METAL TRUSS BRIDGES IN MARYLAND

The development of the metal truss bridge in Maryland resulted from the early growth of railroads in the state. Although Squire Whipple in the early 1840s had designed a number of small iron truss bridges over the Erie Canal in New York State, Maryland soon thereafter became a laboratory for experimentation in adapting iron to railroad bridge design. It was necessity that caused the railroads to pioneer the construction of metal truss bridges: the railroads' heavy locomotives and rolling stock required bridges far stronger and more reliable than those yet built for highway use.

The earliest attempts to adapt truss designs to metal construction were characterized by "an intuitive sense of proportion, stress, and the general 'fitness of things'" that lacked exact science (Vogel 1964:80). Such vagueness had sufficed when constructing timber bridges for the relatively light loads to which highway bridges of the time were subjected, but the results were frequently uncertain when this approach was applied to new materials and new uses. Perhaps the first metal truss bridge in the state was an iron Howe truss that was erected in 1846 at Monument Street in Baltimore to accommodate the Baltimore and Susquehanna Railroad. It appears that the City of Baltimore appropriated $6,000 to J.R. Trimble to erect the bridge; it is not known how successful the enterprise was. Another bridge built at about the same time was a metal truss using cast iron compression members and wrought iron in tension. Unfortunately, it is not known what truss design was used, but the design, materials, or workmanship proved defective; the bridge suffered "absolute collapse" in 1848 "without any warning and in the absence of any unusual loading" (Hilton 1913).

It was under the aegis of the Baltimore and Ohio Railroad in the 1850s that the idea of the metal truss was brought to successful fruition. In his 1849 Chief Engineer's report, Benjamin H. Latrobe announced that "reconstruction of the large Bridges at Little Patuxent and at Bladensburg. . .will be executed in a few months. . . . It is proposed to erect a superstructure of Iron upon stone abutments, at each place -with increased span, for greater security against future floods" (Vogel 1964:88).

The design that was subsequently to be known as the Bollman truss was what Latrobe had in mind. The design, which owed some debt to Latrobe's own work with radiating struts, was the creation of B&O's master of road, Wendel Bollman. One year later, in 1850, the first manifestation of Bollman's design was erected over the Little Patuxent River at Savage Factory. The 76-foot-long Savage Bridge and its sister bridge at Bladensburg gave "much satisfaction" and caused Latrobe in his 1850 report to express great confidence in the future of iron bridge construction. Soon thereafter, Bollman truss replacements were erected by the B&O over the Patapsco River at Elysville and over the Potomac River at Harpers Ferry, followed by numerous B&O Bollman trusses in Maryland and other

states.

Bollman was a transitional figure between intuitive and exact engineering. Although he made use of mathematical analysis, he also relied upon empirical methods to test his designs. He would frequently build models of his designs and then load them until they collapsed in order to discover weaknesses (Vogel 1964:83). Bollman applied for a patent on his truss design in 1851 and received it in 1852. No later than 1855, one of Bollman's former B&O assistants, John H. Tegmeyer (subsequently Baltimore City Commissioner), formed a company in Baltimore that advertised "Wendel Bollman's Patent Iron Suspension Railroad Bridge" in several railway journals (Vogel 1964:87, 91).

Although the design was marketed to railroads, it appears that Allegany County Commissioners and the Cumberland City Council took notice of the Bollman truss in 1854. Will's Creek in Cumberland had been the site of at least six ill-fated bridges since 1755, including an iron suspension bridge that lasted from 1816 to 1838. The suspension bridge's timber replacement was in complete disrepair by 1854 when the County Commissioners and the City Council agreed to split the cost of replacing it. According to an 1878 account, "a contract was made with a Baltimore firm for the erection of an iron bridge of the Bollman pattern," and the bridge was completed by the end of the year (Lowdermilk 1971:371). Although it is unclear if this Cumberland bridge was the first metal truss highway bridge in Maryland, it was certainly one of the first, and appears to be the first direct translation of railroad-developed metal truss technology to highway use in the state. The Will's Creek Bridge had lasted 38 years when it was replaced in 1892, far longer than any of its predecessors at the site.

