Laughery Creek Bridge
Aurora vicinity
Dearborn and Ohio Counties
Indiana

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HISTORIC AMERICAN ENGINEERING RECORD

Laughery Creek Bridge

HAER IN-16

Location:	Spanning Laughery Creek just west of State Rt. 56, 2.5 miles southeast of Aurora. UTM: 16.683010.4321420 Quad: Aurora
Date of Construction:	1878
Present Owner:	
Significance:	Triple-intersection Pratt through-truss bridge, is an extremely rare survivor of its type and the oldest known metal truss bridge in Indiana.
Historian:	Alex Gratiot

I. The Design

The design of the Laughery Creek Bridge was known in the United States as a "triple intersection truss,"[1] "triple truss,"[2] "triple quadrangular,"[3] and "triple system...of the Whipple type."[4] In Germany, it was known as a truss of the "Mohnie system,"[5] and it is possible that there were other names for it.[6] The name "triple intersection truss" refers to the diagonals, which cross three panels, in the same way that "double intersection" referred to what is now known as the Whipple truss.[7] The names "triple truss," "triple quadrangular," and "triple system" all refer to the method used in analyzing the stresses in the truss, which is discussed below.

Throughout the second half of the nineteenth century, standard American bridge design relied on deep trusses with long panels for economy, strength, and ease of erection in long span bridges.[8][9] The double intersection Pratt truss, whose "advantage over the Pratt for long spans is in having short panels, and yet an economical inclination for the diagonals, (about 45°),"[10] was used extensively. The double system of this design permitted much deeper trusses in long spans than was possible with the Pratt while retaining a reasonable panel length.[11] With the Whipple system the largest trusses still had trouble getting a depth-to-length ratio larger than 1:10.[12] There was at least one designer, Thomas Curtis Clarke,[13] who thought that a larger ratio was desirable, and suggested 1:8.[14] The bridge Clarke criticized was Linville's Cincinnati Southern Railway Bridge, which had a center span of 515 feet, and was a double intersection truss.[15] A 1:8 ratio would have caused the bridge to have a depth of 64 feet,[16] giving it a panel of roughly 32 feet, which was much larger than was common.[17] Clarke must have known this, and when he later compared the efficiency and economy of different types of bridges of equal span, his hypothetical 715 foot truss is a triple intersection.[18] Although Clarke was writing long after the triple intersection truss had been developed, his views on bridge design were generally not revolutionary,[19] and it is likely that his criticisms of American truss design were not new. Although on the Laughery Creek Bridge it is not known whether the desire for a deep truss preceeded the design that encouraged it, the depth to length ratio is high: 1:7.5.[20]

The triple intersection Pratt truss, unlike the double intersection, was never common. One textbook author wrote that it had been used "to some extent."[21] Another author, writing in 1888, refers to "the few built," and implies that the design was already obsolete by writing that "they are rarely used in modern practice."[22] The books that give the design the most attention are those that appeared in the 1870's.[23] The most complete analysis of a triple intersection truss is found in a treatise on bridges copyrighted in 1873.[24]

The Roundout Railroad Bridge and viaduct, built by the Phoenix Bridge Company prior to 1885, one mile south of Kingston, New York on the line of the New York, Westshore and Buffalo Railroad, employed a two span triple intersection Pratt to span Roundout Creek.

The stresses in the triple intersection truss were usually found in the same way as in the double intersection Pratt.[27] The standard methods of analysis had no trouble with the Pratt truss, often known as the "simple truss."[28] The same method was not applicable to the Whipple truss, and it was necessary to assume that it was a "double truss", consisting of two Pratt systems superimposed.[29] The two separate systems were analyzed, and the stresses added. The assumption was made that the two systems acted totally independent of each other.[30] This assumption was known to be incorrect,[31] but it was not considered to be significant until the late 1880's and 1890's, when various attempts to cure the problem were made.[32] Similarly, the triple intersection truss was assumed to consist of three simple trusses,[33] which gave rise to the names "triple truss," "triple system," and "triple quadrangular." The indeterminate nature of the strains in multiple systems of trussing eventually made them all undesirable when compared to later determinate truss designs that had the same features.[34]

