

Colossus Bridge Designer

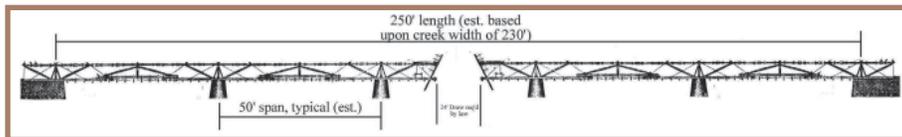
Lewis Wernwag

By F. E. Griggs, Jr.

Wernwag was born in Reutlingen, Württemberg, Germany December 4, 1769. He was named Johann Ludwig Werenwag after his father. Family legend has it that the young Wernwag went into the hills to avoid being forced into the army during the Napoleonic Wars and worked as a shepherd. At that time, he began to study astronomy, natural history and other scientific subjects. The story goes on that he was able to get out of Germany and ended up in Amsterdam prior to taking a sailing ship to Philadelphia. He immigrated in 1788 at the age of 19 and Americanized his name to Lewis Wernwag. He and his wife Elisabeth had four sons and two daughters. His sons, Lewis, William, John and Thomas, were associated with him in his bridge building and millwright work, as were two of his son-in-laws.

In America, he began building water-powered mills in and around Philadelphia using white oak and pine timber from wood lots he purchased in New Jersey. In

After obtaining a local reputation as a can-do person, he was selected in 1811 to build a bridge across the Neshimany Creek on the road from Philadelphia to Bristol, PA. Timothy Palmer and Theodore Burr were the main bridge builders around Philadelphia in the early 1800s. Palmer had semi-retired to Newburyport, and Burr was about to begin his construction of major bridges across the Susquehanna River in Pennsylvania. Wernwag developed what he called his "Economy" bridge, which was a wood and iron cantilever truss. He built trusses of this style over the Frankford Creek near Bridesburg, 1812, just north of Philadelphia as well as the Neshimany Creek Bridge. To permit the passage of masted vessels, both bridges included simple lift spans that could be operated by a single person.

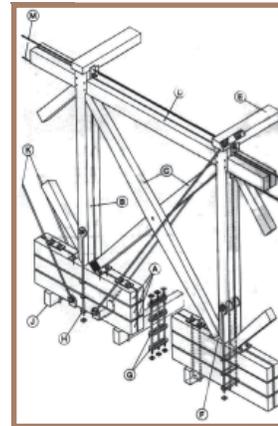


Neshimany Bridge

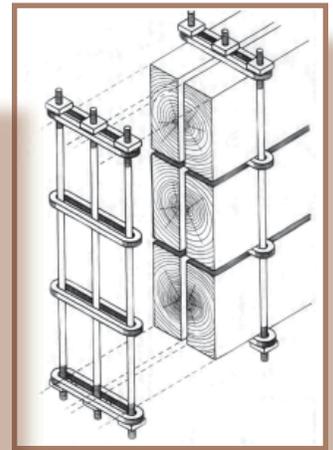
1809, he provided wood for the keel of the first United States frigate built at the Philadelphia Navy Yard. In 1813, he moved to Phoenixville, Pennsylvania, where he took charge of the Phoenix nail-works and there invented the first machine for cutting and heading spikes from four to seven inches in length. He purchased anthracite coal-lands near Pottsville, believing in its use as a fuel for industry and home heating. He built a portion of the canal for the Schuylkill Navigation Company, and Fairmount Water Works and Dam at Philadelphia were erected in accordance with his plans. This information from *Appleton's Cyclopaedia of American Biography* shows a man of wide interests and skills. But Wernwag is known widely for his work in the design and construction of bridges.

In a broadside published in 1813, Wernwag wrote "BRIDGE ECONOMY: The principle of which is across Neshaminy on the Post Road from Philadelphia. To N. York & over Frankfort Creek built for Josh. Kirkbeight. Both of which are drawbridges, one is 32 feet between the piers, where the Draw is, the other 60 feet between the abutments. By this means, the navigation is not obstructed, as it has been by Bridges built on former Principles. The span on this principle can be extended with, or without a Draw, from 120 to 160 feet..."

