

Lakeport Plantation Restoration

Technical Report No. 9

Braced Frame Construction



Lakeport Plantation house is built of wood frame construction using a building technique known as braced frame, or full frame, construction. Braced frame construction was used during the eighteenth and nineteenth centuries for large wood frame buildings. In braced frame construction, heavy timbers are held together with mortise and tenon joinery. Nails are used only for the rafters, floor beams and smaller pieces. Framing members consist of heavy sill beams, corner posts and top plate beams framed together and strengthened by corner braces that extend diagonally from the heavy plate beam to the corner post. Vertical framing members called studs are evenly spaced and extend from the sill beam to the plate beam. The floor joists rest on the sill beam and the rafters are notched to lay on the plate at the top of the studs.

The framing timbers used for Lakeport Plantation house were cut from old growth cypress believed to have been harvested from the surrounding area. Cypress trees were abundant in Arkansas and nearby Mississippi and Louisiana at the time that Lakeport house was built. Old growth lumber refers to lumber that has been harvested from virgin forests that have never been cut. Old growth lumber is denser, tighter grained and stronger than second or third growth lumber and can be identified by its very tight growth rings. Cypress lumber is desirable for construction because of its resistance to rot. Rather than producing sap like other trees, the cypress tree produces an oil called cypressine which helps to preserve the wood and makes it resistant to decay and insect infestation.

Before restoration began on Lakeport Plantation house, framing timbers were used to determine the date



The photo at left was taken in March, 2003, as restoration was beginning. At that time, Lakeport Plantation house was approximately 140 years old. The braced frame method of construction used to build Lakeport had kept the house straight and strong through the years.

The photo at right shows the top plate beam, wall studs, a vertical intermediate post and braces. The bracing is running from the intermediate post to the top plate beam. The top plate beam is supporting the second floor ceiling joists. The ends of the ceiling joists extend beyond the top plate beam to become the roof overhang.



that the house was built. Samples were taken from the rafters and other timbers in the attic area and tested to determine the age of the timbers. This process, called dendrochronology, or tree-ring dating, is the scientific method of dating wood by analyzing the tree ring growth patterns. Through this testing, it was determined that the timbers used in construction of the house were harvested between 1858 and 1859 and Lakeport Plantation house was built approximately between 1859 and 1860. The dendrochronology testing was conducted by the University of Arkansas Department of Geosciences in Fayetteville, Arkansas. A copy of the report on tree-ring dating of Lakeport Plantation house can be found in the Historic Structures Report for Lakeport Plantation.

An important discovery made during restoration was the brick nogging found between the floor joists at the base of the first floor walls. Nogging was used in home construction during the eighteenth and nineteenth centuries. Typically built of bricks and mortar, stone was sometimes used in place of brick. The primary purpose of nogging was to guard against house fire. In both braced frame and balloon frame construction, fire in the walls was a serious threat. In these types of construction, the openings on the insides of the walls would permit fire to pass quickly through the house. The brick nogging served as an obstruction to prevent the fire from spreading so rapidly. Nogging also prevented rodents and other unwanted intruders access into the wall cavities. Brick nogging was found inside the interior as well as exterior walls of Lakeport house. This may be an indication that the primary purpose of the nogging for



The photo at left shows the brick nogging that was discovered during restoration of Lakeport Plantation house. The nogging in this photo was exposed when siding was removed prior to restoration of the foundation walls.



During restoration, the lower siding of Lakeport Plantation house was removed, exposing the framework. In this photo the original sill beams, wall studs and brick nogging can be seen. Notice the missing nogging between some of the wall studs.

Lakeport house was to prevent rodent access.

The framing for Lakeport Plantation house is supported by interior and exterior brick foundation walls. Heavy sill beams, measuring 8 1/2" tall and 13" wide, lay on top of the foundation walls. The sill beams show signs of being both machine sawn and hand hewn, or cut with a broadaxe. It is possible that the sill beams were sawn first and then hand hewn in areas where trimming was necessary. Floor joists for the first floor set on top of the sill beams. The floor joists measure between 2" and 2 1/2" thick and 11" to 12" deep and are spaced approximately 16" apart. Cross bridging is used between floor joists to stiffen the floor and distribute the load over several joists.