Many of the other parts of the Laughery Creek Bridge are standard. The posts, which are 40 teet tall, withstand only small compressive forces, but to prevent buckling because of their length they require either excessive over-design or intermediate support. The "center channel strut," as it is called in the specifications, gives the required support and was a common solution to the problem.[35] 18 feet was the standard width for a "double roadway, admitting the passage of vehicles in opposite directions,"[36] but for lateral strength against wind pressure it was the minimum in a 300 foot span.[37] The commissioners apparently thought it very important that the columns not be closed, be of the Phoenix or Keystone type, and follow closely what later became standard practice. Eyebars in truss bridges had to be drilled within very fine tolerances so that pairs would bear equally on a pin. The designer of the Laughery Creek Bridge used a clever system to cut down on the number of eyebars used. Although the chord stresses increase significantly with each panel closer to the center of the span, each set of eyebars crosses two panels without interruption. To allow for the post unconnected to the main chord bars, there are two smaller bars that cross only one panel, beginning at the unconnected post and continuing to the next post nearer the center of the bridge, which is naturally connected to the main chord bars. The commissioners' requirement that no member be strained more than 10,000 lbs./sq. ft. was fairly standard, but a more precise requirement could have been specified.[39] The live load of 100 lbs./sq. ft. was generous for a country road, but was not excessive or unusual.[40]

The same two design improvements that eliminated the need for the triple intersection truss also made the Whipple truss obsolete.[41] The first, and most important, was the use of subdivided panels, pioneered by Albert Fink[42] Joseph H. Wilson and Henry Pettit.[43] This made possible the use of deep trusses and gave the effect of

short panels, but did not have the indeterminate structure of the multiple systems.[44] The designs of Pettit and Wilson were quickly given a great deal of attention.[45] The second improvement made was in the use of the curved top chord in the Baltimore truss, whose stresses were also easily analyzed.[46] The economies made possible by these designs and the use of steel are evident in a bridge built by the Wrought Iron Bridge Company about 1890. The bridge was 300 feet long and 18 feet wide, which is to say that it had the same overall dimensions as the Laughery Creek Bridge, but required only eight subdivided panels, (giving the effect of 16) as compared to the 21 panels used on the Laughery Creek Bridge.[47] The greatest defect of the design is its lack of economy. Where a Whipple truss of the same span might have 15 panels and 12 posts, the Laughery Creek Bridge has 21 panels and 18 posts. Where the same Whipple truss could have a maximum of 10 different sizes of diagonals, counters and suspenders, the Laughery Creek bridge has 14 different sizes. Where the former would have 30 connections on the chords, the latter has 42.[48]

The triple intersection truss apparently took the designers' desire to have a deep truss with short panels to extreme lengths, without solving any of the problems of design or analysis that developed. The anonymous designer may have seen the advantages of the Whipple truss over the Pratt, and assumed that the triple intersection truss would have a similar advantage over the Whipple.

II. History

In 1867 the commissioners of Dearborn and Ohio Counties decided to replace the ferry across Laughery Creek with a bridge. The bridge was to carry the road from Rising Sun, the seat of Ohio County, to Aurora, then a prosperous town a few miles to the north. Although there are no statistics, the road, which followed the Ohio River to New Albany in the south and Cinncinnati in the north, must have been fairly important.[1]

On December 4, 1867, the counties contracted with John R. Frost, of Hamilton County, Ohio, to build the superstructure. The bridge was to be a single span 300 feet long, 23 feet wide from center to center of the two trusses and 30 feet deep from center to center of the two chords.[2]

The abutments, contracted to "Messrs Green & Co.", were not finished until December of 1868. Although the north abutment had been finished quickly, the contractors found no firm foundation for the southern one, and "so were compelled to drive piles, and were delayed in this by high water." There was 20 feet of earth fill above the tops of the piles outside the abutments. One Aurora paper proudly stated: "It looks as if they were here to stay." These piers are among the finest specimens of that kind of work in the state, and one would judge that they would last for all time."[3]

