A Tale of Two Bridges

By F. E. Griggs, Jr. FASCE

Malta stone arch bridge before collapse

Malta stone arch, collapsed April 1993

In 1873, the Town of Malta, New York, decided to place a bridge over Ballston Creek to provide another north-south roadway in the town. Their choice of bridge material consisted of iron, (more common after the Civil War), wood and stone. After reviewing their options, they decided to build a stone arch bridge and selected Elbin Miller, a local builder and farmer, to build it. He obtained his stone from local fields and quarries, and built a 20-foot span arch over the creek. His southerly abutment was set on shale rock. His northerly abutment was set on rock, but required an extensive approach fill that he contained with a wooden bin. His bridge was sound, and the only periodic repair needed over the years was replacing the wooden bin. The bridge was placed on the National Register of Historic Places in 1988. In 1991 the bin was replaced again. Upon investigation of the stonework, cracks were observed and a recommendation made to correct the situation. The town did not undertake the work at that time. On April 24, 1993, during a major thunder storm, the bridge collapsed. The town investigated several replacement options, but until 1998 no action was taken to replace the bridge. Rebuilding the bridge in stone was not considered, due to the high cost.

In 1888 near Salem, in Washington County, NY, the County Commissioners decided to place a bridge over Black Creek. This bridge was located approximately 35 miles northeast of Malta. Iron bridges were becoming very common at that time, and many regional bridge companies were actively selling their bridges to towns and counties. One of these firms was the Berlin Iron Bridge Company from Berlin, Connecticut. They specialized in a wrought iron lenticular truss called a Pauli Truss in Europe, and patented in the United States by William Douglas in 1878. The bridge was one of 193 that were built in New York State in the 1880s. The bridge has a span of 51', deck width of 12.2' and consisted of four panels. It was built on dry laid stone abutments.

Due to the low volume of traffic, the Salem bridge served well for over 100 years, only requiring wood deck replacement periodically. The State Historic Preservation Officer (SHPO) determined the bridge was eligible for future placement on the National Register of Historic Places. State inspections in the 1980s indicated section losses on the steel stringers of up to 30% and on some of the truss elements up to 20%. The abutment stonework was also collapsing in places. The bridge was flagged at the time and its load rating reduced. In 1990, the county decided to remove the bridge with the intention of restoring and re-erecting it at another location. The bridge was moved to the County Park near Cambridge, where it was cleaned and painted by inmates from Mt. McGregor Correctional Facility. In the spring of 1998, the County was still planning to use the bridge, but by early 1999 the Supervisors instructed the County Engineer to find a new home for it. At this time, the writer was asked to assist in finding a town, county or individual interested in a bridge of this span.

Berlin Iron Bridge, Salem, Washington County, NY

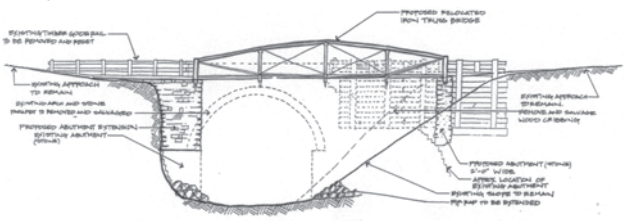
It was immediately apparent that the bridge would be an appropriate replacement of the stone arch bridge in Malta. Before suggesting this to the town, it was necessary to determine the condition of the bridge after several years of storage. Equally important would be the amount of restoration required before it could be reused. The stone from Malta's arch bridge was still in the creek, and could be used in the construction of new abutments. Use of the existing stone would maintain a connection between the original and proposed structure. The key to the financial feasibility of restoration was the condition of the iron structure. It has been the writer's experience that cast and wrought iron structures are very resistant to corrosion, if properly maintained. Having inspected several lenticular bridges of this type, I found that the end posts and verticals were frequently damaged by impacts of vehicles or loads carried on them. If these members needed to be replaced by riveted steel members, the historic authenticity would suffer and the cost of rehabilitation increase.

Inspection & Rehabilitation

The process followed in determining the condition of the trusses and beams varies from project to project, but generally consists of a detailed on site inspection. Since the structure was on the ground, this process was easier. The inspection follows:

1. Document the condition of each connection and structural member with digital photography.

2. Inspect main truss members, looking for members with section loss. The top chord of the truss was built up of wrought iron plates, angle irons and lattice bars riveted together. Rust bulge is common on these members, frequently resulting in rivet failure or tearing of wrought iron plates. Minor amounts of rust bulge existed. Hammer blows removed it. Separation of the plates due to rust bulge was closed by additional hammer blows and some heat. Lattice bars were frequently bent, but not cracked or broken. The verticals were built up with angle iron and lattice bars. They had been impacted and plates were welded to the iron members. Tension links connected by pins, being outside the deck area, are generally not subject to impact or corrosion and were in good condition. The diagonal bars in the two middle panels were connected by pins and generally were free from corrosion. The vertical end posts were built up with plates, angles and lattice bars similar to the top chord. These members were bent in places resulting in tearing of the wrought iron. The inspection revealed that welding could repair them. All rivets were inspected visually and by hammer impact. They were found to be tight and as originally installed. The members connecting the end base plate to the first lower chord panel point frequently are bent or corroded. This was the case in the Washington County structure. Of the four members, one was entirely replaced and the others rehabilitated.



