Five Historic Metal Truss Bridges

By Vern Mesler

Traveling along South Wattles Road about a mile from Michigan Ave (Business I-96) east of Battle Creek, Michigan, you make a long and gentle curve, and as you cross a single set of railroad tracks and glance to the left a bright red structure glimmers through the summer trees. A short distance beyond the railroad tracks and before you see the large "Historic Bridge Park" sign, the 180-foot historic riveted metal truss bridge comes into full view. The Charlotte Highway Bridge, fourteen feet above the road into the park, spans the park's entrance. As you drive under the stately 1886 wrought iron bridge, the Kalamazoo River and its wooded banks are clearly seen ahead.

On July 19th, 2001, the Charlotte Highway Bridge was removed from its picturesque cut stone abutments in Portland, Michigan. Designed by Buckeye Bridge Works and built by H.P. Hepburn Engr. & Contr, Cleveland, Ohio, the bridge is a single span wrought iron double intersection Pratt through truss with pinned connections. There are few double intersection Pratt truss bridges left in Michigan. This bridge was well preserved, and the only major restoration required was the replication of ten riveted floor beams. The bridge was re-assembled using a gin pole, described as follows *(www.peakagents.ca/glossary/g4.htm)*: "Long pole with guy wires and pulleys, which can hoist up and swing around an object being moved and then lower it into a different position."

Gin Pole lifting a top chord section on the Charlotte Highway Bridge.

On Monday morning, June 4th, 2007, a local crane company moved their 550-ton crane to the entrance of the park and placed a 240-ton crane on the hill where the Charlotte Highway Bridge set on wood cribbing. A fleet of trucks with counter weights and rigging gear were set in place around the two cranes, and on Tuesday, June 5th, the bridge was set on its new abutments. The Charlotte Highway Bridge is the fifth historic bridge to be erected in the Calhoun County Historic Bridge Park, providing a dramatic entrance to this unique park.

The first historic metal truss bridge to be restored and placed in the park was the 133rd Avenue Bridge. It was built in 1897 by the Michigan Bridge Company of Portland Michigan. The 133rd Avenue Bridge is a four-panel

half-hip pin-connected Pratt pony truss. The bridge is sixty four feet long, fourteen feet wide and is made of wrought iron. It was removed from Allegan County in 1998 and erected in the Historic Bridge Park in 1999.

The second bridge erected in the Historic Bridge Park was the 20 Mile Road Bridge, which originally spanned the St. Joseph River in Calhoun County. The bridge is a single span steel Pratt pony truss with riveted connections. The bridge is seventy one feet long and fourteen feet wide. Restoration of this bridge required extensive work because of its severely rusted members. Forty percent of the bridge is replacement steel, including all four inclined end posts and the top chord cover plate. The vertical members were cut back to good steel and new steel was added. Almost 3000 rivets were used to restore the bridge. The 20 Mile Road Bridge was re-erected in the Historic Bridge Park in 2000.

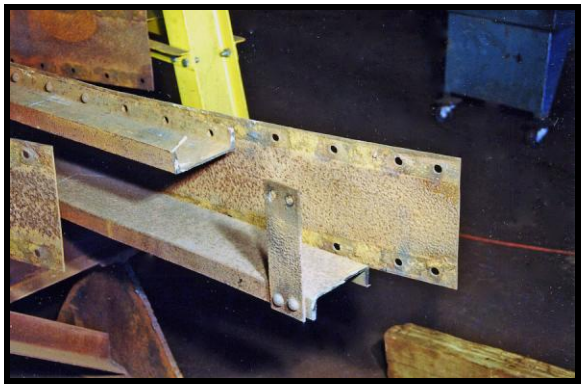
The Gale Road Bridge was the third bridge restored and placed in the Historic Bridge Park. The Gale Road Bridge provided the crew its first experience re-assembling a bridge with a gin pole, in this case erecting it on site across a creek without the need for cranes after assembly. Like all of the restored bridges that now make the park their home, it came from a county in Michigan. The Gale Road Bridge had spanned the Grand River in Ingham County, built in 1897 by the Lafayette Bridge Company of Lafayette, Indiana. The bridge is a single span wrought iron Pratt through truss, one hundred and twenty two feet long and fifteen feet wide. It is significant because it was built at a skew of 13 degrees. Typically bridges were built to cross perpendicular to the river bank. This bridge was more complicated to restore because the members had to fit the skewed angles. Furthermore, unlike the rectangular deck of a straight bridge, the deck of a skewed bridge is a parallelogram with no right angles.