The bridge Frost built was a Howe truss designed after a patented improvement made by Frederick H. Smith, of the well-known firm of Smith, Latrobe and Company. The improvement consisted of a wrought iron bottom chord in the place of the usual wooden one.[4] Frost broke the contract, and the bridge was not finished until 9 September 1869.[5][6] Instead of $21,000, the bridge was finished at a cost of $41,000.[6] On the night of 3 June 1878, the bridge, which for some time had been considered unsafe, fell into the river, and was announced "a perfect wreck."[7]

After selling the remains of the old bridge, the commissioners of both counties met to discuss a new bridge.[8] Of the six commissioners, Scott Billings and R.D. Slater were the only ones who had been directly involved with the earlier bridge, and only Billings had been a commissioner at the time.[9] Unlike the other commissioners, their voting records were consistently in favor of a new bridge. During the 6 July 1878 joint meeting, a vote was taken on a motion to rebuild the bridge. The three Ohio County commissioners and Slater of Dearborn County voted the motion through. Commissioners Hannah and Slater were appointed on a later motion by Scott Billings to "examine such bridges as they may think expedient, and to report in reference to their excellencies."[10]

At another joint meeting on 27 July 1878, Fred Slater reported on what he and Hannah had seen.[11] They had gone to Canton and visited the Wrought Iron Bridge Company, and had spent some time talking to David Hammond, founder and president of the company, who gave them "all the information he could, in regard to bridge building." The two commissioners then went to Tiffin, Ohio, where they examined a bridge built by the Wrought Iron Bridge Company over the Sandusky River, with a span of 206 feet. They proceeded to Cinncinnati, where they looked at both of the bridges designed

by Linville: the Newport Bridge, with a center span of 415 feet, and the Cinncinnati Southern Railway Bridge, whose center span of 515 feet was at the time the longest single span truss in the world. Both of these bridges were double intersection Pratt trusses, the former built by the Edgemoor Bridge Works of Wilmington, Delaware and the latter by the Keystone Bridge Works of Pittsburgh.[12] The only criticism of the commissioners regarding the last two bridges was the use of closed columns.

The commissioners concluded: "As far as our judgement goes, we would recommend the wrought iron bridge built at Canton, Ohio for one reason, and that is this: you can get at all of the parts of the Canton bridge, to paint it, which you can not, on a tubular bridge, and the result will be that the rust on the inside of these tubes will eventually eat through, and for that reason we favor the Canton bridge."

On 5 August 1878, the commissioners decided on a date, September 2, to accept proposals for a new bridge. Henry Fitch, the county engineer, was authorized to write the specifications to send to builders and newspapers. For two weeks, until the first Monday of September, the commissioners had the notice appear in every issue of the Lawrenceburg Register of Dearborn County and the Saturday News of Ohio County, and every other day in the Cinncinnati Daily Enquirer and the Cinncinnati Daily Gazette.[13] Bids were to be accepted on three proposals: the first for a single span bridge of 300 feet with an 18 foot roadway, to be built on the old abutments. The second was for a single span of 200 feet, to be built using the old southern abutment and a new one to be built 200 feet to the north of it. The third was for a 200 foot span of wood, to be built on the same plan as the 200 foot iron span. Specifications were also requested on the additional abutment.[14] Although the bids were required by September 2, the commissioners did not meet until the ninth to discuss them, probably to give Henry Fitch time to look them over.[15]

