Construction Aspects of the Pisgah Covered Bridge
By Randle E. Brim

NOTE: The below construction aspects of the Pisgah Covered Bridge were obtained from interviews with William Moffitt, Jr. during December 2009. Moffitt is a N.C. licensed building contractor of 26 years having built more than 300 structures, mostly residential. He is a life time resident of the Pisgah Bridge Community. Moffitt was the lead contractor for reconstructing the Pisgah Bridge.

Introduction:

Overall, the Pisgah Covered Bridge is 54' in length and 10' in width with a gable roof. The roof pitch of the bridge is called a 9 on 12 pitch. Most of the local historical sources state that the bridge is 40' in length. The bridge uses vertically sheathed exterior boards, mostly 1" x 8", being both oak and pine. Structurally, the bridge is braced and divided into **three** independent sections with each section measuring 18' in length, and tied together, they create the 54' length bridge. Each 18' section rests on two spaced stone abutments or foundation piers, making a total of three 18' sections and four stone abutments or piers. The bridge uses a "queen post truss" system. William Moffitt states that the bridge is also considered a post and beam type construction or a "queen frame segmented construction."

Purpose of the Covered Bridge:

The primary reason that the bridge was covered was to give it a longer life span. Each end of the bridge has about a 40 inch extended roof overhang beyond the flooring length. It also served as a refuge and cover to either commerce or people traveling during bad weather. It shielded animals from being afraid to cross a stream of water. Sometimes covered bridges were referred to as "kissing bridges" because it gave courting couples more privacy from prying eyes. This would have been so from the wagon and buggy days to the first automobiles and then to the tourists and visitors of today. The interior corner beams were used as a community bulletin board. Notices of local events and auction sales were posted to inform the community passerby's of upcoming events.

Purpose of the Bridge Windows:

Along the top sides, just beneath the eaves of the roof, were bridge windows which served several purposes. They provided light and ventilation into the bridge. Structurally, they allowed high wind loads to pass through the bridge without lifting the roof and the bridge. The windows were also high enough to prevent livestock from seeing the moving water.

The Interior Hand Rails:

The hand rails that run length wise on each side of the interior bridge were not part of the original built bridge. They were installed at a later point after the bridge was discontinued from public use, probably by the late 1950's. Because the width of the bridge, 10', was so narrow, all the width space had to be used. The original corner interior side vertical bracing timbers show marks and indentions made from equipment and vehicles hitting the bridge as they entered.

Exterior Bracing:

On the exterior of the bridge near the stone piers, there is a bracing system, called a "Half 'A' Lock-Out Bracing Design" system. It is also called a Flying Buttress System. These bottom braces are concealed with board sheathing and shingle shakes, in the shape of a Half A, which extends out from the bridge about 36" and up the exterior side by about 66". There are four Half A braces on each side of the bridge making a total of eight. These Half A braces connected to a 17' length white oak timber beam that once rested across the stone pier perpendicular to the bridge length. They extended about three feet on both sides of the bridge. These bottom timber beams were replaced with a steel I beam.

These eight "Half 'A' Lock-Out Bracing" sections help to structurally brace the bottom and the entire side walls. The opposite sides of these braces push against each other or oppose each other. They also define the beginning and the end of each 18' length section of the bridge.

Interior Side Bracing:

The interior side wall bracing corresponds to the three independent 18' sections and four stone piers of the 54' length bridge. On each side above each stone pier vertically stands a 4" x 10" white oak post braced and connected with the exterior "Half A Lock-Out System." In each of the 18' lengthwise side sections, there are two 4" x 4" twelve feet length timbers turned at 45 degree angles creating an "A" shape. This angle bracing makes it a post and beam type construction (or the queen post truss system), and it helps to brace each of the three 18' length sections and the entire 54' length wall.

Interior Overhead Bracing:

In the interior roof area, there is a "Lateral X" or cross bracing beam section that corresponds to and matches the 18' length span section of flooring resting on two piers. Overhead and the length of the bridge, there is a total of three of these X bracing sections, corresponding to the three 18' sections resting on the four piers. The overhead beams cross at the center point between two piers, being on nine feet centers between the stone piers.