Next to the Gale Road Bridge is a life-size sculpture of an old bridge shop and just beyond it the Bauer Road Bridge. This bridge, the fourth historic bridge to be erected in the park, required all of the experience the crew had gained from the restoration of the first three bridges. The Bauer Road Bridge is a wrought iron bridge built by the Penn Bridge Works of Beaver Falls, Pennsylvania, around 1880. It had spanned the Looking Glass River in Clinton County and, after an interesting and challenging restoration (detailed below) the bridge was erected in the park in 2005. Another bridge, the Tallman Road Bridge, played an important part in the restoration of the Bauer Road Bridge. The two bridges, of the same truss design and built by the same company for crossing the same river, had been obtained by the Historic Bridge Park at the same time. Parts of the Tallman were used for the restoration of the Bauer, maximizing the preservation of original material.

Saving as much of the original metal as possible has been a main objective in the restoration of historic bridges for the Historic Bridge Park. Historic metal truss bridges are a craftsman's record. If one reads the bridge carefully, much can be learned about the manufacturing processes used in its construction. Those who advocate the wholesale replacement and destruction of the original metal parts of a historic bridge seem to lack the feel, understanding, and respect for metal, and especially for the craftsmen who worked the metal. The goal at the Historic Bridge Park is "in kind restoration," repairing the bridge using the same materials and the same manufacturing techniques that were used when it was originally built.

The bottom section of each of the Bauer's four inclined end posts pinned to the end bearing pad was badly corroded and needed to be restored.

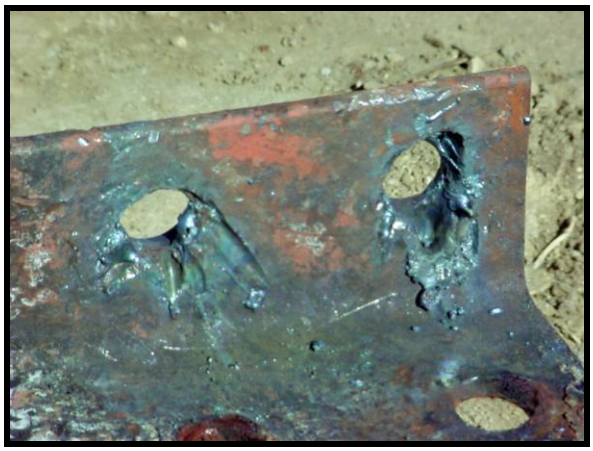
After reviewing the restoration options it was decided to take one of the Tallman Road inclined end posts and disassemble it, using the material to replace the rusted sections of the Bauer Road Bridge. Restoration began with the partial dismantling of the bottom section of the Bauer's inclined end post. In this type of bridge design the inclined end post is made up of plate riveted to two channels and the bearing end pad assembly is attached.



Inclined post sections cut a different length.

Reinforcing plates are riveted to the webs of the channel as part of the bearing end pad where holes are bored for the bridge pin that holds the bottom chord eye-bars.

The Air Carbon Arc process was used to remove the rivets from the top plate of the inclined end post, the bridge pin reinforcing plate, and batten plates. The air carbon arc process is very efficient in removing rivets without damage to the historic parent metal. If the oxygen acetylene process is used with a rivet washing tip it can leave deep gouges requiring repairing, or replacement of the historic metal. The air carbon arc process is a valuable tool in the steel fabrication industry today.



