1577

NPS Form 10-900
(Rev. 8/86)
Wisconsin Word Processor Format (1331D)
(Approved 3/87)

RECEIVED 413
OMB No. 1024-0018
12 1994
INTERAGENCY RESOURCES DIVISION
NATIONAL PARK SERVICE

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES REGISTRATION FORM

This form is for use in nominating or requesting determinations of eligibility for individual properties or districts. See instructions in Guidelines for Completing National Register Forms (National Register Bulletin 16). Complete each item by marking "x" in the appropriate box or by entering the requested information. If an item does not apply to the property being documented, enter "N/A" for "not applicable." For functions, styles, materials, and areas of significance, enter only the categories and subcategories listed in the instructions. For additional space use continuation sheets (Form 10-900a). Type all entries. Use letter quality printer in 12 pitch, using an 85 space line and a 10 space left margin. Use only archival paper (20 pound, acid free paper with a 2% alkaline reserve).

1. Name of Property

historic name Sprague Bridge

other names/site number Ninth Street Bridge (WisDOT ID P-29-0092)

2. Location

street & number Section 23 T20N R3E over Yellow River — N/A not for publication

city, town Finley Township — X vicinity

state Wisconsin code WI county Juneau code 057 zip code 54646

3. Classification

Ownership of Property
___ private
X public-local
___ public-State
___ public-Federal

Category of Property
___ building(s)
___ district
___ site
X structure
___ object

No. of Resources within Property

contributing	noncontributing	
___	___	buildings
___	___	sites
1	___	structures
___	___	objects
1	0	Total

Name of related multiple property listing:

N/A

No. of contributing resources previously listed in the National Register N/A

4. State/Federal Agency Certification

As the designated authority under the National Historic Preservation Act of 1966, as amended, I hereby certify that this _x_ nomination ___request for determination of eligibility meets the documentation standards for registering properties in the National Register of Historic Places and meets the procedural and professional requirements set forth in 36 CFR Part 60. In my opinion, the property _x_ meets ___ does not meet the National Register criteria. ___See continuation sheet.

11/26/94

Signature of certifying official — Date

State Historic Preservation Officer-WI

State or Federal agency and bureau

In my opinion, the property ___meets ___does not meet the National Register criteria.
___See continuation sheet.

Signature of commenting or other official — Date

State or Federal agency and bureau

5. National Park Service Certification

I, hereby, certify that this property is:

- ✓ entered in the National Register. 1/23/95
  - ___ See continuation sheet
- ___ determined eligible for the National Register. ___See continuation sheet
- ___ determined not eligible for the National Register.
- ___ removed from the National Register.
- ___ other, (explain:) __________

Signature of the Keeper — Date

~~6. Functions Or Use~~

Historic Functions (enter categories from instructions)	Current Functions (enter categories from instructions
TRANSPORTATION: Road & Pedistrian Related	TRANSPORTATION: Road & Pedistrian Related

7. Description

Architectual Classification
(enter categories from instructions)

OTHER: Pratt half-hip pony truss

Materials
(enter categories from instructions)

foundation steel

walls steel

roof N/A

other wood

Describe present and historic physical appearance.

Description

The Sprague Bridge (Wisconsin Department of Transportation Bridge No. P-29-0092) is a two-span, pin-connected, metal, Pratt half-hip pony truss bridge.** It formerly carried Ninth Street East across the Yellow River in rural Juneau County connecting the towns of Necedah, Armenia, and the hamlet of Sprague on the Chicago Milwaukee and St. Paul Railroad with this part of Juneau County. In 1989, the bridge was moved in accordance with a compliance agreement approximately 3.5 miles upstream from this location. It now serves as a Yellow River crossing for a snowmobile route. Each span is 58' 8" long, for a total structure length of 121' 7". The roadway width is 15'. The superstructure was constructed of conventional channels and angles, while the floor system is constructed of rolled I-beams. The lower chord is notable in that double tied angles are used in the two outside panels, while looped eyebars are used in the two inner panels. The substructure is constructed entirely of steel, employing metal-capped steel tubes and steel diaphragm retaining walls in the abutments and center pier. The bridge was built in 1913 by the Elkhart Bridge and Iron Company, Elkhart, Indiana, with W.E. Gifford of Madison, WI, as its agent. A second plate on the bridge identifies the Armenia town supervisors (Ole Norsby, Al Gorman, and George A. Mayhue) and the Juneau county supervisors' committee of oversight (E.P. Rogers and George H. Livernash). The bridge remained unaltered except for a bituminous overlay on the deck, which was redone after the relocation.

**A Pratt truss has its diagonals in tension and its verticals in compression, except for the "hip" verticals which run from the inclined end post and top chord joint to the bottom chord. A Pratt half-hip bridge does not have a hip vertical member.

Technical Data:

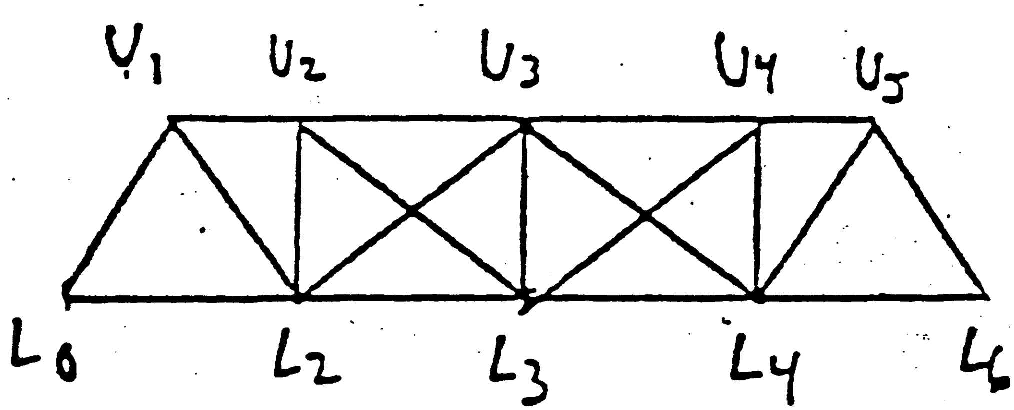
Inclined End-Post/ Upper Chord:	L0-U1, U5-L6: double upright channels (7") with cover plate (12") on top and v-lacing underneath
Lower Chord:	L0-L2, L4-L6: double angles tied with batten plates; L2-L4: double rectangular looped eyebars (2 1/2" x 7/8")
Verticals:	L2-U2, L3-U3, etc.: double back-to-back angles tied with V-lacing ("H" in section)
Diagonals:	double rectangular looped eyebars (L2-U1, L4-U5: 1 3/4" x 7/8"); L3-U2, L3-U4: 1 3/4: x 3/4"

X See continuation sheet

Counters:	L2-U3, L4-U3: single cylindrical looped eyebars (7/8") with open turnbuckles
Floor System:	rolled I-beam floor-beams and stringers, riveted with angles to a plate hung from the pins; corrugated metal deck with bituminous overlay
Bracing:	bottom: threaded rods
Bearings:	all bearings are the same: plates bolted to metal caps on tubs, with no slotted holes or rollers

Web Height (WH):	5.3 feet	WH/Panel length:	.361
Panels:	4 at 14.7 feet each	Overall Length/WH:	11.0

SKETCH DIAGRAM



8. Statement of Significance

Certifying official has considered the significance of this property in relation to other properties: ___nationally ___statewide _x_locally

Applicable National Register Criteria ___A ___B _X_C ___D

Criteria Considerations (Exceptions) ___A _X_B ___C ___D ___E ___F ___G

Areas of Significance
(enter categories from instructions) Period of Significance Significant Dates

Areas of Significance
(enter categories from instructions) Period of Significance Significant Dates

Areas of Significance	Period of Significance	Significant Dates
Engineering	1913	1913

Cultural Affiliation

N/A

Significant Person

N/A

Architect/Builder

Fabricator: Elkhart Bridge & Iron Co.