This is a horizontal type of bracing. It keeps the upper wall and roof area from side swaying and wind over load. It helps to stop the sheer force of wind and the top area of the bridge from trying to twist.

The Original Materials:

The original four stone piers were all dry stacked, without concrete or mortar, and having no concrete footers. These stones would have come from the stream beds and/or the adjacent fields. The stone pier in the middle of the stream was and is protected by what William Moffitt believes is a man made rock island on the north side of the covered bridge. Moffitt believes that the 1911 bridge builders built the approximate 30' length rock island in the middle of the stream so that the middle stone pier could be erected and also protected from the force and weight of water and from scouring erosion.

According to Moffitt, another man made device that originally protected the stone piers and the bridge from the force of flood waters was a "mill type race" or a depressed swale, dug at each end of the bridge. During heavy flood times, the race would divert high water around both bridge ends and flow downstream. According to anecdotal information that Moffitt has collected over the years, there was a swale or a depressed area in the ground, about three feet in depth, just as one entered and as one exited the bridge. During "A Model" travel times, passengers would "lose their stomachs" riding through these swales. Apparently later, maybe sometime in the 1930's, dirt was hauled in to fill these swales and to level the areas around the bridge.

All the original 1911 timber beams beneath the flooring, the sub flooring, and the wall bracing boards were made of fresh cut white oak. White oak is the strongest native wood in Piedmont, N.C. Also, it is resistant to rot and can handle a lot of weight. In fact, William Moffitt wonders how the 14 running beam timbers, about 21' in length, about 10" x 10", would have been handled and laid atop those dry stacked stone piers. He estimates that when they were laid green in 1911, each one would have weighed approximately 2000 pounds each.

The first layer of timber beams lay atop the stone piers, perpendicular to the bridge's length, being about 17' long and 10"x10" in size. Spanning the 54' bridge length atop the first layer of timber beams on the piers, there were a total of 14 timber beams, 21' in length and 10" x 10" in size. These timber beams spanned over each 18' length section, lapping across the stone piers, giving additional strength to the bridge flooring.

Next, white oak boards were laid perpendicular atop the length timber beams to create the sub flooring. Next, the floor runners were nailed and laid length wise through the bridge. These runners were made from virgin forest pine, which is now extinct, with many of the boards measuring about 20' in length and 14" wide. Some of these virgin forest pine boards were mixed in other places of the bridge as well, including the original roof X bracing, the roof stripping, and some of the side boards.

Based on the holes, the mortise slots, and the grains in these floor runners from virgin forest pine, William Moffitt believes the 1911 builders re-used the boards from much older structures, such as a grist mill, dating back well into the early 1800's or before. When these boards were originally cut, according to Moffitt, the grain count indicates the tree would have been 120 to 150 years old. This means that these virgin pine running boards probably first sprouted as a tree in the late 1600's.

Originally, locally made wooden shakes made from white oak, covered the bridge's roof. The original shakes did not require solid sheeting beneath it. The original oak shakes were subsequently replaced with tin metal, maybe sometime in the 1930's after the bridge was assumed by the state. The same white oak shakes covered the eight side flying buttresses.

All of the nails used originally in the 1911 bridge were hand forged nails, probably from a local black smith shop.

The Replaced Bridge Materials:

On early Sunday morning before daylight, August 10, 2003, the bridge being anchored only by its own weight, became buoyant, and floated off its stone piers. In about four hours, the bridge location at the West Fork Branch of Little River, received about 6 l/2" of rain, surging the water level to about 14' above the normal level. The bridge lay toppled and tangled about 100' down stream, totally destroyed. More than 90% of the original bridge was recovered and placed back in the rebuilt bridge.

The remaining four stone piers were temporarily removed so that concrete footers and tiers could be poured in the original stone pier locations. Large oval shaped footers, about three feet deep, about four inches below the water level, were filled with concrete. Then four concrete abutments atop the footers, reinforced with welded and tied steel, clad with the original stones, replaced the original dry stacked stone pillars. The bridge level was raised 14" higher than the original level to be above flood elevation. Approximately 100 thousand pounds of concrete were poured for each of the four footers and pillars. Stone masons then clad each of the concrete piers with the original pier stones. Today, a stone façade conceals the four concrete abutments or piers, giving the impression that the stone pillars are dry stacked.