Rivets removed with a torch washing tip, not recommended.

The air carbon arc torch is connected to an electric arc welder and air compressor. The process is an arc cutting process that severs or removes metal by melting it with the heat of an arc struck between a carbon-graphite electrode and the base metal. A stream of compressed air blows the molten metal out of the kerf or groove.

Splice Jig.

Before cutting off the corroded sections of the four inclined end post channel, a jig was fabricated that would maintain the hole dimension between the bearing end pad bridge pin, and the top chord bridge pin when attaching the replacement sections. Because wrought is a composite material of iron and slag fibers it can be difficult to cut with an oxygen acetylene cutting torch. When the oxygen cutting flame comes in contact with pockets of slag, the flame blows back from the cutting kerf creating a jagged edge and the cutting flame has to be restarted. The corroded wrought iron sections of the Bauer Road Bridge inclined end posts were cut with a grinder. The top chord plate and two channels were cut at different lengths to avoid having welding splice in the same location.

Splice sections

Splice sections were fabricated from the Tallman Road Bridge material, and the Bauer's bridge pin reinforcing plate was reriveted to the splice sections. All welding was done to AWS welding standards with all full penetration welds made with E7018 electrodes. No grinding was done on the weld splices. This was to avoid scarring the metal surface with grind marks, to prevent section loss due grinding, and to allow inspection of the weld splices over the life of the bridge.

Removing pack rust from a Stearns truss bridge in Delphi Indiana

One of biggest issues with structural engineers when doing a structural analysis of older bridges is the buckling of the plate between rivets where pack rust forms between the plate and channel of the inclined end post and top chord plate. A procedure was developed at the Historic Bridge Park using a rivet gun to hammer out a buckle with the rust breaking up and driven from the buckle. To avoid the scarring and to get more impact from the hammering of the rivet gun the end of an old rivet gun snap welded ground to a blunt the end a steel plate with a handle was used as a buffer between the hammering of the rivet gun and buckle; it also keeps from scarring or case hardening

the plate.

Sequencing of the heating to prevent distortion was used, that is to remove a few buckles in one area and move on to other buckles further away to keep from concentrating too much heat in one area.

The restored Bauer Road Bridge now spans a small creek within the Historic Bridge Park. It is a bridge that could have been scrapped without any notice. Its age, simplicity, and the lack of understanding of this unique structure, left it without many friends. This wrought iron bridge, along with all historic metal truss bridges, has an unwritten story within its wrought iron members.

For a hundred and twenty five years this bridge stood and provided the simple service of a river crossing. Over its original wooden deck traveled a much slower traffic of horse and wagon. The sounds that surrounded the bridge in its early days were those that came mostly from nature and not the mechanical sounds of the internal combustion engine. The portals were bent and broken as the result of recent attempts to cross the bridge with heavy farm machinery. At the top of the portal set empty brackets that once held the name plates, the identity of the bridge. They now hang in a family recreation room to be occasionally viewed by a few. There is something beyond its presence, beyond its bent and broken members, beyond the dirt piled at each end to prevent its intended use: an unwritten craftsman's record.

Books both in the nineteenth and twentieth centuries document the bridge engineer's perspective on truss bridges and the development of their designs. This same period saw advances in wrought iron and steel making processes, metal fabrication methods and machinery, but the written record of these accomplishments is less evident. The words of the craftsmen who fabricated these bridges are rarely recorded, and only a few of their tools remain to tell their story. Saving these historic bridges is important because few craftsmen recorded their shop experience. These historic bridges are their record.

Restoration of the Bauer Road Bridge

Most of the following text is excerpted from Vern Mesler's upcoming article in ASCE's Professional Issues in Engineering Education & Practice
Restoration of historic riveted truss bridges
(In press. With permission from ASCE.)