Gifford, Willis E.: Agent Contractor: Unknown

State significance of property, and justify criteria, criteria considerations, and areas and periods of significance noted above.

The Sprague Bridge (P-29-0092), built in 1913, is locally significant under National Register Criterion C (Engineering) as a fine, unaltered, later example of a Pratt half-hip metal pony-truss highway bridge. In addition, the bridge's pin-connected superstructure and its steel-tube substructure are very late examples of this type of construction. The bridge was constructed during the early years of the State Highway Commission (SHC) oversight of bridge construction in this state, but there is no evidence of direct SHC involvement in this bridge. The Sprague Bridge was recognized by the Historic Bridge Advisory Committee (HBAC) of WisDOT in 1981 as one of the four "best examples of Pratt half-hip pony trusses" in the state. The significance of the bridge is enhanced by its highly intact physical condition.

Historic Setting

The Yellow River flows from north to south through Armenia township, although its meandering channel loops to the east just downstream from the bridge site. The highway follows a narrow spit of high land. Most of the nearby land is wetland and floodplain. Most of Armenia township is isolated by the Yellow River on the west and the Wisconsin River and Petenwell Flowage on the east.<1>

_X_See continuation sheet

9. Major Bibliographical References

__X__ See continuation sheet

Previous documentation on file (NPS):
_____ preliminary determination of individual listing (36 CFR 67) has been requested
_____ previously listed in the National Register
_____ previously determined eligible by the National Register
_____ designated a National Historic Landmark
_____ recorded by Historic American Buildings Survey #________________
_x___ by Historic American Engineering Record WI-57________________

Primary location of additional data:
__X__ State historic preservation office
__X__ Other State agency
____ Federal agency
____ Local government
____ University
____ Other
Specify repository:

10. Geographical Data

Acreage of property __less than one acre__

UTM References

	Zone	Easting	Northing		Zone	Easting	Northing
A	1/5	7/3/1/4/6 0	4/8/9/6/4/5/0	B	/	/////	//////
C	/	/////	//////	D	/	/////	//////

___See continuation sheet

Verbal Boundary Description

The general area is a rectangle, 122 feet by 17 feet, whose long center axis coincides with the centerline of the bridge and whose perimeter encompasses the entire bridges and its abutments and wing walls.

___See continuation sheet

Boundary Justification

This boundary encompasses the entire historic resource.

___See continuation sheet

11. Form Prepared By

name/title Robert S. Newbery, Staff Historian; Jon Neidhold, Design Supervisor
organization Wisconsin Department of Transportation date: 1988, April 1993
street & number P. O. Box 7916 telephone (608) 266-0369
city or town Madison state Wisconsin zip code 53707

Sprague, one mile northwest of the former bridge site, was established as a post office on the Chicago, Milwaukee, and St. Paul Railroad around 1909. It is located nine miles north of Necedah. No population was given for 1909, but in 1913, 75 people lived there and in 1919, 100. At this time both Juneau County and Armenia township were losing population. Juneau had 20,579 residents in 1905 and 19,509 in 1910; Armenia 801 in 1900, 837 in 1905 and 714 in 1910. <2>

Sprague Bridge

The Sprague Bridge is a two-span, pinned, steel, Pratt half-hip pony truss bridge, which carried Ninth Street East across the Yellow River between Necedah and Armenia townships in rural Juneau County. It is representative of a rural, wagon bridge. It was most likely constructed with a minimum of power tools, and is one of the last of its type to be built in Wisconsin. The superstructure is constructed of conventional channels and angles, while the floor system is constructed of rolled I-beams. The lower chord is notable in that double tied angles (a 20th century feature) are used in the two outside panels, while looped eyebars (common in the 19th century) are used in the two inner panels. The substructure consisted of steel tubes and steel diaphragm retaining walls. By this time, the SHC clearly preferred riveted Warren pony trusses for bridges of this length, and had come out strongly against the steel tube substructure.

The Historic Bridge Advisory Committee (HBAC--see below) identified 125 Pratt half-hip pony trusses in the state, all built before 1934. Of these 125 Pratt half-hip bridges, more than 20, generally the oldest and longest, were field reviewed and 12 were formally evaluated using the criteria developed by HBAC. Five of these 12 were selected as being significant. The oldest was built in 1886, and the youngest, the Sprague Bridge, was built in 1913. Although 40 of the state's Pratt half-hip bridges were listed in WisDOT files as being built in 1915 or later, it is likely that for most of these bridges, either the date of construction was wrongly guessed at or they were moved to their current site and the date of construction listed in WisDOT files is actually the date of the move. Most of the alleged post-World War I Pratt half-hip bridges in Wisconsin are of very modest length, with poor integrity, and dubious historical credentials. Thus, the Sprague Bridge, is an appropriate representative example of a very late Pratt half-hip bridge suitable for wagon traffic in a rural area.

Design and Engineering

There are three essential aspects of a truss. First, a truss is a combination of relatively small members which are "framed or jointed...to act as a beam". <3> Second, each component member is subjected only to tension or compression. (Tensile forces tend to stretch or elongate a member while compressive forces tend to push or compress a member.) Third, the component members of the truss are configured in triangles because "the triangle is the only geometrical figure in which the form is changed only by changing the lengths of the sides." <4> In other words, the triangle remains rigid until the forces applied distort or break the material used in the components. <5>

A truss bridge consists of two trusses, each with a top chord, bottom chord, and endposts. The space enclosed by these members is called the web. The web members reinforce the truss. The particular arrangement of the web members was the subject of much study in the mid- and late-nineteenth century gives, and different names were given to trusses with different web configurations. The two most popular types of trusses in Wisconsin were the Pratt and the Warren.

Truss bridges are generally divided into three categories: pony (or low) trusses, overhead (or through) trusses, and deck trusses. <6> Both pony and overhead trusses carry the traffic between the trusses and the roadway is at or near the bottom chord of the trusses. A deck truss carries the roadway at or near the top chord; thus the roadway is on top of the trusses.

Materials

The relative merits of cast versus wrought iron for bridge building were still being debated in the late 19th century, when the first surge of truss bridge building began in Wisconsin. Because cast iron is brittle, it is subject to sudden and dramatic failure. Thus, it was "an unsatisfactory material for bridges, and quite a number of failures occurred. " <7> Shunned for a time in the United States in the 1850s, cast iron bridges made a comeback and then only "gradually, but stubbornly," fell out of favor. <8> As late as 1870, one bridge engineer wrote that "the rigidity of cast-iron is the very quality needed in a compression member." Moreover, as the quality of casting in the United States was excellent, "nothing can be found that will compare with cast-iron for resisting strains of compression either in reliability or in cost." <9>

Before the issue of cast versus wrought iron had been completely resolved, a new material entered the picture: steel. Steel was not a newly discovered material, of course, but high cost and small output had limited its use mainly to the manufacture of tools. The Bessemer and Siemens-Martin processes reduced the cost and greatly improved the quantity of structural steel available. <10> Steel was used for special purposes and special bridges beginning with the Eads bridge in St. Louis in 1874. From the late 1880s to the early 1890s structural shapes (beams and columns) were rolled in both wrought iron and steel by the major manufacturers. The qualities of wrought iron and steel remained controversial until the turn of the century, and engineers continued to debate the relative merits of the two metals. <11> Nevertheless steel was the predominant if not exclusive structural material for bridges by the mid-1890s. Although some bridge building companies continued to advertise bridges built of either metal as late as 1900, after 1892 wrought iron structural shapes were no longer being produced. <12>

In the 20th century, the continued development of steel focused on alloys. James A.L. Waddell devoted an entire chapter to alloy steels in his 1916 textbook and its 1921 sequel. <13> By 1921, one English engineer indicated that developments since the turn of the century had made both the "mild" steel of the 1890s and wrought iron old fashioned. Both the engineer and the metallurgist developed an increasingly sophisticated understanding of the variations which resulted from changes in the chemical composition, heat treatment, macrostructure, and microstructure. <14> Because the major advantage of alloy steels lay in very long span bridges and welded connections, the latter feature not becoming common until after World War II, it is assumed that metallurgical developments were not a major concern for bridge engineers designing modest rural bridges such as the ones which predominated in Wisconsin. <15>

