HAER
IOWA
77-MONT.V,
1-

HISTORIC AMERICAN ENGINEERING RECORD

McDOWELL BRIDGE
(Skunk River Bridge)

HAER No. IA-72

Location:	Spanning North Skunk River at abandoned county road ; 8.9 miles southwest of Montezuma, Poweshiek County, Iowa UTM: 15.527070.4596380 USGS: Searsboro, Iowa quadrangle (7.5 minute series, 1979)
Date of Construction:	1883
Designer/Contractor:	King Iron Bridge and Manufacturing Company, Cleveland OH
Present Owner:	Poweshiek County Conservation Board
Present Use:	Roadway bridge (closed)
Significance:	The McDowell bridge was built in 1883,towards the end of the heyday of the use of bowstring arch-trusses. In the 1860s and 1870s bowstring arch-trusses were used extensively because of their great structural efficiency. The 1880s saw a shift towards the pin-connected trusses which offered greater lateral stability. The McDowell bridge is an excellent example of the work of the King Iron Bridge and Manufacturing Company, a major bridge fabricator who erected thousands of these type of bridges throughout the nation, including hundreds in Iowa. This bridge is also of interest for its use of the King Company's patented end support piers.
Historian:	Geoffrey H. Goldberg, engineer, August 1995
Project Information:	This document was prepared as part of the Iowa Historic Bridges Recording Project performed during the summer of 1995 by the Historic American Engineering Record (HAER). The project was sponsored by the Iowa Department of Transportation (IDOT). Preliminary research on this bridge was performed by Clayton B. Fraser of Fraserdesign, Loveland, CO.

The period during which iron bowstring arch bridges proliferated in Iowa is an interesting episode in the history of bridges. Following the exceptional growth in Iowa's population in the wake of its admission to the Union in 1846, there was a need for a basic transportation infrastructure within the fledgling state. Now that Iowa's boundaries had been defined and the Native Americans had been displaced there was a plethora of land to be developed. State and local officials encouraged settlers to the new state. Settlers came from the eastern states and from Europe - Germany was the greatest supplier of these early immigrants, followed by Ireland, England, Scotland, and Scandinavia. They wrote home telling of the rich soil and readily available land, encouraging others to follow. During the 1850s Iowa's population more than tripled.[1]

The development of the state's agricultural industry was highly successful. By 1860 Iowa was the tenth largest producer of grain in the nation.[2] Major markets for Iowa's agricultural products were Chicago and the large eastern cities as well as the overseas markets of England, Scotland, and Ireland. This development could only be sustained if a sufficient transportation infrastructure were present. Where the transportation systems were most developed, hogs were raised. Where populations were less dense and transportation systems undeveloped, cattle were raised.[3]

The need to reach large out-of-state markets was met by the development of the railroad system in the state. This coincided with out-of-state interests to have the key hub of Chicago linked with the Mississippi and Missouri rivers which define Iowa's eastern and western boundaries. In 1856 the United States Congress granted land to establish four railroads across the

---

[1]Leland L. Sage, *History of Iowa,* Ames, IA: Iowa State University Press, 1974, p. 92. In 1850 the population was 192,214. By 1860 the population had risen dramatically to 674,913.

[2]Thompson, William H., *Transportation in Iowa: A Historical Summary*. Ames, IA: Iowa Department of Transportation, 1989, p.43. The major grains produced were(in order of decreasing significance): corn, wheat, oats, buckwheat, barley, and rye.

[3]Thompson, p.43.

state. By 1866 rails had made it to Des Moines; one year later Council Bluffs on the Missouri River was reached.[4]

Although the railway system was vital to the economic development of the state, the intense concentration on the rail system did little to help development of the road systems. Roads were crude affairs. There was very little grading, and improvements were limited to filling in low spots to keep the roads above the water level during the rainy season.[5] Although little effort was put into developing road surfaces, the need to ford streams, rivers, and gullies was given great attention, leading to the need for a great number of bridges.

The responsibility for roads and bridges was for the most part strictly local. Initially townships, later the counties, took on the burden of developing and maintaining the roads. Typically, the cost of building a bridge would be funded by the county paying a large fraction (often 2/3) and the balance was paid by subscribers - that is, the adjacent landowners, merchants, and farmers who held a major stake in the bridge being built.

