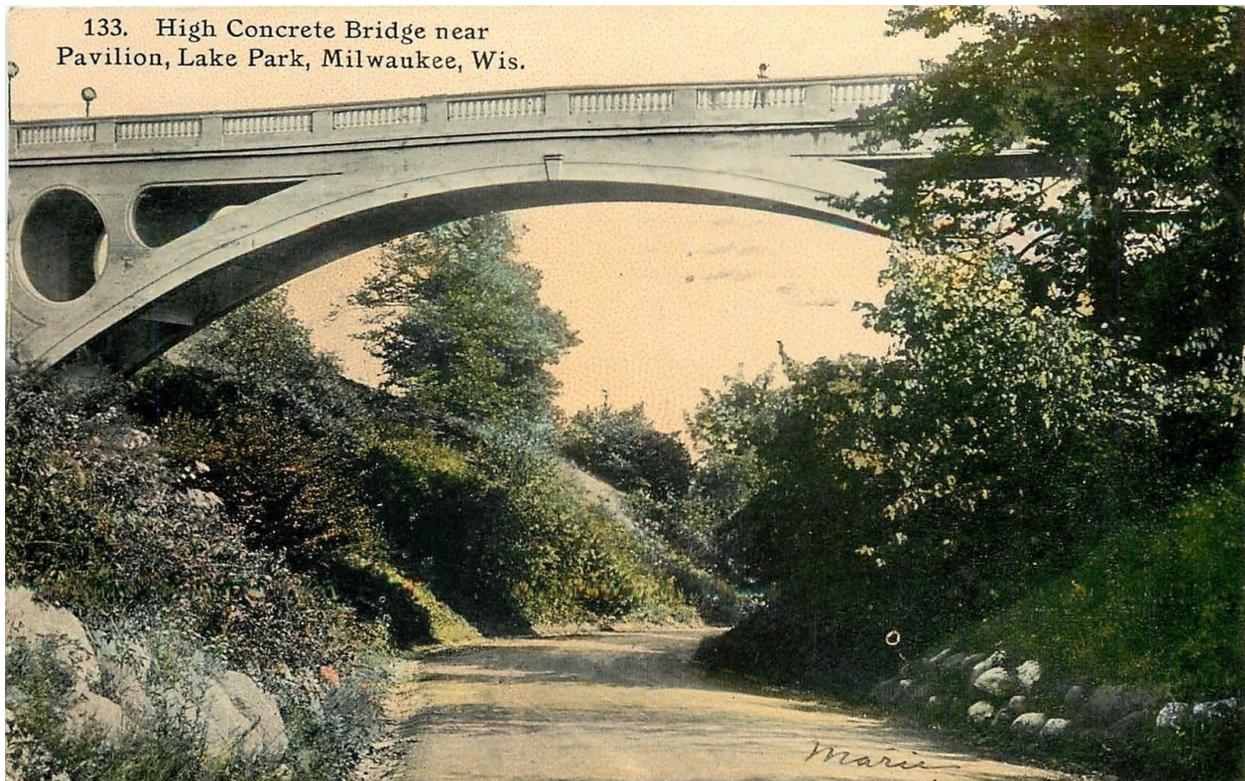


Ravine Concrete Arch Footbridge at Milwaukee Lake Park

A Cultural Heritage Assessment Study and Report

Historic Preservation Office
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Introduction:

This report has been prepared to accompany the current study of the Lake Park Ravine Bridge taking place 2015-2016. The evaluation from Milwaukee County and its consultants consists of an assessment of the bridge's structural condition and alternatives for its repair or replacement. This report concentrates on the significance of the bridge, its context as part of a National Register district, the contribution of its architects and how innovative technology helped to produce the distinctive design of the bridge that we have in Lake Park today.

Many questions are raised when determining the future of this bridge. How significant is significant? Does significance matter? Is or should cost always be the determining factor in preservation? Why haven't we been able to save more bridges in Wisconsin? Is there a bias when evaluating bridges; why aren't bridges looked at the same way as a historic house or site? Does a utilitarian structure have less value than something "attractive"?

This report will hopefully open the door to a productive dialogue on the future of this unique structure.

Many thanks to the UW-Milwaukee students who enthusiastically poured over the hundreds of documents and photos to arrive at the report in the following pages, Emma Rudd, Leila Saboori, and Nader Sayadi. They were interns with the City of Milwaukee Historic Preservation office in 2016.

Lake Park as a context for the Ravine Concrete Arch Footbridge

The origins of the establishment of Lake Park on Milwaukee's East Side go back to the earliest attempts of the city toward providing recreational spaces within the growing city in the mid-nineteenth century. Considered "gardens of the poor," a series of parks were imagined to bring over natural elements to the public who could not afford to have private gardens and yards like the wealthy. With the establishment Milwaukee's first Park Commission by the City of Milwaukee in 1889, the city began acquiring land under the presidency of Christian Wahl. Lake Park was designed by the well-known landscape architect Frederick Law Olmsted, as a part of larger planning project including River Park, now Riverside Park, at the Milwaukee River and Newberry Boulevard connecting these two parks and therefore the river and the lake. Olmsted also laid the foundations of a third park in Milwaukee, West Park, now Washington Park.¹

The work on Lake Park began in 1892, when the city made agreements with Olmsted and his firm, Olmsted, Olmsted & Eliot, of Brookline, Massachusetts, to develop ideas and plans for the park. Olmsted's main spatial idea for the park was based on English Romantic style as a reaction to the fast industrialization and urbanization of societies. There were at least two main factors that shaped Olmsted's design perspective: first, he was greatly influenced by the English Romantic movement and the precedents he saw in his trip to England in 1850. Second, he collaborated with Calvin Vaux who was an assistant of Andrew Jackson Downing, a well-known advocate of the naturalistic movement. In their design for Milwaukee's Lake Park, Olmsted applied some of the features that were already developed in his works, such as New York City's Central Park. Thier features provided a contrast to the surrounding urban area:

¹ . Dolores Knopfelmacher, "History of Lake Park," <http://lakeparkfriends.org/history/> (accessed July 06, 2016).

winding pathways through the park instead of the city grid, ever-changing views, refreshment from the sights and sounds of urban life, and natural scenery.²

Lake Park in Milwaukee is locally and nationally recognized as a significant historic place. One of the first parks in Milwaukee, Lake Park is credited with the emergence of the City of Milwaukee Park Commission and later parks system.³ Prior to 1880, Milwaukee had no legal means or overall plan to fund-raise for the establishment and maintenance of the urban public parks. As a result, the city's green public spaces were limited to small squares, triangles or plots of land donated to the city and often maintained by residents who lived nearby. The establishment of Lake Park, the parks system, and the Board of Park Commissioners was a milestone in the history of Milwaukee's built environment and social history.⁴ "Lake Park is also significant because it is one of the original park locations selected by the first park commissioners when the city became aware of the need to establish city-owned public parks."⁵

The historical significance of Lake Park extends primarily to its designer, the nationally renowned landscape architect Frederick Law Olmsted. Olmsted's belief that public parks are crucial natural segments of urban areas for the public drastically changed cities across the United States in the late nineteenth century and the dawn of the twentieth century, and laid the

² . Lake Park, Milwaukee County, Wisconsin, National Register of Historic Places, Continuation Sheet (United States Department of the Interior, National Park Service, 1992), Section 7, Page 2.

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https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwiI0ofJgNPNAhXK3YMKHYTPA2kQFggcMAA&url=http%3A%2F%2Fcounty.milwaukee.gov%2FImageLibrary%2FGroups%2FentyPark%2Fparkwriteups%2FLake_Park.doc&usg=AFQjCNEyMrt8hyK2uKbXUBg7JtUhJbW7pQ&sig2=FSqGcSk_fkAp_m9q8PDg9A&bvm=bv.126130881.d.amc&cad=rja

⁴ . "Historic Designation Study Report, North Point North Historic District," City of Milwaukee, Designated Reports, p. 6-7 (January 01, 2001): <http://www.city.milwaukee.gov/ImageLibrary/Groups/cityHPC/DesignatedReports/vtincf/HDNoPointNorth.pdf> (accessed July 01, 2016).

⁵ . Lake Park, Milwaukee County, Wisconsin, National Register of Historic Places, Continuation Sheet (United States Department of the Interior, National Park Service, 1992), Section 8, Page 11.

foundations of the cities we live in today. Olmsted's significant influence on the generations of planners, social and environmental activists, and legislators was the result of his design and construction of a series of parks that applied his ideas in practice. The most well-known of these parks is Central Park in New York City, built between 1857 and 1873. When Olmsted won the competition for the Central Park project, he was not yet a well-known designer. At the time he was hired by the Milwaukee Park Commission in 1882, however, he already had done a considerable number of landscape projects in California, Montreal, Boston, and Chicago. With the extensive professional knowledge and experience he had by the 1890s, Milwaukee's Lake Park can be considered an excellent example of his mature works. Two years after the Lake Park project at Milwaukee, Olmsted retired from active practice in 1895. He passed away in 1903.⁶

As previously mentioned, Lake Park was one of the three main projects that Olmsted executed in Milwaukee; however, it is the only one that today most closely retains the original form and intent of its designer. This is a main requirement when seeking designation from the National Register of Historic Places status:

“The significance of Lake Park as a Designed Historic Landscape is based on the fact that the plan of the park is essentially that which was supplied by Frederick Law Olmsted and his firm of Olmsted, Olmsted, & Eliot. The original curving carriage drives through the park have now become walkways. However, what remains are (1) the provision of views of Lake Michigan and (2) the contrast between the expanses of meadow and the rugged scenery in the natural ravines.”⁷

⁶ . Lake Park, Milwaukee County, Wisconsin, National Register of Historic Places, Continuation Sheet (United States Department of the Interior, National Park Service, 1992), Section 8, Page 7.

⁷ . Lake Park, Milwaukee County, Wisconsin, National Register of Historic Places, Continuation Sheet (United States Department of the Interior, National Park Service, 1992), Section 8, Page 11.

The completeness, wholeness, and authenticity of the park as one single historic entity and cultural property are not only substantial characteristics of the park, but also fulfil major criteria for being a National Historic Place. In other words, the significance of the park is not attributed to a few of its particular features but the combination of all existing historic features as a whole regardless of their materiality and form.

Lake Park consists of various features and vegetations. The National Register for Historic Places recognizes ten contributing structures, two contributing buildings, two contributing objects, and two contributing sites within the boundaries of the park. It also considers four sites in the park as non-contributing sites.⁸ Most of the main architectural features of the park were built between 1893-1936, also described as “The Period of Significance of Lake Park.”⁹ The architectural features of the park include but are not limited to buildings, bridges, memorials, golf courses, playgrounds, tennis courts, and pathways. A considerable amount of work, including gardening, planting, and walkways, was accomplished in the 1890’s and early 1900’s. A majority of these elements still exist today, though a few of them has been altered and three have been eliminated. A list of major features are given in the table below:¹⁰

⁸ . Lake Park, Milwaukee County, Wisconsin, National Register of Historic Places, Continuation Sheet (United States Department of the Interior, National Park Service, 1992), Section 8, Page 1.

⁹ . Lake Park, Milwaukee County, Wisconsin, National Register of Historic Places, Continuation Sheet (United States Department of the Interior, National Park Service, 1992), Section 8, Page 12.

¹⁰ . “Lake Park,” County of Milwaukee, Park Write-ups, p. 1:
http://county.milwaukee.gov/ImageLibrary/Groups/cntyParks/parkwriteups/Lake_Park.doc (accessed July 06, 2016).

INVENTORY OF MAJOR FEATURES		
Name	Date	NHP report code
North Point Lighthouse/Dwelling (originally built before the park development)	1879	A11
<i>Park development begins in 1892</i>		
Steel Arch Bridge	1893	A2
Brick Arch Bridge	1893	A3
Formal Entrance at Newberry Blvd.	1893	B1
Street-car station and shelter [demolished later]	1903	-
Lion Bridges (2)	1896 -97	A6
South Concourse	1898	A8
Pavilion	1903	B3
Bandstand [demolished later]	1903	-
6-Hole Golf Course (expanded in 1930)	1903	C8
Concrete Footbridge	1905	B7
Children's building and playground [demolished/eliminated later]	1906	-
Grand Stairway	1908	B8
Indian Mound Plaque	1910	B10
Tennis Court	1911	B11
North Point Lighthouse/Dwelling (relocation & alteration)	1912	A11
Tool Shed/Workshop/Storage Building	1918	B12
E. B. Wolcott Monument	1920	C1
American War Mothers Plaque	1920	C2
Lincoln Memorial Drive	1929	C4

Rustic Bridge	1930s	B2
18-Hole Golf Course	1930	C8
American War Mothers Plaque	1931	C6
Bowling on the Green	1946	C7
Golf Starter's Building	1961	D7
Lawn Bowling Clubhouse	1962	D2
Ice Skating Warming House	1965	D3
County Bicycle Path	1967	D4
Milwaukee Landmarks Commission Plaque	1973	D5
1915 Harp Luminaires (Moved to Park in 1977)	1977	DS
Exercise/Jogging Trail	1978	D6

Among Olmsted’s various ideas embodied in Lake Park, the circulation system of the park and its continuity are the main two elements that make up the structure of the park. Unlike many locations that Olmsted had previously designed, Lake Park is located along a 100 feet high bluff overlooking Lake Michigan. Olmsted designed the park based on a series of pathways so that diverse spaces could be experienced and various sceneries could be seen. In his original plan, he envisioned a main pathway along the park’s western edge that followed the city grid, and a second pathway below the bluff along the lakeshore and the park’s eastern edge which later merged into Lincoln Memorial Drive. A third pathway which winds above the bluff in between the other two main pathways, however, was designed as the spatial spine of the park. The latter not only provides amazing views towards the lake along the crest of bluff, but also ties

the main spaces and structures of the park such as the pavilion, the lighthouse, the meadows, and the golf course together, as illustrated by the following:¹¹

Parks designed by the Olmsted firm all embody elements which reflect their beginning in the naturalistic movement admired by Olmsted. One of the noticeable features is ‘a continuing sequence of spaces ranged on a structure of serially connected sight-lines.’ Olmsted designed his landscapes to be planned sequential experiences. Following a curving drive through Lake Park leads one to view a scene of Lake Michigan at the foot of a bluff, rugged sloping sides of a ravine, or the ordered plantings in a formal garden. The curving carriage drives in the park as designed by Olmsted provide a strong contrast to the grid pattern of surrounding city streets. Views of the sweep of Lake Michigan or broad lawns created vistas which were usually ended by a building or plantings creating the illusion of limitless vision. The first concern of Frederick Law Olmsted was to achieve visual unity. He thought in terms of the organization of space, perspective, and vistas. He placed darker forms of foliage in the foreground and lighter, simpler forms farther away and generally planted densely, but was careful to maintain open views.¹²

This continuing sequence of spaces along the pathways, therefore, is a crucial aspect of the original design of the park. In Lake Park, the paths and other elements of the park have remained similar to Olmsted’s original 1895 drawings, paying homage to the significant of Olmsted’s design. This authenticity of historic parks, however, has not been maintained in the two other Milwaukee parks designed by Olmsted. Both Washington Park’s and Riverside Park’s spaces and features have been altered in ways that make them unlikely candidates for nomination to the

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https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwiI0ofJgNPNAhXK3YMKHYTPA2kQFggcMAA&url=http%3A%2F%2Fcounty.milwaukee.gov%2FImageLibrary%2FGroups%2FentyPark%2Fparkwriteups%2FLake_Park.doc&usg=AFQjCNEyMrt8hyK2uKbXUBg7JtUhJbW7pQ&sig2=FSqGcSk_fkAp_m9q8PDg9A&bvm=bv.126130881.d.amc&cad=rja

¹² . Lake Park, Milwaukee County, Wisconsin, National Register of Historic Places, Continuation Sheet (United States Department of the Interior, National Park Service, 1992), Section 7, Page 3.