Historical Context

On Wisconsin highways, the predominance of metal-truss bridges for crossings of all lengths seems to have lasted from about 1890 to 1910. Trusses remained an important bridge type in Wisconsin until the advent of World War II, but after 1910, most short crossings (less than 35 feet) employed girder, beam, or slab spans of steel and/or concrete. The Wisconsin State Highway Commission (SHC), established in 1911 to improve the quality of road and bridge construction in the state, was particularly enthusiastic about using concrete for culverts and small bridges. <16>

The "bowstring" truss bridge may have been the state's first, common, all-metal truss configuration. Nationwide, thousands were apparently built, but the popularity of this design in Wisconsin is difficult to determine. <17> Although records of a number of them exist, none remain on Wisconsin highways. Seven are preserved in parks and wildlife refuges. <18>

The two truss designs that came to dominate highway bridge construction by the late nineteenth century were the Warren and the Pratt. The Warren truss was patented by two British engineers in 1840. In this design, the vertical members handle only nominal stress, while the diagonals serve as both tension and compression members. The vertical members, like the diagonals, were usually paired angles, but of smaller dimension. In Wisconsin, Warren trusses are by far the most common type of highway truss, having been promoted by the SHC after 1911. Of the approximately 450 Warren trusses in Wisconsin in 1980, over four-fifths were riveted pony trusses built according to SHC standard plans. <19>

The Pratt truss, patented by Caleb and Thomas Pratt in 1844, features vertical compression members and diagonal tension members. Although originally built as a combination bridge, the Pratt truss was not as efficient in that form as the Howe. As an all-metal bridge, however, the Pratt had the advantage because it used less iron and was easier to erect. The oldest existing truss bridge in Wisconsin, the 1877 White River Bridge in Burlington, is a Pratt. <20>

During the 1870s, an important variation of the Pratt design was introduced for long-span bridges. Because the depth of truss required in the center of a bridge is greater than at the abutments, a considerable amount of material can be saved on a long-span structure by "bending" the top chord into a polygonal configuration known as a "Parker" truss. If the top chord has exactly five sides, the bridge, by convention, is called a "camelback" truss. The addition of substruts and/or subties makes a Pratt into a Baltimore and a Parker into a Pennsylvania. <21>

The development of the Pratt and its variations was influenced by a debate over the merits of pin connections versus riveted connections for main truss members. Proponents of riveted bridges usually cited the advantages of increased structural rigidity and the reduction of damaging vibrations. In pin-connected bridges, vibrations caused the pin to grind on the eye-bar, thus enlarging the pin hole. Advocates of pin-connected bridges, on the other hand, emphasized the theoretically correct distribution of stresses and the smaller amount of metal required. They also criticized the difficulty of ensuring that a riveted joint was properly fabricated, especially in the field. The pin-connected bridge, they argued, was the reason why Americans surpassed the rest of the world in bridge building. <22>

The issue of pin versus riveted connections was complicated by practical factors, including machinery, tools, and power sources, both in the shop and in the field. The debate also was easily sidetracked by tangential issues; as, for example, when some commentators denied that the pin per se, was the most important feature of "characteristically American" bridgework. In addition, both connection types came to incorporate features that were not an intrinsic part of the design. Many early riveted spans, for example, used the lattice girder (or multiple triangulation) design, which was clearly excessive in material, while many pin-connected bridges were dangerously light, particularly in their details. Thus, a fair comparison between the two systems was not always made. <23>

According to Waddell, the controversy raged in engineering circles for a dozen years around the turn of the century. No dramatic resolution of the issue occurred, but "time and steady development of the real science of bridge designing" gradually changed minds. Significant changes in rivetting technology also altered the terms of the debate. <24> A compromise of sorts was finally reached, resulting in the adoption of the best features of each design. Riveted bridges were designed with less duplication of members and pin-connected bridges were still accepted for long-span highway bridges. <25>

In Wisconsin, SHC officials clearly favored riveted construction from an early date. Consequently, the distinction between pin connections and riveted connections establishes an important subcategory boundary, separating the era of state-planned bridges from the preceding period in which bridge companies were largely responsible for bridge design. As early as 1908, state engineers advocated the use of riveted pony trusses for short-span bridges. <26> When the SHC was formally established in 1911, the riveted Warren became the state's standard pony design. In that year, the SHC also drafted a standard plan for riveted, overhead, Pratt trusses, and by 1914, the agency had adopted riveted construction for all overhead Pratt variations. As SHC engineer A. R. Hirst wrote in 1913, "Very seldom do we use a pin-connected truss..." <27>

In the mid-1930s, the SHC seems to have developed a preference for overhead Warren trusses for long-span bridges, although some overhead Pratts continued to be built. Riveting remained dominant in bridge building until well after World War II. As late as 1931, the construction specification of the American Association of State Highway Officials (AASHO) stated, "Welding of steel shall not be done except to remedy minor defects and then only with the approval of the engineer." As with other innovations, the full potential of welded bridges. Shortly thereafter, riveting rapidly disappeared, replaced by welding and high strength bolts. <28>

The State Highway Commission

The involvement of local governments in bridge repair, replacement, and construction projects was the subject of numerous laws in the late 19th century. With the Good Roads Movement of the late 1890s and early 1900s, a specific set of proposals were put forth for greater involvement by the state government in promoting good quality bridges. <29>

In 1907, the state legislature established a Highway Division within the Wisconsin Geological and Natural History Survey to conduct experiments in road design and to advise local governments about specific projects. Town governments, traditionally reluctant to hire an independent engineer to assist in bridge building, could now avail themselves of free engineering counsel from the state. At the same time, the legislature required counties to make a commitment to professional oversight and increased funding by appointing "a competent engineer or experienced road builder" to serve as County Highway Commissioner and by levying a tax of not less than one-fourth nor more than two mills on the assessed valuation of all county property for the county road and bridge fund. <30>

In 1908, Wisconsin voters removed their greatest obstacle to creating a progressive statewide system of bridge and highway construction. In that year, by a three-to-one margin, voters eliminated the state's constitutional prohibition against direct state aid to transportation projects. When the legislature made its first appropriation for highway improvements in 1911, it also transformed the Highway Division of the Geological Survey into an autonomous State Highway Commission (SHC), which was given the responsibility of overseeing the expenditure of state funds for the development of a state highway network. <31> Like the former Highway Division, the SHC emphasized the use of standardized plans for various types of bridges and culverts. <32> The first set of standardized truss plans encompassed spans ranging from 36 to 128 feet, generally in five-foot increments. All but one had a sixteen-foot roadway. Revised several times by the 1920s, these plans gradually provided for wider bridges, and continually incorporated the latest engineering wisdom and detailing. <33>

In the first three and one-half years of its work, the SHC designed over 1,500 bridges of all types. All were designed to carry a live load of 15 tons. Believing firmly in the use of reinforced concrete to "the fullest extent practical," the SHC was pleased that all but three of their designs had concrete floors. These figures included almost 900 bridges requested by local governments in 70 counties. Practically all the local bridges in the state during these years were either designed by the SHC or were based on SHC standard plans. <34>

Despite its enthusiastic support for concrete construction, the SHC declared in 1926 that the steel bridge "is not looked upon with disfavor," and it continued to refine its truss designs. In the late 1930s, it made a major commitment to keeping its standardized plans up to date by dropping the Pratt design in favor of the Warren all overhead truss configurations. Newly-completed SHC-designed truss bridges, both monumental and modest, also continued to be featured in the photographic sections of the agency's biennial reports. Nevertheless, the SHC clearly favored concrete spans, citing advantages of lower cost, greater compatibility with aesthetic treatment, and greater adaptability to remodeling, especially in terms of roadway widening. <35> The metal truss, however, remained cost effective in many situations, and the SHC continued to design some truss bridges until well after World War II.

