Benson Street Concrete Bowstring Bridge
Spanning Mill Creek at Benson Street
Lockland/Reading
Hamilton County
Ohio

HAER No. OH-50

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OHIO,
31-LOCK,
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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
U. S. Department of the Interior
P. O. Box 37127
Washington, D. C. 20013-7127

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HISTORIC AMERICAN ENGINEERING RECORD

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Location:	Benson Street (now called Benson Avenue ?) over the gate fork of Mill Creek, between Lockland and Reading, Sycamore Township, 2 miles north of Cincinnati UTM Coordinates: 16/719720/4336870
Date of Construction:	1909-1910
Present Owner:	County of Hamilton (Board of Commissioners) County Courthouse Main Street Cincinnati, Ohio
Present Use:	Vehicular and pedestrian traffic
Significance:	The Benson Street Concrete Bowstring Bridge is important because it may be the first example of a through bridge of this design to be built in America. It was constructed in 1909 (not 1920 as was once thought) and therefore predates James Barney Marsh's influential patent for a concrete bowstring by two years. Although designed by E.A. Gast, It actually may have inspired Marsh at the time when he was working on his own designs. Concrete bowstring bridges were not generally popular in America until about 1920. The bridge is listed as a "reserve pool bridge" in the Ohio Department of Transportation's <u>Ohio Historic Bridge Inventory Evaluation and Preservation Plan</u>.
Report prepared by:	Frances A. Jones Project Historian Ohio Historic Bridge Recording Project Summer 1986

This bridge is important because of its early position in the development of the concrete bowstring in America. It originally was thought to date to c.1920, some nine years after James Barney Marsh patented his design for a bridge of this type (US patent No. 1,035,026, dated 1911), although there is a benchmark on one end of the bridge dated 1912. Marsh's patent was important in the early history of concrete bowstrings, and many bridges were built to his designs, including, it was originally believed, the Benson Street Bridge. The fact that the latter was begun in 1909, however (and finished by the Fall of 1910), makes it not just another variation of an established idea, but an example of the experimentation and innovation of the years running up to Marsh's patent, the years when Marsh himself was working on his designs. The Benson Street Bridge is, in fact, different in a number of ways to Marsh's design as will be shown later.

The Benson Street Bridge is quite well documented, as two contemporary reports survive. One of them, in Engineering News, was written by E. A. Gast, one of the designers.[1] The other report was published in Good Roads, the national magazine of the Goods Roads Federation, which recognized the unusual features of the bridge.[2]

This bridge was built to replace a through Howe truss with a 73 foot span with a clearance of about 20 feet below the deck. The new bridge could not narrow the waterway opening, because of the large water flow when the creek was flooded. A more traditional filled concrete arch bridge was not acceptable since it would restrict the opening too much. Two estimates were submitted for two different designs. One was for $11,000 for a steel girder bridge, the other was for $8,600 for a reinforced concrete bridge. The lower estimate was accepted and a design was finalized. The bridge was designed by the Deputy County Surveyor for Hamilton County, E.A. Gast, under the direction of the County Surveyor, Clinton Cowen. Gast also supervised construction. Hugo Eichler assisted with the design.[3] The contract to build the bridge went to Peter Praechter, whose bid was the lowest at $7,127. Other bids went as high as $14,114.[4] The bridge was built as the gateway to the cities of Reading and Lockland. An identical bridge was built in 1911 across the West Fork of Mill Creek, but it was removed in July 1983.

James B. Marsh had an important role in the early history of concrete bowstrings. He was born in Wisconsin in 1856, and after starting his career by working for the King Bridge Company of Cleveland, he went on to form his own company. He was experimenting with the use of concrete in bridge construction by the mid 1890s, and patented his designs in 1911. He probably had nothing to do with the design of the Benson Street bridge, and may actually have gained inspiration from hearing about it. Marsh produced two basic concrete bridge designs, one for a fixed, and one for a tied arch. His original patent, however, was for the fixed arch. The designs included slideable wear plates at the points where the bridge floor came into contact with the beams and abutments. These plates helped allow for the expansion and contraction of the bridge in varying weather conditions.[5] The Benson Street Bridge, however, has two hingeless arches - no plates are inserted at any point in the arch, and no provision is made for movement at the abutments. The heavy transverse beams beneath the ends of the arches were laid directly on the abutments. The arch ribs, however, were designed to cope with all temperature stresses. Gast said of his design in 1911:

> Although the bridge has now experienced some of the hottest as well as coldest weather of this climate, not a single crack has developed.[6]

The reinforced concrete arch bridge was slow to be accepted by American engineers. It was first developed in Europe. In 1894, Fritz von Emperger (a German born engineer working in America) claimed that steel and concrete could be used successfully in arch bridges. This view was generally distrusted, but tests carried out in Austria showed that the combination did produce a strong structure. It was thought that the reinforcing steel would be permanently preserved by being set in concrete.[7]

In 1904, M. A. Considere designed and built the first recorded example of a concrete bowstring bridge in France. His design was virtually a traditional metal bowstring bridge but made of reinforced concrete. The first known example to be built in America was designed by Howard M. Jones, Engineer of the Cumberland River Bridge Commission in Nashville, Tennessee. His bridge crossed a railyard. He decided that European designs were far too complicated, and they all used diagonal members which he did not believe were properly attached to the top or bottom chords. He used concrete trusses without diagonals as deck spans on the approaches to his bridge. The concrete arches rested on existing piers, and the deck was carried above the arches.