The original flooring, which still remains throughout the house, is built of northeastern white pine, tongue and groove material. The flooring in the north parlor, drawing room and dining room was covered over in the 1960's with modern oak flooring. Original plans were to remove the oak flooring to expose the original. However, because removal of the oak flooring would cause damage to the original, it was decided that the oak flooring would remain in place.

The wall studs are built of 2" by 6" machine sawn lumber placed approximately 16" apart. The first floor



In the photo at right the floor joists, sill beam and foundation wall can be seen from underneath the house. Notice the moisture in the bricks near the ground. The moisture is absorbed up from the ground, through the mortar, and will eventually reach the sill beams.

The photo at right shows the cross bridging between the floor joists of the second floor. The purpose of the cross bridging is to strengthen the floor by distributing the load over several joists. The photo below shows a close-up view of the bridging.

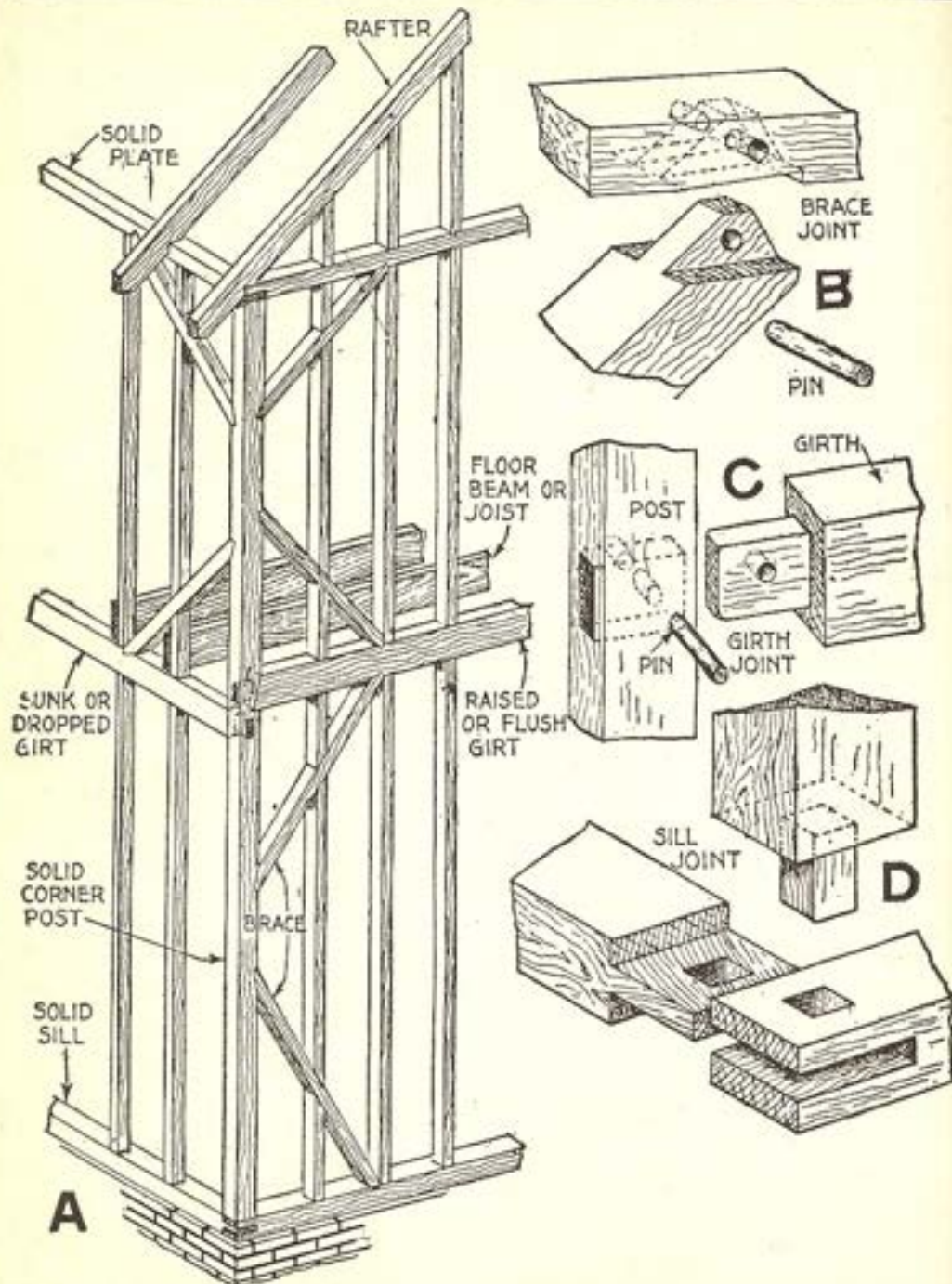


wall studs are mortised into the sill beam at the bottom and the intermediate plate beam at the top. The intermediate plate beam sets at the second floor level and supports the floor joists as well as the wall studs for the second floor. The second floor joists are the same size as the first floor. Vertical intermediate posts are placed between wall studs in areas where interior walls meet the exterior wall frame. The intermediate posts, heavier than the wall studs, are 7" square. The purpose of the intermediate posts is to give additional structural support in areas where additional weight causes stress to the framing. The same framing method is used for the interior walls that is used for the exterior walls. Heavy timbers are used for the interior walls as well.

Evidence found during restoration indicates that the walls of Lakeport Plantation house were put together and then raised into place. This was typical for braced frame construction. The flooring was constructed first and then the walls. After each wall was built, it was set into place and temporarily braced until another wall was built and set in place. The first and second floors were both constructed in this manner.

Heavy corner posts, 7" square, set at each corner of the house. Corner bracing, the same size as the wall studs, runs diagonally from each corner post to the sill beam below. Another brace runs from the corner post to the intermediate plate beam above. Bracing is also found on intermediate posts of the exterior and interior wall framing. The purpose of the diagonal bracing is to prevent racking and to keep the house frame square.