During its early years, the SHC was guided by five key figures, all of whom had previously worked at the Highway Division of the Geological Survey. These staff members were W.O. Hotchkiss, first chief of the Highway Division; Arthur R. Hirst, first State Highway Engineer; Martin W. Torkelson, first State Bridge Engineer; Herbert C. Keulling, assistant highway engineer; and Walter C. Buetow, assistant bridge engineer. When these men moved on to the SHC, they found a helpful ally in Frederick E. Turneaure. Turneaure was Dean of the College of Engineering at the University of Wisconsin and had been instrumental in establishing the new state highway agency. <36>

<u>Builder</u>

Willis E. Gifford was an agent for the Elkhart Bridge and Iron Company, of Elkhart, Indiana, for a quarter of a century. One of almost 100 small independent bridge builders known to have operated in Wisconsin from 1870 to 1930, Gifford may have been the most successful. He is certainly the one about whom the most is known. His start runs counter to the trend toward monopolies at that time, a trend symbolized in the bridge industry by the formation of the American Bridge Company. Moreover, Gifford appears to be the only bridge builder/agent who lasted more than a few years. As such, the Wisconsin Department of Transportation and its historical consultant consider Gifford to be an important representative of the small businessman, all the more important because of the period in which he operated. The State Historic Preservation Office has determined, however, that not enough is known about Gifford or Elkhart Bridge and Iron to determine if either is significant in terms of National Register criteria. <37>

Born in New York in 1867, Gifford married and moved to Michigan before coming to Madison. Arriving in Madison about 1900, he travelled extensively, selling road graders and other machinery. <38> Soon he was also an agent for Elkhart Bridge and Iron, although until 1916, he identified himself in the census and in city directories as only a traveling salesman. <39> Gifford kept a photograph album of bridges which he built. This album begins in 1905, although it would appear that he built some bridges earlier than that. It is unclear if all the bridges constructed under his arrangements were fabricated by the Elkhart Bridge and Iron Company. <40> In 1916, he gave his occupation as "bridge contractor" and advertised himself as an agent for the Elkhart Bridge and Iron Company. He continued as an agent for this company until 1931. <41>

The Elkhart Bridge Company was incorporated in Indiana in November, 1901. This date was late in the third phase of industrial development of Indiana's metal bridge building companies, a period which has been termed an age of "industrial expansion" for these companies. This period of expansion lasted roughly from 1889 to 1902, and was marked by a change from experimentation in design to a focus on efficient fabrication. Elkhart was one of eight important bridge companies founded in Indiana during this phase. The Company was identified and rated in Cultural Resource Management In Wisconsin as a "known prolific out-of-state builder". It received the second highest ranking accorded to bridge companies by this rating scale. <42>

Frank Brumbaugh and John Fieldhouse were the prime movers in establishing the Elkhart Bridge Company. Brumbaugh was an agent for the Bellefontaine Bridge Company of Ohio, and Fieldhouse was an Elkhart industrialist who wanted to boost the local economy.

The company did not prosper until after it was reorganized as the Elkhart Bridge and Iron Company in 1906. By 1910, the company had 125 employees and earned $40,000 annually. The company is known to have built bridges in Montana as well as Indiana and Wisconsin. <43>

Elkhart followed the pattern of shop erection and disassembly before shipping a bridge to the erection site. This system would have made Gifford's role more tenable than the alternative method of the template system. <44> Elkhart prided itself on the ornamental features of its bridges, but the remaining Wisconsin examples of their bridges do not display much ornamentation. The company began to diversify into other structural metal work almost as soon as it was reorganized, and the fabrication of buildings became an increasingly important part of its business. <45>

Little is known about the details of how Gifford operated but according to his son, he was never involved in the actual construction process. Rather, Gifford attended lettings and arranged for the contract. Once he had a contract, he contacted the company and hired a foreman, most often Ed Rudd, George Sarbarker, or H. C. "Duff" Fagan. The latter man may have worked for Elkhart elsewhere. It was the foreman who hired the construction crew and directed the actual erection. <46>

Most of Gifford's early bridges were pony trusses, either pin connected Pratts or riveted Warrens. The longest bridge he contracted for was a 150-foot Pratt overhead truss, although he did arrange for repair work on some larger structures. He apparently built I-beam bridges as early as 1905. These would probably have been less than 20 feet in span length. What involvement, if any, the Elkhart Bridge Company had in these very small structures is not known. The earliest evidence have of Gifford's involvement with a concrete girder bridge is a photograph in his album of a 1914 bridge in Dane county. <47>

According to his son, Gifford was a resourceful and aggressive agent, but he never made very much money at bridge building. <48> Interestingly, his entry into the bridge building field coincides with the formation of the American Bridge Company. This company was formed by "an immense merger of virtually all of the national bridge fabricators of the time," including the Milwaukee Bridge and Iron Company. According to one historian, the creation of the American Bridge Company radically changed the complexion of the entire industry. <49>

Gifford, however, had obviously found a niche, and he built as many as 70 bridges a year in the years before World War I. <50> Although the Elkhart Bridge and Iron Company apparently survived at least the early years of the Depression, Gifford's involvement with bridge projects dropped off drastically in the 1920s. He built only one bridge in 1929, and that may have been his last. <51> He died in Madison in the 1940s. <52>

Historic Bridge Advisory Committee

The systematic study of Wisconsin truss bridges began in 1976. Under the sponsorship of the State Historic Preservation Office (SHPO) of the State Historical Society, George M. Danko produced two volumes. The first volume was based on an extensive literature search, and traced related developments in engineering, metallurgy, and manufacturing to provide a general historical overview of truss-bridge design and construction on both a state and national level. In 1977, Danko conducted an intensive field survey of truss bridges in 11 Wisconsin counties. Using the records of the Wisconsin Department of Transportation (WisDOT), he focused his study on counties which he hypothesized would have both a high concentration of truss bridges and high replacement pressures. Danko's second volume included intensive survey forms for 35 bridges. The forms for bridges which Danko thought significant were starred. <53>

By 1980, when WisDOT established the Historic Bridge Advisory Committee (HBAC), 17 bridges had been listed in or found eligible for listing in the National Register of Historic Places. Neither Danko's studies nor the individual nominations and determinations of eligibility provided a fully developed statewide historical and chronological context or specific criteria for rating truss bridges. The goal for HBAC, then, was a statewide inventory that would expedite the evaluation of truss bridges, which, in 1980, accounted for approximately one-tenth of the state's 10,386 surviving highway bridges built before 1950.

The HBAC was guided by the basic assumption that all distinctive types of truss bridges are worthy of some degree of preservation. Thus, the planning for the statewide survey focused on two major information sources in the WisDOT Bridge Section: (1) a card file containing rudimentary structural information and a photograph for every highway bridge in the state; (2) a computerized data bank adapted to meet the FHWA's interest in a statewide inventory to promote an engineering evaluation of all bridges in the state. These two sources generated an initial pool of 996, pre-1941 truss bridges representing 18 structural types. <54>

The 1941 cut-off date was selected to satisfy, with a comfortable margin, the 50-year age criterion customarily required for National Register eligibility. Moreover, Danko had only located one truss built after that date. Although subsequent research located several dozen trusses built after 1941, these trusses were markedly different in design. Thus, the 1941 date is an appropriate interim boundary if not final marker for the truss bridge era in Wisconsin. <55>

On the basis of data derived primarily from WisDOT sources, the initial pool was carefully studied to identify, for each truss type, those bridges which had the earliest known construction dates, were in the best condition, had the best available historical data (e.g., bridge plates, SHPO research files, previous historical studies), and had the most obvious noteworthy features (e.g., longest span, greatest number of spans, unusual workmanship). This winnowing reduced the initial pool by approximately 75 per cent. Up to this point, the study had focused exclusively on bridges on or over public thoroughfares, including city streets, county highways, and town roads. Some bridges of historical interest, however, were known to exist in park settings, and these also were included in the study. With these additions, the study sample totaled 247 bridges.