Register for National Historic Places, making Lake Park the only remaining example of historical accuracy and authenticity of original design.¹³

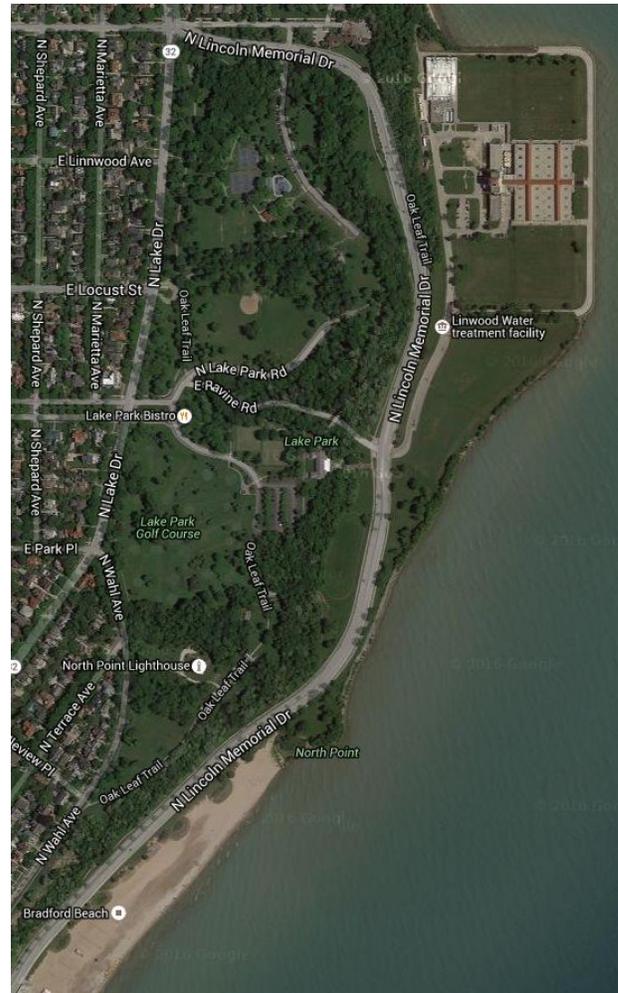
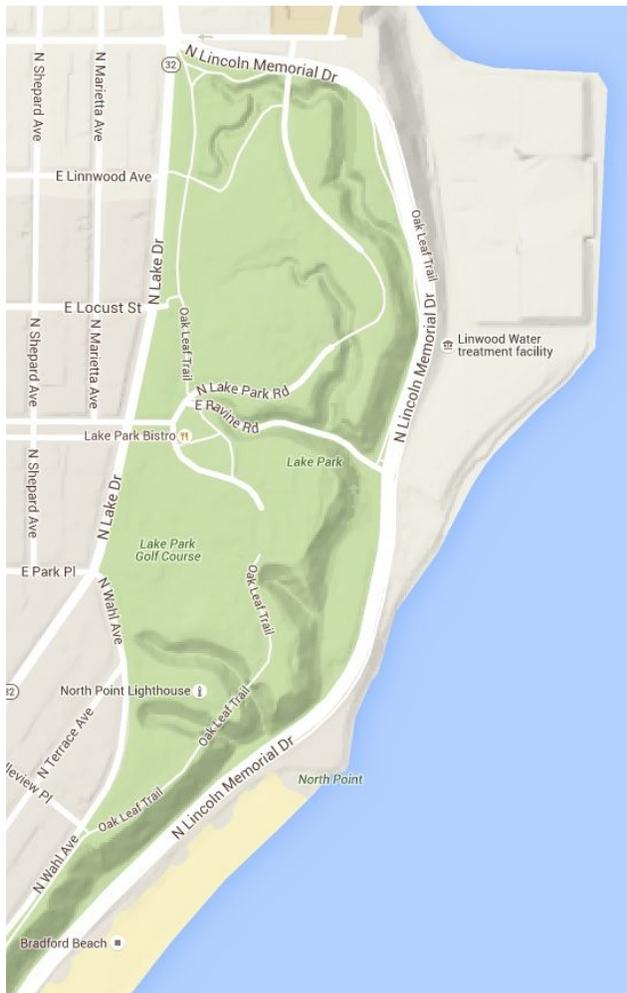
Lake Park's Structure and Ravines:

As previously mentioned, Lake Park is located along a bluff overlooking Lake Michigan on Milwaukee's East Side. This lot, however, is not one solid piece of land: there are several ravines cutting through the park down towards the lakeshore at the bottom of the bluff. These ravines are perpendicular to the lakeshore, running through the length of the park from east to west. They were shaped naturally by years of erosion and glacial melting, which subsequently shaped the entire landscape of the Lake Michigan region. In order to provide the flow of north-south pathway as the main circulation structure of the park, Olmsted considered two strategies: the majority of the ravines were to be crossed on bridges and in one instance, the ravine was filled in entirely.

At the time of the development of Lake Park, there were originally six natural ravines on the lot. From south to north today, there are two ravines (A and B) which meet on the edge of the bluff at east, where they make a fork-shape. They are located between East Bellevue St. (formerly Gilman St.) and East Park Pl. Olmsted planned a double bridges (with approximately 100 feet distance in between) close to the junction of the Ravine A and B. These two bridges are now known as the Lion Bridges. The Ravine C, also known as Trinity Ravine, used to be almost in line with East Locust St. running through the park all the way to the lakeshore. Olmsted

¹³ . Walking Tour Guide (Amy J. Smith and Milwaukee County Department of Parks, Recreation and Culture, 1992), 15.

decided to completely fill this ravine in to provide a 10 acre meadow.¹⁴ This was done by using 40,000 yards of earth in 1896. This also saved some money for the project since there was no need for building any bridges on this ravine anymore. The golf course today is mostly located over the former Ravine C.¹⁵ At the far east end of this ravine, there is a man-made waterfall, marking the very last end part of the Ravine C.



¹⁴ . “Lake Park,” County of Milwaukee, Park Write-ups, p. 1: http://county.milwaukee.gov/ImageLibrary/Groups/cntyParks/parkwriteups/Lake_Park.doc (accessed July 06, 2016).

¹⁵ . Walking Tour Guide (Amy J. Smith and Milwaukee County Department of Parks, Recreation and Culture, 1992), 7.

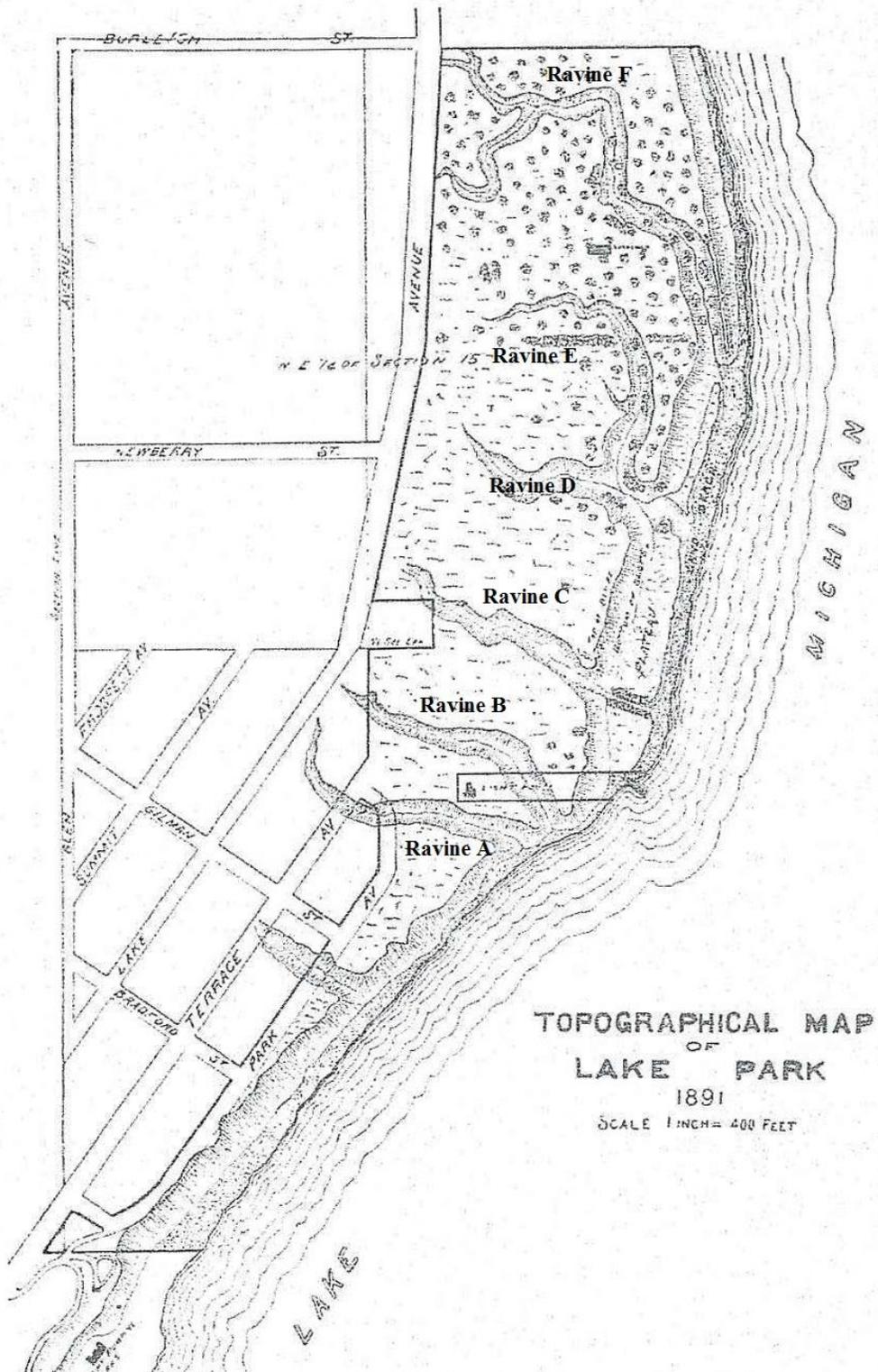


Figure 03 - Ravines at Lake Park

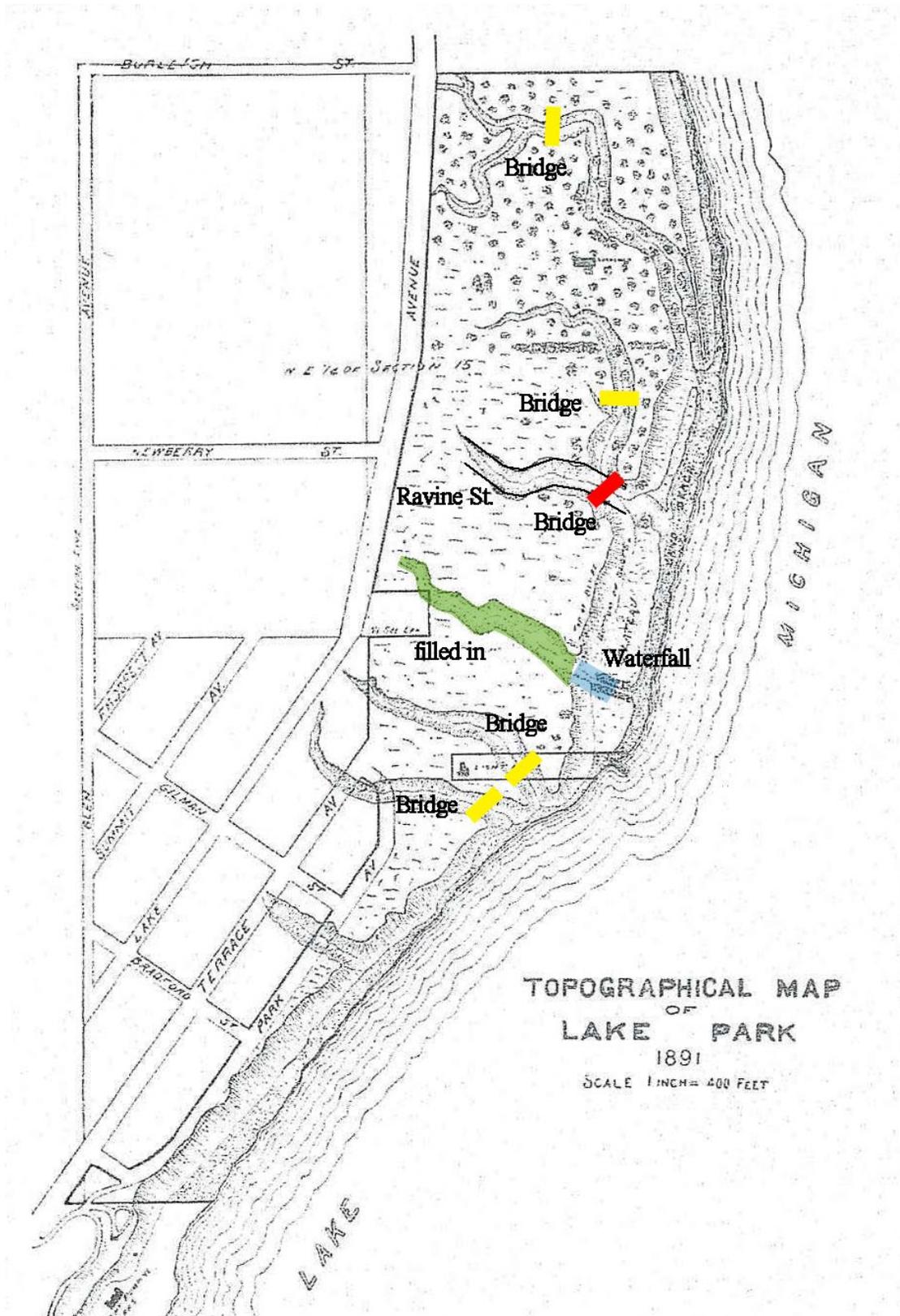


Figure 04 - Bridges and other features related to the ravines at Lake Park.