The framing for the house is covered on the exterior with a 6" wide cypress lap siding. On the interior, the



FIGS. 1,776 to 1,779.—Full frame and details of the joints A, corner of frame showing the various members; B, brace joint; C, girth joint; D, sill joint.

The braced frame construction method that was used in the building of Lakeport Plantation house is very similar to the building method shown in the illustration above. The girth joint, shown in figure C, is the type of joinery most frequently used in the construction of Lakeport. This illustration was taken from *Audels Carpenters and Builders Guide # 3* by Frank D. Graham and Thomas J. Emery published in 1923.

The photo at right shows the large rafters which can be seen from the attic of Lakeport Plantation house. The rafters provide the framework for the roof. The vertical support post, in the center of the photo, provides structural support for the roof.



framing for the walls and ceiling is covered lathe and plaster. The wood lathing is 1 1/4" wide and 5/16" thick. The lathing on the walls is hand split, from poplar and gum timber. Lathing on the ceilings is machine sawn cypress.

The main section of Lakeport Plantation house is built with a hip roof design. A gabled roof covers the porch at the front of the house. At the back of the house, above the single story ell, is another gabled roof. The hip roof is characterized by four straight sides, all sloping toward the center of the roof, forming a ridge at the peak. The gabled roof is much simpler, having only two sloping sides that meet at the ridge which runs the length of the roof.

The second floor ceiling joists are exposed in the attic of the house. They measure between 2" and 2 1/2" thick and 8 1/2" to 9 1/2" deep. These joists rest on the top plate beam and extend beyond to become the roof overhang where they provide support for the built-in guttering system. The rafters are the framework for the roof and give the roof its shape. They measure the same as the second floor ceiling joists. A support board sets on top of the ceiling joists to support the rafters tails. The rafter tails are notched to set level over the support board.

Vertical support posts rest on top of interior intermediate plate beams in the attic to provide structural



The photo at left shows the rafters and second floor ceiling joists where they meet in the attic of the house. A support board sets on top of the floor joists to support the rafters. This photo was taken from the Historic Structures Report of Lakeport Plantation.



