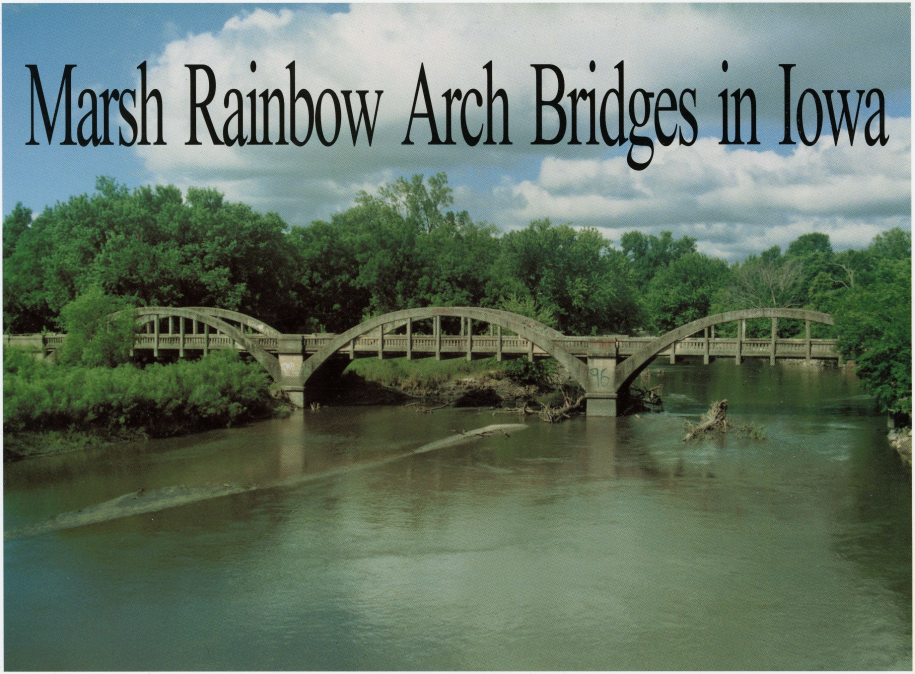
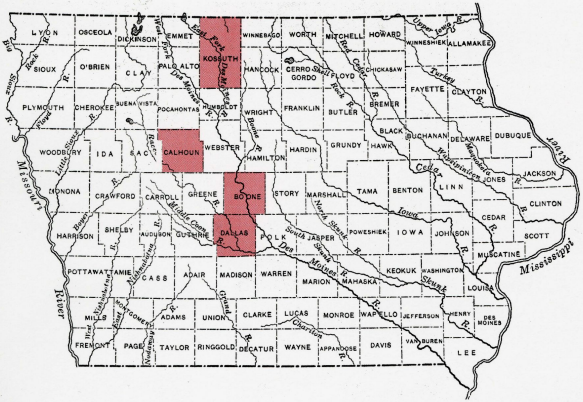
Marsh Rainbow Arch Bridges in Iowa



This booklet documents the eleven Marsh Rainbow Arch Bridges which existed in Iowa in the summer of 1996. At the time of publication nine remain. These bridges are/were located in four Iowa counties – Boone, Calhoun, Dallas, and Kossuth – as shown on the map. Their exact location is indicated in the text describing each bridge. The *Iowa Transportation Map*, issued by the Iowa Department of Transportation, will assist in finding the bridges.



1. Squaw Creek Bridge (North), Boone County: page 10.
2. Squaw Creek Bridge (South), Boone County: page 11.
3. Big Creek Bridge (North), Boone County: page 12.
4. Big Creek Bridge (South), Boone County: page 13.
5. Beaver Creek Bridge (South), Boone County: page 14.
6. Beaver Creek Bridge (Middle), Boone County: page 15.
7. Beaver Creek Bridge (North), Boone County: pages 16-17.
8. Lake City Bridge, Calhoun County: pages 18-19.
9. Rockwell City Bridge, Calhoun County: page 20.
10. Beaver Creek Bridge, Dallas County: page 21.
11. Des Moines River Bridge, Kossuth County: page 22.

(Front cover: Lake City Bridge.)

Marsh Rainbow Arch Bridges in Iowa

by James C. Hippen

Published by Boone County, Iowa 1997

Acknowledgements

Advertising card from one of the builders of Marsh designed bridges.

The publication of this booklet is part of a long process undertaken by various state and federal agencies to document a number of the historically important bridges on the Iowa highway system. The basic principle has been to document as many significant bridges as possible when it was determined that they must unavoidably be replaced. The guidance of the State Historical Society of Iowa, through the State Historic Preservation Officer (SHPO), was offered on a case-by-case basis. Then, the Iowa Department of Transportation provided for an inventory of highway bridges throughout the state, which was completed in 1993 by FRASERdesign. As a result some 200 existing bridges were declared eligible for the National Register of Historic Places. These included eleven Marsh Rainbow Arch bridges, seven of which were in Boone County. As it became necessary to replace several of these, the SHPO agreed with Boone County that the loss of some of the Rainbow Arches would be mitigated by structural testing of one bridge by Wayne Klaiber and associates of Iowa State University, by the preservation of at least one bridge, the Beaver Creek Bridge (North), and by the publication of this documentary record of the eleven bridges left in 1996 with an essay on their historical significance. In addition, the Iowa Department of Transportation sponsored a two-summer campaign (1995-1996) by the Historic American Engineering Record to document historically significant bridges, which included the Lake City Rainbow Arch.