The Ravines D and E also join at the edge of the bluff making a fork-shape. The Ravine D cuts the entire site in two making a northern and southern half. This ravine is almost in line with East Newberry Blvd. (former Newberry St.). The Ravine D had a significant role in the Olmsted design ideas for the park, particularly for its central location: This is the only ravine out of six in the entire park that Olmsted saw as a main public access connected to the city grid streets which provides direct access to the lakeshore through the park. The Ravine D was also a part of Olmsted's larger plan for the city to connect the Riverside Park and Newberry Blvd. all designed by him, to the lake. The Ravine D today is Ravine Road. today. Interestingly enough, Olmsted found a middle-ground solution to propose an appropriate look for the Ravine St.: It simultaneously bears characteristics of both park and city grid. Olmsted gave the Ravine D to the city grid but it is not a straight line. So Olmsted retained the winding shape of the ravine for the Ravine Road. which gives a unique experience to its passengers. In order to keep the flow of the structural circulation in the park, a bridge was proposed to be built on the mouth of the Ravine D where the Ravine E just connects to it. This is where the Concrete Arch Footbridge was built.

The Ravines E and F were originally treated as Ravines A and B: They were retained and one bridge was built over each. The bridge which is built over the Ravines E is known as Steel Arch Bridge. The other bridge over the Ravine F, located almost on the northern boundaries of the park, is known as Brick Arch Bridge. The ravine E is approximately in line with E Locust St. and the Ravine F is in line with E Kenwood Blvd (formerly Burleigh Avenue). As a result of Olmsted's main idea for the park, one ravine was filled in, one turned into a street, and other four retained their natural form. Five bridges in total was built over the five existing ravines.

Lake Park's Bridges:

Although the bridges were a crucial part of the Olmsted main idea in order to maintain the continuous flow of the movement of people through the park, the significance of these bridges was not limited to their functional and spatial roles in Lake Park as an integrated entity. As it has been explained,

“Within the park, the bridge was not merely an expected necessity, but emerged as an opportunity. Here the city park commission and landscape architect could request special bridge designs, in harmony with the grand park scheme. Bridge engineer and aesthetic critic Henry G. Tyrrell declared in 1901," In the matter of ornamental park-bridges the engineer has opportunity to display more or less artistic taste, and create, not only useful works, but architectural ornaments as well." He indicated also that “The opportunity in the line of ornamental bridge-construction lies chiefly in and around our large cities and park systems and it is greatly to be hoped that, as old wooden bridges decay and are removed, our progressive American people will see their opportunity to replace these with suitable ones of iron and stone, made not simply to carry loads, but to be prominent architectural ornaments.”¹⁶

The bridges were among the first features of the park that were completed. Among five main bridges of the park, four were designed by Oscar Sanne (1856-1913). Sanne, a German trained engineer, worked for the Chicago, Milwaukee, and St Paul Railroad, then the City of Chicago in 1906. He specialized in designing iron and steel bridges, between 1893 and 1897.¹⁷

¹⁶ . Jeffrey A. Hess and Robert M. Frame III, “Historic Highway Bridges In Wisconsin,” vol. I, Stone And Concrete Arch Bridges (Madison, WI: Wisconsin Department Of Transportation, 1986), 233-4.

¹⁷ . Besides these five bridges, there used to be rustic log bridges over the streams deep in the five ravines. With the early improvements of the park, Board President Christian Wahl made these bridge which no longer exist. There are, instead, ten smaller and shorter wooden bridges in the ravines today, which were probably constructed in the 1930s as part of a program for employment during depression years. See: Lake Park, Milwaukee County, Wisconsin,

The Brick Arch Bridge was the second bridge designed by Oscar Sanne in 1893. This is a shorter bridge of 35 feet long, but almost the same width of 26 feet wide with 6-foot wide sidewalks on either side. The total cost of the bridge was \$10,449 (roughly \$275,017 today) and the mason contractor was Gerhard F. Stuewe Co. of Milwaukee. Lake Park's Brick Arch Bridge is recognized as "the only example remaining in Wisconsin of a high style masonry bridge" and "among the nation's most prominent ornamental park bridges." Unlike the Steel Arch Bridge (and Lion bridges), this structure is a masonry bridge in Renaissance Revival style. Also known as Terracotta Bridge, Sanne designed an extensive number of terracotta ornaments and detailing, including four medallions with floral motifs frame the arch. The bridge has gone through few alterations and maintenances; however unlike Steel Arch Bridge, this bridge, particularly its original structural system, has been considerably preserved.¹⁹ As one of the first treatments of the bridge, the original terracotta railings, forming quatrefoil openings, were replaced with the same replicas out of concrete by the Milwaukee County Park Commission and City of Milwaukee's Department of public work in 1990. The project also included replacement of the original pavement with its concrete counterpart and common pointing and masonry repair. The project's total cost was \$79,000 (roughly \$145,207 today).²⁰ Another major restoration project executed in the first half of 2010 by GRAEF, including patching the major cracks on the underside of the main barrel vault by tie rods, rebuilding cast concrete balustrades, and repointing the brick and

¹⁹ . Ibid, Page 6-7.

²⁰ . "Certificate of Appropriateness Report Document, Lake Park Bridge," City of Milwaukee, Historic Preservation Office, 1990.

terracotta.²¹ Later in the second half of 2010, Wisconsin DOT has redone the driveway and walkway of the bridge, including asphalt pavement, and concrete sidewalks, curbs, and gutters.²²

The twin Lion Bridges are perhaps the most well-known bridges in Lake Park. Designed by Oscar Sanne and constructed in 1896-7 with the cost of \$36,573 (roughly \$962,601 today), each of these twin bridges is 164 feet long spanning two ravines A and B of 88-foot wide each. There is a 95 feet distance between these two bridges on the top of the ridge between ravines A and B. Like the Steel Arch Bridge, each of the Lion Bridges' structure consisted of six 88-foot long steel arches supported by a series of 16 decorative cross struts. With completion of the construction, eight stone lions were added to each end of the bridges. Designed by Paul Kupper, sculptor, these lions were donated by Henry Clay Payne, vice president and general manager of the Milwaukee Electric Railway & Light Co. which operated the streetcars serving the park. These twin bridges have been known as Lion Bridges since then.²³ The bridges were narrowed from 50 feet to 10 feet in 1966, in order to limit the traffic passing over the bridge to pedestrian. As a result of this alteration, four out of six arches of each bridge were removed and, therefore, each bridge today stands on a pair of arches instead of six. Unlike the spans, the abutments of both bridges have not narrowed, so they look more bulky today. The bridges decks are reinforced concrete over the steel structure beneath. The bridges were restored by Mead & Hunt between 2007 and 2011: the north Lion Bridge in 2009 and south Lion Bridge in 2011. The project included repairing and repainting of all metal parts, tuckpointing of stone abutments (and

²¹ . "Certificate of Appropriateness Report Document, Lake Park Brick Arch Bridge, Rehabilitate the Structure" City of Milwaukee, Historic Preservation Office, 2008-2010.

²² . "Certificate of Appropriateness Report Document, Lake Park Bridge over Ravine, Restore Bridge," City of Milwaukee, Historic Preservation Office, 8/31/2010.

²³ . Lake Park, Milwaukee County, Wisconsin, National Register of Historic Places, Continuation Sheet (United States Department of the Interior, National Park Service, 1992), Section 7, Page 7.

replacement of stones if needed), major restoration of the metal railing, extensive preservation and renovation of trusses, installation of new concrete deck, and realignment and/or replacement of the tipped or missing bollards. The project costs were estimated as \$830,600 (roughly \$962,371 today) for each bridge. Mead & Hunt received the National Trust for Historic Preservation 2010 Honor Award for the North Lion Bridge Rehabilitation Project.

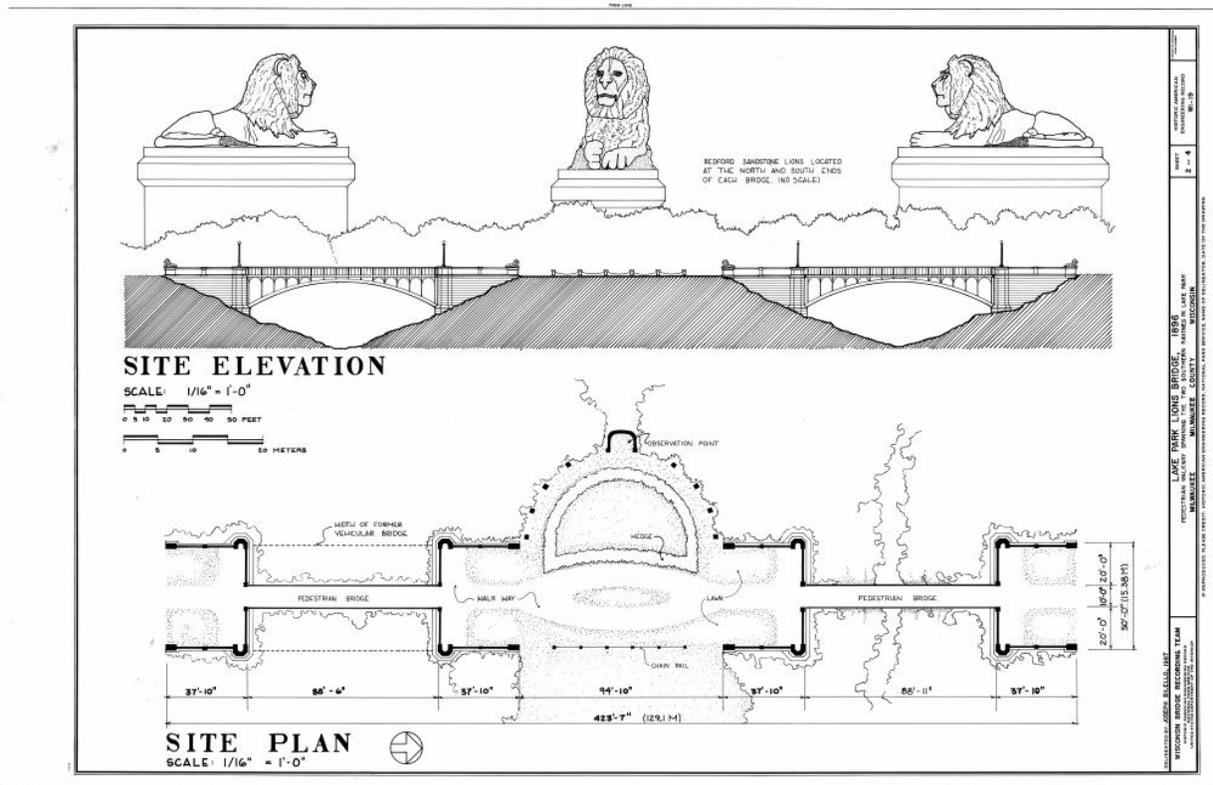


Figure 06 - Lion Bridges at Lake Park

The fifth bridge of the park is Concrete Arch Footbridge. Unlike the other four earlier bridges, this bridge is not designed by Oscar Sanne. The bridge was constructed by Newton Company in 1905 based on the design of the Milwaukee architectural firm of Ferry & Clas, established by George Bowman Ferry and Alfred C. Clas.²⁴ Clas was not only an architect and

²⁴ . Ibid.

planner of considerable note, but also one of the original members of the Milwaukee County Park Commission. He served as a commissioner for 10 years, 1907-1917.²⁵ The bridge spans over the Ravine D, the Ravine Road.²⁶ It has the overall length of 216 feet and the width is 10 feet.²⁷ This reinforced concrete bridge is an open spandrel type arch with two arch ribs spaced 13 foot apart. The bridge's span is 118 feet and the rise of the arch is 18 feet. Vaulted abutment are solid concrete thrust blocks. The deck consists of two-way concrete slabs. Solid concrete parapets are 3'-8" tall and allow for a 12'-5" clear deck width between the inside faces.²⁸ This bridge is a very early example of concrete rib-arch bridges which has been constructed with the Kahn reinforced concrete system.²⁹ Concrete Arch Footbridge at Lake Park emerged out of a great opportunity for exploration of the construction innovations and new forms. As it is mentioned, "The park further provided an ideal opportunity to explore the possibilities of the new concrete, and a great variety of forms emerged. Today, since parks seldom have undergone the heavy

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https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwiI0ofJgNPNAhXK3YM_KHYTPA2kQFggcMAA&url=http%3A%2F%2Fcounty.milwaukee.gov%2FImageLibrary%2FGroups%2FcentyPark%2Fparkwriteups%2FLake_Park.doc&usq=AFQjCNEyMrt8hyK2uKbXUBg7JtUhJbW7pO&sig2=FSqGcSk_fkAp_m9q8PDg9A&bvm=bv.126130881.d.amc&cad=rja

²⁶ . The Ravine Road beneath the Concrete Arch Footbridge has been developed at the same time and it became very popular since its improvement. As it has been mentioned, "the beach drive [Ravine Road], which starts at the head of this ravine and runs down under this bridge and extends for a thousand feet along the lakeshore, was graded this season, catch basins were put in and a sewer built nearly the whole length of the ravine. The steep parts of the bank were dressed up with boulders and the sides of the ravine and around the abutments of the bridge will be planted with shrubs the coming season. The drive was temporarily covered by cinders this winter, and brick gutters will be put in as soon as possible. The beach drive ends in a concourse and hitching place for horses opposite the government lighthouse. This drive became popular even before the grading was finished last fall. One of the old rustic bridges was replaced by a rough timber bridge as rustic wood work is not durable, the bark comes off in a year or two, and the many places for moisture to get in leads to quick decay. Rough timber construction with creosote stain forms work much more permanent." See: Fifteenth Annual Report of the Milwaukee County Park Commission (The Legislative Reference Bureau, City of Milwaukee, 1905), 25-30.

²⁷ . Lake Park, Milwaukee County, Wisconsin, National Register of Historic Places, Continuation Sheet (United States Department of the Interior, National Park Service, 1992), Section 7, Page 8.

²⁸ . GRaEF, "Historic Lake Park Arch Bridge over Ravine Road In-Depth Inspection Report, Structure P-40-576," (July 2015), 03.

²⁹ . Jeffrey A. Hess and Robert M. Frame III, "Historic Highway Bridges In Wisconsin," vol. I, Stone And Concrete Arch Bridges (Madison, WI: Wisconsin Department Of Transportation, 1986), 233-4.

usage and expansions of all other road systems, many of the original park bridges survive. Parks now provide us with significant extant examples of some of the earliest and most ornate reinforced-concrete bridges.³⁰

Ferry & Clas cluster at Lake Park

The design and construction of Concrete Arch Footbridge was actually a part of a larger project in Lake Park which was developed slightly later than the most of the park. This larger project also included a pavilion (1903) and a grand stairway (1908) from the pavilion on the top of the bluff to the lakeshore. These were all located adjacent to each other, creating a cluster in the middle of the park. The components of this cluster were all designed by the local firm Ferry & Clas. While the park itself was designed based on romantic naturalist style by Olmsted and later Sanne added Renaissance revival style bridges to it, Ferry & Clas designed their cluster in neoclassical style. This diversity was an initial goal of Olmsted's design. Olmsted intentionally arranged to have variety in materials and styles of construction in Central Park.³¹ This was accomplished at Milwaukee's Lake Park as well through leaving the design of some particular features of the park to other designers. In other words, Olmsted envisioned the layout of the park, its spatial structure and the continuous circulation system, and designated the features and their location location in relation to each other, but he did not design every single feature such as bridges and buildings. Work on the Lake Park's "Ferry & Clas cluster" began in 1902. The pavilion was a 140 feet long and 45 feet wide building to be used for a picnic shelter. A kitchen was considered at the north side of the building and a stage for music performances at its south.