To determine the most significant bridges within each truss category, a set of evaluation criteria, with a corresponding numerical rating system, was developed, using the model developed by Virginia. <56> A trial run was conducted on the bedstead-truss (truss-leg) category. Because this category consisted of only 8 examples, it was possible to rate all examples and compare the results with a "subjective" analysis of the entire group. The criteria were revised in light of this experience and then applied to each category with more than a dozen examples. Evaluations included a field review of the structure, and, when time permitted, limited historical research. Results were presented to HBAC at bimonthly meetings. Members of the HBAC found a slide show to be a useful complement to the evaluation sheet and other printed materials.

The HBAC evaluation process yielded a final group of 53 bridges deemed potentially eligible for the National Register. A thematic determination of eligibility, however, was not completed, and some attrition occurred. In 1986, WisDOT re-evaluated the remaining truss bridges, selected "next-best" substitutes for those that had been replaced, and initiated an intensive survey to document authoritatively the National Register eligibility of the sample. The field survey was conducted, on a contract basis, by historians Jeffrey A. Hess and Robert M. Frame III. The intensive field-survey sample contained a total of 54 bridges, including two which were already on the National Register (P-18-720 and P-53-162) for which additional information was desired. In addition to an in-depth field inspection, the consultants compiled historical research dossiers on the various bridges from local and state archives, libraries, and local residents.

The results of the intensive field-survey indicated that 48 bridges are immediately eligible for the National Register and that 2 bridges will soon be eligible when they reach 50 years of age (P-09-715 and P-10-266). These fifty bridges represent a total of 33 of Wisconsin's 72 counties. The SHPO determined that two wooden king post bridges (P-04-043 and P-04-044)were ineligible for the National Register because they were built in the 1950s. One has subsequently been replaced. <57>

Criteria Consideration B

Unlike most resource types, metal truss bridges were intentionally designed in a manner that facilitated disassembly and reassembly so that they could readily be moved to a new site when conditions at the original site changed. In the context considerations section of the Iron and Steel Truss Highway Bridges study unit of the CRMP the question of integrity of location is dealt with by noting that: "Integrity of location simply indicates whether the bridge is located at its original site or has been moved. Iron trusses are somewhat unique in this respect in that they were designed for easy transportation and erection and thus were very mobile structures. Such mobility should be viewed as proof of the intrinsic engineering value of iron trusses." <58> Consequently, the fact that the Sprague bridge has been moved from its original location does not appear to be of great importance in evaluating its potential significance. Since many smaller truss bridges have been moved at least once in their lifetime the significance of such bridges is not generally considered to have been compromised by having been moved if the structural integrity of the bridge remains intact. Because the Sprague Bridge still retains a high degree of structural integrity, the Sprague Bridge, despite having been moved, is believed to meet the conditions set forth in Criterion Consideration B.

ENDNOTES

1. Robert S. Newbery and Jeffrey A. Hess, field reviews; USGS, New Miner 7.5' Quad (NE/4 Necedah 15' Quadrangle), 1969.

2. Wisconsin State Gazetteer and Business Directory, R. L. Polk & Co., Chicago, 1909-10, p. 1192; 1913-14, p. 1013; 1919-20, p. 1137. No listings for Sprague in Juneau County were found for 1901 to 1906. The volume for 1907-08 was not located. Wisconsin Blue Book, 1911, Madison, 1911, pp. 71, 101.

3. Johnson, J.B., C. W. Bryan, and F. E. Turneaure, Modern Framed Structures, 1905 ed., p. 3. In other words, the "assemblage had rigidity and behaved as a unit." Ellis L. Armstrong, History of Public Works in the United States, 1776-1976, American Public Works Association, 1976, p. 109.

4. Milo S. Ketchum, Design of Highway Bridges, New York, 1908, p.1.

5. A rectangle, on the other hand, can become a parallelogram as everyone with a sagging screen door knows. The common solution to the sagging door is to run a small rod diagonally across it, thus creating two triangles. The resulting figure looks remarkably like one panel of a 19th century Pratt truss.

6. American Association for State and Local History Technical Leaflet 95, History News, Vol. 32, No. 5, May 1977: T. Allan Comp and Donald Jackson, "Bridge Truss Types: A Guide to Dating and Identifying," 5-7. Ketchum, Design of Highway Bridges, pp. 5-11.

7. James A. L. Waddell, Bridge Engineering, New York, 1925, p. 16.

8. Theodore Cooper, "The Use of Steel for Bridges, " American Society of Civil Engineers, Transactions, Vol. VIII (October, 1879), p. 265. Important railroad bridges in the United States were built of cast iron in the 1870s and thousands of short span cast iron girder bridges were still in use on the railroads in England and Wales as late as 1896. Waddell, Bridge Engineering, pp. 17, 24; Tyrrell, Henry Grattan. History of Bridge Engineering, Chicago, 1991, p. 151.

9. Captain William E. Merrill, Iron Truss Bridges for Railroads, New York, 1870, p. 126.

10. Bessemer's initial claims of tons rather than pounds was met with skepticism but, after some initial disappointments, proved true. Douglas A. Fisher, The Epic of Steel, New York, 1963, p. 117.

ENDNOTES CONTINUED

11. David Plowden, Bridges: The Spans of North America, New York, 1974, pp. 125-7; Fisher, Epic of Steel, p. 103; Herbert W. Ferris, editor, Rolled Shapes: Historical Record--Dimensions and Properties--Steel and Wrought Iron Beams and Columns, American Institute of Steel Construction, New York, 1953.

12. A number of companies, including Wisconsin Bridge and Iron, continued to advertise both iron and steel bridge until the turn of the century. See the advertisements for Wisconsin Bridge and Iron Company, in Polk's Wisconsin State Gazetteer and Business Directory, 1895-96, p. 687; and for Wrought Iron Bridge Company in Cassier's Magazine, Vol. 17, No. 6, (April 1900), p. 25. On the page opposite the Wrought Iron advertisement, the Berlin Iron Bridge Company prominently advertised only "Steel Bridges and Buildings."

13. Waddell, Bridge Engineering, Chapter IV, "Alloy Steels;" Economics of Bridgework; A Sequel to Bridge Engineering Chapter V, "Economics of Alloy Steels", New York, 1921.

14. Leslie Aitchison, Engineering Steels, New York, 1921, p. vii; W. E. Dalby, Strength and Structure of Steel and Other Metals, London, 1923, relies on three sophisticated laboratory instruments designed and developed by the author. A brief overview of 20th century structural steels is in Edwin H. Gaylord and Charles N. Gaylord, Design of Steel Structures, New York, 1957, pp. 43-46.

15. Although the Biennial Reports were not sophisticated in their engineering discussions, they did highlight new techniques and designs. The lack of any mention of metallurgy in the Biennial Reports is taken as a measure of a lack of priority.

16. Hans Nelson Brue, "The Development of Highway Bridges in Wisconsin," Bachelors Thesis in Civil Engineering, University of Wisconsin, 1916, pp. 4-5. The historical record is sketchy here, and there is no reliable census of bridges by type for this period. The 1880s and 1890s saw a large number of metal trusses built, often with some controversy of the higher first cost when compared to the familiar old wooden bridge. It was not just a phenomenon of the late 19th century. Simple wood beam, beam-and-pier, and truss bridges were recommended for the cost-conscious land owner in Frederick S. Langa's, "Bridge Your Way to a Low-Cost Lot," Rodale's New Shelter (April 1981) pp. 66-75.

17. Diane Kromm, "Milford Bridge," Historic American Engineering Record Report, unpublished, 1987, HAER No. WI-21.

ENDNOTES CONTINUED

18. Oconomowoc City Clerk Records, 1871, City Engineer's Office, unprocessed collection, Archives Division, SHSW; Kromm, "Milford Bridge," pp. 2-4.