Even a small booklet such as this leaves the author in debt to many people for the generous assistance they have provided. I wish to express my sincere appreciation to David T. Anthoney (Boone County Engineer, Boone), Decorah Public Library, Eric DeLony (Historic American Engineering Record, Washington, D.C.), Randall Faber, LeRoy Bergmann, Harry Budd, David Drake, and Judy Torgeson (Iowa Department of Transportation, Ames), Iowa State University Library (Ames), Wayne Klaiber and Chad M. Streeter (College of Engineering, Iowa State University, Ames), Joe Nolte (Masonic Library, Cedar Rapids), Chip Peterson (Decorah), Michael Schweyen (Federal Highway Administration, Ames), Lowell Soike (State Historical Society of Iowa, Des Moines), Rashelle Wagasky (State Historical Society of Iowa, Iowa City), Lawrence Williams (Luther College, Decorah), and the persons cited in the "Note on Sources and Further Reading."

Design: Crilley Design Studio (Cedar Rapids)
Printing: Anundsen Publishing Company (Decorah)

Photo Credits: inside front cover, map of Iowa, from Alison E. Aitchison, *Iowa State Geography* (1921); page 4, Mason City bridge, photographer unknown; page 5, J. B. Marsh, from Sara Mullin Baldwin, *Who's Who in Des Moines 1929*, courtesy of State Historical Society of Iowa—Iowa City; page 7, detail of Rainbow Arch at Carmi, Illinois, from Milo S. Ketchum, *Design of Highway Bridges* (1920); page 13, Marsh Engineering Co. advertisement, from *Huebinger's Automobile and Good Road Atlas of Iowa* (1912); page 17, map by Automobile Club of Southern California (ca. 1920); page 19, drawing courtesy of Historic American Engineering Record; location maps for each bridge from maps prepared by Iowa Department of Transportation (1983-84); decorative vignettes from technical literature, ca. 1910-1930; all other photographs by James C. Hippen.

James Barney Marsh

This booklet is a study of a particular type of highway bridge, once fairly common in Iowa and other states in the central part of the country, but now passing from the scene. The bridge under consideration is a reinforced-concrete through arch, known as the "Marsh Rainbow Arch." It was a patented design, built as early as 1911 and as late as the 1930s. These bridges were formed by the conjunction of a new and exciting technology—reinforced concrete—with the clear thinking of one of Iowa's leading bridge contractors and engineers.

James Barney Marsh, the designer and promoter of the rainbow arch, was born in North Lake, Wisconsin, April 12 in one of the years 1854-1856. He came to Iowa in about 1877, enrolled at the Iowa State College of Agriculture and Mechanic Arts (now Iowa State University) at Ames, and graduated with a Bachelor of Mechanical Engineering in 1882. Within a year he was located in Des Moines as contracting agent for the King Bridge Company of Cleveland, Ohio. Marsh spent the rest of his life based in Des Moines, in the bridge business. His life outside the office and drafting room was what might be expected of a successful Iowa entrepreneur. He was married, had three children, was an Episcopalian, a Republican, and an active Mason. Marsh died June 26, 1936.

The last decades of the nineteenth century were a bonanza time for sellers of bridges. Iowa counties, dominated by prosperous farmers, were eager to replace wooden bridges, or, worse yet, mere fords, with "permanent" bridges. The ideal solution, from the end of the Civil War to the early twentieth century, was the iron (and later steel) bridge. These combined the advantages of durability with economical price. (Everyone agreed that stone bridges were both more elegant and more permanent, but labor and material costs were too high.) J. B. Marsh was a particularly successful example of the iron bridge salesman. He represented King Bridge Company (1883), Kansas City Bridge and Iron Company (1886), and was made general western agent for the King Company in 1889. By 1893 he had put up numerous bridges in Iowa, including the three-mile elevated railroad structure at Sioux City and three bridges for the City of Des Moines. Others were built in Montana, South Dakota, Minnesota, Colorado, and five other western states. In 1896 Marsh began to act as an independent bridge designer and contractor, although he would have maintained his contacts with the large bridge companies as sources of materials.

One aspect of this period of building activity, strongly criticized by the engineering press, was the process of pooling. Bridge companies adjusted bids to pass the work around among friends, and added enough to the bids so that all involved received a certain profit. Marsh, as far as can be told from the record, played the game with the rest of them. A lawsuit left traces of a practice that was rarely documented. In 1896, John H. Killmar of Des Moines, formerly a bookkeeper for Marsh and the King Bridge Company, made the lowest of nine bids for building the Southwest Fifth Street bridge in Des Moines. Apparently Killmar had not been a member of what the *Des Moines Leader* (August 11, 1896) called the bridge "combine." The next lowest bidder was George E. King; J. B. Marsh was also one of the eight frustrated bidders. The spread among the top eight prices was only $1611.00, while Killmar's ninth bid was $5844.00 lower than the next lowest bid. An injunction was obtained on technical grounds to deprive Killmar of the contract by what Killmar called "a figure head plaintiff for the bridge combine." The Iowa Supreme Court, however, ruled for Killmar in 1897, although the court refused to allow questions as to whether pooling had actually occurred. Marsh and the others lost; they had, however, made their point to a competitor who carried competition too far. The bridge business was a tough game.

James Barney Marsh, the designer and promoter of the Rainbow Arch.

The arrival of a new type of bridge construction around 1900 introduced more flexibility into the situation. Reinforced concrete, first used in Iowa for a bridge at Rock Rapids in 1894, provided for the use of new and often cheaper materials, and it could be made to look like stone arches. Various systems of concrete reinforcement were developed, the most important in the early days being the Melan

system, used at Rock Rapids for the single 30' span, but gaining national prominence with the five-span (693' long) bridge at Topeka, Kansas, in 1897. Marsh undoubtedly followed these developments, and in a few years he was at the forefront of the application of reinforced concrete to major urban bridges. In 1901 he was engineer for a Melan arch bridge at Waterloo (completed in 1903), and he bid unsuccessfully on the Melan arch bridge for Sixth Avenue in Des Moines. Marsh was involved in the national discussion on this new technique; his written comment on several "concrete-steel" (i.e. reinforced concrete) girder bridges appeared in the publications of the International Engineering Congress held at St. Louis in 1904.