After hearing a petition from a number of Dearborn County citizens "praying the commission to build a wooden bridge," and after speeches from two Aurora residents in favor of an iron bridge, the commissioners heard what the county engineer had to say about the various bids. Mr. Fitch reported that although he had not done all the homework he would have liked, he had found that many of the bids were not up to the standards set out in the advertisement. He stated that the Wrought Iron Bridge Company, the Pittsburgh Bridge Company,[16] and perhaps two others had proposals that "were nearly or quite up to the required specifications." The only other company known to have made a bid was the Keystone Bridge Company, whose bid arrived 20 minutes after the deadline, but was accepted nevertheless. Fred Slater moved that they build a 300 foot iron bridge, and the motion was carried. After a motion to scrap all the bids failed, Slater moved that they accept the Wrought Iron Bridge Company's proposal. Only he and Hannah voted for the motion. Slater then moved that they accept the Pittsburgh Bridge Company's proposal, whose bid, roughly 30% higher than that of the Wrought Iron Bridge Company, could not have been very attractive to the commissioners. No one seconded the motion. At that point John

Cofield, an Ohio County commissioner, moved that they reconsider their vote on the Wrought Iron Bridge Company's bid, and by the end of the day the commissioners had accepted the bridge company's plan "A", for a wrought iron bridge of 300 feet. The contract, signed the next day by David Hammond, required that the bridge be finished by 1 December 1878, and imposed a $20 penalty for each extra day the bridge remained uncompleted. The bridge was to cost $17,458; the cost was to be divided between Dearborn and Ohio counties in proportion to their taxable property.[17]

No details survive describing the building of the bridge. It was finished on December 10, and the commissioners met twice before the end of the month to have it tested. Each time the testing was postponed as inconvenient either for the counties or the bridge company.[18] In August of 1879 the commissioners permanently postponed the testing of the bridge, saying that they were fully assured of its strength and of the quality of the materials used.[19]

Before the $200 delay fine was refunded, the bridge cost Ohio County $2,931.05, and cost Dearborn County $14,526.95. Henry Fitch, the county engineer, was paid $135.26 for his services. Other expenses to the counties associated with the new bridge came to $899.84.[20]

The commissioners had faith in the strength of their new bridge. In March of 1879 the bridge was reported to be moving out of line. The commissioners looked at it, and "upon examination concluded that said bridge was in no danger and not likely to suffer any damages in their judgements."[21]

Commissioners in the 1870's knew very little of iron bridges,[22] and were probably aware of their ignorance. The commissioners of Dearborn and Ohio Counties were especially sensitive to this lack of knowledge because of the failure of their first attempt to have a bridge built across Laughery Creek. This experience did not lead them to be overly cautious when plans were made to build a new bridge. Even though Commissioners Slater and Billings were the only individuals who had been involved with the earlier bridge, they knew little more than the other committee members about the technical aspects of the project. Hannah and Slater, who had made the recommendation to accept the bid of the Wrought Iron Bridge Company, had little data justifying their decision. It may have been luck that made David Hammond's company as good as his salesmanship.[23] In any case, Hannah and Slater were convinced of the superiority of the Wrought Iron Bridge Company's work, and the other commissioners relied on them for advice. The vote of the commission appears to have been based largely on hearsay knowledge.

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Notes

I. The Design

1 Johnson, John Butler. The Theory and Practice of Modern Framed Structures. Copyright 1893. New York: 1896. p. 59.

2 Shreve, Samuel H. A Treatise on the Strength of Bridges and Roofs. 3rd edition. New York: 1882. Copyright 1873, not revised in later editions. See chapter of triple trusses.

3 Green, Charles Ezra. Trusses and Arches. Copyright 1879, 2nd edition 1884. Vol. 2, p. 64.

4 Merriman, Mansfield and Jacoby, J.S. A Textbook on Roofs and Bridges. Copyright 1888, New York: 1889. Vol. I, p. 115.

5 Mehrtens, Georg C. A Hundred Years of German Bridge Building. Berlin: 1900. p. 59.
In this reference, the author is describing the Greithausen Bridge, and it is possible that he here refers not to the triple intersection truss but to a curious system of endposts on the bridge, in which each of the systems of diagonals had a separate end column. For a thorough description of this feature, see Shreve on triple trusses.

6 Each of the textbooks found to mention the truss gives a different name, so it would not be unreasonable to suppose that there are others.