19. T. Allan Comp and Donald Jackson, "Bridge Truss Types: A Guide to Dating an Identifying," American Association for State and Local History, Technical Leaflet 95, History News 32 (May 1977); Working Files, HBAC.

20. Comp and Jackson,"Bridge Truss Types." A few all metal Howe trusses were built, including, apparently, one built in Watertown in 1875. Kromm, "Milford Bridge," p. 2.

21. Comp and Jackson, "Bridge Truss Types."

22. Waddell, Economics of Bridgework, pp. 73-74; Boller, Practical Treatise on the Construction of Iron Highway Bridges, pp. 44-49; "Discussion of American Railroad Bridges," American Society of Civil Engineers, Transactions 26 (No. 429, December 1889), p. 593. According to Boller (p. 47), "Whatever objection has been urged against shop-riveting is intensified in a high degree when the field-riveter steps in to do his part of the work." For an argument that pin-connected Pratts require more metal than riveted Warrens, see Johnson, et. al., Modern Framed Structures, p. 276.

23. Waddell, Economics of Bridgework, p. 7; "The Development of Bridge Trusses," Engineering Record, 42 (November 3, 1900), p. 411.

24. Fowler, "Some American Bridge Shop Methods," Machinery in Bridge Erection," Cassier's Magazine, 17 (January, February 1900), pp. 200-215, 327-344; "Pneumatic Percussion Riveters," Engineering News, 39 (March 3, 1898), pp. 148-149; "Field Riveting by Power," Engineering News, 42 (October 27, 1900), p. 385; "Pneumatic Field Riveting in Railway Bridgework," Engineering News, 42 (October 27, 1900), pp. 393-94.

25. Waddell, Economics of Bridgework, p. 74; "Development of Bridge Trusses," p. 411.

26. See, for example, the photograph of "a riveted steel [Pratt pony truss] highway bridge 40' span...built under the supervision of the Highway Division" in Arthur H. Hirst and M. W. Torkelson, Culverts and Bridges (Madison, Highway Division, Wisconsin Geological and Natural History Survey, Road Pamphlet No. 4, second edition, 1908), p. 43. The SHC standard plan (dated 1908) for a riveted Warren pony truss with a 40-foot span is found in Microfilm Reel M-1, "Miscellaneous Standards," Bridge Section, WisDOT.

ENDNOTES CONTINUED

27. A. R. Hirst, "Bridges and Culverts for Country Roads," Engineering News (October 9, 1913), p. 729. With minor modifications, these standards are reiterated in Wisconsin Highway Commission, Second Biennial Report, p. 24.

28. U. S. Department of Transportation, Federal Highway Administration, "Design and Construction of Welded Bridge Members and Connection," Washington, D.C., 1980, pp. 1, 6-9.

29. Ballard Campbell, "The Good Roads Movement in Wisconsin, 1890-1911," Wisconsin Magazine of History, 49 (Summer 1966), pp. 273-93; M. C. Davis, A History of Wisconsin Highway Development, 1825-1945 (Madison, 1947), pp. 218--222; Wisconsin Statutes, Second Session of the Legislature, January 10, 1849 (Southport, 1849), pp. 182-83; Town Laws of Wisconsin, 1858, p. 157; Legislature of Wisconsin, Private and Local Laws, 1867, pp. 60-61, 179-82; Laws of Wisconsin, 1881, Chapter 315, pp. 407-08; Laws of Wisconsin, 1885, Chapter 187, pp. 162-64. Richard N. Current, The History of Wisconsin, volume II, The Civil War Era, 1848-1873, (Madison, 1976), p. 28; Robert Nesbit, Wisconsin, A History (Madison, 1973), p. 197. A sampling of available county board records suggest that county-aid bridge projects were infrequent during the 1880s, and numbered five to ten per county per year during the 1890s.

30. Campbell, "Good Roads," p. 278-79; Laws of Wisconsin, 1907 (Madison, 1907), Chapter 552, p. 292.

31. Campbell, "Good Roads," pp. 279-84; Davis, Wisconsin Highway Development, p. 104.

32. SHC, Second Biennial Report, July 1, 1911 to January 1, 1915 (Madison, 1915), p. 24.

33. WisDOT, Bridge Section, Microfilm Reel M-1.

34. Davis, Wisconsin Highway Development, pp. 112-13; SHC Second Biennial Report, pp. 14, 21, 30; see also SHC, Preliminary Biennial Report, July 1, 19ll to January 1, 1913 (Madison, 1913), p. 17.

35. The SHC succinctly assessed the pros and cons of steel and concrete bridges in its Sixth Biennial Report, 1925-1926 (Madison, 1926), p. 67. From 1911 to 1915, truss bridges in Wisconsin cost considerably less per foot to build than concrete structures, but then steel began its "great advance in price." see SHC, Fourth Biennial Report, 1916-1918 (Madison, 1918), pp. 11-12; see also the comparative cost chart in Engineering News, 47 (February 28, 1917).

ENDNOTES CONTINUED

36. Brief biographies of these men are in Robert S. Newbery, Jeffrey A. Hess, and Robert F. Frame, III, Truss Bridges; Vol. II, Historic Highway Bridges of Wisconsin, Wisconsin Department of Transportation, 1988.

37. Paul Lusignan to Robert S. Newbery, personal correspondence, May 19, 1988.

38. Mss. Census, 1900, Enumeration District 47, Sheet 1, line 62; Mss. Census, 1910, Enumeration District 64, Sheet 6, Line 94. Interview with Willis E. Gifford, Jr., October 5, 1987. Before moving to Michigan, Gifford married Elbertine Swan.

39. Madison City Directories: 1902, p. 172; 1904, p. 135; 1907, p. 144; 1909, p. 157; 1911, p. 179; 1914, p. 187.

40. The Gifford Photograph Album is in the possession of his son. The list for 1905 begins with his number 82, indicating that he built quite a few bridges before 1905. There are some discrepancies, however, between the typed lists and two different sets of labels on the photographs. A few of the photographs have what appear to be older white ink labels, and almost all have black ink numbers. A newspaper article dated 1909 states Gifford was an agent for Elkhart.

41. G. R. Angell & Company, Madison City Directory, Vol. 14. 1916, pp. 184, 627; Madison Directory Company, Madison City Directory, 1916, p. 301; Madison City Directory, 1931, p. 326.

42. James L. Cooper, Iron Monuments to Distant Posterity, Indiana's Metal Bridges, 1870-1930, DePauw University, 1987, pp. 22-32. Curiously Elkhart Bridge and Iron is not mentioned in either Anthony Deahl, ed., A Twentieth Century History and Biographical Record of Elkhart County, Indiana, New York, 1905, pp. 235-42; or in Abraham E. Weaver, ed., A Standard History of Elkhart County, Indiana, Vol. I, New York, 1916, pp. 268-75.

43. Cooper, Iron Monuments, pp. 29-30; Fredric L. Quivik, Historic Bridges in Montana, Historic American Engineering Record, National Park Service, U. S. Department of the Interior, Spring 1982.

ENDNOTES CONTINUED

44. Cooper, Iron Monuments, pp. 29-30. The template method is assumed to be a more modern fabrication technique. Charles Evan Fowler, "Machinery in Bridge Erection," Cassier's Magazine, Vol. XVII, No. 4 (February 1900), pp. 327-29. See also, Robert S. Newbery, Jeffrey A. Hess, and Robert F. Frame, III, Truss Bridges, Vol. II, Historic Bridges in Wisconsin, Wisconsin Department of Transportation, 1988.

45. Cooper, Iron Monuments, pp. 29-30.

46. Interview with Willis E. Gifford, Jr., October, 1987.

47. Photo Album; Interview with Willis E. Gifford, Jr., October, 1987.

48. Interview with Willis E. Gifford, Jr., July, 1987. In the October interview, Willis, Jr. did say his father paid for sending him to the Lake Forest Academy for one year of high school.