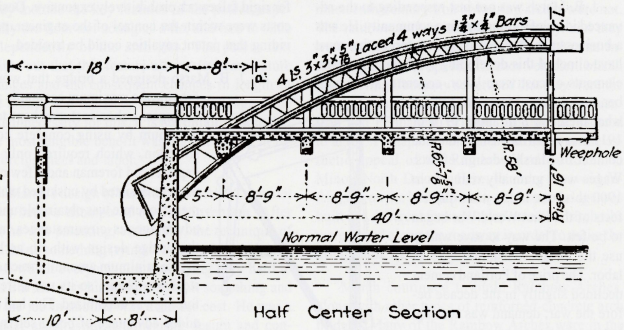
Marsh continued building bridges, both reinforced concrete and steel, through the first decade of the twentieth century. His company, the Marsh Bridge Company, provided bridges for both city and country. These ranged from a reinforced concrete wagon bridge for Greene County (1902) to an eight-span Melan arch for Second Avenue in Cedar Rapids (1906). But bridge building remained a risky enterprise. Early in 1909—perhaps as a result of the Panic of 1907—the Marsh Bridge Company was put in the hands of a receiver. The Marsh Engineering Company was the successor. But that was not all; in May 1909 a Melan arch bridge that Marsh had begun in Peoria, Illinois, in 1906 and that was still uncompleted, collapsed. *Engineering News* (May 13, 1909) awarded the dubious distinction to this disaster as "the largest recorded failure of a reinforced-concrete bridge." The principal cause was probably the unauthorized removal of some protective sheet piling at one abutment, the fault, perhaps, of a subcontractor. Regardless of these difficulties, J. B. Marsh and his new company continued to build bridges; a three-span arch at Dunkerton, Iowa, still standing, was completed in November 1909.

The building of reinforced-concrete bridges, which was becoming Marsh's specialty, faced another problem in the early twentieth century which had nothing to do with the understanding and application of a new technology. This was the manipulation of the United States patent system by persons securing patents on various arrangements of the structural parts of reinforced-concrete structures. Patents were granted on the pioneering systems, the first in the United States being on the Melan design in 1893. The Melan type bridges built by Marsh and others included the payment of royalty to the American holders of the Melan patent. This was not particularly restrictive in the early days, as the then novel "concrete-steel" method could justify itself on other grounds—such as esthetics—if not on strict economy. But the future of the reinforced-concrete bridge depended on it becoming as economical as steel. As Fritz von Emperger, who introduced the Melan system into this country at Rock Rapids, told the American Society of Civil Engineers in 1894, "if it should be possible to construct a concrete bridge for the same price as an iron bridge, it needs not a great prophet to predict a revolution in the construction of highway bridges." But the payment of patent royalties, wherever they applied to the construction of a reinforced-concrete bridge, added a cost which could not be met by efficiencies in design and construction. The trick became to include in a patent claim as many as one could of the possible arrangements of reinforcing and other elements in a concrete bridge, and then collect royalties or sue for infringement.

The undoubted master of this game was Daniel B. Luten of Indianapolis, Indiana. By the end of 1910 Luten had been granted 17 patents related to concrete bridges. Also by the end of 1910 Luten had filed ten patent infringement suits in various federal courts, including one in Iowa. (By 1913 Luten held 36 patents covering 384 claims which might be infringed.) In 1911 Marsh was himself sued by Luten for patent infringement in reinforced-concrete bridge construction. Marsh answered with a strong defense, assisted by the Iowa Highway Commission, which finally defeated Luten in 1918.

J. B. Marsh did not content himself with building infringement-safe bridges or paying royalties to Luten. He developed his own patentable design for a reinforced-concrete highway bridge, that which became known as the "Marsh Rainbow Arch." This design, the subject of this booklet, was a masterpiece of the adaptation of engineering materials to current methods and the current marketplace.

The Rainbow Arch design is more sophisticated, both structurally and economically, than has been thought in the past. (This writer and other bridge historians have tended previously to dismiss



Typical Marsh Rainbow Arch bridge.

it as a wasteful combination of structural steel and concrete.) It is the creation of an engineer and contractor, one who understood concrete and arches thoroughly, but one who was primarily concerned with building sound bridges with competitive prices. The Rainbow Arches in this booklet were built as relatively small highway bridges, with individual spans from 40' to 100'. They were designed so that they could be built without any supporting scaffolding ("falsework" or "centering") in the streambed. The construction sequence was as follows. First the concrete abutments (end supports) were built about halfway up, to provide a platform for the ends of the structural steel lattice (or "laced") girders which formed the reinforcement for the arch ribs. These steel ribs could be raised with simple derricks. Then the structural steel for the verticals and the reinforcement for the floor beams and floor slab were hung in place. When the steel was all in place, wooden forms were hung from the steel. Then concrete was poured, first to enclose the ends of the arch ribs at the abutments, and then in a continuous process from each end filling up the forms to complete the arch ribs. After several days the floor beams and slab would be poured. Finally the vertical hangers would be encased in concrete and the railings put in place. Formwork could be removed in stages, starting with the ribs, so that the bridge need never carry a dead load much greater than that for which it was designed.

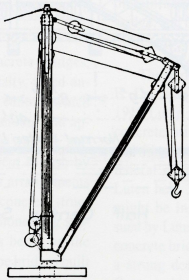
The structural steel skeleton of each rib could be calculated as a two-hinged (flexible at each end) arch and would function that way as it was loaded with the hanger and floor steel and the wooden formwork. The load was applied in such a way that the rib steel would retain its parabolic shape even as it deformed. The rib steel was, in a sense, prestressed to take part of the compressive load from the concrete. When the concrete of the abutments and ribs was set, the ribs then became hingeless and acted as a fixed arch. The structural armature of the ribs resembled that of a concrete column, and it acted in the same way since the ribs were always in compression. (Structural analysis of the ribs of one of the Rainbow Arch bridges in 1996 showed no tensile axial forces in the ribs even under live load.)

