors, like Carnegie's Keystone Bridge Works, and smaller area concerns, such as Schultz Bridge & Iron Works of nearby McKee's Rocks. Morgan's reach also encompassed New York's Union Bridge Company, Gillette-Hezon Manufacturing Company of Minneapolis, and Berlin Iron Bridge Company of Connecticut in that first year, as well as other operations in coming years.¹²⁶

The Foundation Company of New York brought its own wide experience in to Pittsburgh. Incorporated as the Foundation & Contracting Company in 1902 and specializing in "design and construction of difficult foundations," the firm shortened its name to the Foundation Company to reflect its specialized focus. Known for constructing foundations for skyscrapers at Manhattan Island's southern tip where bedrock was exceptionally deep, the company also expanded its operations to Canada and the Midwest. The Foundation Company's projects in the first decades of the twentieth century included bridges, mine shafts, tunnels, dams, and sea-walls. The firm used a variety of techniques, such as pneumatic caisson work, pile driving, and coffer-dam construction. The most prominent of its projects included sinking foundations for the Woolworth Building in New York City, at the time the tallest building in the world, 750'-0" above street level, and weighing 136,000 tons. The company also constructed foundations for the Miramachi and Pitt River bridges in Canada and the Penn Bridge in Coshocton, Ohio.¹²⁷ With rock lying 50'-0" to 60'-0" under the Allegheny River's vigorous current, an experienced firm was needed for the Three Sisters Bridges.¹²⁸

The Three Sisters, 1924-28

The Sixth, Seventh, and Ninth Street bridges form a striking trio of structures crossing the Allegheny River in downtown Pittsburgh. These bridges are unique in the United States for the clustering of three similar bridges in such close proximity, their place as the first American self-anchored suspension bridges, and as significant examples of eye-bar suspension bridges. They

¹²⁵ Steinman, *Practical Treatise*, 2nd ed., 225, 230-31.

¹²⁶ Darnell, *Directory*, 85-86.

¹²⁷ The Foundation Company, "Difficult Underground Construction," promotional brochure, n.d., in Trade Catalogs File, Technology and Science Room, Carnegie Library, Pittsburgh, Pa.

¹²⁸ *Engineering News-Record*, "Three New Bridges," 995.

are also the first cantilever-erected suspension bridges in the world.¹²⁹ The bridges vary only slightly from one another in measurements. The Sixth Street Bridge, more famous because of its historic site and selection by the American Institute of Steel Construction as "The Most Beautiful Steel Bridge of 1928," typifies the set of three-span steel eye-bar suspension structures.¹³⁰

The bridges were built with a basically north-south orientation over the Allegheny River. From the intersection of Duquesne Way and the respective streets for which the bridges are named, they traverse the river to the north shore, where the street names change. Upon reaching the North Side, Sixth Street becomes Federal Street; Seventh, Sandusky Street; and Ninth, Anderson Street.¹³¹ The Sixth Street Bridge has a total span of 995.1' from back wall to back wall, which is identical to its complement at Ninth Street and slightly shorter spans than the Seventh Street structure. From south to north, the Sixth Street Bridge includes an approach span 75.1' long; a side span, 215.0'; the main span, 430.0'; another side span, 215.0'; and an approach span, 60.0'. The Seventh Street Bridge, with its slightly longer total length of 1061.0', includes (again from south to north) an approach span of 72.80'; a side span, 221.12'; the main span, 442.08'; another side span, 221.12'; and two approach spans, 41.95' and 61.45'.¹³²

The south and north approaches rise at a 4.175 percent grade on all three bridges. The relatively steep grade reflects not only the shift from animal-powered to motorized vehicles but also the short approaches available for each structure. The camber of just more than 15'-0" forces the plate girders to perform their stiffening duties along a noticeable curve, serving as a 885'-0"-long double struts that bear about 10 million pounds of compression. The structure itself acts as a weight to counter the potential for buckling.¹³³

The stiffening plate girder rises approximately 3'-0" above the roadway. The girder serves not only as an unobtrusive compressive member but also as a safety barrier separating pedestrian and vehicular traffic. The roadways measure 38'-0" wide on the Sixth and Ninth Street bridges and 37'-6" on the Seventh Street Bridge. When designed, they carried four lanes of traffic, with two lanes for vehicles and two for street railways, with a track gauge of 5'-2-1/2" (and center-to-center measurement of 9'-6-1/2"). The clear sidewalk width at the time of construction was a constant 10'-3-1/2".¹³⁴

¹²⁹ Plowden, *Bridges*, 238.