The photo at left shows the braced frame construction from the interior of Lakeport Plantation house. Seen in this photo is a corner brace, wall studs and top plate beam as well as ceiling joists for the plantation office. The siding that covers the framing on the exterior and the plaster lathing that covers the framing on the interior can also be seen.

support for the roof. Two of the largest support posts set beneath the ridge of the roof to provide support where the hip rafters tie into the ridge. Horizontal beams, called collar ties, are also used in the roof framing. Collar ties are placed between two rafters opposite of each other and form an A shape. The purpose of the collar ties is to make the rafters stronger and keep them from bowing. The rafters for Lakeport Plantation house are covered with rough sawn cypress skip sheathing spaced about two inches apart. The purpose of the skip sheathing is to hold the wood shingles which cover the roof.

The porches for Lakeport Plantation house are framed in the same manner as the rest of the house using large timbers, between 6" and 8" square, for all of the support beams. Floor joists for the porches are all of similar size, approximately 2" by 6". The floor joists are built to set slightly higher than the supporting beams. The purpose of this is to allow air to flow underneath the porch flooring and prevent moisture deterioration. The floor joists were also built so that the flooring would slope slightly away from the house. This assures that water will run off of the porch rather than laying on the porch flooring.

There are two types of joinery used in the framing of Lakeport Plantation house. They are half-lapped and mortise and tenon joinery. Each would have been cut by hand using a saw and a chisel. In mortise and

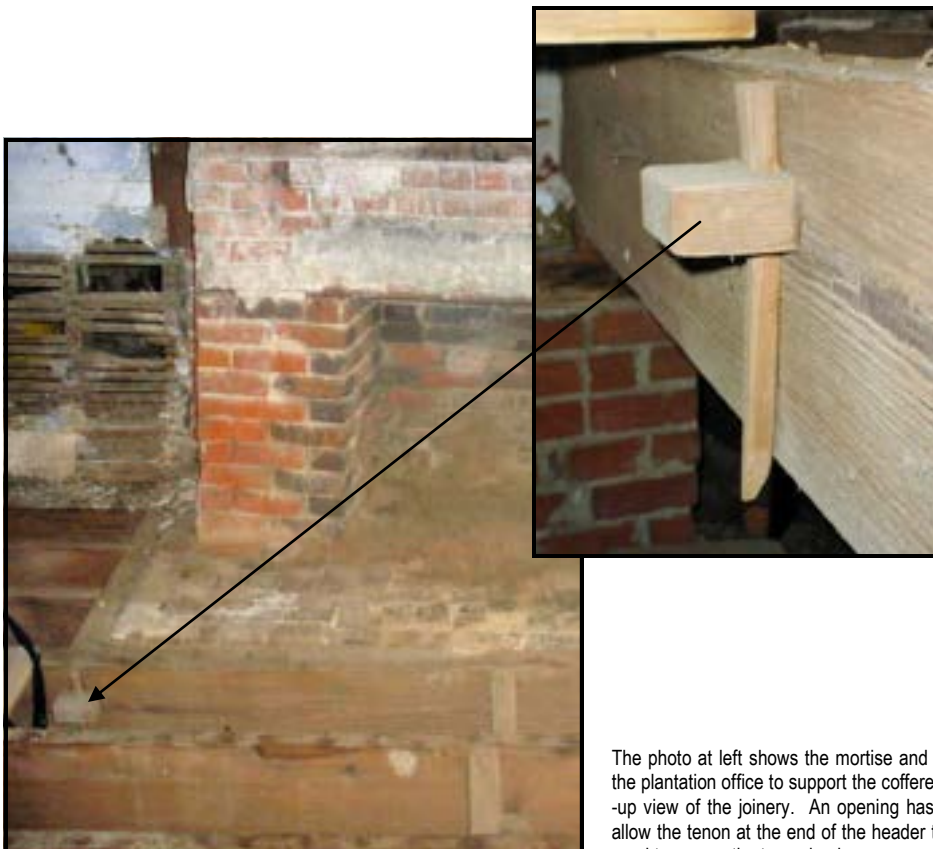
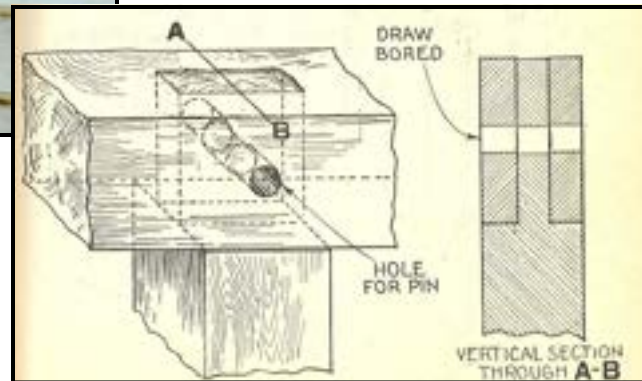