Marsh received a patent, No. 1,035,026, for this design on August 6, 1912. Two questions arise at this point. Just what features did Marsh claim, and what was the inspiration for his design? His patent "claimed as new" a reinforced-concrete bridge consisting of a pair of arches (ribs) which rose from below floor level at the abutments to above the floor in the middle. The floor was suspended from the arches by hangers. At the abutments and where the floor slab crossed the arches, arrangements were made for the floor to slide independently of the arches, so that longitudinal expansion and contraction would be transmitted between the floor slab and the arches only through the hangers, which had enough flexibility to bend slightly. This meant that the floor did not serve as a tie between the ends of the arch ribs. (Tied through – where the road goes

between the ribs – concrete arches were built widely, particularly in Ohio and Kansas, and although often called "Rainbow Arches," they were not based on the Marsh patented design.)

Turning to the second question, we may ask where this idea came from? Of course we have no record of what went on in Marsh's mind. Although often called "inventions," especially when patented, advances in technology are almost always a new synthesis of existing ideas. Marsh had before him, in the contemporary engineering press, most of the elements involved in the Rainbow Arch. Von Emperger had noted as early as 1894 that the reinforcement in the Melan system acted as "a kind of centering." Josef Melan apparently pointed out the possibilities of prestressing around 1908 in German, but we cannot know if Marsh saw it. (In fact the lattice girder ribs used by Marsh were of a type covered by Melan's patent, which expired in September 1910.) Reinforced-concrete bowstring trusses in Nashville, Tennessee, and Avranches, France, were reported in *Engineering News* in 1909. In 1911 the same journal noted a reinforced-concrete through arch bridge near Cincinnati, Ohio, which looks just like a Marsh Rainbow Arch, except that the rib ends are at the level of the roadway. This bridge, like the earlier bowstring trusses, used the lower chord to take the tension of the arches. And the reinforcement consisted of bars, not structural steel. Finally, again in *Engineering News* in 1911, was a long article offering alternatives for falsework under arches and pointing out that the cost of falsework is the main disadvantage concrete bridges have as compared to steel.

J. B. Marsh was not just responding to the advanced ideas of the engineering community. He was a businessman, and it was market forces that must have clinched this developing synthesis. The main elements of cost were labor, concrete, steel, lumber, and design. We must consider what these were in about 1910 or 1911 in order to reconstruct the true context of Marsh's design efforts. Wages were gradually rising from 1900 to about 1916, when the effects of the First World War began to be felt. The way to save was to use the cheapest feasible type of labor. The price of Portland cement declined slightly in the decade before the war; demand was soaring, but production increased to keep pace. Cement was the key to concrete costs, as rock and sand could usually be obtained locally. Much of the cost of cement was in transportation, but, luckily for Marsh, cement production began right in Iowa at Mason City where, by 1908, one company alone was producing 3,500 barrels per day. Structural steel, although times were prosperous, also declined in price, reaching a low in 1911-1912 that was half the price in 1900. *Engineering News* reported in 1910 that "the unit cost of structural steel is...less than the unit cost of proprietary [reinforcing] rods." Lumber, necessary for formwork and falsework, was rising steadily in price. Furthermore, many engineers considered that a timber shortage would soon occur, making the heavy sticks required for rigid falsework prohibitively expensive. Design costs were within the control of the engineer, providing that patent royalties could be avoided.



Hand-operated derrick which provided enough lifting power to construct a Rainbow Arch.

So J. B. Marsh designed a bridge that would provide the maximum economic advantages. Labor cost was kept to a minimum by using concrete construction, which required only an experienced foreman and a few carpenters, assisted by unskilled workmen. Concrete was obtainable under advantageous circumstances, and the bridge design with rib arches used a minimum amount. Structural steel was cheap, so its use as reinforcing was maximized. This had the added advantage of being self supporting, which reinforcing rods were not, thus eliminating the need for a heavy timber falsework. And, since the floor slab did not act as a tie for the arch ribs, a large amount of tension reinforcing was eliminated, along with four complex joints. Finally, since Marsh had his own patented design, he did not owe royalties to anyone.

Marsh worked out his patent by building test bridges. He filed his patent application November 1, 1911. One bridge was built in Blue Earth County, Minnesota, in 1911, which still survives. It appears identical to the representation in the patent drawing. The bridges covered in this booklet (built 1914-1919) are essentially the same, except that they have a more ornamental and substantial form of railing.

They include the key features of the patent, especially the floor not acting as a tie, and free to slide independently of the arch ribs. The patent text points out that this feature allows for temperature changes and the consequent changes in length of the arches and the floor. Without challenging the actual necessity for this, it is not unfair to note that the most tangible benefit was a great saving in reinforcing steel and labor.

Marsh's design of the "Rainbow Arch" may not have been a triumph of original invention. After all, he was patenting, essentially, the technique of not doing something (tying the ends of through arch ribs) which everyone else was trying very hard to do. But that was his genius: to omit something and do the job in another way at lesser cost. He was a master at adjusting engineering design and construction cost for maximum effect. He also seized on a name for his bridge—the "Rainbow Arch"—which was a public relations triumph. The name is not part of the patent, but it appears in published advertisements in 1912. The name appealed to all the deep-seated folklore about rainbows, and made an advantage of the fact that the structure was visible above the roadway.