With the success of these two bridges Wernwag developed a design for a single span bridge of 340-foot span to cross the Schuylkill River just north of Palmer's Permanent Bridge that opened in 1805.



Typical Truss work and arches

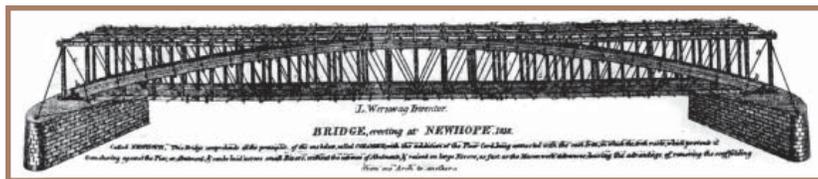


Arch members with spacers

His plan was selected from several others, and he began construction in 1812. His contract read in part "Whereas the said Lewis Wernwag hath furnished... a Plan of a Permanent Bridge... and hath proposed to superintend... to collect all the material necessary... to find fit and suitable Workmen to do all the work... and lend all his Tools and apparatus for building erecting raising and finishing of the said Bridge... In consideration of all which services to be rendered... and for the Plan of the said Bridge and the use of Tools and Apparatus... the Company will pay within one year from cornerstone laying, the sum of \$3,000, if they are satisfied with the superintendence, care, management and conduct of Wernwag."

By going to a single span structure, he eliminated the need for river piers that had greatly increased the cost of Palmer's Bridge. On the easterly shore rock was fairly near the surface, but on the westerly shore he needed 499 piles to support his massive masonry abutment. His model and proposal was for five arches, but he convinced the owners that he could build the bridge with four. They agreed, provided that Wernwag would add the additional arch at no cost if needed.

With Masonic ceremonies, a cornerstone laying on the easterly abutment was held on April 28, 1812 and work on the foundations began shortly after. The design had "the ribs, the cart-way, and the string-pieces, form so many arches, which are all connected and secured by ties, braces and bars of iron, in such a manner as to form one connected and combined



New Hope - typical span

whole, equal in strength, perhaps, to any thing that human ingenuity could devise." His major innovation was in his arches. He wrote each arch "is composed of six small ones, in thickness six inches, and of the average depth fourteen inches—the small ribs are placed on their edges, two in breadth and three in depth, and so formed as to be at the abutment equal to a solid mass of timber, four feet deep and one foot thick gradually diminishing in size, so as to be at the apex but three feet deep and one foot thick. They are prevented from coming into contact by one inch iron bars placed between them, six feet assunder, but are connected together by large iron bans also six feet apart, well secured, and susceptible of being drawn together as the timber dries, by strong screws." He provided lateral stability by having his outside arches converge towards the center of the span, and by providing massive lateral bracing between the top chords.

He used braces and counterbraces, as well as an iron tension diagonal, in each panel. After construction, Wernwag found it necessary to add iron rods between the tops of each vertical. The bridge opened January 7, 1813 and was called by some the Colossus rather than its formal name the Lancaster Schuylkill Bridge. In his broadside Wernwag claimed, "This bridge has a superiority of any other, having near 100 feet span more than any in Europe or America. The dry rot is entirely prevented by the timber being sawed through the heart, for the discovery of any defect & kept apart by iron links & screw bolts, without mortice or tenon, except the kingposts & truss ties. No