As a nexus for railways and the accompanying concentration of engineering talent, Baltimore rapidly became an early center of bridge building activity. Not only were there railroad bridges to construct in the city and its environs, but Baltimore had need of a great number of metal highway bridges as the earlier timber bridges proved unequal to the traffic demands placed on them by the growing city.

In 1858, Bollman left the employ of the B&O and joined John Tegmeyer and John Clark in Baltimore to found W. Bollman and Company, apparently the first company in the nation to design, fabricate, and erect bridges (Vogel 1964:91). Advertising designs for roofs, engine houses, and machine shops as well as Bollman truss bridges, the company ceased operations in the early 1860s because of the Civil War. Before its close, W. Bollman and Company obtained considerable B&O work (Olson 1980:107). After the conclusion of the Civil War, in 1865, Bollman (John Tegmeyer having become City Commissioner of Baltimore) organized the Patapsco Bridge and Iron Works, which built railroad and highway bridges (including other proprietary types as well as Bollman trusses) not only in Maryland, but also in North Carolina, Cuba, and Mexico until the company was dissolved upon Bollman's death in 1884. One of Bollman's last projects was the

replacement of the movable bridge at the mouth of the Jones Falls (giving entry to the City Dock) with a truss swing span that opened for travel in 1880 (Baltimore City, Jones' Falls Commission 1882:695). This project was conducted under the aegis of the Commission for the Improvement of Jones' Falls, formed in response to the flooding of 1868 and the drought of 1872 (Olson 1980:163).

Bollman's chief Baltimore competitor was Smith, Latrobe and Company, organized by Charles Shaler Smith, Benjamin H. Latrobe, and C.H. Latrobe in 1866, and reorganized as the Baltimore Bridge Company in 1869. Before its dissolution in 1880, this company constructed major bridges across the Mississippi, Missouri, and Kentucky rivers (built in 1876, the Kentucky River Bridge was the first major cantilever bridge in the nation).

H.A. Ramsay & Co. was another bridge firm operating in Baltimore in the 1870s and 1880s. This firm was responsible for at least three of the bridges built by the Jones' Falls Commission in the 1880s. The first, a replacement at Pratt Street, was a heavy wrought-iron bridge of 106 feet, including three 20-foot-long through trusses. The second was at Chase Street, crossing both Jones Falls and the tracks of the Northern Central Railroad; it consisted of two spans "of the triangular type." The third bridge built over the Jones Falls was a heavy three-span though truss. All three of these bridges were built by Ramsay in 1881 (Baltimore City, Jones' Falls Commission 1882:697-699).

Other bridge-building firms operating in Baltimore in the nineteenth century were Campbell and Zell Company (1896-1899); J.G. Clarke and Company, subsequently Clarke Bridge Company (1879-1883); A. and W. Denmead and Sons (1850s); and Murray and Hazelhurst (building bridges 1857-1869).

Baltimore's flurry of metal truss bridge activity from the 1850s through the 1880s, along with the 1854 Bollman truss bridge over Will's Creek in Allegany county, proved the usefulness of metal truss bridge design to highway applications. County Commissioners in the Piedmont and Appalachian Plateau counties soon took notice of Baltimore's experience. They undoubtedly noticed, too, that the metal trusses the railroads were erecting in their counties were withstanding prodigious loadings and were not being washed away by every spring freshet. The typical timber beam bridge so prevalent in the counties was notorious for its inability to deal with either challenge. In addition, the timber bridge, covered or uncovered, was subject to decay and required a considerable amount of maintenance. The proven ability of metal truss bridges to bear great loads and to remain standing through flood and time must have impressed county commissioners considerably.