Twelve anchor bolts, one inch in diameter, 48" long (45" in the concrete), were mounted in each of the four concrete piers, making a total of 48 bolts. Three steel leveling plates, with four holes in each for the anchor bolts, were spaced atop each of the concrete piers. An18' long ten inch steel I beam was then welded to the three steel leveling plates atop each of the four concrete piers. Then four 54' continuous steel ten inch I beams were perpendicularly laid atop the 18 feet wide I beams, bolted and welded. All of the steel I beams were sheathed and concealed with oak boards re-cut from the original 10" x 10" timbers. The I beams are not visible to the observer.

Then a line of 2" x 8" treated boards were bolted atop the length of the four 54' length I beams. A subflooring of 2" x 8" treated boards was then nailed perpendicularly to the treated runners atop the 54' I beams. Then, the original bridge sub flooring, being mostly white oak, was then nailed atop the treated wood subflooring. Last, the original running boards, being virgin forest pine, were placed back in the same places as before. William Moffitt stated that it took him three hours to figure how the "pieces of the puzzle" of the running boards were originally laid, before nailing the boards in place. Today, one can still see the indentions in the virgin pine running boards made from the metal cleats of old farm tractors and equipment that crossed the bridge from its inception.

The roof rebuilding began with a solid sheeting of recycled pine boards. Then rolls, 36" wide, of "Winter Guard" (a rubber based sheeting) covered the board sheeting. New cedar shakes were placed on last. The shakes were made from northern Red Cedar from Canada, and they were hand split at a shingle mill in West Virginia. The lapping shakes were 24" long, with 9" exposure showing. For additional weather protection, tar felt paper was spaced between the layers of cedar shakes. There were several reasons the roof was sheeted solid with wood, instead of strips. It made the roof system stronger. It helped to protect the winter guard sheeting. It helped to protect the shakes from vandalism.

Where possible in the bracing, the retrieved original bolts with their old washers were re-installed. Where visible nails were used, special hand cut nails were obtained from Treemont Nail Company in Massachusetts, the oldest nail manufacturing company left in USA, established in 1819, and the only company still making these nails.

NOTE: The following is a materials summary list that was provided by William Moffitt, Jr., lead contractor for the bridge project. These were the materials used in the reconstruction of the Pisgah Covered Bridge during 2003-2004:

1. **Concrete by conc. truck-** 388, 000 pounds (194 tons) *(See Comments Below)*
2. **Steel Rebar**-- 3580 linear feet
3. **Steel I Beams --** 283 linear feet
4. **Type "S" Mortar Mix**-- 147 bags *(See Comments Below)*
5. **Sand--** 42 yards
6. **Hand split cedar shakes--**80 bundles, 24" size
7. **Metal corro form--** 105 square feet
8. **Black felt, # 30 pound--** 20 rolls
9. **Brick--** 3675 bricks
10. **Concrete Block, 12 in.--** 96 blocks
11. **Nails--** 832 pounds
12. **Lumber--** 8100 board feet (This was all lumber, both old & new)
13. **Gravel: fill & grading--** 423,440 pounds (211.72 tons) *(See Comments Below)*
14. **Cross ties**-- 23 (used in stabilizing banks & landscaping)
15. **Masonry stones, for tiers & end ramps--** **a**pprox. 250,000 pounds (125 tons) *(See Comments Below)*
16. **Bolts--** 632 (old & new; 10 of the 15 old bolts & washers)
17. **Steel straps, l/4" x 4"--** 32 linear feet
18. **Man Hours--** approx. 2450 hours

COMMENTS:

1. Concrete: 15 concrete truck loads, totaling 97 yds. of. concrete; times 4,000 lbs. per cubic yd. equals 388,000 lbs. This concrete went into the bridge tiers, wings, footings, and the two ramps and their footings.

4. Mortar Mix: each bag mixed equals 200 lbs. times 147 bags equals 29,400 lbs.

13. Gravel: Used for fill and grading around the bridge, parking area, picnic area and connecting trails.

15. Masonry stones: this total includes existing tier stones and purchased stones.