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Ü Transformation in the USA 1870-1920
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The Rise and Fall of Bowstring Arch Bridges in the USA 1850-1890

Introduction:

When driving into Decorah, Iowa, a town of approximately 8,300 inhabitants, there are many places to see which fits the town's image and would make a tourist want to spend a week there. The town is located deep in the Upper Iowa River Valley, with bluffs as high as 100 feet. Various paths are available to take the tourist up the hills for a gorgeous overview. There are several museums and places of historic interest in and around the city that deal with its pioneer history. There are historic buildings constructed of masonry and brick that look as beautiful as they were when they were built. Then there is a structure located at Trout Run Park, just outside the city, which resembles an archer's bow, supported by vertical and diagonal beams pinned to its flooring. It spans a small man-made ravine and has plaques on both sides of the bridge stating Built by the Wrought Iron Bridge Company, 1878. This bridge, known as the Freeport Bridge, is a very popular attraction for passers-by, who are visiting the city and want to stop in for a few minutes to rest and take a look at it. Originally located four miles from the city, the 160-foot long structure- the second longest in the United States- was relocated to Trout Run Park in 1989, to successfully preserve its structural integrity. What makes this bridge special is not only the company that built the bridge, but the bridge type that was popular at that time, the bowstring arch bridge. Patented by Squire Whipple in 1841, bowstring arch bridges were very popular during the late 1800s not only because of its ability cross smaller streams and carry local traffic into the town, but also because it represented a symbol to the community and the people who cherished them. What made Whipple design such a unique structure, and why were these bowstring arch bridges used so frequently in the United States during the 1870s and 1880s? Are there many examples of these bowstring arch bridges still in use today? This essay will focus on the significance of bowstring arch bridges and how they had an impact on the transportation system and the community during the 1870s and 1880s. It will begin with a brief history on Squire Whipple and his creation of the bowstring arch bridge, followed by popularity bowstring arch bridges during this time span. One must keep in mind that because of Whipple's new innovation in civil engineering, bowstring arch bridges were commonly used until after 1890, when they were phased out and replaced with more versatile and longer bridge spans.

The Father of Bowstring Arch Bridges- Squire Whipple

Born in Worcester Co. Massachusetts on 16 September, 1804, Squire Whipple had a fondness for machinery as a child, for his father owned a cotton factory during his childhood in New York, where he and his family moved to shortly after his birth. Because of this passion, Whipple paid his way through the Hartwick Seminary and Fairfield Academy before graduating from Union College near Albany, New York. After graduating from Union College, Whipple worked for the Baltimore and Ohio Railroad, before finding and developing his only passion in life: civil engineering. With the invention of the steam engine, the expansion of the railroad industry, and the rising popularity of cast and wrought iron during his time, Whipple, beginning in 1840, developed ways to strengthen the bridge structures, so that they could carry heavier loads from not only horse and buggy, but also from railroads. His concept was that the upper chord, made of cast iron would curve like an arch, compressing the lower chords, which are made of wrought iron. This would resemble an archer's bow, with the vertical and diagonal beams supporting the lower chord, but anchored with pinned connections, thus producing equilibrium between the two chords. As a result, he developed and

patented the bowstring arch bridge, also known as the Whipple truss bridge. The first one of this type was constructed in 1841 over the Erie Canal near Utica, New York. It was after that time that a proliferation of the bowstring arch bridges began to take shape with many of these bridges being built not only along the Erie Canal in New York but in other places in the eastern half of the US. Even some of his nephews, including J.W. Shipman and J.M. Whipple contributed to the bridge construction using the bowstring method. Whipple later developed the technique further, by incorporating it in the trapezoidal design of the truss bridge including the Pratt truss design, which was patented by Thomas and Caleb Pratt in 1844, by which the diagonal bracings of each panel meet towards the middle of the span. He further reinforced the Pratt truss design by creating the double- and even triple-intersecting designs, which the diagonal support beams support two and three panels at a time respectively. This served in the construction of longer spans that were to handle heavier traffic. While there are some examples of the double-intersecting Pratt types remaining in the country, the 300 feet long Laughery Creek Bridge in Indiana is the only triple-intersecting Pratt truss bridge remaining in the USA. Upon his death in 1888, Whipple became known as the “father of iron bridges,” for his development of his Whipple truss designs and his bridge reinforcing methods. He wrote two manuscripts describing his Whipple truss designs, *A Work on Bridge Building* in 1847 and *An Elementary and Practical Treatise on Bridge Building* in 1872. He was also famous for his invention of the canal lock as well as the bascule (Draw Bridge) design, both of which were first used for the Erie Canal, where he devoted most of his time to his engineering work while working for the Baltimore and Ohio Railroad.