However, erecting metal truss bridges was a proposition qualitatively different from the way counties had hitherto built bridges. With timber or stone arch bridges, a local artisan was contracted to build the structure and be responsible for its upkeep (Thomas and Williams 1969:271). With metal truss

bridges, not only was the engineering talent needed to design them usually unavailable locally, but the metal members of the truss could be produced only at major foundries. The advent of the metal truss required the importation of expertise and materials from urban areas.

The formation of Bollman's companies in their various manifestations (starting with John Tegmeyer's enterprise) provided the means by which counties could import both the necessary design expertise and the actual spans into their locales at a reasonable cost. In the early years of Bollman's companies and subsequent rival companies, it was probably necessary for a firm is representative to visit the site of the proposed bridge and return to the company's fabrication plant with the necessary data. Soon, however, the process was streamlined; the fabricating companies provided local officials with all the information necessary to determine which truss type was suitable for a given site. The local officials would then complete and return to the fabricating company an order form that provided all the data necessary to the fabrication of the desired bridge. The bridge company would then fabricate the truss members and ship them to the site, along with detailed instructions (and imprints or matchmarks on the members) for the erection of the bridge. Finally, the local officials would have the truss erected on abutments made by local masons.

Numerous companies across the nation were formed to provide metal truss bridges to cities, towns, and counties. The Baltimore companies described above conducted a degree of business in Maryland, but the Patapsco Bridge and Baltimore Bridge companies by the 1870s had begun to expand to other states and countries. The bridge building business became extremely competitive, with companies from other states also expanding into Maryland. Information gathered from previous Maryland Historical Trust historic resource survey forms on metal truss bridges in Maryland indicates that a number of bridge companies provided metal truss bridges in the late nineteenth and early twentieth centuries, including the following firms:

Wrought Iron Bridge Company, Canton, Ohio - built Pratt through truss bridges in Maryland from 1870s through 1890s;

King Iron Bridge Company, Cleveland, Ohio - built Pratt and bowstring trusses in Maryland from 1880 through 1892;

Patapsco Bridge and Iron Works, Baltimore - in addition to its work in Baltimore, built a Pratt pony truss in 1879;

Baltimore Bridge Company - in addition to its work in Baltimore, built a Pratt pony truss in 1885;

Pittsburg Bridge Company, Pittsburgh, Pennsylvania - built a Pratt through truss in 1882;

Smith Bridge Company, Toledo, Ohio - built Pratt and Pratt half-hipped trusses from 1889 through 1890;

Groton Bridge and Manufacturing Company, Groton, New York - built Pratt pony trusses in the last years of the nineteenth century;

York Bridge Company, York, Pennsylvania - built Pratt, Warren, and Parker trusses in the first quarter of the twentieth century;

Vincennes Bridge Company, Vincennes, Indiana - built a Pratt through truss in the first quarter of the twentieth century;

John Stauver McIlvane, Philadelphia, Pennsylvania - built a modified Pratt pony truss in 1909.

Not surprisingly, given its close proximity to Baltimore City, Baltimore County appears to have taken the lead among Maryland counties in erecting metal truss bridges at an early date, not always with the happiest of results. By 1868 the county apparently had erected an iron truss bridge in Phoenix, a bridge that met the same fate as so many in 1868, being washed away by the floods of November (McGrain n.d.). The loss of this bridge may have caused some second thoughts about the invincibility of metal trusses, for in 1874 the county solicited sealed proposals "for building an open wooden truss bridge, on the Burr Truss plan, over the Gunpowder Falls" (McGrain n.d.).

Despite this regression, there is a great deal of evidence that metal truss bridges were totally back in favor by the 1880s. As an example, in 1884 H.A. Nagle, Superintendent of Bridges for Baltimore County, advertised for sealed proposals for "a wrought iron Pratt truss bridge over the Big Gunpowder Falls." Nagle was very specific about what type of bridge the county wanted, stipulating that "parties tendering must furnish a clearly made out strain sheet of their design" for a "through bridge, consisting of one span 86 feet between masonry" with a roadway "12 feet wide in the clear and not less that 13 feet high in the clear" (McGrain n.d.).