¹³⁰ American Institute of Steel Construction, award citation in File AL 02, ACDPW.

¹³¹ *Engineering News-Record*, "Three New Bridges," 995.

¹³² "6th St. - 7th St. - 9th St. Allegheny, Bridges No. 2, 3 & 4," n.d., in File AL 02, ACDPW; and "Sixth Street Bridge, No. 2 Allegheny River, Pittsburgh, Pa., Plan & Elevation," Drawing No. 5857 (11 Feb. 1927), in file AL 02, ACDPW.

¹³³ Roush, "Sixth, Seventh and Ninth Street," 196.

¹³⁴ R. C. Chaney, Engineer, Columbus, Ohio, City Planning Commission, to V. R. Covell, Chief Engineer, Allegheny County Department of Public Works, 12 Nov. 1929, in File AL 02, ACDPW.

The towers measure 77'-11-3/8" in height.¹³⁵ At the towers, the eye-bar chains bear up to six million pounds of vertical load. The Seventh Street Bridge has a chain sag of approximately 54'-4", with towers 83'-5" over the level of piers. The plate girders' vertical stiffeners are riveted to stirrups, which connect to suspenders. Floor beams and stringers carry the concrete slab deck, and the floor beams and brackets for the cantilevered sidewalk are riveted to the stiffening girder. Engineers based live-load calculations on two 18-ton trucks of a pair of 60-ton streetcars for the roadway, and a 66-pound live load for the sidewalks, making a live load total of 6,590 pounds per lineal foot. In figuring the ratios for cable and stiffening girders, the live load results were calculated using a 16.9-percent impact factor. The unit stress of the eye-bars was specified as 27,000 pounds per square inch.¹³⁶

The Pittsburgh Railways Company, which controlled most of the rail transportation throughout the city after a period of railway consolidation in the first decade of the twentieth century, faced the problem of rerouting a dozen railway lines while work on the bridges proceeded.¹³⁷ The county allocated \$85,000 to pay for a portion of the \$200,000 cost of realigning tracks and posting detours, which included making the Manchester Bridge and other local roads serve as alternate routes. The process delayed the Ninth Street Bridge work from February 1926 into the next month.¹³⁸

Construction

The Sixth Street Bridge served as a model for design of the three structures, but the Foundation Company and the American Bridge Company first constructed a replacement for the Seventh Street Bridge, which was razed beginning in September 1924. Covell explained the first project at Seventh Street:

The structure may be briefly described as a self-anchored suspension bridge. The suspension system consists of 14-in. eyebars extending from anchorage to anchorage, having two pins on the top of each tower, and carrying the roadway by 4-in. eyebar suspenders at the panel points. The stiffening system consists of triple-web plate girders placed parallel to the grade. The horizontal component of the stress in the eyebar chain is taken by the stiffening girders, while the reactions

¹³⁵ V. R. Covell, "Erecting a Self-Anchored Suspension Bridge — Seventh Street Bridge at Pittsburgh," *Engineering News-Record* 97 (1926): 502.

¹³⁶ Roush, "Sixth, Seventh and Ninth Street," 196.

¹³⁷ Bion J. Arnold, *Report on the Pittsburgh Transportation Problem* (Pittsburgh: City of Pittsburgh, 1910), 43.