The early bridges were made of wood and had very limited life expectancy. By the time that Iowa was admitted to the Union iron bridge technology was reaching a critical mass. The birth of iron bridges occurred in Britain following the development of industrial processes for the smelting of iron. The first iron bridge was built by Abraham Darby III in 1779 in Coalbrookdale, England. This was a cast-iron arch design which exploited the compressive strength of cast iron. Cast iron presented the early bridge designers with a problem, however, because it offered very poor strength when loaded in tension. In 1783 Henry Cort patented a method for shaping wrought-iron sections using rollers.[6] The following year he patented the puddling process for the conversion of cast iron to wrought iron. For the first time, wrought iron, capable of accepting compression *and* tension, was available in sufficient quantities in convenient shapes.

The first iron bridge in the United States was built in 1836 by Captain Richard Delafield of the Army Corps of Engineers in Brownsville, Pennsylvania. A decade latter, at the time of the

---

[4]Sage, p.112.

[5]Thompson, p.69.

[6]Emory L. Kemp, "The Introduction of Cast and Wrought Iron in Bridge Building," *IA: The Journal of the Society for Industrial Archaeology* 19,no.2(1993): 5-16 presents an excellent discussion of the early use of iron in bridge building.

creation of the state of Iowa, the railroads were beginning to build iron trusses. In 1841 Squire Whipple, of upstate New York, received a patent for a bowstring arch-truss.[7] This design consisted of a cast-iron arch with a wrought-iron lower chord, as well as diagonals and vertical rods of wrought iron. Many of these bridges were built in New York state, particularly for crossing the Erie Canal. Whipple's bowstring inspired many copies. In 1857 Thomas Moseley patented a bowstring design which used arches that were "built up of wrought plate iron...to give the whole arch transversely the form and strength of an arch, and to admit of very long spans without excessive weight, presenting at once the combined features of extraordinary strength and lightness."[8] The idea of building-up the upper chord was the key. Other patents would follow - all using built-up sections of one type or another.

The bowstring arch was the preferred design because of its efficient use of material. The relatively light wrought-iron members were delivered to the site and assembled by iron worders according to the shop drawings. Moseley created the Moseley Bridge Company in Cincinnati and in 1861 one of his agents, Zenas King (along with a metalworker Peter Frees) took out his own patent for a bowstring bridge.[9] The company King created - the King Iron Bridge and Manufacturing Company of Cleveland, became a powerhouse in the iron bridge building industry. During the 1860s and 1870s they built hundreds of bowstring bridges throughout the nation. Other large bridge companies got in the act, including David Hammond's Wrought Iron Bridge Company of Canton, Ohio; and Joseph Davenport's Massillon Bridge Company of Massillon, Ohio. During this brief period thousands of bowstring arch bridges were built, spanning rivers, streams and gullies throughout the nation.

As intense as the bowstring building activity was, the bloom was short lived. Although the bowstring form is efficient in its use of material, it did suffer from some major problems. Because the upper chord members were bent to take the shape of the arch, each span length required a unique curve. This was a distinct manufacturability problem. The competing Pratt design, patented in 1844 by Thomas and Caleb Pratt, had straight upper and lower chords. Bridges of various spans could be accommodated by adding additional panels or simply selecting the appropriate element lengths, while the bowstring, with its fixed curved arch, could

---

[7]Letters Patent No. 2064, April 24, 1841.

[8]Letters Patent No. 16,572, February 3, 1857.

[9]Letters Patent No. 33,384, October 1, 1861.

not. Probably, an even greater problem was the perception that the bridges were unsafe. The feelings of one Iowa state highway engineer from 1914 is indicative: "The bridges are light and flimsy. Everything about them is conducive to extreme and excessive vibration. Every man who has crossed one has noticed the trembling of the structure and the rattle of the rods and members of the bridge."[10]

The McDowell Bridge is a typical example of the bowstring bridges built by the King Iron Bridge and Manufacturing Company. King fabricated his upper chords in the form of a wrought rectangular iron tube, building upon the tubular bowstring design of Moseley for whom King had previously worked.[11] Before joining Moseley's company in 1858 King had developed his business acumen during the previous years that he spent in Milan, Ohio where he had set up as a carpenter for eight years and later as a clothing merchant for another eight years.[12] In 1856 King began a two year stint as a salesman for Hedges, Frees & Company of Cincinnati, who manufactured agricultural machinery, including an "agricultural steam boiler." This exposed King to boiler-plate manufacturing technology which played an important role in the fabrication of King's tubular arch bridges.[13]