³⁰ . Ibid.

³¹ . Lake Park, Milwaukee County, Wisconsin, National Register of Historic Places, Continuation Sheet (United States Department of the Interior, National Park Service, 1992), Section 8, Page 10.

A porch, 60 feet long and 12 feet wide, was on the east side of the building. The building was designed in neoclassical style with Doric column porticos on three sides. The pavilion was dedicated on July 11, 1903. The original cost of the pavilion was \$16,000 (roughly \$432,480 today). Later in 1905, Concrete Arch Footbridge was constructed few steps north of pavilion. This gave a more convenient access from the pavilion to the northern half of the park cross the ravine. With adding the Grand Stairway on the east of the building in 1908, easy access from the pavilion to the lakeshore down the bluff was provided. The “Ferry & Clas cluster” included other features such as a Promenade at the end of the stairway and an octagonal bandstand in front of the pavilion, which do not exist anymore.³² So Concrete Arch Footbridge should be seen as an integrated part of not only the Olmsted’s Lake Park, but also the Ferry and Clas smaller ensemble within the Park.

³² . Lake Park, Milwaukee County, Wisconsin, National Register of Historic Places, Continuation Sheet (United States Department of the Interior, National Park Service, 1992), Section 7, Page 8.

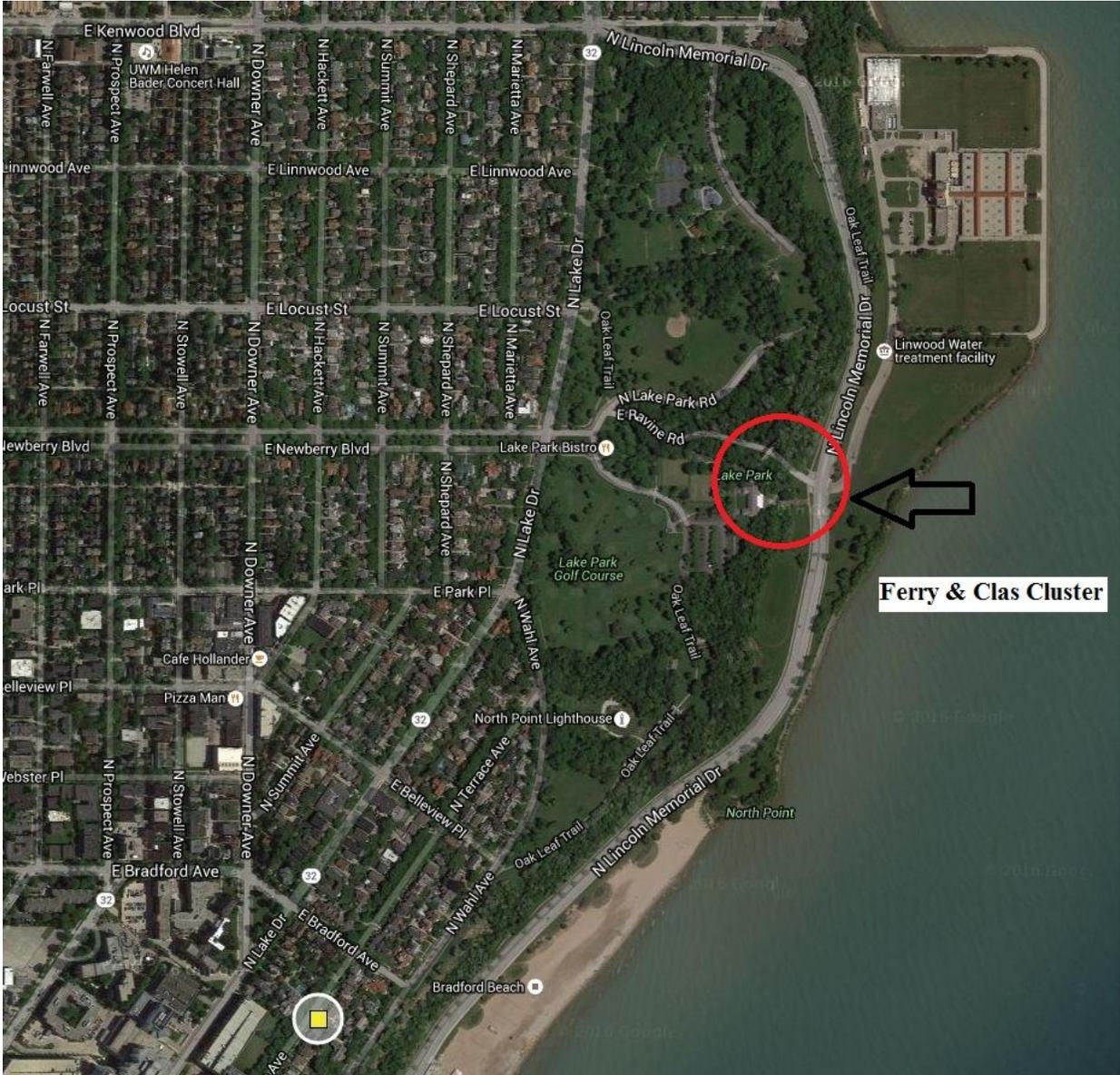


Figure 07 - The Location of the “Ferry & Clas Cluster” at Lake Park

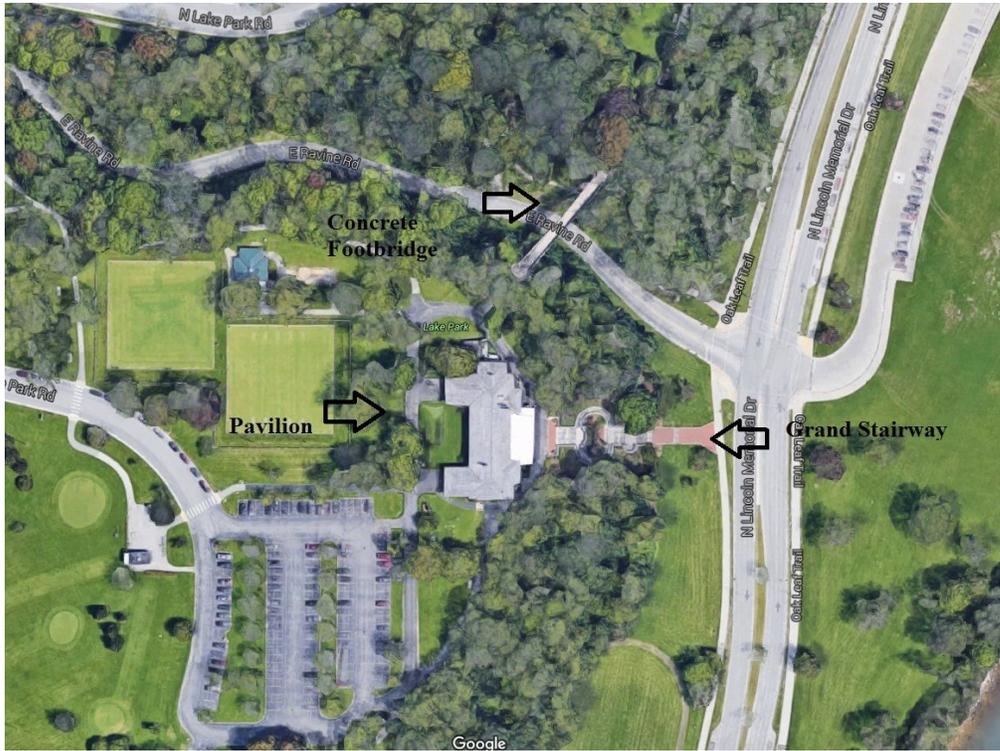


Figure 08 - The main features of the “Ferry & Clas Cluster” at Lake Park



Figure 09 - The main features of the “Ferry & Clas Cluster” at Lake Park

Ferry & Clas: A Brief Background

Perhaps two of the most influential architects in Milwaukee's rich history, Alfred C. Clas and George B. Ferry were widely involved throughout the city. They are credited for fathering a revolution in Wisconsin civic development and architectural achievement, all the while maintaining a high presence in the field of architecture. Both men played a great role in establishing a civic style to Milwaukee's landscape, building what are now over 30 National Register listed civic structures, private homes and developments.³³



Figure 10 & 11 - Alfred C. Clas (left) & George B. Ferry (right)

Both men took a great interest in the architectural and civil culture of Wisconsin, establishing the very first Wisconsin chapter of the American Institute of Architects.³⁴ Alfred

³³ National Park Service. *National Register Information System*. <http://mhp.focus.nps.gov/natreg/docs/AllData.html> (accessed July 6, 2016)

³⁴ "Alfred C. Clas, Architect, Dies" *Milwaukee Journal*, July 1942, market edition.

Clas was a prominent leader for the city and county park commissions. He served for fifteen years on the Milwaukee park board, was president of the metropolitan park commission, and in 1907 was appointed to a committee of three to make a report and recommendation for state parks. As a result this report, many of the state's finest parks were created and have been maintained to this day.³⁵

One of the first college-educated architects in Wisconsin, George Ferry was likewise invested in the progress of the community of Milwaukee. He was the last surviving member of the original joint committee of ten, along with Richard M. Hunt (noted architect of Biltmore Estate, the grounds of which were designed by Frederick Law Olmsted), who helped frame the constitution and by-laws of the present-day American Institute of Architects, bringing the first architectural association chapter to Wisconsin.³⁶ His character as a designer, builder and all around professional was held in high regard throughout the state. Upon his untimely death, Armand Koch proclaimed:

Mr. Ferry was considered by the profession an ideal architect – a man who was conscientious, extremely well educated, well read and above all, artistic...of all the architects who have practiced in Milwaukee, I believe that Mr. Ferry is the typical man to serve as a model for the rising generation of architects.³⁷

Ferry's reputation was widespread; his partner Alfred Clas made many remarks of a similar fashion: "He was one of the best designers ever in Milwaukee, an architect of exceptionally good

³⁵ John G. Gregory, *History of Milwaukee, Wisconsin Vol. III*. (Chicago and Milwaukee: S.J. Clarke Publishing Co., 1931), 188-191.

³⁶ "Noted Designer Passes Away," *Milwaukee Journal*, January 1918, market edition.

³⁷ "Noted Designer Passes Away," *Milwaukee Journal*.

judgment and of very artistic temperament...He was a rare architect, and an honorable, high-minded man.”³⁸

In 1890, George Ferry and Alfred Clas partnered to form the architecture firm Ferry & Clas, beginning a 25 year partnership as one of the most influential architect teams in Milwaukee’s history. Known as the fathers of civic development, the firm of Ferry & Clas was responsible for the vast majority of public buildings throughout the city of Milwaukee and state of Wisconsin. As stated previously, over 30 projects have been listed on the National Register of Historic Places, including the Milwaukee Public Library and Museum, the State Bank of Wisconsin, Milwaukee Hospital, the State Historical Society of Wisconsin and Lake Park.³⁹



Figure 12 - The Firm of Ferry & Clas, Wisconsin State Historical Society

³⁸ “George B. Ferry, Noted Architect, Dies Suddenly,” *Evening Wisconsin*, January 1918.

³⁹ National Park Service. *National Register Information System*.

Ferry & Clas and the Concrete Arch Bridge

Despite their multitude of large scale achievements, throughout the prolific history of Ferry & Clas there are very few examples of small-scale civil or structural designs. Though there is evidence of George Ferry developing the design for the steel concrete arch bridge in Madison in 1904 (the former Steensland bridge), the Reinforced Concrete Arch Bridge over Ravine Road, located in Frederick Law Olmsted's Nationally Registered Lake Park, is one of the only known examples of a bridge designed by both partners of the firm.⁴⁰

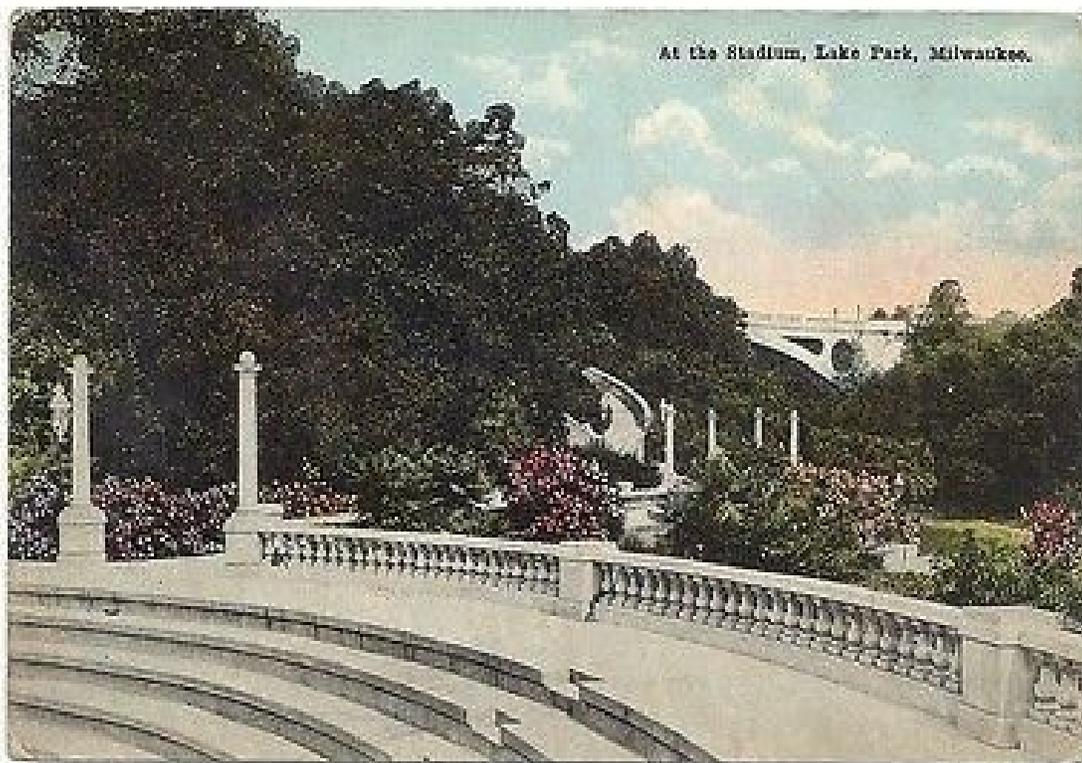


Figure 13 - Ravine Bridge as seen from Grand Staircase

The concrete arch bridge in Lake Park was designed in tandem with the plans for the Pavilion and Grand Staircase. Though constructed after the death of Frederick Law Olmsted,

⁴⁰ Clas & Clas, *Ferry & Clas; Alfred C. Clas; Clas, Shepherd and Clas; Clas & Clas, Inc., 1890-1936* (Milwaukee: Clas & Clas, 1936).