Preliminary Plan (elevation) for bridge at Malta (CHA)

3. Inspect the wrought iron pins connecting the members together. This can be done visually. However, visual inspection should be supplemented with hammer blows to the ends of the pins, listening for signs of cracking or fracture. Non-destructive tests can also be run, but it was decided that this was not necessary.

4. Inspect the deck beams. These beams are variable depth, and consist of plates and angle irons riveted together and hung from the lower chord pins by U-bolts. Located below the deck, they generally show section loss. This was the case on the Washington County bridge, but they could be rehabilitated with welding and the addition of plates as required.

5. Inspect the under deck bracing. Located below the deck, these members are frequently corroded and require replacement. In this case, the bracing on the first panels were missing, and assumed to have been discarded as they were beyond repair. They were replaced with new steel. The remaining bracing was in good condition.

6. Inspect the cast iron junction block at the first top chord panel point. The end post, top chord and tension link diagonals all are connected to this casting; the diagonals by nuts and the other two members by bearing.

The welding of wrought iron requires a technician with experience, and the use of a low hydrogen-welding rod such as E7018. All cracks are grooved and welded, and the weld ground smooth. One cast iron junction block needed minor repair, and this was done with a high nickel content welding rod Cronocast 211.

All the rivets were in good condition, so none had to be replaced. In the event that some would have been in poor condition, they would have been replaced with real rivets installed by trained technicians. The use of steel bolts, while structurally acceptable, is not in keeping with good historical restoration practice.

Painting the bridge was necessary due to the welding required on the members. A three coat paint system was required using Dupont Imron 333, Dupont Imron 610P and Corlar 25P. Since the bridge was sandblasted and primed earlier, the three-coat system was applied directly over the prime coat.

An Old Bridge at a New Site

Based upon the inspection, it was clear that the bridge was in excellent condition and could be restored without significant expense. An estimate and preliminary plan for was prepared for consideration by the Town of Malta. The writer, as a representative of Clough, Harbour & Associates LLP (CHA) of Albany, NY, approached the Town Supervisor and proposed the use of the Washington County bridge at the stone arch location, stressing the

South abutment using stone from the arch bridge

Bridge at Malta, August 2003

replacement of a historic structure with a historic structure providing a crossing for pedestrians and bicycles at a reasonable cost. The SHPO was supportive of the project and indicated that the bridge at its new site would also be eligible for the National Register. After several public hearings, the project was approved and CHA was retained to prepare a TEA 21 (Transportation Equity Act for the 21st Century) proposal. The proposal was then submitted, with the Town committing to cover 20% of the project.

On July 21, 1999 Washington County formally "sold" the bridge to the Town of Malta for $1.00 and offered to assist in moving the structure from the County Park to Malta near the bridge site. The only stipulation was that a plaque be mounted on the bridge indicating that it was "donated by the people of Washington County." The TEA 21 grant was approved. In November 2000 the trusses were moved to Malta, using Washington County equipment to load and transport them. Town of Malta personnel and equipment unloaded them near the bridge site. This effort could not be considered as part of the local 20% grant match, as the paper work of the grant was not complete at that time.

It was decided that the Town's 20% match would be used in the restoration of the trusses, beams, approach paving and site work. The contract for the remainder of the project was awarded in the amount of $90,000, with alternates for placing stone facing on the new concrete abutments, setting the bridge on the new abutments and installing the bridge decking. The three alternates were included as the town was negotiating with the local National Guard Unit to perform these tasks as a community service. The Guard could not work the project into their schedule, so the three alternates were added to the contract, bringing the total to $105,500. Unforeseen foundation conditions on the south and north abutments resulted in change orders of approximately $13,500.

Work began in October 2001. A mild, snow free fall and early winter enabled the contractor to finish the bridge by Christmas of the same year, with the exception of site work and railing which were completed in the spring of 2002. The bridge was dedicated in the fall of the same year.

And the Moral Is…

Any good tale should have a moral. The moral of this story is that with the cooperation of the town, county, consultant, DOT, and SHPO from conception to completion historic bridges can be saved at reasonable cost and serve as reminders of the engineering of the 19th Century before the age of steel. This project is also a fine example of how historic iron bridges meet the transportation needs of bicyclists and pedestrians in the 21st century.

Bridge at Malta, August 2003

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 in an independent Consulting Engineer.