Such advertisements attracted a healthy response; one such advertisement for yet another bridge over Gunpowder Falls received bids from nine bridge companies, including The Penn Bridge Company, H.A. Ramsay and Sons, Pittsburg Bridge Company, the Wrought Iron Bridge Company, and the King Bridge Company (McGrain n.d.). Clearly, the Superintendent of Bridges was able to satisfy his requirements for metal truss bridges in Baltimore County.

Judging from available information, the distribution of metal trusses in Maryland encompasses few in the Tidewater, but a number of examples, with

fairly equal distribution, in the Piedmont and Appalachian Plateau. One exception is Frederick County, where the York Bridge Company in the early twentieth century built a great number of metal trusses, primarily Pratt but also Warren and Parker trusses. In the same county, King Iron Bridge Manufacturing Company erected several bowstring pony truss bridges. It is possible that there are inaccuracies in these estimates of preliminary distribution trends owing to the variation in the level of available documentation throughout the counties.

By the turn of the century, reinforced concrete technology had made great strides and local officials thus had another option from which to choose. In some counties, such as Baltimore County, reinforced concrete bridge technology was eagerly embraced at an early date. Just as Baltimore County had been in the forefront among counties in the adoption of the metal truss in the third quarter of the nineteenth century, it was also the first county to build a reinforced concrete bridge in the first quarter of the twentieth. In fact, the 25-foot reinforced concrete beam bridge near Sherwood Station was the first of its kind in the state, and in the words of its creators "shows the progressive character of the work that the County Roads Engineer is inaugurating" (Johnson 1903:169).

As evidenced by Baltimore County Reports in subsequent years, this bridge was the harbinger of the future; reinforced concrete structures were rapidly to gain ascendancy over the metal truss in the county. The announcement of the Sherwood Bridge provides the rationale: "Steel rods are imbedded in the concrete beams to enable them to withstand heavy loads; but no steel surface is exposed to the air, so that there is practically no cost for maintenance of a bridge of this character" (Johnson 1903:169).

Although other counties were not quite so quick to embrace the new technology, reinforced concrete bridges began to compete with truss bridges for the small to moderate spans across rivers and creeks. The State Roads Commission committed itself at the end of the first decade to developing standard plans for reinforced concrete bridges and intensified its efforts in the 1920s.

Metal truss bridges were still being erected throughout the state, but in significantly declining numbers. The older metal bridge fabricators were disappearing, or had already disappeared, by this time. A new, and less numerous, generation of metal truss fabricators (many comprising large companies which absorbed smaller competitors) met the needs of this declining market:

Bethlehem Steel, Bethlehem, Pennsylvania - built at least one camelback through truss in the 1920s;

American Bridge Company, Ambridge, Pennsylvania - built Pratt and camelback trusses in 1920s and 1930s;

McClintic-Marshall, Pittsburgh, Pennsylvania - built Pratt, Parker, and Camelback trusses beginning in the teens through the early 1930s;

Roanoke Iron and Bridge Company, Roanoke, Virginia - built Pratt and Camelback trusses in the 1920s and 1930s.

Besides the decline in numbers, the character of truss bridges was changing; the lighter and more delicate appearance of nineteenth century trusses was giving way to more solid forms that addressed the heavier load requirements necessitated by the dramatically increasing loads, volumes, and speeds of automobile and truck traffic on Maryland roads.

Although reinforced concrete designs dominated the spanning of small to moderate crossings by the 1930s, the metal truss assumed renewed prominence as the means by which monumental bridges spanning major rivers were built in the late 1930s and 1940s. The bridges over the Susquehanna River at Havre de Grace and over the Potomac at Ludlows Ferry, and the Wichert truss bridge over the Potomac at Washington County heralded a new era in truss bridge building. These bridges exemplified the adaptability of the form as it continued to evolve in response to the need to span longer distances and carry heavier loads.