7 Green, p. 59.

8 See note 5.

9 Edwards, Llewellyn Nathaniel. A Record of History and Evolution of Early American Bridges. Orono, Maine: 1959, pp. 104-5. Edwards was comparing the European practice of using rigid, riveted structures, to American pin connected trusses.

10 Johnson, p. 57.

11 In all the articles and textbooks examined, no mention is ever made (in connection with Pratt, Whipple or triple intersection trusses) of changing the inclination of the diagonals significantly from 45 degrees. What this meant for the Pratt truss was that the panel length could only be somewhat shorter than the truss depth. In the Whipple truss, it meant that the truss depth was roughly equal to twice the panel length. In the triple intersection truss, it meant that the panel length was about one third the depth of the truss. On the Laughery Creek Bridge, the panels are slightly over 14 feet long, and the truss is 40 feet deep.

12 Both of Linville's Cinncinnati bridges, for example, had channel spans with a depth to length ratio of 1:10 . The largest of these was the 515 foot Cinncinnati Southern Railway Bridge built in 1877. For measurements

of both of these bridges, see p. 194-5 of the Clarke article in note 13.

13 Thomas Curtis Clarke, p. 188.

14 Clarke, p. 188, 194-5.

15 Clarke, p. 188.

16 Clarke, p. 188.

17 Naturally this assumes a roughly 45 degree inclination for the diagonals, which was what Linville generally used and what Clarke recommended. Standard practice connected the iron floor beams, suspended one below each panel, to each other with wooden floor joists running parallel to the chord bars. This set a fairly short limit to the length of a panel that used this system of flooring. See A.H. Heller, Stresses in Structures, New York: 1916, p. 222.

18 Clarke, pp. 188-90.

19 Clarke doubts, for example, that large cantilevers are possible, and ends his discussion of them by saying that "their success on an extensive scale is problemmatical."

20 Measurements from Dearborn County Commissioners' Record, Vol. 15, p. 229. It is tempting to suggest that the Clarke article influenced the Wrought Iron Bridge Company's choice of design for the Laughery Creek Bridge, but the time delay, between May 21 and 22, when the article was read and discussed, and August 15, when the notice to contractors first came out, is probably too short. Engineering News, published in Chicago, printed a condensation of the paper in 1881, on January 15, and if this is an indication of how long it took for the news to travel, then it is improbable that anyone at the Wrought Iron Bridge Company heard anything of the article within three months. The possibility should not be ignored that a large concern like the Wrought Iron Bridge Company may have had some sort of private channel of information to keep them in touch with what was going on in terms of bridge design. That one of their engineers, E.J.Landor, was barely two years out of Rensselaer Polytechnic Institute makes this sound even more possible.

One consideration not mentioned is the desire to keep the compression members short, which according to Carl Condit was an important factor in certain truss designs. Although this must have been of importance when the use of cast iron was still widespread, by 1878 it was probably a secondary concern. I found no reference to it as an important factor in the design, and the 40 foot posts seem to contradict that theory.

21 Johnson, p. 59.

22 Merriman and Jacoby, p. 115.

23 Shreve (1873) includes a whole chapter; Green (1879) gives a few pages. Neither gives his opinion of the trusses.

24 Shreve. Better than one-tenth of the book is on triple trusses.

25 Mehrtens and Shreve, p. 59.

26 Phoenixville Bridge Works. An Album of Designs: The Phoenix Bridge Company, p. 21; plate 9.

27 Shreve. Chapter on triple trusses.
Merriman and Jacoby. P. 115.
The only exception to this is Green's graphic theory, but this was not favored, by Green's own confession. See Green's preface.

28 Shreve, Chapter on simple trusses.

29 Shreve, chapter on Whipple trusses.

30 Shreve, chapter on triple trusses.

31 Johnson, p. 57.
Bowser, Edward A. Treatise on Roofs and Bridges, New York: 1898, p. 94.

32 J.A.L. Waddell, in his popular book, The Designing of Ordinary Highway Bridges, had the diagonals of the Whipple truss cut and connected at their centers, but this had the sad defect of doubling the number of diagonals in the bridge. Theories for analyzing indeterminate structures, needed for the Warren truss, were also applied to the Whipple.