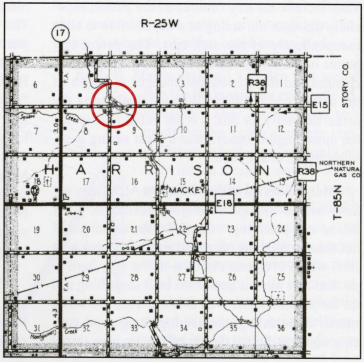
The esthetic appeal of the Rainbow Arch was always a selling point. Arches appealed to the public, and concrete was the ideal material for building arches. Marsh's design allowed even rural townships to have bridges that, in their own eyes at least, matched the elegant style of the times that adorned the river crossings in the big cities: Des Moines, Cedar Rapids, and others. And the concrete rainbow arches were acceptable while the old nineteenth-century iron bowstring arches were not. The rainbow arches looked more sturdy, and they were indeed more solid, especially under the increasing load and speed of motor vehicles. Marsh Engineering Company advertised that they were the "designers and builders of Safe, Economical, Beautiful and Permanent Bridges"; the public seemed to agree. Perhaps the ultimate testimony to the esthetic appeal of the Rainbow Arch is found in Minot, North Dakota. Here, in order to avoid infringing on the Marsh patent, a concrete bridge was built in a different form, but non-structural arch ribs were raised along the roadway in order to make the bridge look like a Rainbow Arch.

Marsh continued to build Rainbow Arches, along with other types of reinforced-concrete arch bridges. Many of the Rainbow Arches were in the plains states, including Iowa and Kansas. Probably the largest Rainbow Arch ever designed by Marsh was at Cotter, Arkansas. This bridge, finished in 1930, was built without falsework and to the same basic design as the smaller, earlier bridges shown in this booklet. It has five spans, each of 190', and has been designated a National Historic Civil Engineering Landmark by the American Society of Civil Engineers.

J. B. Marsh made other contributions to bridge engineering. In collaboration with Thomas H. MacDonald, Iowa Highway Engineer, and others, Marsh developed a set of "Minimum Specifications for Highway Bridges" completed in 1914 for the Iowa Engineering Society. Marsh secured at least two other patents (in 1914 and 1921) for concrete construction, one of which was an addition to his Rainbow Arch design. The Marsh Engineering Company provided careers for several associates in addition to the founder. His son, Frank E., organized a construction company which often got the contracts for building Marsh-designed bridges. A more famous civil engineering contractor who got his start with J. B. Marsh was Archibald ("Archie") A. Alexander, one of Iowa's most distinguished African-American citizens. Alexander was the first black to graduate as an engineer from the State University in Iowa City, in 1912. He then worked for Marsh for two years, where he became engineer in charge of bridge construction in Iowa and Minnesota before leaving to start his own construction company. Alexander was a great success and eventually built projects all over the country, and received on honorary doctorate in civil engineering from Howard University.

For over fifty years Marsh was in the bridge business, starting as a salesman for iron bridges and ending his career as an accomplished designer of concrete arches. The Rainbow Arch remained viable in his hands until the 1930s, as noted above with regard to the Cotter bridge. He also designed a number of beautiful and functional open spandrel deck arch bridges, ranging from that at Mederville, Iowa (1918), to the magnificent six-span Henley Bridge at Knoxville, Tennessee, completed in 1932. His esthetic sense and his masterful handling of the medium of reinforced concrete, which made his bridges appeal to both public taste and the public pocketbook, are evident in the Marsh Rainbow Arch bridge.

Squaw Creek Bridge (North)



1. Squaw Creek Bridge (North)
Boone County

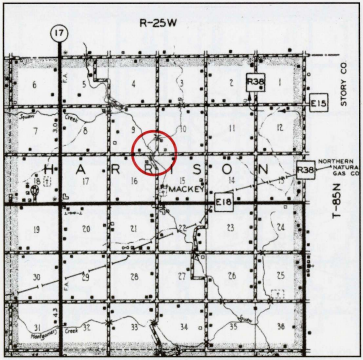
Date Built: 1918

Location: Crossing Squaw Creek, on county road between sections 4 and 9, Twp. 85N, Range 25W (Harrison Township). Bridge is in the northeast corner of Boone County, one mile east of state highway 17 and one mile south of the county line.

Span: 60 feet

Note: Concrete deck slab.

Squaw Creek Bridge (South)



2. Squaw Creek Bridge (South)
Boone County

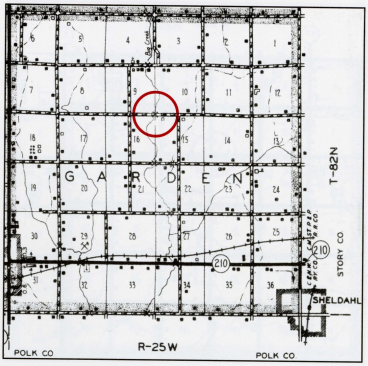
Date Built: 1917

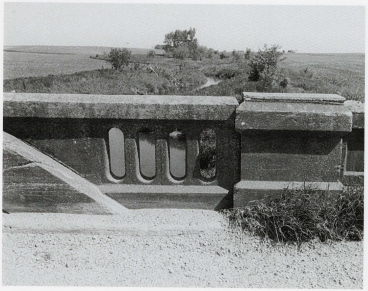
Location: Crossing Squaw Creek, on county road between sections 9 and 16, Twp. 85N, Range 25W (Harrison Township). Bridge is in the northeast corner of Boone County, two miles east of state highway 17 and two miles south of the county line.

Span: 75 feet

Note: Horizontal marks made by wooden concrete forms on outside of arch rib.