This photo was taken in the attic above the plantation office. The center board, called a rat run, is used to tie the ceiling joists together. The boards used for the ceiling joists were all different widths and had to be cut away in the center at different depths for the rat run to lay level.

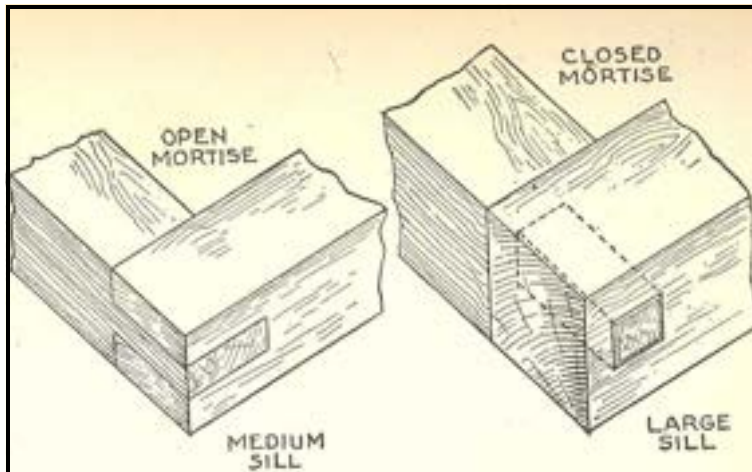


The photo at left shows the mortise and tenon joinery used for the second floor porch tie-in to the front of Lakeport Plantation house. The intermediate vertical post is mortised on each side to accept the tenoned top plate beams and the joint is secured with wooden pegs.

The illustration below demonstrates how the wooden pegs are used to secure the joint. This illustration was taken from *Audels Carpenters and Builders Guide # 3* by Frank D. Graham and Thomas J. Emery published in 1923.



The photo at left shows the mortise and tenon joinery used for the floor joists in the plantation office to support the coffered hearth. The photo above is a close-up view of the joinery. An opening has been mortised into the floor joist to allow the tenon at the end of the header to pass through. The wooden peg is used to secure the tenon in place.



The illustration at left shows two different types of mortise and tenon joinery. As can be seen from this illustration, not all joints are secured with the use of pegs. This illustration was taken from *Audels Carpenters and Builders Guide # 3* by Frank D. Graham and Thomas J. Emery published in 1923.

tenon joinery, a framing member is narrowed at the end to form the tenon. The tenon is specially shaped to fit the mortise, or opening, that has been cut into the adjoining framing member. The two pieces are then fitted together to form a joint and wooden pegs are used to secure the joint. This type of joinery would have required the work of a skilled craftsman. There are several different types of mortise and tenon joinery and they are usually identified by the shape of the mortise and tenon.

With the half-lap joint, two framing members, generally of the same thickness, are fitted together by overlapping them. Half of the material is removed from the end of each framing member and fitted together with wooden pegs to form a joint. When fitted together, the joint is the same thickness as the framing members. Although simple in design, both half-lap and mortise and tenon joints are very strong.