¹³⁸ "County Signs Pact To Pay \$85,000 For Re-Routing Changes," *Pittsburgh Post*, 24 Jan. 1925, in Clippings File, Pittsburgh Bridges — Ninth Street, Pennsylvania Room, Carnegie Library.

at the ends are vertical. The girders are thus subjected to stresses due to bending combined with direct compression.¹³⁹

Engineers rejected using a temporary anchorage for the chain during erection because the site lacked adequate anchorages, both in clearance and in access to rock. Falsework was considered but the War Department's order to keep the river navigable precluded that method. One of the several unique aspects of the Three Sisters Bridges became, out of necessity, the erection of a suspension bridge with cantilever methods. The American Bridge Company suggested the cantilever technique, keeping the main span over the river channel navigable at all times.¹⁴⁰

Erection began in July 1925 with the driving of wood piles to place metal bents at points 1 through 9 on both sides of the main span (with twenty panel points denoting each half of the structure). The piles at points 4 and 7 were reinforced to protect against possible flooding during construction. Barges delivered eye-bars and other equipment when directed. A 100-ton crane traveled finished portions of the floor to aid in erecting the lower chord between points L0 and L10. Workers put the stiffening girders and chains into place, using jacks to produce the correct camber for the girders and bolting the splices. Using bases already constructed, workers erected the towers and affixed adjustable struts to the stiffening girders and tower bottoms.¹⁴¹

Eye-bars and hangers were set in permanent positions at points U0 to U3, but intermediate pins at U4 and U6 and the cradled sections around them (U3 to U5 and U5 to U7) were connected to a supporting I-beam, with struts attached at U5 and U7. The next section, between U7 and U10, received a similar treatment, with I-beam cradles at U7 and U10 and with slotted-hole plates attached to the I-beams cradling U8 and U9. Point U10 reached the tower.¹⁴²

Stretching the massive chain to the connection point at U20 required setting the towers 12" closer than their final position. To allow this movement, the south pier contained a roller bearing and the north pier a rocker bearing. Workers left unattached the bottom hanger pins points L4 to L6, and L17 to L17* (* indicating the north span). Point L0 had to be shifted 12" toward the south tower and segmental rollers at the tower adjusted to anticipate the movement, then locked. The northern tower and points did not have to be altered. Cantilever deflection and camber made the task of joining the chain at U20 more exacting. Five hundred-ton jacks connected to a strut at U5 alleviated secondary stresses caused by deflection, raised point L19 for the closure process, and allowed pins from L4 to L6 to be fastened.¹⁴³

¹³⁹ Covell, "Erecting a Self-Anchored Suspension Bridge," 502.

¹⁴⁰ Covell, "Erecting a Self-Anchored Suspension Bridge," 502.

¹⁴¹ Covell, "Erecting a Self-Anchored Suspension Bridge," 502-503.

¹⁴² Covell, "Erecting a Self-Anchored Suspension Bridge," 503-504.

¹⁴³ Covell, "Erecting a Self-Anchored Suspension Bridge," 504.

Commencing with the cantilever erection, workers installed diagonal struts in panels 10-11 and 15-16, continuing at panel 17 with a truss unattached to final bridge components to correct the chain's curve. Cantilevering the independent truss brought the splices past points L19 and L19* by 3'-8". The gap of 44'-2-1/2" between splices, less the 3'-8" measurement doubled from each span, then appeared 1'-0" away from the center girder's last placement, leaving only 35'-8-1/2" for the girder. Workers prepared a girder 2" shorter than that measurement (requiring a 14" addition later), allowing the girder to be attached to cantilever truss supports and the eye-bar chains to be joined. A quartet of 500-ton jacks per chord aided in controlling the member stress during the operation. The rollers shoes were then unlocked and pins at the exact mid-point driven, relying on the center girder and jacks to make the stresses on the chain negligible. Workers then drove the remaining unattached hanger pins near the center of the bridge and pins in lower chord points on either span.¹⁴⁴

As workers modified the cantilever construction into a suspension system by jacking and shifting the south span into final position, the diagonal trusses fell away, leaving a strictly suspension form. With the insertion of the last 14" member and cover splices, workers completed riveting every point along the structure and took away jacks, leaving the bridge with virtually the same stresses anticipated by engineers before erection.