Ferry & Clas's design fulfills the ongoing practice of Olmsted of connecting a park to its wider surroundings, in this case Lake Michigan. In a letter, George Ferry once commented on bridge designs by stating:

As I see it, the bridge to secure the best results should be a circumstance of the conditions of the landscape, the same as the trees and the stream; nature did not provide a crossing, and so it has been necessary to render her that assistance. If this assumption is a correct one, it will naturally follow that the bridge should have the appearance of strength and ruggedness, together with a graceful outline and be free from architectural and decorative accessories.⁴¹

In particular, the Concrete Arch Bridge was designed as a compliment to the other four bridges in the park, now listed as a contributing factor to the National Register nomination. Ferry & Clas designed the bridge in neoclassical styling to further compliment their design for the Pavilion and Grand Staircase, the unit of three pieces finished to create a grand procession along the eastern edge of the park itself.⁴²

⁴¹ Report of the Officers of the Madison Park and Pleasure Drive Association for the year ending April 11, 1905. 28-31.

⁴² National Park Service. *National Register Information System*.

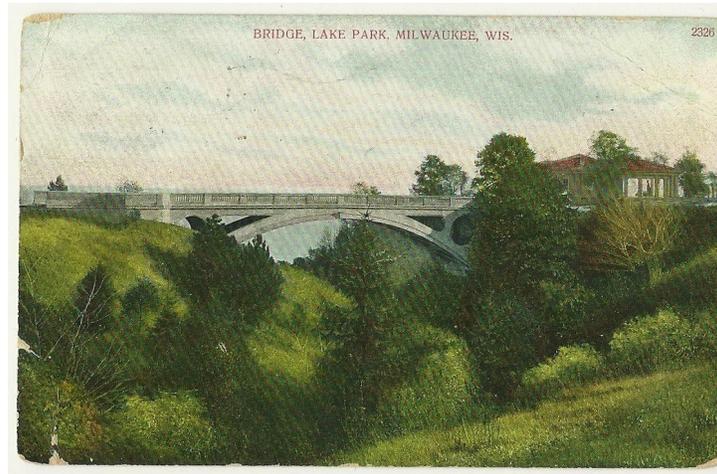


Figure 14 - Ravine Bridge as seen looking SE towards Lake Michigan. Note the Pavilion to the right, also in Neoclassical Stylings and designed by Ferry & Clas

Though the Concrete Arch Bridge does not seem to hold the same national prestige as much of Ferry & Clas's other works, such as the Pabst Mansion, it stands as a significant part of their civil repertoire. One of the only bridges in Milwaukee on record as credited to the firm, Ferry & Clas's bridge over Ravine Road stands as an example of their ability to deploy high artistry even on the smallest scale. They created a connection over a deep ravine not with a plain utilitarian structure, but with a sculpture - a piece of art that utilized the contemporary construction methods of the time while honoring the vision of Frederick Law Olmsted, tying the design into nearby structures of equal or greater significance. Over a hundred years later and the bridge still stands as a testament to the interest of Alfred Clas in beautifying the parks, the artistic designs of the firm Ferry & Clas, and as an isolated piece of simple, masterful design from a firm that created much greater architectural landmarks that fill the City of Milwaukee to this day.

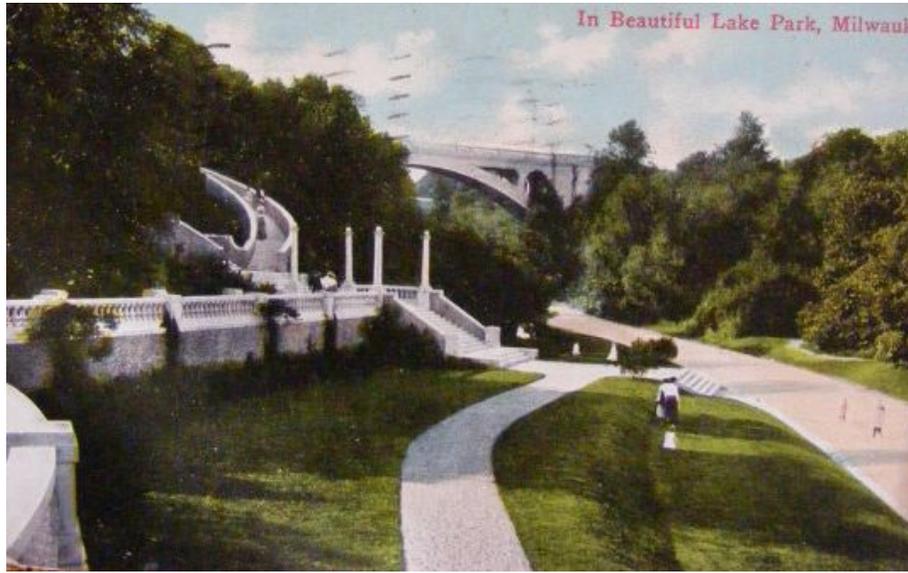


Figure 15 - View from Ravine Road & Grand Staircase, looking northwest

Integrity and authenticity: Think globally, act locally

The concepts of integrity and authenticity are two substantial criteria in the realm of historic preservation, history, and cultural heritage management world wide. The United Nations Educational, Scientific and Cultural Organization (UNESCO) defines integrity as follows:

“Integrity is a measure of the wholeness and intactness of the natural and/or cultural heritage and its attributes.”⁴³

Based on this definition, cultural heritage properties, including historic buildings, ensemble of historic buildings and city districts, and historic parks and gardens, should include all elements necessary to express their historic and cultural values, and to represent their significance.⁴⁴ It is important to remember that the value of architectural and cultural heritage is not only in its

⁴³ . Operational Guidelines For The Implementation Of The World Heritage Convention, United Nations Educational, Scientific, And Cultural Organisation Intergovernmental Committee For The Protection Of The World Cultural And Natural Heritage, Revised Edition 2015, Article 88.

⁴⁴ . Ibid.

appearance or a part of it, “but also in the integrity of all its components as a unique product of the specific building technology of its time.”⁴⁵ Maintaining the integrity of cultural heritage properties, if possible, has been strongly suggested and encouraged in many international official charters, and documents. In many of these documents, intervention in historic buildings, places and sites is not necessarily condemned. The development and progress have been undoubtedly seen as assets and necessities for public’s convenience and societies’ improvement in international pro-preservation documents; however it has been simultaneously suggested that interventions in cultural heritage properties “should be carried out in a manner which will respect and maintain the integrity of the siting, the relationship to the physical and cultural landscape, and of one structure to another.”⁴⁶ The concept of integrity particularly invites attentions to the context of the historic buildings and parks to ensure that the sites of monuments have been considered as “the object of special care in order to safeguard their integrity and ensure that they are cleared and presented in a seemly manner.”⁴⁷

In a local scale, Guidelines for Lake Park emphasizes the maintenance of the integrity of Lake Park as a whole. Related to the Concrete Footbridge under the section entitled Roadways, Paths and Bridges, it has been suggested that “Every attempt should be made to maintain the historic vehicular and pedestrian circulation system in the park including drives, paths, stairways and bridges.”⁴⁸ The importance of the integrity of Lake Park in general, and its bridges as crucial

⁴⁵ . Icomos Charter- Principles For the Analysis, Conservation and Structural Restoration of Architectural Heritage (2003) Ratified by the ICOMOS 14th General Assembly in Victoria Falls, Zimbabwe, in 2003, Principle 1.3.

⁴⁶ . Charter on The Built Vernacular Heritage, (1999) Ratified By The Icomos 12th General Assembly, In Mexico, October 1999: 2.

⁴⁷ . International Charter for the Conservation and Restoration of Monuments and Sites (The Venice Charter 1964), International Congress of Architects and Technicians of Historic Monuments, Venice, 1964, Article 14.

⁴⁸ . “Historic Designation Study Report, North Point North Historic District,” City of Milwaukee, Designated Reports, p. 12-13 (January 01, 2001):

<http://www.city.milwaukee.gov/ImageLibrary/Groups/cityHPC/DesignatedReports/vtictnf/HDNoPointNorth.pdf>

(accessed July 01, 2016). It should be mentioned that, “these guidelines are based upon those contained in Section

circulation and structural features in particular, is already embedded in its National Register of Historic Places report, which represents Lake Park's eligibility to be a nationally recognized historic place:

“Lake Park contains a high degree of integrity in spatial relationships, topography, design intent, and circulation system. Only the property boundary on the east has changed, and that is due to landfill added for Lincoln Memorial Drive during the park's period of significance. That the major landscape components have not changed may be ascertained from plans for Lake Park drawn by F. L. Olmsted & Co., later known as Olmsted, Olmsted & Eliot.”⁴⁹

Structural System

Evolution of concrete bridges

The first concrete arch bridge in the United States was a plain, unreinforced concrete footbridge with a 31-foot span, constructed in Prospect Park, Brooklyn, New York, in 1871.⁵⁰ But, this bridge did not have many successors. Despite the advantages of plasticity and good compressive strength, un-reinforced concrete has little tensile strength, and therefore its usefulness for bridge construction was limited. “The path to full exploitation of concrete as a building material lay in the development of a system of reinforcement that made use of the tensile properties of metal.”⁵¹

2-335(10) of the historic preservation ordinance. These guidelines are not intended to restrict an owner's use of his/her property, but to serve as a guide for making changes that will be sensitive to the architectural integrity of the structure and appropriate to the overall character of the district.” See: *ibid*.

⁴⁹ . Lake Park, Milwaukee County, Wisconsin, National Register of Historic Places, Continuation Sheet (United States Department of the Interior, National Park Service, 1992), Section 8, Page 1.

⁵⁰ Parsons Brinckerhoff and Engineering and Industrial Heritage, *A Context for Common Historic Bridge Types*, (National Cooperative Highway Research Program (NCHRP), 2005, 53.

⁵¹ *Ibid*

The oldest reinforced concrete bridge in the United States is the National Historic Civil Engineering Landmark Alvord Lake Bridge (1889) in San Francisco's Golden Gate Park. (Figure 16) It was one of two bridges built in San Francisco that were designed by Ernest Ransome, the father of reinforced concrete construction in the United States. The bridge was reinforced with rods or bars, which were twisted in accordance with the Ransome design, patented in 1884. This structure was the predecessor of thousands of reinforced concrete bridges built across the nation in the twentieth century.⁵²

Eventually, other engineers and designers propagated Ransome system for use in buildings. However, in the late 1890s and well into the twentieth century there were other reinforcing systems for concrete bridges that were better promoted and much more widely used in the bridge construction.



Figure 16 - Alvord Lake Bridge (1889), San Francisco, CA. Designed by Ernest Ransome. The first reinforced concrete bridge in the United States. (<http://historicbridges.org>)

⁵² Ibid

Reinforced Concrete Melan/von Emperger/Thacher Arch

In 1893, Joseph Melan, a Viennese engineer, patented a concrete reinforcing system in the United States using parallel metal I-beams curved to the form of arch and embedded in the concrete.⁵³ This was rather a conservative system, because bridges were basically steel arches encased in concrete rather than concrete arches with metal reinforcement. (Figure 17)

In 1897, Fritz von Emperger patented a system of reinforcing concrete arches with steel ribs consisting of a pair of parallel, curved, rolled I-beams, each beam placed near one surface of the concrete, with secondary members connecting the beams.⁵⁴ (Figure 18) In 1899, Edwin Thacher was granted a patent for an arch construction similar to that of von Emperger. The difference with the von Emperger patent is that in the Thacher system the ribs are independent of one another.⁵⁵

Although not all of the mentioned systems relied upon some types of the Ransome's twisted bar system, his emphasis on metal bars as a reinforcement element for concrete bridges, rather than metal beams, eventually began to predominate over the Melan/von Emperger/Thacher line of development.

This group represents the first generation of patented reinforced concrete arch bridges constructed in America. They were built in the late 1890s through the first decade of the twentieth century, before the establishment of state highway departments.

⁵³ Brinckerhoff and Engineering and Industrial Heritage, A Context for Common Historic Bridge Types, 54

⁵⁴Ibid

⁵⁵ Ibid, 55



Figure 17 - Sandy Hill Bridge, Bridge Street (1906-07), Hudson Falls, New York. An example of Melan system. (A Context for Common Historic Bridge Types, P57)



Figure 18 . Melan Arch Bridge (1893), Emma Slater Park, Lyon County, Iowa. An example of a von Emperger bridge. (A Context for Common Historic Bridge Types, P57)

Reinforced Concrete Luten Arch

Daniel Luten made a significant contribution to advance the movement from concrete-steel to reinforced concrete bridge design. His focus was on the practical combination of theory and empirical practice. “Luten diverged from the relatively conservative Melan/von Emperger/Thacher line of development that placed the importance of steel or iron as a load-bearing element in bridge arches above that of concrete, and aggressively promoted a system that stemmed more from the Monier methodology that gave primacy to concrete in load bearing, with metal as a strengthening element. And he did so with great success.”⁵⁶

During the years of his career, Luten built different types of reinforced concrete arches, including open spandrel deck arches and open spandrel through arches, however he mostly focused on building filled spandrel arches.⁵⁷

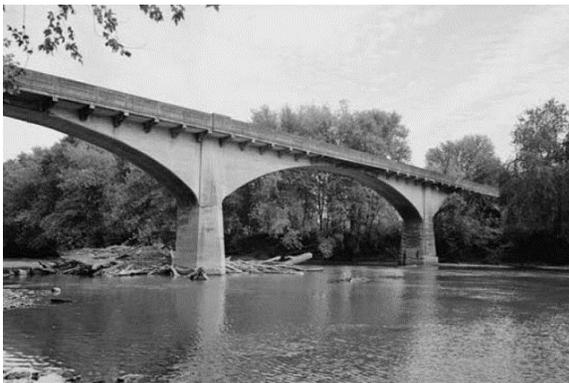


Figure 19. Andrew J. Sullivan Bridge (1928), Whitley County, Kentucky. An example of a Luten closed spandrel Arch. (A Context for Common Historic Bridge Types, P60)

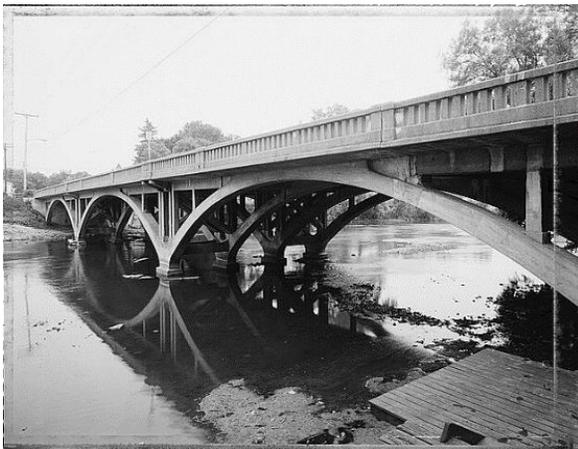


Figure 20 . Milwaukee Street Bridge (1930), Watertown, Wisconsin. An example of the Luten open-spandrel arch. (Library of Congress, Prints & Photographs Online Catalog)

⁵⁶ Brinckerhoff and Engineering and Industrial Heritage, A Context for Common Historic Bridge Types, 58

⁵⁷ Ibid

Reinforced Concrete Marsh and Rainbow (Through) Arch

The through arch, which was developed in the 1910s, is another type of reinforced concrete arch bridge that was built in considerable numbers all over the United States. The best known patented design for this type was developed by James Marsh in 1912.⁵⁸ The deck of a Marsh arch was supported by vertical connections between the crown of the arch and the floor beams, and all forces in tension are applied on the vertical members. Marsh was granted another patent in 1921 for a flexible short hanger to be used as a modification of the 1912 design, and “this modification adopts a continuance of the sliding deck concept.”⁵⁹

A technological characteristic of the Marsh arch was its ability to be fabricated without the use of falsework. All concrete arches need a temporary wooden scaffolding to support the formwork until the concrete is cured and structurally stable. Marsh arches essentially are a steel armature around which concrete is formed – a steel framework encased in concrete. Hence, the formwork for the concrete could be hung from the reinforcing armature without the need for scaffolding in the bed of the river.⁶⁰

⁵⁸ Brinckerhoff and Engineering and Industrial Heritage, A Context for Common Historic Bridge Types, 61

⁵⁹ Ibid

⁶⁰ Ibid, 62



Figure 21.. Spring Street Bridge (1916), Chippewa Falls, Wisconsin. The state's only example of a Marsh arch. (Library of Congress, Prints & Photographs Online Catalog)

Reinforced Concrete Closed Spandrel Arch

Closed spandrel arch bridges are the most basic of reinforced concrete bridge types, their appearance is similar to those of masonry arch bridges. Filled spandrel concrete arches date primarily from the earliest decades of reinforced concrete, i.e., the 1890s through the 1920s.