In 1861 Moseley moved his operation to Boston, and King along with Peter Frees established his own company. The King and Frees bowstring tube was fabricated from parallel boiler plates forming the front and back sides of the tube and channel stock forming the upper and lower surfaces. In 1864 King and Frees parted company. Shortly thereafter King hired a trained civil engineer, Cyrus G. Force who simplified the design of King's bowstring,

---

[10] "Treacherous Danger in Bow String Bridge," *Iowa Highway Commission Service Bulletin*. August, 1914, p.7.

[11] David A. Simmons, "Bridges and Boilers: Americans Discover the Wrought-Iron Tubular Bowstring Bridge." *IA: The Journal of the Society for Industrial Archaeology* 19,no.2(1993): 63-76. Discusses and compares the tubular bowstring designs and manufacturing operations of Moseley and King.

[12] Simmons, David A. "Bridge Building on a National Scale: The King Iron Bridge and Manufacturing Company." *IA: The Journal of the Society for Industrial Archaeology* 15,no.2(1989): 23-39. gives the definitive history of King's Company. Much of the history of the King Company presented here is drawn from this source.

[13] Simmons, "Bridges and Boilers," p.70.

making manufacturability improvements which made the bridges more economical.[14] Moseley's move to Boston left the important bridge market of Ohio wide open for King who was quick to exploit the opportunity. King sold a great number of bowstrings in Ohio, and it has been suggested that "the efforts of other companies to meet King's competition undoubtedly promoted the popularity of the bowstring in Ohio during the 1860s and 1870s."[15] Once King and the other major bridge companies of Ohio had developed the bowstring form to meet the Ohio market, it was natural that they would employ this form elsewhere. Because the need for bridges was so great in Iowa during this period it is not surprising that so many bowstrings were built in Iowa.

The McDowell Bridge is an excellent example of King' bowstring design. In June of 1883 the Poweshiek County Board of Supervisor's ordered the decaying bridge over the North Skunk River, near the residence of John McDowell, closed. The road was barricaded and the floor boards were removed at each end of the bridge to prevent passage.[16] That August the county issued a contract to William Cricket, an agent for the Pennsylvania Iron Bridge Works for an iron bridge to replace the old McDowell Bridge. Soon after issuing the contract to Crickett, the county became aware that Crickett was no longer affiliated with the bridge company.[17] The supervisors began corresponding directly with the Pennsylvania firm, who agreed to deliver the bridge within 60 days for $2,500, but the board wanted an earlier completion to the whole affair. Pennsylvania Iron Bridge agreed to transfer the contract to the King Iron Bridge Company who assumed the contract in November. By the end of the year King had completed the bridge.

---

[14]Simmons, "Bridge Building on a National Scale," p.26. In 1867 King revised his patent changing from the varying cross-section of the original patent to one of a uniform cross-section.

[15]Simmons, "Bridge Building on a National Scale," p.26 - p.27.

[16]Poweshiek County Board of Supervisors' Journal, Book E: page 161 (7 June 1883), Poweshiek County Courthouse, Montezuma, IA.

[17]Clayton B. Fraser, *Iowa Historic Bridge Inventory,* v.4: POWE05, McDowell Bridge. Loveland CO: FRASERdesign, produced for the Iowa Department of Transportation, April 1993. presents the account of Crickett's involvement.

The 120 foot span bowstring was constructed of King's patented tubular arch which was built-up from channels forming the upper and lower surfaces and continuous plates making up the side covers. These plates were riveted to the channels in the shop, with the exception of intervals where bolts were installed in the field to attach splice plates. The bottom chords were made of paired rectangular eyebars. The verticals were constructed of star irons and the diagonals were made from round rod. Lateral stability was provided by a set of lateral struts composed of round tubes. Additional lateral stability was provided by outriders which ran from the ends of lateral struts, extending beyond the vertical plane of the trusses, to the upper chords. The upper and lower chords are joined at either end at the bridge with a cast-iron shoe. Whereas the lower chord, a rolled flat iron bar that tapers at each end into a threaded cylindrical bar, extends through the cast-iron shoe and is secured by hexagonal nuts, the upper chord frames, into a pair of brackets (cast with the shoe) and is held in place by its frictional bearing against the shoe.