Popularity of the Bowstring Arch Bridge:

As the Westward Movement continued, many networks of local and regional roads were constructed so that there was access to the nearby communities. While the Whipple truss design was gaining popularity during the 1860s and 70s, many of the regions in the middle and western part of the United States were still dependent on structures made out of wood, of which many were built of wooden beam or trestle designs, using wood pilings as support. However, many of these structures were prone to the extremes of weather as well as the spring thaw, which took out many of them. The resulting factors of countless failing structures combined with sometimes poor network of roads and consistent shortage of funding for construction of roads and bridges prompted many states to look at alternatives to bridge and road construction. Because of the effectiveness of iron in the construction of bridges, many of the states, including Iowa, Ohio, Indiana and Wisconsin began using the bowstring arch bridges for many of the crossings. While some of the local bridge builders, like the Missouri Valley Bridge and Iron Works in Leavenworth, KS constructed some of the bridges using the Whipple model, the Wrought Iron Bridge Company as well as King Bridge and Iron Company, both located in Ohio, were the leaders in bowstring arch bridge construction, as the companies built and patented the parts for the bowstring arch bridge there before transporting them by rail to their destinations, where the local contractors assembled them over the ravines. This method of assembly was cost-effective in terms of time and money, and was used for other truss bridge types as well. By 1890, bowstring arch bridges became a popularity in the United States as they were not only used for the purpose of transporting goods across ravines from point A to point B, but they were also one of the most popular places for leisure activities, as many artists and photographers spent time on the bridge; some for the purpose of marketing the bridges through their respective companies, while others considered them symbols for their own communities. The reason was not just the various structural and ornamental designs that were created by the bridge companies during the time of their construction, but also their conformity to the landscape. Unfortunately due to the popularity of steel in the construction of buildings and bridges, the number of bowstring arch bridges from 1890 on began to dwindle. The bridge companies, aware that stronger bridge structures were needed, phased out the bowstring bridge design. It is unclear when they began to phase them out, but one can assume that the successful completion of the Eads Bridge in St. Louis in 1874, combined with the proliferation of steel truss bridges consisting of all variants of the Pratt and Warren designs spelled doom for the iron bridges, and with that the bowstring arch bridges. One by one, the bowstring bridges were replaced with newer structures made of steel, which were more effective in carrying heavier loads and handling extreme weather conditions. However, they were not completely phased out. The bowstring arch bridge construction was revived briefly after World War II in Iowa, where severe flooding wiped out dozens of bridges in Crawford County, prompting the steel manufacturers to construct six bowstring arch

bridges in that area. The reason for this revival: The same reason that prompted the state as well as other states in the Midwest to introduce bowstring arch bridges beginning in the 1870s- the shortage of funding and resources for bridge construction and a need to reconstruct the highway network.

Where are these bridges today?

While bowstring arch bridges are no longer being used for construction purposes, only a handful of them remain in the United States, many of which have been documented thoroughly by historians, engineers, and organizations such as the American Society of Civil Engineers and the Historic American Engineer's Records. Nearly all of them have been listed on the National Register of Historic Places. Thanks to some efforts by local activists and civil engineers, many of the bowstring arch bridges, which are no longer able to handle the ever increasing load of traffic, are being relocated to different places to be used for tourist attraction purposes. A person would find one at a rest stop, like the 1878 structure which now has a home at the Ironto Wayside Rest Area in Virginia. Some are incorporated into a bike trail system, like the one at the Delphi Historic Trails Park in Indiana. There are also some that are privately owned like the bridge spanning Normans Kill at a farm place in New York, built in 1867, which is one of the oldest structures still standing in the country. Some bridges, like the Hale Bridge in Jones Co., Iowa, have been removed and are awaiting relocation to a new home. Of the number of bowstring arch bridges that are remaining in the United States, the majority of them can be found in the eastern and central parts of the country, where the number of bowstring arch bridges are prevalent. Some of the structures constructed by Squire Whipple himself in New York are still standing including one at his alma mater, Union College. Even the ones constructed by his nephews can still be seen, including the one located on the campus of the Ohio State University-Newark Campus. The state which has the largest number of bowstring arch bridges in the country is Iowa, where 20 bowstring arch bridges exist today, with three fourths of them located in Crawford, Jones, and Winneshiek Counties, including the Freeport Bridge, which is located in Winneshiek County. Interesting enough, the county also has the third longest bowstring arch bridge in the USA, which is located in the southern part of the county, the Turkey River Bridge. Built in 1873, this bridge is one the two remaining bowstring arch bridges still carrying vehicular traffic in the county.

Conclusion:

The bowstring arch bridge is a fine example of one of the finest works of architectural art that existed during the late 1800s. Even though they represented a fine example of engineering creativity that existed during this period and represented an identity to the community and the people, like all other historic bridges, they are being ignored and demolished without even considering saving them. Before a historian has an opportunity to even look at the history of each historic bridge, they are promptly replaced with bigger and more versatile structures, which on the one hand provide the travellers with safer passage over the ravine, but on the other hand represent the dullness of engineering integrity as well as conformity to their environmental surroundings. According to bridge historian Eric Delony, at least half of the historic structures have met the wrecking ball within the past 20 years, when preservation was at its peak. This is alarming considering the importance of historic bridges and their connections with American history. If the trend continues many of these bridges, regardless of what type (truss or arch) or of historic significance, will disappear before an effort is made to preserve them.

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