Workers closed the girder in February 1926 and prepared the bridge for roadway construction. The next month, the War Department gave the county an ultimatum to begin work on the Sixth Street Bridge by the end of the year, forcing the county to rush work in progress on the Seventh and Ninth Street bridges. The Foundation Company eased the situation by providing pedestrian access across the old Sixth Street Bridge while it was prepared for removal. Combined with the opening of the first bridge in July and the second in November 1926, this allowed commissioners to avoid having all three bridges closed at the same time. Business interests had opposed working on the Seventh and Ninth Street bridges at the same time because of the disruption it would cause to commercial interests — a concern that certainly would have been expressed even more strongly if all structures were down at once.¹⁴⁵

Coraopolis and the Old Sixth Street Bridge

With the construction of the Seventh Street Bridge finished in mid-1926 and the Ninth Street Bridge nearing completion, Allegheny County's attention turned toward the main commercial thoroughfare between the two halves of Pittsburgh: the Sixth Street Bridge. The Cooper spans remained in good shape, and concerns for economizing in public works projects led to recycling of the 1892 bridge.

Commissioner Armstrong took credit for proposing to reuse the Cooper bridge instead of building an entirely new structure in nearby Coraopolis, saving Allegheny County \$350,000. The

¹⁴⁴ Covell, "Erecting a Self-Anchored Suspension Bridge," 504-05.

¹⁴⁵ "6th Street Bridge Must Be Razed By December 31," *Pittsburgh Gazette-Times*, 10 Mar. 1926, in Clippings Files, Pittsburgh Bridges — Sixth Street, Pennsylvania Room, Carnegie Library, Pittsburgh, Pa.

Foundation Company bid on a contract to move the Sixth Street Bridge from its site in downtown Pittsburgh to Coraopolis, twelve miles away. Winning the contract at a bid of \$316,200, the company also assumed any risk that the spans would sink or be damaged during the project.¹⁴⁶ The company allowed pedestrians to cross the structure while roadway removal proceeded in the fall of 1926 in order to reduce the inconvenience for residents. Workers took off half of the roadway at a time, leaving pedestrian areas accessible until final segments were taken away.¹⁴⁷

The bowstring trusses, in addition to weighing 1,600 tons each, presented the difficult problem of being slightly too tall to fit under a bridge along the journey. Because of the stresses inherent in a bowstring truss, the Foundation Company could not merely disassemble them; instead, the firm had to transport the entire 450'-0" spans, which were 44'-0" wide and 80'-0" high.¹⁴⁸ The Cooper bridge consisted of sixteen eye-bar panels pinned together. Removing one part would break the structure's rigidity and make moving it very difficult.¹⁴⁹

Instead of shifting the spans off piers for lowering or pivoting them from their present support, the Foundation Company lowered the structure in position, taking off the masonry and using substitute supports for resting the structure without getting in the way of the process. The contractor attached a frame to each of the piers and abutments, used straps to bind the trusses to each frame, and lowered them using the straps. With twenty-six 7" holes punched in the strap, the company used a matching chain to counter the eight straps. Using pins to move the strap by hole sets, the company brought the spans downward 15" at a time with jacks. The pins attached to the plungers of eight 500-ton jacks. The jacks remained in place while the pins moved 15". The water-cylinder jacks were also 15" high, capable of exerting 3200 psi after pumping. By bleeding water out of the cylinders of the jacks all at once, workers used the four jacks on each side of the bridge to lower the spans on alternate sides to the full depth of 16'-0".¹⁵⁰

Workers made a pontoon out of two pairs of barges, spaced to create a platform 400'-0" long and 52'-0" wide, which carried the bridge with 20'-0" of overhang. Stringers supported the bridge in forty-two places, with a 40-ton screw jack at each stringer for easier loading and unloading. When workers reached the Manchester Bridge, they had to adjust the bridge to fit the

¹⁴⁶ "Continuous Service of Structure, Since 1892 Ended; Will Be Used Down River," *Pittsburgh Sun*, 3 Jan. 1927, in Clippings File, Pittsburgh Bridges — Sixth Street, Pennsylvania Room, Carnegie Library, Pittsburgh, Pa.

¹⁴⁷ "Ninth St. Bridge Formally Opened," *Chronicle Telegraph*, 26 Nov. 1926, in Clippings File, Pittsburgh Bridges — Ninth Street, Pennsylvania Room, Carnegie Library, Pittsburgh, Pa.

¹⁴⁸ "Floating Intact to Coraopolis Pittsburgh's Old Sixth Street Bridge Spans," press release from Norman F. Brown's office, n.d., in File AL 02, ACDPW. For a published account and published photos of the process and the jacks used, see D. T. Jerman, "Moving the 440-Ft. Truss Spans of Sixth St. Bridge, Pittsburgh," *Engineering News-Record* 98 (1927): 850-51. Jerman notes that the transported spans were too high for the Ohio Connecting Railroad bridge over the Ohio River as well as the Manchester Bridge over the Allegheny.