Big Creek Bridge (North)





3. Big Creek Bridge (North)
Boone County

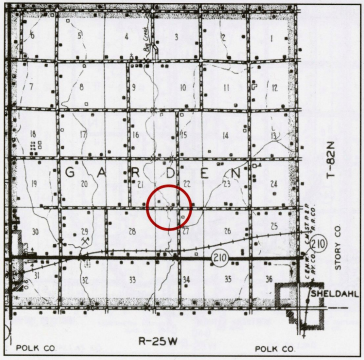
Date Built: 1916-17

Location: Crossing Big Creek, on county road between sections 9/10 and 15/16, Twp. 82N, Range 25W (Garden Township). Bridge is in the southeast corner of Boone County, three miles east of state highway 17 and three miles north of state highway 210.

Span: 40 feet

Note: Taper of the arch ribs and their anchorage in the abutment below floor level.

Big Creek Bridge (South)

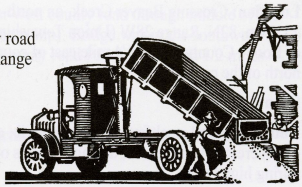


4. Big Creek Bridge (South)
Boone County

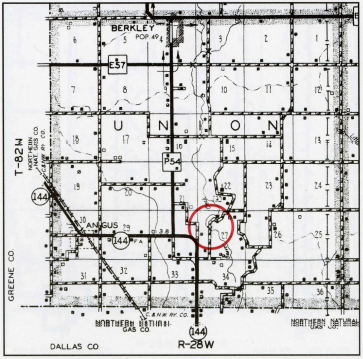
Date Built: 1917

Location: Crossing Big Creek, on county road between sections 22 and 27, Twp. 82N, Range 25W (Garden Township). Bridge is in the southeast corner of Boone County, three and 1/3 miles east of state highway 17 and one mile north of state highway 210.

Span: 50 feet



Beaver Creek Bridge (South)



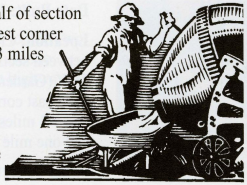
5. Beaver Creek Bridge (South)
Boone County

Date Built: 1914 (replaced, fall 1996)

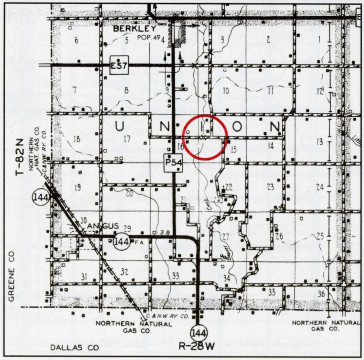
Location: Crossing Beaver Creek, on north-south county road in west half of section 27, Twp. 82N, Range 28W (Union Township). Bridge was in the southwest corner of Boone County, about 3/4 mile east of county road P54 and one and 2/3 miles north of the county line.

Span: 90 feet

Note: Structural steel frame inside arch rib, exposed due to deterioration of concrete covering; also, damage to ends of arch rib due to logs and ice during high water.



Beaver Creek Bridge (Middle)



6. Beaver Creek Bridge (Middle)
Boone County

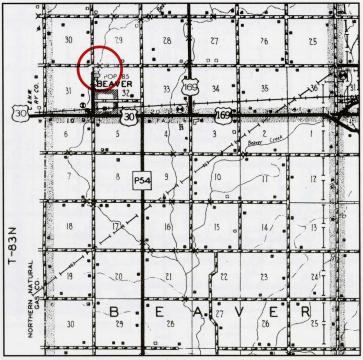
Date Built: 1919 (replaced, June 1997)

Location: Crossing Beaver Creek, on east-west county road through middle of section 15, Twp. 82N, Range 28W (Union Township). Bridge was in the southwest corner of Boone County, 3/5 mile east of county road P54 and two and 1/2 miles south of county road E57.

Span: 85 feet

Note: Very narrow clearance for farm machinery, which is a major reason for the replacement of these bridges.

Beaver Creek Bridge (North)



7. Beaver Creek Bridge (North)
Boone County

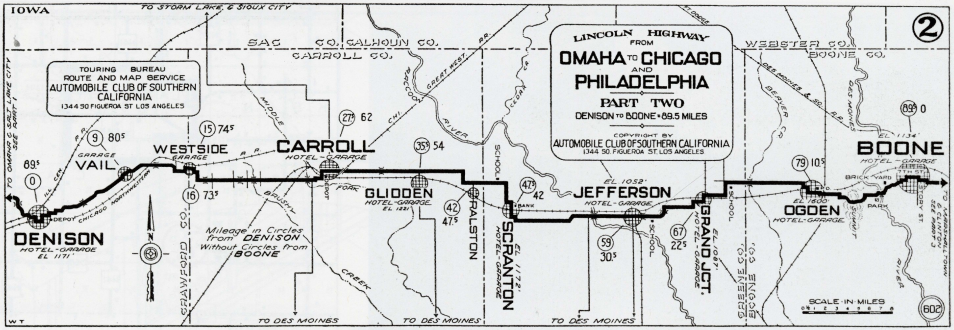
Date Built: 1919.

Location: Crossing Beaver Creek, on county road between sections 29 and 32, Twp. 84N, Range 28W (Amaqua Township). Bridge is just north of the town of Beaver near the western edge of Boone County, one mile north of U.S. highway 30 and almost two miles west of U.S. highway 169.

Span: 50 feet

Note: This bridge is on the route once designated as The Lincoln Highway.

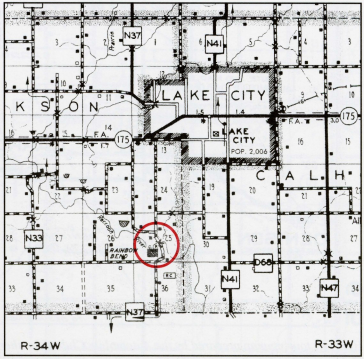
The Lincoln Highway



Highway touring map prepared by the Automobile Club of Southern California, ca. 1920. Note the Beaver Creek Bridge (North) west of Ogden, near the county line.
© Automobile Club of Southern California. Reproduced by permission.