“This type of bridge was not built for long because engineers soon realized that considerable amount of material could be saved and a consequent reduction of weight could be achieved by eliminating the triangular section between the deck and arch. Therefore, open spandrels were born.”⁶¹

⁶¹ Brinckerhoff and Engineering and Industrial Heritage, A Context for Common Historic Bridge Types, 65



Figure 22. Elevation drawing of filled spandrel concrete arch. (A Context for Common Historic Bridge Types, P66)



Figure 23. Penns Creek Bridge (1919), Pennsylvania. An example of a reinforced closed spandrel concrete structure. (A Context for Common Historic Bridge Types, P66)

Reinforced Concrete Open Spandrel Arch

This type of bridge was first constructed in the United States about 1906, and was the dominant form for concrete bridges in 1920s and 1930s.⁶² Open spandrel concrete bridges developed, as span length of the reinforced concrete arches increased and the weight and cost of the material of the spandrel walls of the closed spandrel bridge type became excessively high.

“By eliminating these walls and the fill material inside them, not only could dead loads be reduced, but cost savings were seen in materials. In addition to economics and durability, aesthetics was another factor. Open spandrel bridges had a lightness and visual appeal not

⁶² Brinckerhoff and Engineering and Industrial Heritage, A Context for Common Historic Bridge Types, P67

possible with heavier closed spandrel bridges. This relative openness made open spandrel arch bridges more aesthetically appealing for prominent or scenic locations.”⁶³

Open spandrel construction marked engineering competency during the height of long span concrete arch bridges through the 1930s and 1940s. By the 1940s, the open spandrel concrete structure began to be superseded by the more economic pre-stressed beam and reinforced concrete girder structures.⁶⁴



Figure 24. Elevation drawing of open spandrel concrete arch, A Context for Common Historic Bridge Types, P68



Figure 25. Broad River Highway Bridge (1935), Madison County, Georgia. An example of the open spandrel concrete arch. (A Context for Common Historic Bridge Types, P68)

⁶³ Ibid

⁶⁴ Ibid

Milwaukee Context

Grand Avenue Viaduct, West Wisconsin Avenue, Milwaukee

The Grand Avenue Viaduct, Milwaukee's earliest example of a large scale concrete bridge, was the result of a national design competition which included entries from some of the most prominent architects and engineers of the day. The winning entry by The Concrete-Steel Engineering Company and by Palmer & Hornbostel of New York employed the Melan steel beam reinforcement method.

The bridge was built as an open-spandrel arch bridge in 1911 and was replaced in 1993. The bridge was of a barrel arch design and a relatively late example of the Melan system. Second place in the competition went to a more innovative ribbed arch design by the well-known concrete engineer, C.A.P. Turner. City officials envisioned the viaduct as one link in a grand boulevard that would eventually connect Milwaukee with Madison, 100 miles to the west.⁶⁵



Figure 26. Grand Ave Concrete Bridge and Driveway. (Digital Collection UWM Library)

⁶⁵ Library of Congress, <https://www.loc.gov/item/wi0193/>



Figure 27. Grand Avenue Viaduct, (Library of Congress, Prints & Photographs Online Catalog)



Figure 28. Current Bridge. Wisconsin Ave and Menomonee River

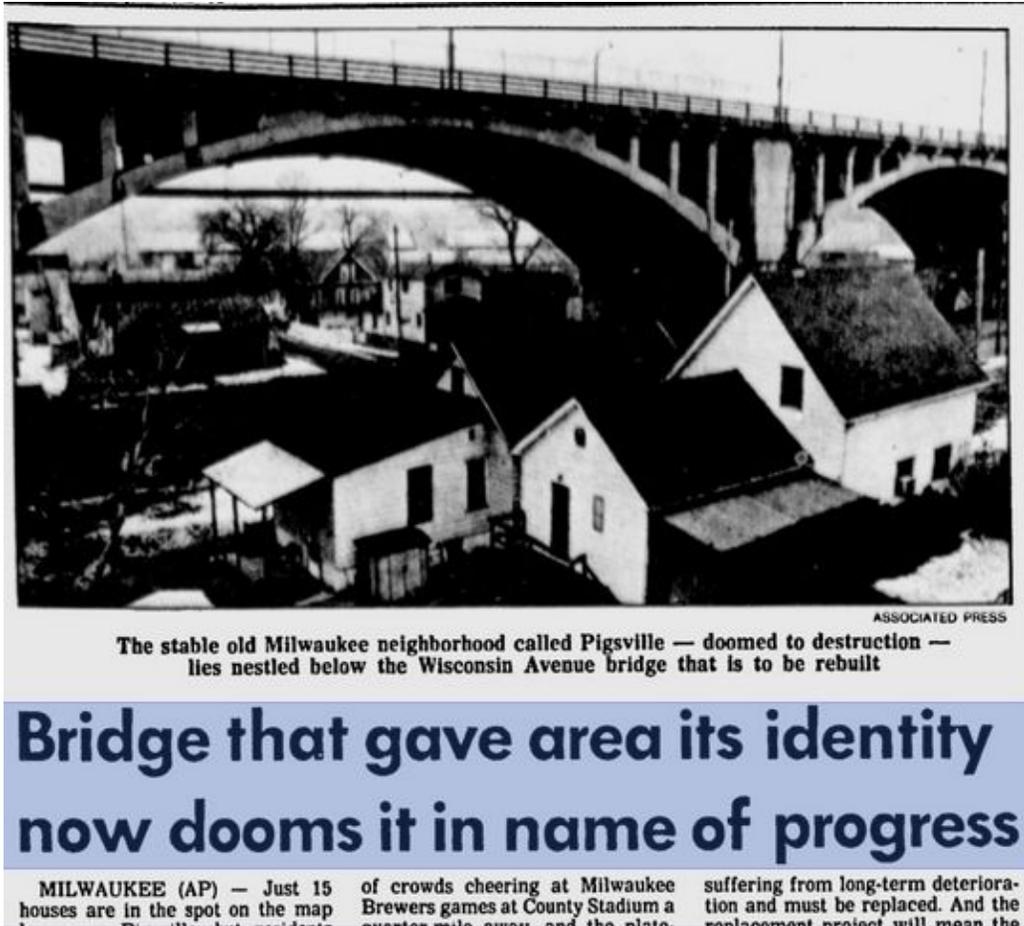


Figure 29. The Blade: Toledo, Ohio, 1990, Section A, P10

Capitol Drive Bridge

Spanning 532 feet and requiring more than 20,000 tons of concrete, the former Capitol Drive Bridge over the Milwaukee River was an imposing structure. The bridge was built in 1927.



Figure 30. The former Capitol Drive Bridge over the Milwaukee River. (Digital Collections, UWM, <http://collections.lib.uwm.edu/cdm/singleitem/collection/gfmmke/id/48/rec/1>)



Figure 31. The current Capitol Drive Bridge.

(<https://milwaukeeenotebook.com/2014/07/17/how-the-1927-capitol-drive-bridge-saved-the-milwaukee-river/>)

North Avenue Viaduct, Spanning Milwaukee River

The North Avenue Viaduct is one of Milwaukee's largest spans. Its former bridge was constructed and opened to traffic in 1921. Designed by former Superintendent of Bridges and Public Buildings for the City of Milwaukee and Marquette University's dean of the College of Engineering, J.C. Pinney, the 1,385-foot-long reinforced concrete bridge employed a complex open spandrel, ribbed arch support system. The structure originally contained detailed neoclassical ornamentation and large comfort stations at either end. However, all have since been removed.⁶⁶ ⁶⁷ On December 26, 1990, the bridge closed to traffic and demolition work began. The replacement bridge was designed and built in the early 1990s.⁶⁸

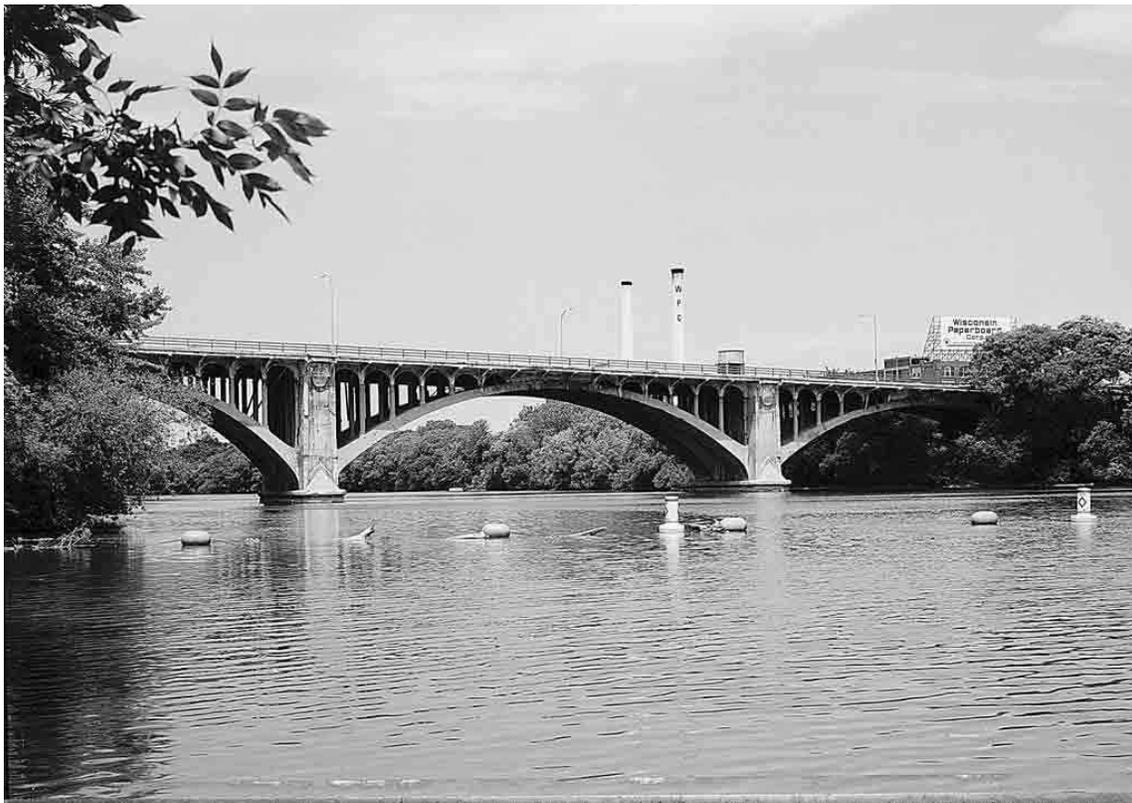


Figure 32. Former North Avenue viaduct in 1987. (Library of Congress, Prints and Photographs Division, <https://www.loc.gov/item/wi0191/>)

⁶⁶ Library of Congress, <https://www.loc.gov/item/wi0191/>

⁶⁷ milwaukeeenotebook.com (<https://milwaukeeenotebook.com/2014/05/28/north-ave-bridge/>)

⁶⁸ Ibid



Figure 33. Current North Avenue Bridge.

Highland Boulevard Viaduct

The concrete arch bridge Spanning Railroad Tracks on West Highland Boulevard was built 1909 and replaced in 2009. The two-span reinforced concrete, arch bridge was designed by the well-known engineer, Claude A.P. Turner. The Neoclassical bridge allowed the extension of Highland Boulevard, one of the city's most prominent addresses to the west. Mr. Turner, based in Minneapolis, is known for his many theories on concrete construction, including the flat slab construction method. The Highland Boulevard Viaduct was one of the earliest remaining Turner-designed bridges in the United States until its replacement.⁶⁹

⁶⁹ Library of Congress, <https://www.loc.gov/item/wi0192/>



Figure 34. Highland Boulevard Viaduct. (Library of Congress, Prints and Photographs Division, <https://www.loc.gov/item/wi0192/>)



Figure 35. Current Highland Boulevard Bridge. (bridgehunter.com, <https://bridgehunter.com/wi/milwaukee/P4008740000000/>)

Construction System

Concrete as a construction material

Structural engineering developed as a profession only with the industrial revolution and the re-invention of concrete. Throughout the late 19th and early 20th centuries, materials science and structural analysis developed at a remarkable pace. The history of reinforced concrete in the 19th century is more complex than that of iron construction, mostly because it was concentrated in a shorter period of time. “There has been no class of structures, no line of the building trades which has not been affected by reinforced concrete, and many of them have been revolutionized.”⁷⁰ Reinforced masonry spread to England and the United States in the early half of the twentieth century. In the 1860’s a number of American patents were issued for reinforced

⁷⁰ Kahn System Standards, a Handbook on Reinforced Concrete, (Trussed Concrete Steel Company, Detroit, Michigan, 1913), P5

concrete pipe, reinforced joints in brickwork, and timber-reinforced concrete walls. More valuable for structural purposes was Josef Monier's invention in 1867 of a method of reinforcing with wire mesh.⁷¹

Concrete can only work in compression, so, it will quickly fail if it is used for members subject to high bending forces, such as beams and floor slabs. If it is reinforced with iron or steel bars, however, the elastic metal will take the tensile and shearing stresses, and the rigid concrete will sustain the compressive forces. As the engineers progressively increased their knowledge of reinforcing methods, they gradually came to realize that the structural possibilities of concrete are practically unlimited. "In its reinforced form it combines the elastic properties of ferrous metals with its own initial plasticity and ultimate rigidity, an almost paradoxical union of virtues that makes it the most adaptable of all building materials. Indeed it is the supreme engineering material because it is susceptible of the most exact scientific analysis and can be cast in the most nearly organic form, in which the shape of the structural element most closely approximates the distribution of stresses within it."⁷² Thus, reinforced concrete offered the possibility of a more efficient design, since the elastic reinforcing could do the work formerly done by the additional volume of concrete.