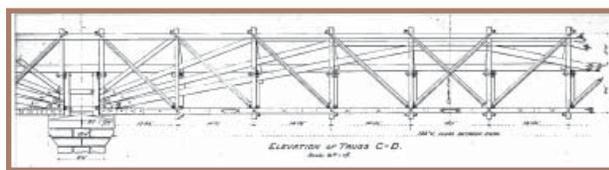
part of the timber comes in contact with each other, & it can be screwed tight at any time when the timber shrinks. Any piece can be taken out & replaced if required without injury to the superstructure..." The bridge had been designed from the beginning to be covered, and the bridge company built tollhouses at each end in the form of Greek temples. With its span of 340.5-feet, it exceeded any American or European Bridge and remained the longest span until Theodore Burr built his McCall's Ferry Bridge in 1815. Unfortunately, Burr's bridge was destroyed in a flood in 1818, and the title of the longest bridge reverted back to the Colossus. It retained this title until September 1, 1838, when it was destroyed by fire and later replaced on the same abutments by Charles Ellet's wire cable suspension bridge.

Immediately after completing the Colossus and tending to the iron works at Phoenixville, Wernwag contracted to build a bridge across the Delaware River at New Hope, PA. Palmer at Easton and Burr at Trenton had bridged the Delaware by this time, and Burr was beginning a bridge at Stockton/Centre Bridge. Once again, Wernwag developed an entirely new design for six identical tied arches with spans of 175-feet, for a total length of 1,050-feet, and a versed sine of each arch of 13-feet. He designed the arches as tied arches similar to Theodore Burr's at Trenton.

He made them tied arches by having "the ends of the segments rest upon cast iron shoes, fitted upon solid blocks of timber, that are interposed between the feet of the several arches. These blocks are connected by string pieces, which form the chord line of the arches, so that each arch would stand

alone, without the resisting pressure of the adjoining ones. There is no oblique pressure upon the piers; hence, no greater strength is required." In this bridge, he made a far greater use of wrought iron and provided a much flatter deck with his top and bottom chords parallel.

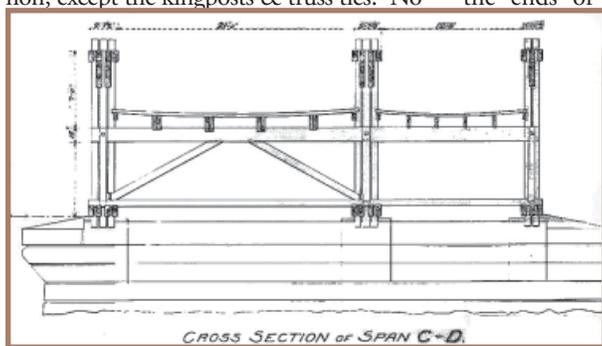
By the end of 1814, he had designed and built three distinctively different bridges. His work earned him the reputation as one of the premier wood bridge builders in Pennsylvania. He built bridges in Reading, PA (1815), Schuylkill River at the Falls (1817), Wilkes-Barre, PA (1817), Jones Falls, Baltimore, MD (1818), Monongahela River, Pittsburg, PA (1818), Allegheny River, Pittsburg, PA (1819). He designed some of the bridges, but they were built by his associates from



Harper's Ferry B & O Truss by Latrobe/Wernwag

Philadelphia. Around 1818 he moved to Conowingo, MD to build a major 10 span bridge across the Susquehanna River, just north of the Rock Run Bridge built by Theodore Burr. This bridge opened in 1820. He then built bridges at Wilmington, DE, Market St. (1821), Rockland Bridge, Wilmington, DE (1823), Pawling's Ford, Schuylkill River (1823), Goose Creek, Loudon County, Virginia (1823), Great Gunpowder Falls, MD (1823), and rebuilt a pile bridge over the Choptank River, MD (1823).

In 1824, he moved to Harper's Ferry where he built a mill on Virginus Island and contracted to build a bridge for the Wager family over the Potomac River. This four span bridge was completed in 1829, even though it was open for travel earlier than that. Between 1824 and 1830 he was primarily occupied with his work in Harper's Ferry. In 1830, he resumed his bridge building with the rebuilding of eight spans of the Burr's Rock Run Bridge over the Susquehanna and a bridge in Cambridge, Ohio on the National Road (1830). He followed these with a two span bridge over the Monocacy River in Maryland for the Georgetown and Frederick Turnpike opening in December 1830, and four bridges on the Maysville



Harper's Ferry Bridge - Two track RR on left, carriage way on right

Turnpike in Kentucky starting in 1831.