The Lincoln Highway was organized by private initiative in 1913 to provide for a properly designated and improved transcontinental route from New York to San Francisco. Its aims were to facilitate automobile travel, promote tourism, and provide a memorial to Abraham Lincoln. It crossed Iowa from Clinton to Council Bluffs, following the route of the Chicago & North Western (now Union Pacific) railroad. It passed through Boone County utilizing existing county roads. When the northern Beaver Creek Rainbow Arch (bridge no. 7) was built north of the town of Beaver in 1919, it allowed the Lincoln Highway to be routed west out of Ogden north of the railroad, thus eliminating several dangerous railroad crossings. The highway remained on this route for a few years in the early 1920s until it was again moved south of the railroad and became U.S. highway 30.

Lake City Bridge



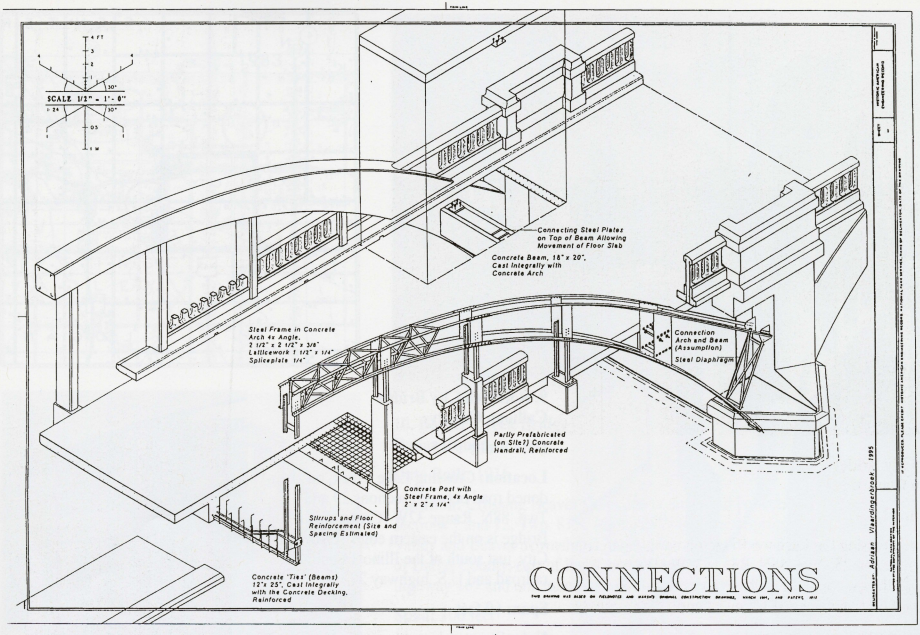
8. Lake City Bridge
Calhoun County

Date Built: 1914

Location: Crossing the Raccoon River, on north-south county road in middle of section 25, Twp. 86N, Range 34W (Jackson Township). Bridge is in the southwest corner of Calhoun County, one and 1/2 miles west of county road N41 and one and 1/2 miles north of the county line.

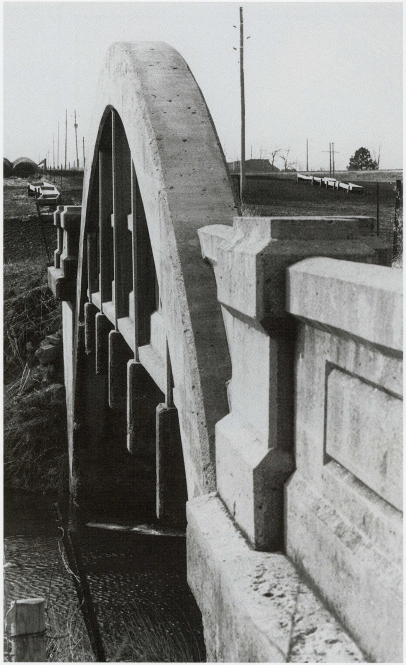
Span: Three spans of 80 feet each.

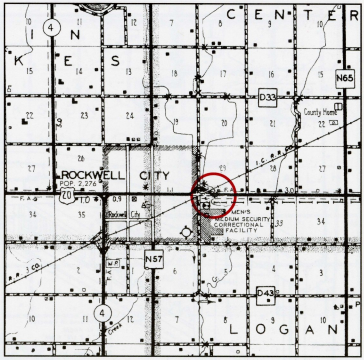
Note: This is the only multi-span Rainbow Arch remaining in Iowa.



This detail drawing of the Lake City Bridge was made as part of the Iowa Historic Bridges Recording Project during the summer of 1995 by the Historic American Engineering Record. The project was sponsored by the Iowa Department of Transportation. The extension into the abutment of the bottom members of the rib was probably not done.

Rockwell City Bridge





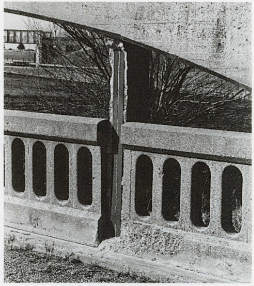
9. Rockwell City Bridge
Calhoun County

Date Built: 1915

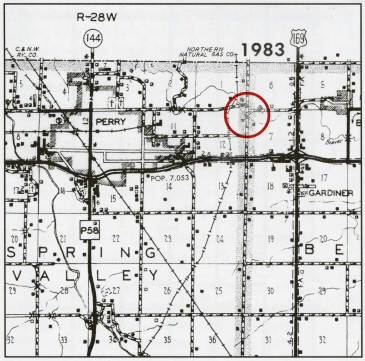
Location: Crossing Lake Creek, on abandoned road between sections 29 and 32, Twp. 88N, Range 32W (Center Township). Bridge is on the eastern edge of Rockwell City, just south of the Illinois Central railroad and U.S. highway 20.