At the turn of the century the Melan system of reinforcing was the predominant system for the construction of concrete arches, although the more efficient methods of bar reinforcing, introduced by Ransome in 1889, were beginning to gain new attention. For a decade after 1900 the design of arch bridges tended to be conservative. "By 1910, however, the main line of evolution was moving away from massive construction toward the flattened parabolic curves of

⁷¹ Carl W Condit, *American Building: Materials and Techniques from the First Colonial Settlements to the Present* (The Chicago history of American civilization). University of Chicago Press; 2nd edition (1982), P168

⁷²Ibid

narrow ribs, the slender spandrel posts, and the minimal piers that scientific reinforcing was to make possible.”⁷³

The pattern for concrete reinforcement development up to 1910 was irregular. The intention of more inspired engineers was to create forms in which the concrete and the steel might work in ways most appropriate to the properties of each material. “The problem was to design reinforcing that would most effectively absorb the tensile and shearing stresses in narrow ribs under moving loads. The Melan system worked well enough, but it was so redundant in the quantity of metal it required as to result in virtually a steel bridge with a concrete cover. The new techniques of bar reinforcing that were incorporated in the Marlborough Hotel and Terminal Station revealed greater promise than the clumsy I-beams of the Melan bridges. Although it is difficult to discover who first returned to the path initially marked by Ransome at Golden Gate Park, the Monier- Wayss and the Kahn systems of reinforcing appear to have led the way.

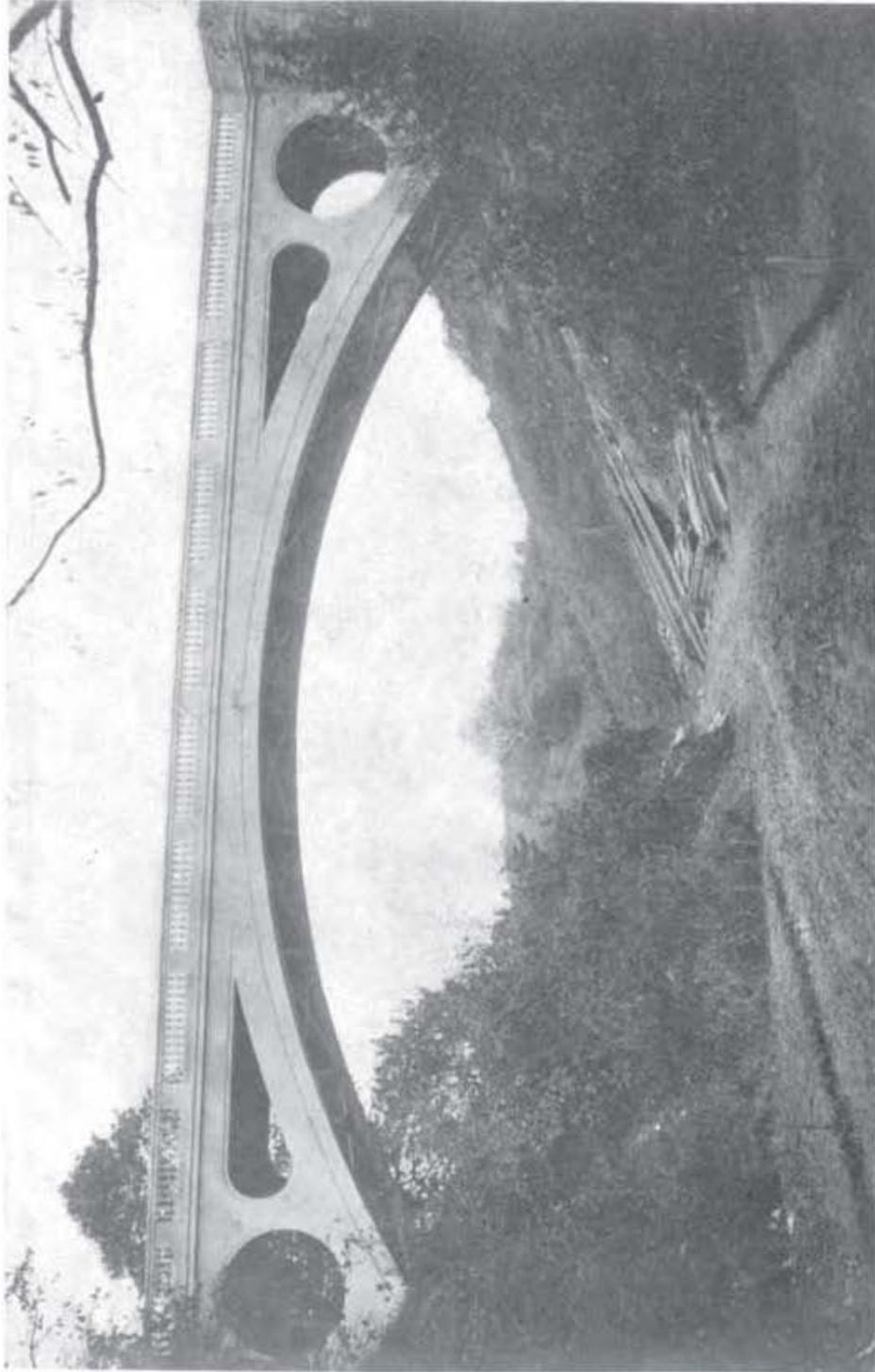
The Lake Park’s Concrete Arch Bridge in Milwaukee, designed and built in 1905 by the Newton Engineering Company, was an early example of Kahn’s trussed bars in Wisconsin. This structure was a pierced-spandrel, reinforced-concrete, rib-arch bridge. Its total length is 216.5 ft, total width is 10 ft. and it carries the pedestrian walkway. The deck rested on two parabolic ribs spanning 118 feet with an 18-ft. rise and is reinforced throughout their length with the Kahn bars. There are two reinforced-concrete ribs, 12 in. wide and 54 in. deep, placed 12 ft. apart. They are reinforced with Kahn-patent trussed bars. The ribs are connected with cross walls, struts, and lateral bracing of truscon bars. The ribs were braced by reinforced beams set between them on the transverse line and by double diagonals in the panels formed by the ribs and the beams.”⁷⁴

⁷³ Ibid, P251

⁷⁴ Carl W Condit, American Building: Materials and Techniques, P252

“The overall effect is designed to reduce structure weight. F.E. Turneure (1866-1951), dean of college of Engineering at UW-Madison, assisted Ferry & Clas, an architectural firm, with the design, and engineer R.E. Newton may also have been involved. This is among the earliest American rib-arch bridges and possibly the first concrete-arch bridge to use the Kahn trussed-bar system of reinforcement.”⁷⁵

⁷⁵ Historic Highway Bridges in Wisconsin, Vol1, Stone and Concrete Arch Bridges, Wisconsin Department of Transportation, 1986, P280



LAKE PARK BRIDGE, MILWAUKEE, WIS. NEWTON ENGINEERING CO., CONTRACTORS.
Span 118 feet, two arch ribs, forming spandrels, support roadway.

Figure 36. Lake Park Bridge, Milwaukee, Kahn Building Products Catalog 1913, Trussed Concrete Steel Co.

of four 3 in. by 1 in. Kahn bars, two at the top and two at the bottom, connected by twin buckles. These bars are connected by auxiliary reinforcement, as shown in the drawing, and in addition to them another form of patented bar was used at the top and bottom of the rib for a distance of about 36 ft. from either abutment. The pierced spandrils are also reinforced by 3 in. by 1 in. Kahn bars for the adequate support of the floor slab. The bridge was designed by the Newton Engineering Company of Milwaukee, with Professor F. E. Turneure as consulting engineer.

The Kahn System of Reinforced Concrete



The Kahn Trussed Bar is now considered the perfect reinforcement, incorporating all the advantages of the old forms with the more modern improvements and refinements.⁷⁶

“The Kahn Trussed Bar is made of a special grade of medium open-hearth steel with an elastic limit up to 42,000 pounds and an ultimate tensile strength of 70,000 pounds per square inch. The cross section, has two horizontal flanges or wings, projecting at opposite sides. These flanges are sheared up at intervals to form the rigidly connected diagonals, making a unit of main bar and shear members.”⁷⁷

⁷⁶ Kahn System Standards, P7

⁷⁷ Kahn System Standards, P6



Albert Kahn



Julius Kahn

Julius Kahn (1874–1942), civil engineer, manufacturer, and inventor, was granted a patent in 1903 for the design of Kahn Reinforced System. (Figure 23) He was Albert Kahn's younger brother, graduated with a civil engineering degree at the University of Michigan in 1899. Soon after graduation, he joined his brother's architectural firm and they work together in many different projects. His innovations and designs were the basis of all Albert Kahn's projects. Julius left the architectural firm on October 1903, and formed the Trussed Concrete Steel Company in Detroit to better exploit his new patents. The company became widely successful during the first ten years of its establishment.⁷⁸

⁷⁸ Chris Meister, Albert Kahn's Partners in Industrial Architecture, *Journal of the Society of Architectural Historians* 72, no. 1 (March 2013)

No. 736,602.

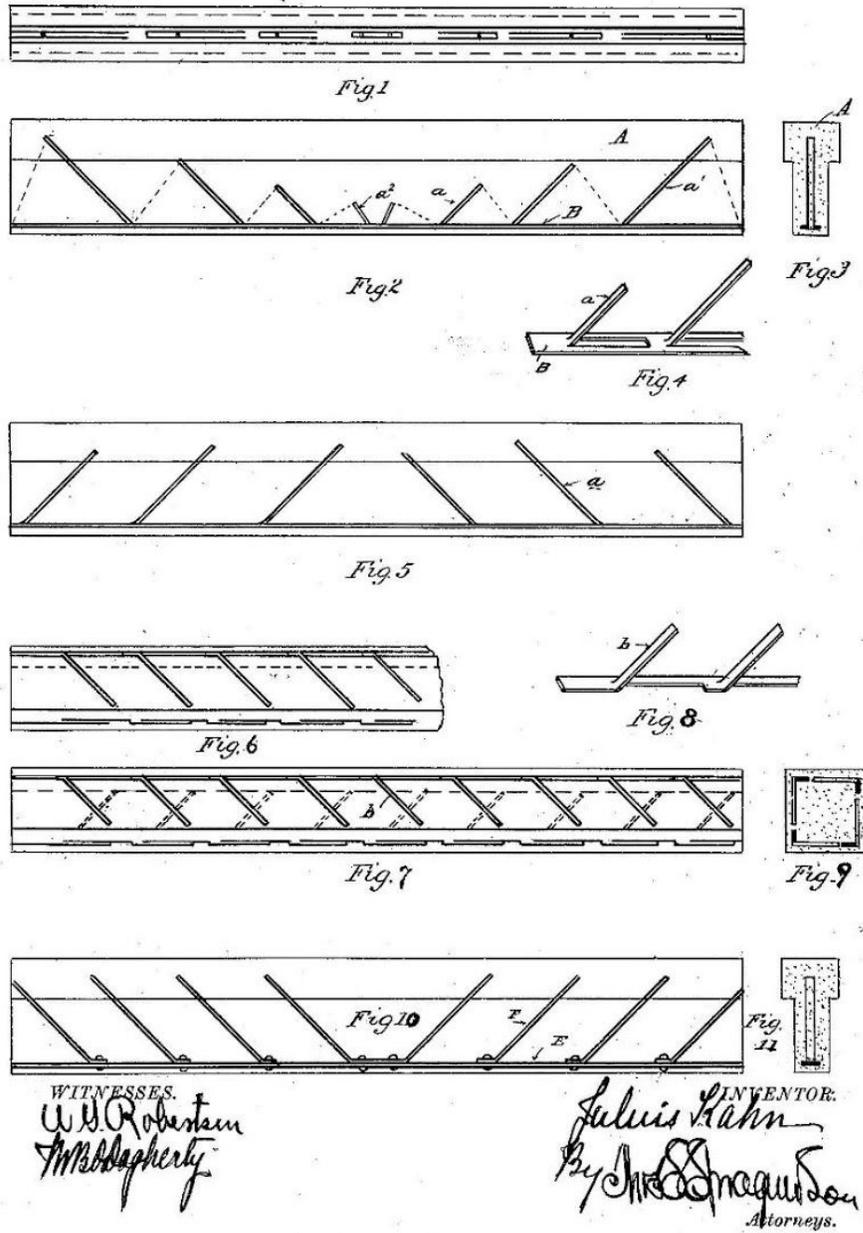
PATENTED AUG. 18, 1903.

J. KAHN.
CONCRETE AND METAL CONSTRUCTION.

APPLICATION FILED DEC. 11, 1902.

NO MODEL.

4 SHEETS—SHEET 1.



WITNESSES.
W. B. Robertson
M. S. Sweeney

INVENTOR.
Julius Kahn
By M. S. Sweeney
Attorneys.

Figure 38. Julius Kahn was granted a patent in 1903 for Kahn Trussed Bar. (From the original Kahn Bar patent (Julius Kahn, 1902. Concrete and Metal Construction. U.S. Patent 736,602)



Kahn Trussed Bar—with alternating diagonals.
Note rigidly connected shear members.

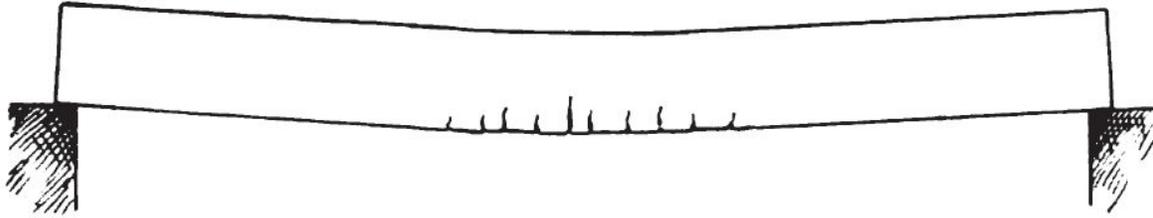
Figure 39. Kahn Trussed Bar. (Kahn System Standards, Trussed Concrete Steel Company, 1913, P6)

In the Kahn patented bar the members in the vertical plane, being made from a part of the main tension member, transmit stress from the body of the beam directly to the main steel bar. “This is the ideal reinforcement.”⁷⁹

When beams, which have been reinforced with the Kahn Trussed Bar, are tested to destruction, they fail by pulling the steel in two at the center, showing that there is absolutely no unknown weakness in the beam and that the full proportion of the strength of all the materials is developed. “It is, therefore, the only means of reinforcing concrete that makes it possible to obtain the full value of the materials used. Tests made at the University of Wisconsin, Madison, Wis., show that beams with Kahn Trussed Bars carry over 33 percent more load. Complete reports of these tests is found in Bulletin No. 197 of the University of Wisconsin. (University of Wisconsin Test Report will be gladly supplied by Trussed Concrete Steel Co.)”⁸⁰

⁷⁹ Kahn System Standards, P8

⁸⁰ Ibid



Kahn reinforcement. Method of failure when tested to destruction. Maximum load. Very gradual and ideal failure. Steel stretching in center.