The bridge is supported on King's four-legged, tapered frame piers which were built of wrought-iron beams. These structures, unique to the King company, were designed in 1872 by Theodore B. Mills, president of the Iola, Kansas operation of King.[18]

In 1989 the county closed the road that was carried by the McDowell Bridge. Ownership of the road and bridge was transferred to the Poweshiek County Conservation Board who operate the Millgrove Access Wildlife Area where the bridge serves to carry hikers. The bridge stands today as an excellent example of King's bowstring and pier designs.

---

[18]Letters Patent No. 132,307, October 15, 1872. For an illustration of this interesting structure see Simmons, "Bridge Building on a National Scale," p. 29, fig. 8.

SOURCES CONSULTED

Cooper, Clare C. "The Role of Railroads in the Settlement of Iowa: A Study in Historical Geography." M.A. thesis, University of Nebraska, 1958.

Iowa Department of Transportation, Structure Inventory and Appraisal: Structure Number 292080, McDowell Bridge

Iowa Historic Bridge Inventory, v.4: POWE05, McDowell Bridge. Loveland CO: FRASERdesign, produced for the Iowa Department of Transportation, April 1993.

Kemp, Emory L., "The Introduction of Cast and Wrought Iron in Bridge Building," *IA: The Journal of the Society for Industrial Archaeology* 19,no.2(1993): 5-16.

King Iron Bridge and Manufacturing Company, correspondence to Poweshiek County Commissioners, 15 October 1883, 16 October 1883

King, Zenus and Peter M. Frees, Letters Patent No. 33,384, October 1, 1861.

Mills, Theodore B., Letters Patent No. 132,307, October 15, 1872.

Moseley, Thomas W.H., Letters Patent No. 16,572, February 3, 1857.

The Pennsylvania Iron Bridge Works, correspondence to Poweshiek County Commissioners, 17 September 1883, 24 September 1883, 16 October 1883, 31 October 1883, 17 November 1883

The Pennsylvania Iron Bridge Works, Western Union Telegrams to Poweshiek County Commissioners, n.d.

Poweshiek County Auditors, correspondence to William Crickett, 27 October 1883

Poweshiek County Board of Supervisors' Journal, Book E: page 48 (7 June 1882), pages 75-76 (7 September 1882), page 161 (7 June 1883), page 162 (8 June 1883), page 204 (January 1884), Poweshiek County Courthouse, Montezuma, IA.

Sage, Leland L. *A History of Iowa*. Ames, IA: Iowa State University Press, 1974.

Simmons, David A. "Bridge Building on a National Scale: The King Iron Bridge and Manufacturing Company." *IA: The Journal of the Society for Industrial Archaeology* 15,no.2(1989): 23-39.

Simmons, David A. "Bridges and Boilers: Americans Discover the Wrought-Iron Tubular Bowstring Bridge." *IA: The Journal of the Society for Industrial Archaeology* 19,no.2(1993): 63-76.

Thompson, William H. *Transportation in Iowa: A Historical Summary*. Ames, IA: Iowa Department of Transportation, 1989.
"Treacherous Danger in Bow String Bridge," *Iowa Highway Commission Service Bulletin*. August, 1914, p.7.

Whipple, Squire, Letters Patent No. 2,064, April 24, 1841.

HISTORIC AMERICAN ENGINEERING RECORD

McDOWELL BRIDGE
(Skunk River Bridge)

This appendix is an addendum to a 9-page report previously transmitted to the Library of Congress.

APPENDIX: ADDITIONAL REFERENCES

Interested readers may consult the Historical Overview of Iowa Bridges, HAER No. IA-88: "This historical overview of bridges in Iowa was prepared as part of Iowa Historic Bridges Recording Project - I and II, conducted during the summers of 1995 and 1996 by the Historic American Engineering Record (HAER). The purpose of the overview was to provide a unified historical context for the bridges involved in the recording projects."