Span: 60 feet

Note: Structural steel in vertical hangers.



Beaver Creek Bridge



10. Beaver Creek Bridge
Dallas County

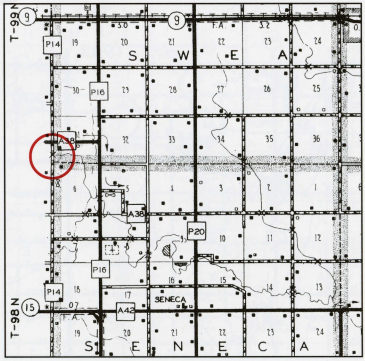
Date Built: 1916

Location: Crossing Beaver Creek, on county road between sections 7 and 12, Twp. 81N, Range 28W (between Spring Valley and Beaver Townships). Bridge is in the northern part of Dallas County, east of Perry, one mile west of U.S. highway 169 and one mile north of state highway 141.

Span: 100 feet

Note: Scratches on inside of arch ribs caused by farm machinery due to close clearance.

Des Moines River Bridge

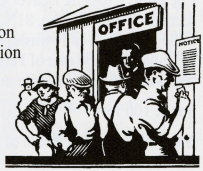


11. Des Moines River Bridge
Kossuth County

Date Built: 1916

Location: Crossing East Fork of the Des Moines River, on county road along western county line, west edge of section 31, Twp. 99N, Range 30W (Swea Township). Bridge is on western edge of Kossuth County, two and 3/4 miles south of state highway 9 and one mile west of county road P16.

Span: 100 feet



A Note on Sources and Further Reading

Limitations of space preclude a complete bibliography, but titles have been included for those who wish to go deeper into bridge history (section I.) and to provide references to sources that might be difficult to find (sections II. and III.).

I. Background reading on the history of bridges:

Condit, Carl. *American Building*. Chicago: University of Chicago Press, 1968.

DeLony, Eric. *Landmark American Bridges*. New York: American Society of Civil Engineers, 1993.

Jackson, Donald C. *Great American Bridges and Dams*. Washington: Preservation Press, 1988.

II. Papers and reports on Marsh arch bridges and a few others. Unpublished reports can usually be found at the state historic preservation office or the agency for whom the report was prepared. HAER is the Historic American Engineering Record, National Park Service, Department of the Interior, Washington, D.C.

Bennett, Lola, and Corinne Smith. Cotter Bridge (R. M. Ruthven Bridge). HAER No. AR-15, 1988. [Cotter, Arkansas]

Cook, David L., and Randall Faber. Marsh Rainbow Arch Bridge. HAER No. IA-4, 1980. [Newton, Iowa]

Fraser, Clayton B. Rock Valley Bridge. HAER No. IA-29, 1987. [Marshalltown, Iowa]

FRASERdesign. Iowa Historic Bridge Inventory. Prepared for Iowa Department of Transportation, 1993.

Gimmestad, Dennis. Marsh Concrete Rainbow Arch Bridge, Blue Earth County. Minnesota Historic Properties Inventory Form, 1980.

Harrison, Dawn M., and Dario Gasparini. Reinforced Concrete Arch Bridges. Prepared as part of HAER, Iowa Historic Bridges Recording Project II, 1996.

Jochims, Larry. "Rainbow Arch Bridges Add Variety to Kansas Highways." *Kansas Preservation* 2 (September-October 1980): 1-3.

_____. "Marsh Arch Bridges—A Part of Kansas' Transportation History." *Kansas Preservation* 5 (March-April 1983): 1-5.

Landler, Juliet. Lake City Rainbow Bridge. HAER No. IA-46, 1995.

Ohio Department of Transportation. *Ohio Historic Bridge Inventory*, 1983.

_____. *Second Ohio Historic Bridge Inventory*, 1990.

_____. *Concrete Arch Supplement to the Ohio Historic Bridge Inventory*, 1994.

Builder's plate on Rockwell City Bridge. The patent date is apparently incorrect.

Vidutis, Richard, and James Hippen. Mederville Bridge. HAER No. IA-79, 1996.

Wynes, Charles E. "'Alexander the Great,' Bridge Builder." *The Palimpsest* 66 (May/June 1985): 78-86.

III. Articles in the engineering press which were available to J. B. Marsh and which provide elements of the synthesis which resulted in his patent.

"The Application of Spiral Hooping to a French Concrete Bridge." *Engineering News* 61 (April 22, 1909): 438. Editorial comment, 440.

Aylett, Philip. "A Suspended Flexible Centering for Masonry Arches as Used on the Chickahominy River Bridge, Virginia." *Engineering News* 65 (June 15, 1911): 717-722.

Creighton, W. F. "Concrete Work on Sparkman St. Bridge, Nashville, Tenn." *Engineering News* 61 (February 25, 1909): 199-201.

Emperger, Fritz von. "The Development and Recent Improvement of Concrete-Iron Highway Bridges." *American Society of Civil Engineers Transactions* 31 (April 1894): 438-488.

_____. "Concrete-Steel Bridges." *Publications of the International Engineering Congress, St. Louis, 1904, in ASCE Transactions* 54, part E (1905): 523-544. [J. B. Marsh's contribution can be found at pages 580-581 of the same publication.]

Gast, E. A. "A Through Reinforced-Concrete Bridge." *Engineering News* 65 (February 16, 1911): 196-197. Editorial comment, 199.

Melan, Josef. *Plain and Reinforced Concrete Arches*. Translated by D. B. Steinman. New York: Wiley, 1915. [This book is a translation of the second edition, 1912, of Melan's article in F. von Emperger's *Handbuch für Eisenbetonbau*, first published Berlin, 1908.]

A tractor just clears a Boone County arch – Beaver Creek Bridge (North), Boone County