49. Clayton Fraser, Historic Bridges of Colorado, eds., Rebecca Herbst and Vicki Rottman, Colorado Department of Highways, 1986, p. 11.

50. The SHC reported that 235 county aid bridges were constructed in 1912. This number grew to 433 by 1916. Although we do not know how many of Gifford's bridges were county aid bridges, it would appear that he had cornered a sizeable share of this market in the pre-World War I years. "Facts and Figures on State Highway Construction," Wisconsin Blue Book, Madison, 1917, pp. 427.

51. Frank J. Miller, who succeeded Brumbaugh as president, held that position "well beyond 1930." Cooper, Iron Monuments, p. 29; Gifford Photograph Album.

52. Gifford's son could not remember the exact year but calculated it would have been shortly after World War II.

53. George M. Danko, "The Development of the Truss Bridge, 1820-1930, with a Focus Toward Wisconsin," unpublished report prepared for the State Historic Preservation Office, State Historical Society of Wisconsin, 1976; Danko, "A Selective Survey of Metal Truss Bridges in Wisconsin," unpublished report prepared for Historic Preservation Division, State Historical Society of Wisconsin, 1977.

ENDNOTES CONTINUED

54. Originally, Pratt pony trusses with a single vertical member were considered to be a separate category, but this distinction was subsequently dropped and the number of categories was reduced to 17.

55. See Danko, "Selective Survey," p. 1.

56. Howard Newlon, Jr., "A Trial Rating System for Bridge," Interim Report No. 1, Criteria for Preservation and Adaptive Use of Historic Highway Structures,, Virginia Highway and Transportation Research Council, 78-R29, January 1978.

57. Richard W. Dexter to David H. Pantzlaff, January 20, 1988. WisDOT Project ID 8355-04-00; SHSW: #88-0053.

58. Wyatt, Barbara (Ed.). Cultural Resource Management in Wisconsin. Historic Preservation Division, State Historical Society of Wisconsin, Madison, 1986, Vol. 2, pg. 12/20 (Transportation).

MAJOR BIBLIOGRAPHIC REFERENCES CONTINUED

Aitchison, Leslie
Engineering Steels. London: Macdonald, 1953.

Armstrong, Ellis L.
History of Public Works in the United States, 1776-1976, American Public Works Association, 1976.

Aston, James, and Edward B. Story
Wrought Iron: Its Manufacture, Characteristics, and Application. Pittsburgh, Pa.: A.M. Byers [1939].

Boller, Alfred P.
Practical Treatise on the Construction of Iron Highway Bridges. 1876; 4th ed. 1890.

Boylston, Herbert Melville
An Introduction to the Metallurgy of Iron and Steel. New York: J. Wiley & Sons, 1928.

Brook, F. B.
"An Illustrated Historical Description of All Expired Patents on Truss Bridges." Engineering News (October 28, 1882) and American Contract Journal (September 8, 1883).

Brue, Hans Nelson
"The Development of Highway Bridges in Wisconsin," Civil Engineering Thesis, University of Wisconsin, 1916.

Campbell, Ballard C.
"The Good Roads Movement in Wisconsin, 1890-1911." Wisconsin Magazine of History 49.4 (1966): 273-93.

Cassier's Magazine
Charles Evan Fowler, "Machinery in Bridge Erection,", 17.4 (February 1900), pp. 327-29.

Advertisement for Wrought Iron Bridge Company and the Berlin Iron Bridge Company, 17.6 (April 1900), pp. 25-26.

MAJOR BIBLIOGRAPHIC REFERENCES CONTINUED

Chamberlin, William P.
Historic Bridges—Criteria for Decision Making. National Cooperative Highway Research Program. Synthesis of Highway Practice 101. Transportation Research Board. National Research Council, Washington, D.C., [1983].

Comp, T. Allen and Donald Jackson
"Bridge Truss Types: A Guide to Dating and Identifying." American Association for State and Local History, Technical Leaflet 95, History News 32(5), 1977.

Cooper, Theodore
"The Use of Steel for Bridges." Transactions of the American Society of Civil Engineers, 8 (October 1879): 263-294.

"American Railroad Bridges." Transactions of the American Society of Civil Engineers, vol. 8 (October 1879):1-58

Current, Richard N.
The History of Wisconsin, Volume II, The Civil War Era, 1848-1873, ed. by William Fletcher Thompson. Madison, Wisc.: State Historical Society of Wisconsin, 1976.

Dalby, W. E.
Strength and Structure of Steel and Other Metals. London: E. Arnold, 1923.

Danko, George M.
The Development of the Truss Bridge, 1820-1930, with a Focus Toward Wisconsin. Historic Preservation Division, State Historical Society of Wisconsin, Madison, 1976.

A Selective Survey of Metal Truss Bridges in Wisconsin. Historic Preservation Division, State Historical Society of Wisconsin, Madison, 1977.

The Evolution of the Simple Truss Bridge, 1790-1850; From Empiricism to Scientific Construction. Ph.D. Thesis, University of Pennsylvania, 1979.

Darnell, Victor C.
A Directory of American Bridge-Building Companies, 1840-1900, Society for Industrial Archeology, Occasional Publication No. 4, Washington, D. C., 1984.

MAJOR BIBLIOGRAPHIC REFERENCES CONTINUED

Davis, M. G.
A History of Wisconsin Highway Development, 1825-1945. Madison, Wisc.: Wisconsin Department of Transportation, 1989.

Deahl, Anthony, ed.
A Twentieth Century History and Biographical Record of Elkhart County, Indiana. Chicago: Lewis Publishing Co., 1905.

Dexter, Richard W.
Letter to David H. Pantzlaff, January 20, 1988. Re WisDOT Project ID 8355-04-00; SHSW: #88-0053.

Engineering News
"Pneumatic Percussion Riveters," 39 (March 3, 1898), pp. 148-149.

"Field Riveting by Power," 42 (October 27, 1900), p. 385.

"Pneumatic Field Riveting in Railway Bridgework," 42 (October 27, 1900), pp. 393-94

Hirst, A. R., "Bridges and Culverts for Country Roads," (October 9, 1913), p. 729.

Engineering Record
"The Development of Bridge Trusses," 42 (November 3, 1900), p. 411.

Ferris, Herbert W., ed.
Rolled Shapes: Historical Record—Dimensions and Properties—Steel and Wrought Iron Beams and Columns. American Institute of Steel Construction. New York: n.pub., 1953.

Fisher, Douglas A.
The Epic of Steel. New York: Harper & Row, [1963].

Fowler, Charles Evan
The Ideals of Engineering Architecture. Chicago: Gillette Publishing Co., 1929.

Gaylord, Edwin H. and Charles N. Gaylord
Design of Steel Structures. New York: McGraw-Hill, 1957.

MAJOR BIBLIOGRAPHIC REFERENCES CONTINUED

Gifford, Willis E., Jr.
Interviews conducted July and October, 1987. The Gifford Photograph Album is in his possession.

Hirst, Arthur R.
Culverts and Bridges. Road Pamphlet No. 4, Wisconsin Geological and Natural History Survey, Madison, 1907.

Hirst, Arthur R. and M.W. Torkelson
Culverts and Bridges. Road Pamphlet No. 4, 2nd ed., Wisconsin Geological and Natural History Survey, Madison, 1908.

Hopkins, Henry James
A Span of Bridges: An Illustrated History. New York: Praeger, 1970.

Hotchkiss, W. O.
First Biennial Report of the Highway Division, Road Pamphlet No. 5, Wisconsin Geological and Natural History Survey, Madison, 1909.

Johnson, J. B., C. W. Bryan, and F. E. Turneaure
The Theory and Practice of Modern Framed Structures. 1893; 8th Ed., 1905.

Ketchum, Milo S.
The Design of Highway Bridges and the Calculation of Stresses in Bridge Trusses. New York: McGraw-Hill, 1908.