34 Johnson, p. 57, p. 60.
Bowser, p. 94.

35 Johnson, p. 281. Sub-strut is the name Johnson uses for "center channel strut."
Dearborn County Commissioners' Record, Vol. 15, p. 229.

36 "Iron Highway Bridges at the Penn Bridge Company, Beaver Falls, Pennsylvania." Pamphlet, n.p. 1885.

37 Penn Bridge Company, Pamphlet, p. 5.

38 Dearborn Commissioner Fred Slater's report to the Ohio and Dearborn Company Commissioners, in the Dearborn County Commissioners' Reports, Vol. 15, pp. 133-4.

39 Penn Bridge Company, Pamphlet, p. 7.

40 Penn Bridge Company, Pamphlet, p.7.

41 Johnson, pp.57,60.

42 See his patent descriptions or a source that describes the center span of the bridge over the Ohio at Louisville that he designed and was built 1868-70, which had subdivided panels. The best article on the bridge is in Engineering News of 1917, written when the bridge was being replaced.

43 There are three good articles in Engineering (London) that describe the bridges designed by Wilson and Pettit for the Pennsylvania Railroad. See Engineering, August 17, 1874; February 16, 1877; and March 23, 1877.

44 Johnson, p. 60.

45 See note 43.

46 Johnson, p. 60.

47 "Wrought Iron Bridge Company, Canton, Ohio".
Pamphlet. 1893c. Compare p. 24 with p. 31.

48 Waddell, J.A.L. The Designing of Ordinary Iron Highway Bridges. New York: 1884.

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Notes

II. History

1 Commissioners' Reports of Dearborn County, Indiana. Vol. 9, p. 54-64. In Ohio County Courthouse, Rising Sun.
2 Ibid.
3 Lawrenceburg Press, November 26, 1868, "The Laughery Bridge."
4 Commissioners' Reports of Dearborn, Vol. 9, pp. 54-64. Specifications for the Laughery Bridge.
5 Commissioners' Reports, Ohio County, Indiana, 1869.
6 Lawrenceburg Register, June 6, 1878.
7 Ibid.
8 Commissioners Reports of Dearborn, Vol. 15, p. 87, (June 8, 1878); p. 126 (June 15, 1878).
9 Commissioners Report, Dearborn, Vol. 9, pp. 54-64.
10 Commissioners Report, Dearborn, p. 131, Meeting of July 6, 1878.
11 Commissioners Reports, Dearborn, Vol. 15, p. 133, Meeting of July 22, 1878.
12 Brown, F.W. Cincinnati and Vicinity, 1898.
13 Commissioners Reports, Dearborn, Vol. 15, Meeting of August 5, 1878.
14 Lawrenceburg Register, August 15-29, 1878.
15 Commissioners Report, Dearborn, Vol. 15, September 9 and 10, 1878.
16 "Pittsburgh Bridge Company" may refer to the Keystone Bridge Company in the same manner that the Wrought Iron Bridge Comapny was insistently called the "Canton Bridge Company" throughout the meeting. This makes even more interesting their later rejection of the bid, as the Keystone Bridge Company almost certainly specified a bridge built with Keystone columns, which was the only thing the commissioners definitely did not want.
17 Commissioners Reports, Dearborn, Vol. 15, September 9 and 10, 1878.
18 Commissioners Reports, Dearborn, December 18, 1878.
19 Lawrenceburg Register, August 21, 1879.
20 Commissioners Reports, Dearborn, December 18, 1878.
21 Commissioners Reoorts, Dearborn, March 29, 1879.
22 Edwards, Llewellyn Nathaniel. A Record of History and Evolution of Early American Bridges, Orono, Maine: 1859, p. 102.
23 Danner, John. Old Landmarks of Canton and Stark County, Logansport, 1904, pp. 1349-50. David Hammond is described as being more of a salesman than a bridge builder. After retiring as President of the company in 1880, he became their sales agent. See the Canton directories.