He built the first wooden railroad bridge in the United States for the B & O Railroad over the Monocacy River just north of his turnpike bridge. Prior to this the railroad built stone bridges, but the Monocacy Crossing called for a 350-foot long bridge well above the river, which could not be built in stone for the money that was available or in time for the opening of a branch line to Frederick. He built a three arch deck bridge 37-feet above the river, and covered the deck and sides of the arches with wood that had its joints caulked with oakum to protect the wooden superstructure. This bridge opened in December 1831 and survived until it burned in 1854.

He, along with his sons and associates, designed or built bridges over the Cheat River, Virginia (1834), White River, Indianapolis, Indiana (1835), and two bridges on the Northwestern Turnpike in



Colossus - Upper Ferry Bridge

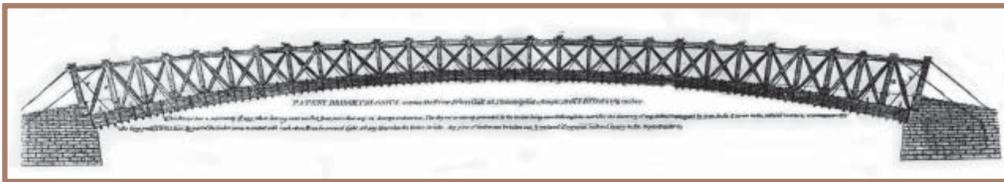
Virginia, one at Romney over the South Branch of the Potomac River (1835) and the other over the Great Capacon (1835).

His last major project in which he was personally involved in its construction was the B & O railroad bridge over the Potomac River at Harper's Ferry. The railroad arrived on the easterly bank

angle, curve.

After completing this bridge, he designed one over the Kentucky River at Fort Nelson that opened in 1838 and lasted until 1930. He was also involved with the design of a bridge over the Shenandoah River that crossed Virginius Island in 1844, after his death.

He received his first bridge patent on March 28, 1812 and a second on December 22, 1829. The drawing for the second patent was erroneously reconstructed after the Patent Office fire of 1836 and numbered



Upper Ferry Bridge - Colossus

of the Potomac opposite Harper's Ferry in 1835, and needed a bridge to link with the Winchester & Potomac railroad which was under construction from Winchester VA to Harper's Ferry to the west. Benjamin H. Latrobe designed the bridge with the assistance of Wernwag. Wernwag was awarded the contract to build the superstructure for the five span bridge crossing both the C & O Canal, that had reached Harpers Ferry in 1834, and the river. It was finished in 1836, but due to masonry problems on the piers was not opened until 1837. Shortly after, the B & O fixed its route to the west by branching off the bridge and passing through the grounds of the US Armory on the westerly side of the Potomac River. This required building two spans off Wernwag's bridge to handle the sharp, almost right

5,760x. The drawing presented was more likely that of his 1812 patent.

Wernwag died August 12, 1843 at Harper's Ferry after a bridge building career spanning 30 years. No painting or sketch of him is known to exist. His most innovative designs were the Economy, Colossus and New Hope bridges near Philadelphia built between 1811 and 1814, and his two railroad bridges for the B & O in 1831 and 1836. He was a contemporary of both Timothy Palmer and Theodore Burr, and together they formed a United States version of the Brothers of the Bridge that began in the 12th Century in France. ■

Dr. Griggs specializes in the restoration of historic bridges, having restored many 19th century cast and wrought iron bridges. He was formerly Director of Historic Bridge Programs for Clough, Harbour & Associates LLP in Albany NY and is now an independent Consulting Engineer.

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