Some interesting building techniques used in the framing of Lakeport Plantation house were discovered during restoration. Wooden wedges, found in several of the wall studs when siding was removed, revealed a technique that was used to straighten the bowed studs. Each stud was sawn two-thirds of the way through on the opposite side of the bow in the stud. The wedge was driven into the saw cut as pressure was put against the bow. The wedge prevented the bow from returning after pressure was released. It was important to have the wall framing as straight as possible for plastering.

Diagonal bracing, found in the attic space of the house, is comparable to seismic bracing found in modern



The photo at right shows a half-lap joint where two sections of the top plate beam are joined together. The top plate beam is resting on top of a vertical support post. The half-lap joint is typical joinery used in braced frame construction.

Several interesting building techniques were discovered during restoration of Lakeport Plantation house. The photo at right shows a wooden wedge driven into a wall stud, a technique used to straighten a bow in the stud.



day construction. Boards measuring 1" thick and 8" wide were nailed to the tops of the ceiling joists running diagonally and intersecting with each other. The purpose of this would have been to strengthen the house and prevent it from twisting during high winds.

The layout of the second floor of the main house is the same as the first floor, meaning that the framing for the walls of the second floor is directly above, and supported by, the framing for the walls of the first floor. One exception is the west wall of the second floor which is the back wall of the two closets off of the dressing room. This wall is suspended over the sitting room below. To support this wall, a type of trussed rafter called the queen post truss was used. This framing method uses two large steel rods that run vertically from the top plate beam through the large support beam on which the wall sets.

Materials used for framing the house showed different types of saw marks indicating the different types of methods used to cut the materials. Up-down saw marks were found on floor joists, wall studs and sill beams. The up-down saw is an early type of frame saw. Large blades were held in a frame and the blades reciprocated up and down. The up-down saw is powered with steam or water. The sill beams also showed signs of being hand cut with the use of an axe or hand plane. The hand tools would have



The photo at left shows the diagonal bracing found nailed to the tops of the ceiling joists in the attic of the house. The boards run diagonally, intersecting with each other. The purpose of the bracing is to prevent the house from twisting during high winds.

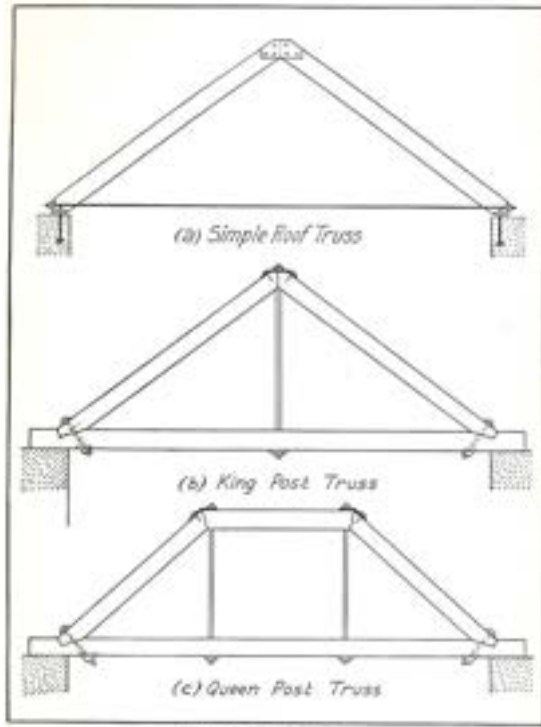


FIG. 134. Simple Roof Trusses

The queen post truss, shown in the illustration at left, is the framing technique used to support the wall of the second floor that is suspended over the sitting room below. This illustration was taken from the book *Building Construction: Materials and Types of Construction* by Whitney Clark Huntington, C.E. published in 1953.

been used after the sill beams were machine cut to bring the sill beams down to an even dimension.

Circular saw marks were found on the bottoms of some of the flooring material as well as the roof sheathing. Circular saw marks are left from a round saw blade. The saw marks are equal in circumference to the saw blades used. This type of saw would have been operated with the use of steam or water. The circular saw is more efficient than the up-down saw. It would have been the most modern technology used at the time.