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Bibliography

Printed Sources

Bowser, Edward A. A Treatise on Roofs and Bridges. New York: 1898.
Brown, F. W. Cincinnati and Vicinity. 1898. Information on Cincinnati bridges.
Canton City Directories, 1878 and 1881. Information on employees of the Wrought Iron Bridge Company.
Oanner, John. Old Landmarks of Canton and Stark County, Ohio. Logansport: 1904, pp. 1349-50 on David Hammond.
Greene, Charles Ezra. Trusses and Arches Analyzed by Graphical Methods. New York: 1879, on triple trusses. Editions prior to 1879 have nothing on triple trusses.
Heald, Edward T. The Stark County Story.c. 1949. pp. 628-34 on Bridge Companies of Canton and Massillon; good collection of information.
Heller, A.H. Stresses in Structures. New York: 1916, p. 222 on Whipple trusses, gives clear explanation of theory of design.
Indianapolis City Directories. Information on Indianapolis Bridge Company, and illustrations of Aurora Bridge.
Johnson, John Butler. The Theory and Practice of Modern Framed Structures. New York: 1896, copyright 1893. A number of good, short descriptions of the theories behind various designs.
Mehrtens, Georg C. A Hundred Years of German Bridge Building. Berlin: 1900. Information on Greithausen Bridge.
Merriman and Jacoby. A Textbook on Roofs and Bridges, New York: 1889, copyright 1888. Vol. I, p. 115: triple systems.
Perrin, William Henry. History of Stark County, with an outline sketch of Ohio. Chicago: 1881, pp. 334, 337, Wrought Iron Bridge Company.
Phoenixville Bridge Works. An Album of Designs: The Phoenix Bridge Comapny. Philadelphia: J.B. Lippincott, 1885.
Tyrell, Henry Grattan. Bridge Engineering, A Brief History, 1911. p. 178: a list of bridge company pamphlets.
Waddell, John Alexander Low. The Designing of Ordinary Iron Highway Bridges. New York: 1884. In his appendix of plates he shows a Whipple Truss with the diagonals attached at every post, and yet his analysis is the standard one of assuming that the truss consists of Pratt trusses. The logic of this is totally invisible and probably non-extant.

Periodicals

Canton Repository. 1871 to date. September 14, 1878: mention of contract.
Clarke, Thomas Curtis. "The Design Generally of Iron Bridges of Very Large Span for Railway Traffic", Institution of Civil Engineers, Minutes of Proceedings, London: 1878. Vol. 54. Meeting of May 21, 1878, pp. 179-247. A wonderful collection of outdated ideas that would make a good core for a paper on changing ideas.

Cooper, Theodore. "American Railroad Bridges", Transactions A.S.C.E., Vol. 21, 1889. Extensive, well-written article.
Engineering. London. August 17, 1874; February 16, 1877; March 23, 1877. Articles on Wilson and Pettit trusses.
Engineering News. July 22, 1876, p. 234; September 10, 1878, p. 302; January 25, 1879; March 8, 1879, p. 78. References to the Wrought Iron Bridge Company.
"1865-1885 Iron Highway Bridges at the Penn Bridge Company, Beaver Falls, Pennsylvania." n.p. 1885. Very informative pamphlet for details and Penn Bridge Company biases.
Lawrenceburg Press. Lawrenceburg, Indiana. Information on first bridge, 1868.
Lawrenceburg Register. Lawrenceburg, Indiana. Official paper of Dearborn County. Information on present bridge: August 15-29, 1878.

Unpublished Manuscripts.

Dearborn County Commissioners Reports. Information on both bridges. The manuscript is in better condition and more detailed than the Ohio County commissioners reports. Located in the Court House of 1871 in Lawrenceburg, Indiana.
Ohio County Commissioners Reports. Located in the court house at Rising Sun.
Permanent Biographical Reocrd of all Members of the A.S.C.E. For Edward John (E.J.) Landor, in the possession of Mrs. Alice Landor, Canton, Ohio.