Kromm, Diane
"Milford Bridge," Historic American Engineering Record Report, unpublished, 1987, HAER No. WI-21.

Langa, Frederick S.
"Bridge Your Way to a Low-Cost Lot," Rodale's New Shelter, (April 1981), pp. 66-75.

Lusignan, Paul
Letter to Robert S. Newbery, May 19, 1988.

Madison City Directory. Madison Directory Company: 1902, 1904, 1907, 1909, 1911, 1914, 1916, 1931. G. R. Angell & Company: vol. 14 (1916).

MAJOR BIBLIOGRAPHIC REFERENCES CONTINUED

Merrill, Captain William E.
Iron Truss Bridges for Railroads, New York, 1870.

Meyer, H.W. Guy and Robert Newbery
"Ordinary Iron Highway Bridges." Wisconsin Academy Review 30.2 (1984):34-37.

Newbery, Robert S., Jeffrey A. Hess, and Robert F. Frame, III
Truss Bridges; Vol. II, Historic Highway Bridges of Wisconsin, Wisconsin Department of Transportation, 1988.

Newlon, Howard, Jr.
"A Trial Rating System for Bridge," Interim Report No. 1, Criteria for Preservation and Adaptive Use of Historic Highway Structures, Virginia Highway and Transportation Research Council, 78-R29 (January 1978).

Oconomowoc, City of
Clerk Records, 1871. City Engineer's Office, unprocessed collection, Archives Division, State Historical Society of Wisconsin.

Ohio State University and Ohio Historical Society
Proceedings of the First Historic Bridges Conference, Ohio State University, Department of Civil Engineering, and Ohio Historical Society-Historic Preservation Division. 1985.

Plowden, David
Bridges: The Spans of North America. New York and London: W.W. Norton & Co., 1974.

Schneider, Charles C.
"The Evolution of the Practice of American Bridge Building." Transactions of the American Society of Civil Engineers 54 (1905):213-234.

MAJOR BIBLIOGRAPHIC REFERENCES CONTINUED

State Highway Commission

Preliminary Biennial Report, July 1, 19ll to January 1, 1913. Madison, Wisc.: published by the State, 1913.

Second Biennial Report, July 1, 1911 to January 1, 1915. Madison, Wisc.: published by the State, 1915.

Fourth Biennial Report, 1916-1918. Madison, Wisc.: published by the State, 1918.

Sixth Biennial Report, 1925-1926. Madison, Wisc.: published by the State, 1926.

State of Wisconsin Legislature

Private and Local Laws, 1867
Laws of Wisconsin, 1881, Chapter 315
Laws of Wisconsin, 1885, Chapter 187
Laws of Wisconsin, 1907, Chapter 552
Wisconsin Statutes, Second Session of the Legislature, January 10, 1849
Town Laws of Wisconsin, 1858

Torkelson, Martin W.

"Highway Bridges in Wisconsin." The American City, Town and Country Edition 12 (1915): 287-289.

"Wisconsin Highways," pp. 8-29. Wisconsin Blue Book; Madison, 1933.

Tyrrell, Henry Grattan

History of Bridge Engineering: From the Earliest Times to the Present Day. Chicago: published by the author, 1911.

U. S. Department of Transportation, Federal Highway Administration

"Design and Construction of Welded Bridge Members and Connection," Washington, D.C., 1980.

U. S. Government, Census Office.

Mss. Census, 1900, Enumeration District 47.

Mss. Census, 1910, Enumeration District 64.

MAJOR BIBLIOGRAPHIC REFERNCES CONTINUED

Waddell, James A.L.
The Designing of Ordinary Iron Highway Bridges. 1884; 2nd Edition, 1891.

Bridge Engineering. 1st ed. 1916; New York: J. Wiley & Sons, 1925.

"Simple Truss Bridges." The American City 16 (1917): 114-120.

Waddell, James A.L.
Economics of Bridgework: A Sequel to Bridge Engineering. New York: J. Wiley & Sons, 1921.

Weaver, Abraham E., ed.
A Standard History of Elkhart County, Indiana, Vol. I. Chicago: American Historical Society, 1916.

Whitney, Charles S.
Bridges: Their Art, Science, and Evolution. 1929; New York: Crown Publishers-Greenwich House, 1983 .

Wisconsin Blue Book
1911 edition. Madison, Wisc.: published by the State, 1911.

"Facts and Figures on State Highway Construction," 1917 edition. Madison, Wisc.: published by the State, 1917.

Wisconsin Department of Transportation
Bridge No. P-33-217 plans, 1917. Central Office, Bridge Section, Microfilm Reel M-1.

"Miscellaneous Standards." Central Office, Bridge Section, Microfilm Reel M-1.

Wisconsin State Gazetteer and Business Directory
1895-96, 1909-10, 1913-14, 1919-20 editions. R. L. Polk & Co., Chicago.

Withey, M. O. and James Aston
Johnson's Materials of Construction. 1897. New York: J. Wiley & Sons, 1930.

Wyatt, Barbara (Ed.). Cultural Resource Management in Wisconsin. Historic Preservation Division, State Historical Society of Wisconsin, Madison, 1986, Vol. 2, pg. 12/20 (Transportation).

OTHER STATEWIDE STUDIES

Cooper, James L.
Iron Monuments to Distant Posterity: Indiana's Metal Bridges, 1870-1930. Indiana Department of Highway and the Federal Highway Administration, 1987.

Deibler, Dan Grove
An Examination of the Development of the Truss Form Including an Annotated List of Nineteenth and Twentieth Century Bridge Companies: Metal Truss Bridges in Virginia: 1865-1932. Virginia Highway & Transportation Research Council, Charlottesville, Virginia, 1975.

Georgia Department of Transportation and Georgia Department of Natural Resources
Historic Bridge Survey, 1981.

Herbst, Rebecca and Vicki Rottman, et al.
Historic Bridges of Colorado, Colorado Department of Highways, 1986.

Meyer, H.W. Guy
"Iron and Steel Truss Highway Bridges," in Barbara Wyatt, ed., Cultural Resource Management in Wisconsin, vol 2., Historic Preservation Division, State Historical Society of Wisconsin, 1986.

Ohio Department of Transportation
The Ohio Historic Bridge Inventory, Evaluation, and Preservation Plan. Ohio Department of Transportation, 1983.

Pennsylvania Department of Transportation and Pennsylvania Historical and Museum Commission
Historic Highway Bridges in Pennsylvania, 1986.

Quivik, Fredric L.
Historic Bridges in Montana, U.S. Department of the Interior, National Park Service, Historic American Engineering Record, 1982.

Juneau County Parks Committee
Room 100, Courthouse
Mauston, Wisconsin 53948

Items a-e are same for photographs 1-3
Photo 1

a) Sprague Bridge
b) Necedah/Armenia Townships, Juneau County, Wisconsin
c) Robert S. Newbery
d) July 1988
e) State Historical Society of Wisconsin
f) View looking south
g) Photo 1 of 10

Photo 2

f) View looking south, detail of western truss
g) Photo 2 of 10

Photo 3

f) Detail of plate
g) Photo 3 of 10

Items a-e are the same for photographs 4-10
Photo 4

a) Sprague Bridge
b) Finley Township, Juneau County, Wisconsin
c) Amy A. Ross
d) September 1993
e) State Historical Society of Wisconsin
f) View looking southwest, general setting
g) Photo 4 of 10

Photo 5

f) Barrel view looking west
g) Photo 5 of 10

Photo 6

f) Barrel view, detail of deck
g) Photo 6 of 10

Photo 7

f) View looking southwest, detail of northern truss
g) Photo 7 of 10

Photo 8

f) View looking southwest, detail of pier
g) Photo 8 of 10

Photo 9

f) View looking south, detail of panel
g) Photo 9 of 10

Photo 10

f) View looking east, detail of endpost
g) Photo 10 of 10