The exterior foundation walls of Lakeport Plantation house were in poor condition. Settling over the years had caused them to become uneven. Prolonged water exposure along the north side of the house had caused the mortar between the bricks to deteriorate and the foundation walls to collapse. The foundation walls on the southwest corner were collapsing as well. As a result, the framework of the house was no longer being supported by the foundation, and the house was sagging in these areas.

When restoration began on the foundation walls, about four feet of the lower siding was removed, exposing the framework of the house in this area. The exposed sill beams showed major signs of deterioration. The corner posts and wall studs shown signs of deterioration as well. The sill beams are



The photo at right shows two different types of saw marks on the bottom of the flooring material used to build Lakeport Plantation house. The board at the top shows up-down saw marks while the board below it shows circular saw marks.

The photo at right shows a deteriorated corner post and sill beam on the north side of the plantation office before restoration began. Further deterioration was discovered when siding was removed during the restoration process.

the most vulnerable part of the framework of the house. They are the closest framing member to the ground and are exposed to moisture from above and below. The moisture below is absorbed from the ground up through the masonry to the sill beam. The moisture from above comes from a leaky roof or damaged siding or both.

The brick nogging was also exposed when the siding was removed. Although missing in some areas, the nogging was found to be in generally good condition. The missing nogging was replaced to match the original.

To rebuild the foundation walls, the frame of the house was lifted up with the use of hydraulic jacks. Damaged sill beams were removed at this time and replaced using pressure treated southern pine material. Traditional half-lap and mortise and tenon joinery were used for the restoration of the sill beams. Deteriorated corner posts were replaced and the deterioration at the ends of the wall studs was cut away and new materials were spliced onto the existing studs.

The framing for all of the porches was deteriorated to various degrees. The front porch framing was on the verge of collapse when restoration began. Support posts on the outside perimeter of the first floor were so badly deteriorated that only a sliver of wood remained to provide support for one of the posts. The ell porch header beams, which support the ends of the porch rafters, were in need of replacement. The west porch suffered the most deterioration with very little of the original framework remaining. And the flooring for the porches was in poor condition. All of the porches were restored to their original condition. Detailed information on the restoration of the porches can be found in *Technical Report*



The photo at left shows the exterior foundation wall from underneath the house before restoration began. Prolonged water exposure had caused the mortar to deteriorate and the foundation wall to collapse. Brick piers had been built to support the house framing. This photo was taken from the Historic Structures Report for Lakeport Plantation.



The photo at left shows a deteriorated sill beam at the southwest corner of the main house. In the close-up below, the deterioration has left a corner post tenon exposed.



No. 8: Lakeport Porches.

At the time that braced frame construction was most popular, wood was abundant. Nails were being made by hand and mortise and tenon joinery was preferable. As lumber became scarcer, sawmills became faster and nails were being produced by machinery. Speed and cost of construction became important. With the cost of heavy timbers and the amount of labor required to make the joinery, braced frame construction became too costly and too slow. It was then replaced by a similar method called balloon frame construction. In balloon framing, lighter timbers are used for all of the framing members and nails are used for fastening all of the joints. This method of construction is much quicker and cheaper



The photo at left shows the framework of Lakeport Plantation house being lifted with the used of hydraulic jacks as the foundation walls were being rebuilt. The foundation walls had collapsed in several areas causing the framework of the house to sag.

The photo at right shows the north side of Lakeport Plantation house as the foundation walls are being rebuilt. Deteriorated sill beams have been replaced and brick nogging is being laid where original was missing.



than the braced frame method. A problem that developed with balloon frame construction was that the lighter timbers used were often too light for building construction. The combination frame method of construction then developed, using the best of both braced frame and balloon frame construction. Some of the features of braced frame construction, the use of the sill beam and corner braces, continued to survive for several years. However, as framing methods continued to change over the years, the sill beam and corner braces were replaced with more modern building techniques.

Resources:

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Lakeport Plantation is an Arkansas State University Heritage Site located in Chicot County, Arkansas. The *Lakeport Plantation Restoration Technical Reports* were compiled by Ronnie and Sonya Walker to document the restoration of Lakeport Plantation.