¹⁴⁹ ACDPW, "Floating Intact."

¹⁵⁰ ACDPW, "Floating Intact."

clearance, which was 14'-0" and 12'-0" less than the bridge's height. After supporting the bridge under the floor beams, they disassembled the top chord and stabilized each panel point on the trusses.¹⁵¹

Steering the bridge under the Manchester Bridge and the railroad bridge at Brunot's Island, the tugboat captains went through the Ohio River lock and up the back channel toward Coraopolis, where piers and abutments had been constructed. Reversing the process and using the same jacks and steel frames to raise the structure 32'-0", the company erected the Cooper bridge 30 days after the project began.¹⁵²

Completing the Sixth Street Bridge

Work proceeded on the new Sixth Street Bridge, with the Foundation Company called to accept last-minute revisions of piers 1 and 4 to accommodate subway construction at a later date. Bion J. Arnold's influential transportation report called for converting street-level areas downtown to pedestrian and automobile use. He recommended building tunnels for subways to connect Pittsburgh's central business district with selected areas, including the North Side. Although business owners and city officials hotly contested the exact route for such a system, the North Side access required by any future subway system was not in doubt.¹⁵³

The revisions proposed constructing tunnel shields that could be pierced when the city decided on a final route. The tubes were 68'-0" on center, with suggested radii ranging from 7'-9" to 9'-0", and steel reinforcement overhead. One proposal for the construction shows plans using three separate open box caissons to form the base of each pier.¹⁵⁴ The tube openings provided slightly different angles for each direction to adapt to the grades and length of approaches on north and south shores, anticipating lines that bent outward to avoid the two main piers. The city of Pittsburgh absorbed the cost of the alterations to the original plan, paying the Foundation Company the same contract costs negotiated for the bridge work of up to \$40,000 for the south pier and \$80,000 for the north pier.¹⁵⁵ (The subway openings have yet to be used, however. Pittsburgh's underground light rail system, constructed between 1980 and 1985, follows a Sixth Street alignment for several blocks but does not cross the river.)

¹⁵¹ ACDPW, "Floating Intact."

¹⁵² ACDPW, "Floating Intact."

¹⁵³ Arnold, *Report*.

¹⁵⁴ "Scheme B, Suggested Plan for Using Three Separate Open Box Caissons for Base of Each Pier," 23 Aug. 1926, in Files AL 02-04, ACDPW.

¹⁵⁵ City of Pittsburgh, to Allegheny County, regarding articles of agreement for construction work on the south pier and abutment of the Sixth Street Bridge and the north pier and abutment of the Sixth Street Bridge, in File AL 02, ACDPW. See also Drawings No. 287 and 297 (23 Nov. 1926), in Files AL 02-04, ACDPW.

Even with the subway alterations, the Foundation Company completed its work four months ahead of schedule, leaving to the American Bridge Company a working schedule during Pittsburgh's bitter winter weather. The company continued to fabricate components at its Ambridge shop, completing two-fifths of the 6,000 tons needed while it waited for better river conditions. In the meantime, workers pre-assembled smaller components off site. Brown's office justified the apparent delay in a press release, responding to business owners who insisted that work continue amidst the winter by noting no contractor could reasonably be expected to erect the side-span falsework necessary for the project with the dangerous currents and ice faced by the American Bridge Company. The uniqueness of a suspension bridge erected by cantilever methods required exceptional caution.¹⁵⁶

Conclusion

Its predecessor razed in September 1924, the Seventh Street Bridge was the first completed. The county opened the Seventh Street Bridge on 17 June 1926, and the Ninth Street Bridge on 26 November of the same year. County commissioners soothed area business owners anxious for a return to normal commerce by allowing pedestrians to use the Sixth Street Bridge's downstream sidewalk on 14 September 1928, in advance of the bridge's official opening. In a move that symbolized commitment to keeping its public works promises, the capstone of Allegheny County's 1924 construction program was brought to a close almost exactly four years after workers began tearing down the first of the three bridges. The Sixth Street Bridge was opened to all traffic on 19 October 1928.¹⁵⁷