Figure 40. Load test of a Kahn System beam to failure. (Kahn System Standards, Trussed Concrete Steel Company, 1913, P8)

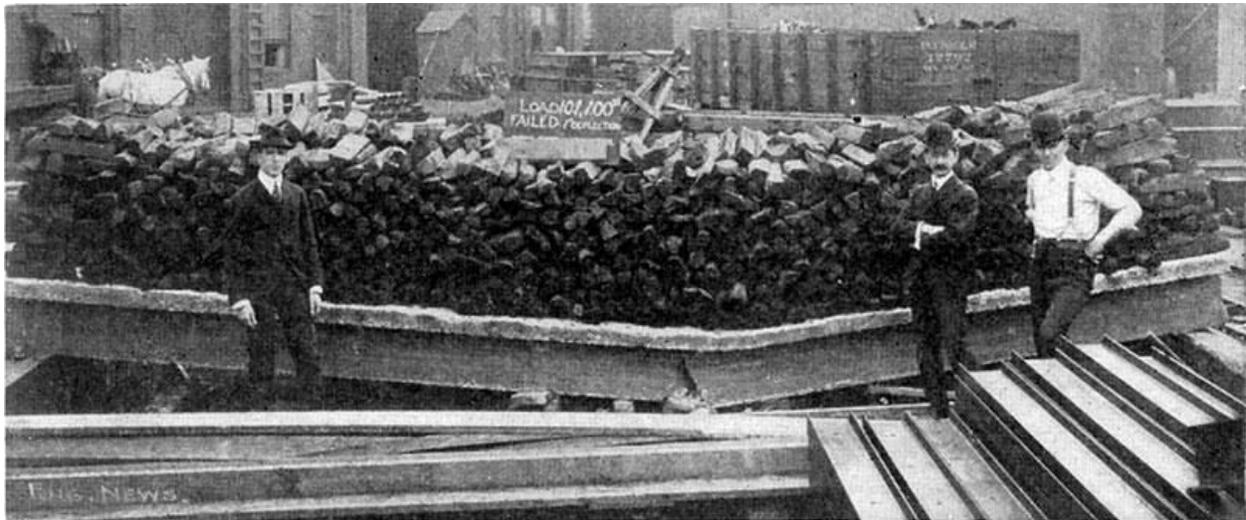


Figure 41. Load test of a Kahn System beam to failure. (The Kahn System of Reinforced Concrete, Structure Magazine, April 1913, P10)

Newton Engineering Company

Newton Engineering Timeline ⁸¹	
1903	-Newton Engineering Company founded

⁸¹ Sources:
 -Official Directory of Corporations of Milwaukee, Wisconsin.
 -Shipping: A Weekly Journal of Marine Trades, Vol4, Shipping Publishing Company, 1918, Merchant Marine
 -International Marine Engineering, Vol 24, Part1, Simmons-Boardman Publishing Company, 1919
 -Who's In Engineering, a Biographical Dictionary of Contemporaries 1922-1923
 -Pacific Marine Review, august 1918

	-George C. Newton foreman and surveyor for University of Wisconsin and Newton Engineering Co
1904	-Patent filed for design of Bascule Bridge
1906	-Contracted to build the Reinforced Concrete Arch Bridge in Lake Park -Patent issued for Ralph Newton for design of Bascule Bridge
1907	-George C. Newton senior research assistant in testing and application of Reinforced Concrete for Kahn Steel Truss Company System -George C. Newton graduates from UW-Madison with a degree in Mechanical Engineering.
1907-1917	-George C. Newton mining engineering work M.A. Hanna Co, Lake Superior Iron Mines
1908	-R. E. Newton of Newton Engineering Co, Milwaukee was in charge of the construction at the country place of Frederick Pabst, near Oconomowoc, WI. The Kahn System of reinforcement was used. ⁸²
1909	-Patent filed for Masonry Viaduct Construction
1914	-Patent issued for Ralph Newton for Masonry Viaduct Construction
1916	-George C. Newton inspired by Mr. McDougal's new shipyard in Duluth that steel ships could be built without "enormous expenditure for plant and equipment generally associated with shipyards." ⁸³ -Reinforced concrete ship construction beginning to see prominence, Newton Engineering Company begins experimental work
1917	-Ralph E. Newton president of Fabricated Ship Corp until 1919 -George C. Newton vice president and chief engineer of Fabricated Ship Corp
1918	-Newton Engineering increases capitol stock, thus purchasing all assets of Coddington Engineering Company and jointly forming the Fabricated Ship Corporation in order to receive government contracts for wartime shipbuilding for the US War Department & the Emergency Fleet Corporation

⁸² Standard Journal on Manufacture and Uses of Portland Cement, Concrete, Vol VIII, Jan 1908

⁸³ George C. Newton, A Shipyard Enterprise During The War, Thesis Submitted for The Degree Of Mechanical Engineer, University of Wisconsin, 1921

	-Patent filed for method of building reinforced concrete and Composite vessels -Patent filed for Reinforced Concrete Ship Design
1919	-First evidence of Ralph E. Newton's presidency of the Magnetic Realty Company, later known as Ralph Newton Real Estate(c.1939) -Patent issued for George and Ralph Newton for Reinforced Concrete Ship design
1921	-George C. Newton listed as residence in Iron Mountain, MI and agent for Newton Engineering -Patent issued for Ralph and George Newton for method of building reinforced-concrete and composite vessels
1922	-Ralph Newton still listed as owner of Newton Engineering Co. and president owner of Magnetic Realty Co. -Fabricated Ship Corporation listed in "The Navy of War II,1922-1947"
1941	-Fabricated Ship Corporation discloses WWI production information
1944	-Ralph Newton still listed as president of Magnetic Realty and Construction Company in gas ration citation

ALPHABETICAL LIST
OF
PATENTEES FOR THE YEAR 1921.

1,379,833; May 31; v. 286; p. 914.
Newton, George C. and R. E., Milwaukee, Wis. Building reinforced - concrete and composite vessels. No. 1,367,986; Feb. 8; v. 283; p. 273.
Newton, George F., Kansas City, Mo. Adjustable rad.

Ralph E. Newton, Graduated from U-Michigan in 1898 with a civil engineering major.

He is mentioned in University of Michigan Alumnus 1902-03, as an Associate Member Society

of Civil Engineer, who is now in the recently incorporated Newton Engineering Company of Milwaukee, Wis., which is equipping a shop for structural steel work, was at one time in the employ of the Keystone Bridge Works, and of the Wisconsin Bridge & Iron Co., and for several years was structural engineer of the Boston & Montana Mining Co.

Barge Model Built of Concrete to Test New Type of Construction

A navigable barge model has been built of concrete by the Newton Engineering Company, Milwaukee, Wis., according to designs by George C. Newton, vice-president of the company. It has a length of sixteen feet, beam of forty inches, and molded depth of twenty inches. The concrete skin is only three-quarters inch thick, being supported at intervals by fabricated concrete frames. The vessel has a draft light of seven and one-half inches and a total displacement of about two tons.

In its construction a concrete keelson and keel, together with one row of longitudinal girders midway between the keelson and bilge, were cast integral with the skin. The concrete deck extends for three feet at the bow and two feet at the stern, together with a short section in connection with a concrete bulkhead amidships. The lines of the model are those of a cargo-carrying barge for canal use.

This boat was built primarily to test out certain construction methods and features of design involved in the Newton system of concrete ship construction. Among the objects sought were the securing of a comparatively thin concrete skin, a special design of reinforcement for all torsional, reverse, and longitudinal stresses, as well as those due to the direct water and cargo pressures. The Newton system also aims primarily to secure a practical method of concrete ship construction following the existing system for fabricating steel ships, and one which will permit the use of forms for a number of times for standardized ship sections. Incidentally it is claimed that great speed can be secured with this method of ship construction, due to the use of many parts fabricated in advance.

An interesting feature of the construction of this boat was that all the methods used in its building were exactly those that will be used for large ships. No difficulty was encountered in securing very good results in pouring the three-quarter inch thickness of concrete between forms for the skin.

For testing it out under power a three and one-half horsepower Evinrude row-boat motor is used. With this motor a speed of from four to five miles per hour is secured, with practically no vibration.

Figure 42. International Marine Engineering, Vol XXIII, January to December 1918

CONCRETE MODEL BOAT

The model boat "Concrete" is the first concrete vessel built in Milwaukee, and as far as known in the first boat of moulded or poured concrete completed on the Great Lakes. It was built by the Newton Engineering Company at its Milwaukee Yards and was designed by George C. Newton, vice-president of this company.

This boat was built to test out certain construction methods involved in the Newton system of ship construction, and among the objects sought under these methods are the securing of as thin a concrete skin as possible and with special design of reinforcement. The Newton system aims to secure a practical method of concrete ship construction and one which will permit of using the forms for a number of times for standardized ship sections.

The "Concrete" has a length of sixteen feet, beam of forty inches, and moulded depth of twenty inches. The concrete skin is three-quarters of an inch thick and is supported at intervals of twelve inches by fabricated concrete frames. Its draft light is about seven and one-half inches and it has a total displacement of about two tons. There is also a concrete keelson and keel cast together with the skin, and one row of longitudinal concrete girders midway between the keelson and bilge. There is a concrete decking for three feet at the bow and for two feet at the stern, and a small section of deck amidships in connection with a concrete bulkhead. The lines are modeled on those of a cargo carrying barge, and in spite of blunt bow and stern the "Concrete" goes through the water with surprisingly little resistance.

For testing it out with power, a three and one-half horsepower Evinrude row boat motor is used. A speed of from four to five miles per hour is secured with this motor. A noticeable feature of the concrete construction is the freedom of vibration of the boat when the motor is running. Various collision tests have been made, such as ramming docks when under way, which have had no effect on the boat at all.



Schwartz furnaces at work in one of Oakland, California's largest brass foundries.

An interesting feature of the construction of this boat is the fact that all the methods used in the building of this boat were exactly the same that will be used for large ships. No difficulty was encountered in securing very good results on so thin a layer of concrete as three-quarters of an inch poured between forms. The proof of this is the water-tightness of this boat, which is never taken out of the water and which will remain perfectly dry for weeks at a time without even a trace of dampness on the inside.

The officers of the Newton Engineering Company believe that there is a big future ahead for the concrete boat construction. There are many advantages of this type of construction over steel and wood, such as the possibility of reinforcing to properly meet stresses in any direction, greater facility for making repairs, lower maintenance, freedom from rust and rot, absence of vibration, etc. Just as pleasing lines can be secured with concrete as with either of the other types of construction, and the outer surface so smooth as to offer the least frictional resistance when travelling through water.

FORM NEW ORGANIZATION

The Dravo Contracting Company, Pittsburgh, Penna., have announced they will operate their Neville Island plant as a separate department, to be known as The Dravo Contracting Company, Engineering Works Department. They have been manufacturing whirlers, steel towboats and barges for some time, and, due to very much increased business, they have found it advisable to make this change. They have contracts for 33 towboats and barges, the majority of which are for use by the United States Government. In addition to this, they have a large number of orders for tower whirlers for handling material at shipyards.

An entirely separate purchasing, accounting and engineering organization has been installed. Mr. J. D. Berg has been made vice-president of the Dravo Contracting Company in charge of the engineering works department.

Evidence of the prosperity of the working man and skilled labor under the new war-time conditions throughout the United States is revealed by the view of the situation taken by the automobile underwriter.

B. G. Wills, superintendent of the automobile department of the Fireman's Fund, in commenting upon the increased volume of automobile premiums of the company, is authority for the statement that a large percentage of the business from San Francisco brokers and business firms is on cars purchased by shipyard workers at the Union Iron Works and other plants.

Automobile salesmen are taking advantage of the sudden prosperity of this class of workmen, approaching the men when they emerge from the shops. Sales are often closed on the spot, the purchaser driving his new car home.

A. Niedermeyer, for many years connected with the Worthington Pump and Machinery Corporation, most recently as works manager of the Snow-Holly Works of that corporation at Buffalo, New York, resigned on May 31st to devote his entire time to enterprises of his own.



The model concrete ship of the Newton Engineering Company, Milwaukee.

Conclusions:

This report demonstrates that the Lake Park Ravine Bridge has significance on many levels and that these extend beyond the boundaries of Lake Park. It is set within a National Register listed district the design of which was meant to celebrate the experience of nature, it is an expression of civic architecture whose look in Milwaukee was set by architects Ferry & Clas, it is an expression of the skillful exploitation of the new medium of reinforced concrete whose lighter weight, more plastic/organic forms led to a unique design not seen on other bridges.

In the broad overview of Frederick Law Olmsted's production, Lake Park was a later commission, but designed at a time he had perfected his talents in landscape planning. It is important that Milwaukee Park Board members sought out his recognized genius to design a park at this most dramatic of sites. The series of carriage ways, meadows and plantings would be tied together by a series of bridges that would contribute to the circulation through the park. Did Olmsted design the bridges, no, but he determined where they would be located. The property had numerous ravines. Rather than fill all to make a flat landscape, Olmsted saw these as opportunities to place artful structures, bridges, to accent the views.

The location of the Lake Park Ravine Bridge, while determined in the original plans, was not built until later. It forms part of a cluster of buildings/structures, including the Pavilion, grand staircase, and now-gone bandstand, all designed by Ferry & Clas along the bluff's edge at the east side of the park. The classical styled buildings reflect what Ferry & Clas considered appropriate for a forward looking enlightened civic realm. The firm gave us timeless civic structures, and later Clas on his own tackled the planning of a formal Civic Center for Milwaukee, adopted but never quite realized in execution.

The use of concrete for building was in its infancy in the 19th century; the earliest reinforced concrete bridge was just constructed in 1889. By the 1890s many engineers were involved in experimentation in how to make the material more load bearing and yet lessen the weight of the product. Julius Kahn revolutionized the construction industry with his Kahn Method of reinforcing concrete. Rather than wire mesh, twisted bars of iron or steel, or encasing iron I-beams in concrete he devised a system of bars with angled elements that proved stronger than what his predecessors devised. The system was patented in 1903 and found itself in Milwaukee just two years later. How did this happen? Since Kahn was headquartered in Detroit how did Alfred Clas and Newton Engineering come to utilize this new technology? Overlapping ties with the University of Michigan (Julius Kahn and Ralph Newton were civil engineering students at the school) and with the University of Wisconsin to test the new system seem to indicate that the Newton's wanted to try out this system created by one of their fellow alums. Julius Kahn himself featured the Lake Park Ravine Bridge in his 1913 catalogue of building products, placing it on page one. Julius' famous brother Albert Kahn used his brother's system in the industrial buildings and revolutionized their design.