Jones' bridge was much criticized. The editors of Engineering News said that the design created indeterminate secondary stresses in its members. They also doubted the ability of a concrete truss to withstand the stresses imposed on it by heavy traffic, and, perhaps justifiably, criticized the complex formwork needed to build the bridge.

In contrast to this attitude, Hamilton County had already accepted concrete construction. One of the earliest reinforced concrete arch bridges in America was built in Cincinnati's Eden Park in 1895. The Ingalls building, the first reinforced concrete skyscraper in America, also was built in Cincinnati in 1902-3.[8] Gast said of the building of the Benson Street Bridge:

> The new bridge was built by the authority of the Hamilton County Commissioners, whose policy it is to rebuilt the bridges in the county of reinforced concrete as fast as the old ones of wood and iron become unfit for use.[9]

It was quite unusual, at this early date, for a county in the United States to have such a confident and positive attitude towards concrete construction.

The bridge was constructed in reverse order. With a bridge of this type the substructure would be erected first, and then the arch, floor beams and hangers. In this case, however, the designers considered the various construction methods and decided to build the floor and haunches of the arch first. They were supported on heavy falsework. The hangers were erected next and encased in concrete, and the arch was constructed last. This method had a number of advantages. It would have been necessary to build heavy falsework from the creek bottom right up to the height of the arch, if the arch was constructed first. The falsework would then have been in the way of the floor construction, as it could not be removed until the floor was in a finished enough state to take the weight of the arch. Building the arch last meant that it was supported by the floor and hangers which were already firm. The men working on the bridge also had the advantage of a fairly firm surface (the finished deck) from which to work as the building progressed. Finally the 'reverse' building method caused less disruption to traffic as the old bridge was not touched until the falsework was in place for the new bridge. The old bridge could then be taken down with the falsework being used as support. It was found that most of the reinforcing was quite easy to place, but there were problems with placing it in the deep girders. In the end the reinforcing was firmly wired together and then lowered as a block into the girder form.[10]

The masonry abutments for the old bridge were found to be in good condition when the new bridge was built, and they were also large enough to take the load of the new bridge as long as its weight was evenly distributed across their width. Consequently the bridge is of the 'tied' as opposed to 'fixed' arch design. In both, the arch rises above the deck, but a tied arch rests on the abutments. A fixed arch continues below deck level, and is attached to the abutments. The tied arch causes a vertical load on the abutments and this is distributed at Benson Street by means of a heavy transverse beam laid directly on the abutments beneath the ends of the arch. Horizontal thrust is resisted by the lower chord. The abutments of the bridge are only 36 feet wide, but the bridge has an overall width of 50 feet. The roadway is 31 feet wide, and there are two cantilevered walkways, 9 1/2 feet wide on the outside of the two concrete arches. The bridge has an overall length of 100 feet and a clear span of 73 feet. The reinforcing is of cold twisted steel. The floor is suspended from nine pairs of hangers. The reinforcing in the hangers is hooked around the reinforcement in the arch above, and that in the floor girders below. Since the lower chord is in tension the concrete here is used only to stiffen the reinforcing materials, and it does not take the stresses imposed upon the structure itself. The hangers support the deck and also act as wind braces. The arch is three feet wide but decreases in depth from four feet ten inches at the springing line to three feet six inches at the crown.

Although the concrete bowstring bridge was distrusted at first, in later years it grew in popularity. Many were erected throughout Ohio in the 1920s, and they began to be built in other states as well. The Benson Street Bridge is important because although Jones' bridge predates it, the latter used deck spans (the deck was carried on the arches, whereas the arches rise above the deck at Benson Street). The Benson Street bridge may be the first example of a through bridge of this design in America.[11] (For a report on a concrete bowstring bridge of the 'fixed arch' type, please see HAER report No. OH-52 on the First Street Reinforced Concrete Bridge.)

NB This bridge is called the Benson Street Bridge by E. A. Gast in his article in Engineering News. The road now seems to be called Benson Street or Benson Avenue.

NOTES

1 E. A. Gast, "A Through Reinforced-Concrete Arch Bridge." Engineering News 65 (16 February 1911): 196-7.

2 "Reinforced Concrete Through Arch Bridge in Ohio." Good Roads 12, no. 5 (May 1911): 170-1.

3 Gast, Engineering News 65: 196-7.

4 Bridge files, Ohio Historical Society (compiled by David A. Simmons, OHS).

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

6 Gast, Engineering News 65: 196-7

7 Jochims, Kansas Preservation II: 1-3.

8 David A. Simmons, "'Rainbow Arch Bridge' Hamilton County Believed To Be First Of Its Kind in Ohio." Ohio County Engineer XLV (November 1985): 21.

9 Gast, Engineering News 65: 196-7.

10 Gast, Engineering News 65: 196-7.

11 Simmons, Ohio County Engineer XLV: 21.

BIBLIOGRAPHY

Condit, Carl W. American Building Art: The Nineteenth Century. New York: Oxford University Press, 1960.

Gast, E. A. "A Through Reinforced-Concrete Arch Bridge." Engineering News 65 (16 February 1911): 196-7.

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

Simmons, David A. "'Rainbow Arch Bridge' Hamilton County Believed to be First of Its Kind in Ohio." Ohio County Engineer XLV (November 1985): 21.

"Reinforced Concrete Through Arch Bridge in Ohio." Good Roads 12, no. 5 (May 1911): 170-1.

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