The county's public works projects in the 1920s employed local labor instead of contracting with outside consultants or companies, and materials were procured from area manufacturers. "Every pound of the thousands of tons of steel used in our bridges was manufactured in the mills of our district," Armstrong wrote in his re-election campaign literature in 1931. He reminded voters that he had helped oversee the construction of ninety-nine bridge projects at a cost of \$47.2 million. Included in the list were the Coraopolis Bridge, at Neville Island in Coraopolis Borough in 1928, costing \$0.8 million; the Sixth Street Bridge in 1928, \$1.5 million; the Seventh Street Bridge in 1926, \$1.4 million; and the Ninth Street Bridge in 1926, also \$1.4 million. Significant in themselves, the bridges were only part of a massive \$31 million construction plan beginning in 1924 and ending in 1931. Armstrong boasted, "More county

¹⁵⁶ Carbon copy of memo, "New 6th Street Bridge," n.d., in File AL 02, ACDPW.

¹⁵⁷ Plowden, *Bridges*, 239; "Ninth St. Bridge Formally Opened," *Pittsburgh Chronicle Telegraph*, 26 Nov. 1926, in Clippings File, Pittsburgh Bridges — Ninth Street, Pennsylvania Room, Carnegie Library, Pittsburgh, Pa.; "Parade Marks Sixth Street Span Opening," *Pittsburgh Post-Gazette*, 20 Oct. 1928, in Clippings File, Pittsburgh Bridges — Sixth Street, Pennsylvania Room, Carnegie Library, Pittsburgh, Pa.; and "Opening of the Sixth Street Bridge Sidewalk, Friday, September 14, 1928, 4:00 P.M. Daylight Saving Time," press release from Norman F. Brown's office (12 Sep. 1928), in File AL 02, ACDPW.

improvements were made during this 8 year period than during the previous 136 years of the county's existence."¹⁵⁸

One of Armstrong's pieces of campaign literature, a lavishly illustrated brochure, prominently featured an aerial view of the "Trinity of Bridges" overlaid with a photo of American Institute of Steel Construction's 1928 award to the Sixth Street Bridge.¹⁵⁹ AISC named the structure "The Most Beautiful Steel Bridge" constructed in 1928, adding to the fame of the Allegheny County Department of Public Works and publicizing the potential of steel for enhancing not only strength but attractiveness. One of five judges, Charles Evan Fowler, commented on the choice of winners:

The new Sixth Street Bridge at Pittsburgh was selected because in my opinion it combined the essential elements of beauty, simplicity, symmetry, harmony, and proportion, and also because of its originality of design, it being a self anchoring eye-bar cable suspension bridge. The cables have enough section to give a very satisfying appearance of stability, combined with simplicity of construction. The towers are very chaste in design, yet heavy enough to give every appearance of strength and solidity. The large arch over the roadway is surmounted by an unequal number of portal openings, yet very harmonious with the entire design of the towers, and the graceful curve of the cables.¹⁶⁰

The award enhanced the city's image as a forward-thinking municipality with an economy based on a material of the future, but the bridges also healed friction that had festered between business interests in former Allegheny City and Pittsburgh since the mid-nineteenth century. Roush noted, "As has already been expressed by some business interests on the north side of the river, 'There is a feeling that a barrier had been removed between the two business sections of the City.'"¹⁶¹ The Three Sisters Bridges embody not only a unique construction method and design but also a specific response to local and national political configurations. The structures represent a larger process of social conflict and cohesion that began half a century before, as well as advances in material technology and design that became available only within the decade of its construction.

¹⁵⁸ "8 Eventful Years," 1931 campaign brochure for Joseph G. Armstrong, in James D. Van Trump Library, Pittsburgh History and Landmarks Foundation, Pittsburgh, Pa.

¹⁵⁹ Armstrong, "8 Eventful Years."

¹⁶⁰ "The Artistic Bridge: 1928 Award," 1929 award brochure from American Institute of Steel Construction, Inc., New York, in File AL 02, ACDPW.

¹⁶¹ Roush, "Sixth, Seventh and Ninth St.," 196.

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