

2023

First Christian Church Tower Renovation

FIRST CHRISTIAN CHURCH
531 FIFTH ST., COLUMBUS, INDIANA

Introduction

First Christian Church, Columbus, Indiana was completed and dedicated in 1942. Designed by Eliel Saarinen, it is considered to be one of the first churches of contemporary architecture in the United States. In 2001 it was designated a National Historic Landmark by the National Register of Historic Places, U. S. Department of the Interior, one of seven buildings in Columbus to have been recognized as such.

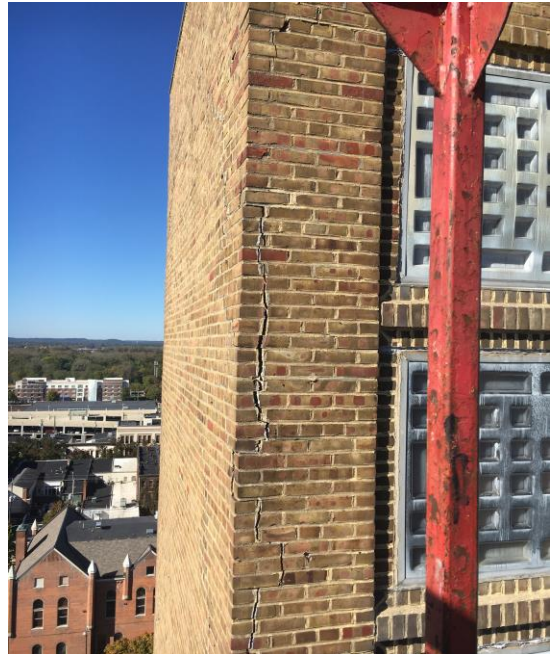
The church's bell tower has gone through several modifications and repairs over the years to prevent or minimize damage that was occurring as the result of water penetrating the all-brick structure. Freezing and thawing, growing structural cracks, brick spalling on both the interior and exterior, had taken their toll on the 82-year-old tower.

Engineering studies in 2006, 2014 and 2018 all recommended upgrades to the church and tower and as the years passed professional consultants agreed that the tower's repair was a focal point needing ever increasing attention.

The tower is 166 feet tall from the street level. Its wall structure was originally constructed as solid brick, 29 inches thick at the base and thinned to 17 inches at the top. The exterior's perimeter appearance is such that it is uniformly rectangular from bottom to the top, so the bricked tapered portion happens on its interior.

One would assume that the tower would not move, but it does: twisting, expansion and contraction caused by cold winter mornings, hot summer days and high winds. The sun's heat and position at different times of the day has an impact. Thus, cracks had opened, rain water had penetrated its surface and wintertime freezing and thawing had added to its weakening. In or about 1956, a reflecting pool located inside the church courtyard, was filled in because it was thought that the heat from sunlight reflecting off the water was contributing to the structural twisting (torsion) and damaging the all-brick structure.

The tower has had repairs over the years, some were effective and some were not, and in themselves may have contributed to further damage. In 1964 improvements were attempted to fix the results of the tower's moving. In 1976, brick veneer damage repairs, and the replacement of the brick grid openings in the upper clock chamber, with plastic panels to prevent water infiltration, were completed. At the same time the installation of a reinforced concrete "patch" inside the vertical line of openings on the NW corner, commonly termed "the zipper", to stiffen it from the first floor up to the bell chamber, was finished. Vertical spidery cracks on the corners along the tower's height especially on the north and south faces, were caulked and tuck pointed many times. Engineers have had stainless steel pins drilled and epoxied into the brick layers and cracks, to strengthen them and to prevent them from expanding. However, the accumulated damage had reached a point where more effective and permanent repairs were necessary.



On the interior, corrosion from moisture that had condensed on the walls and metal surfaces along with a leaking roof and roof drain caused significant damage. Brick was spalling on all levels and mortar was breaking off between the brick courses. Rust and corrosion have caused the metal ladders between floors to deteriorate and become unsafe.



The grating in each floor had rusted and determined to be dangerous to open and close. The sump pump was on its last leg and needed replacing.

In late 2018 Louis Joyner Architect, Ratio Design, Arsee Engineers, and The Engineering Collaborative were engaged by the church to once again assess the tower's condition and make recommendations. The failures were documented and long-term repair and corrective measures were recommended. Fix alternatives were considered, studied to understand their necessity, durability evaluated and a final approach determined. The repairs agreed upon included:

- Removal and replacement of failing sections of the brick veneer on the exterior.
- Fix damaged brick backup under the veneer.
- Remove and reconstruct the bell chamber "window" grid adding lateral strength and rigidity.
- Mill new limestone panels to replicate the zipper and the upper east and west bell chamber walls.
- Remove and replace spalled, cracked and broken bricks on all the exterior faces, top to bottom.
- Replace access to the roof, the rubber roof membrane, roof drain and flashings.
- Remove, clean, repair and reinstall the limestone coping at the top of the roof parapet walls.
- Find and eliminate water leaks from external and internal sources.
- Restore the structural integrity of the interior floors.
- Replace all of the interior grates and ladders with OSHA compliant components and materials.

- Eliminate the method of water vapor entering the tower from the cistern located in its base.
- Install a system to control the tower's internal temperature and humidity to prevent condensation buildup.
- Replace the sump pumps in the tower's lowest level.
- Replace the interior electrical wiring and add new LED lighting fixtures.
- Rebuild the pedestrian door to the tower base.
- Replace the clock hands, reface the dial and install a modern clock drive mechanism that can be easily adjusted.

In early 2019 FCC Trustees received the engineering reports and recommendations along with timelines and initial cost estimates.

Since the church and its tower is integral to Columbus's architectural heritage, a significant effort to raise funds for the tower restoration outside the church, was begun. Many individual Church members, organizations, government and private funding sources contributed to the estimated cost of \$3.2 million.

Several architectural design firms from around the country expressed an interest in leading the project. Companies from Chicago, New York, Washington, Philadelphia, Cleveland, Columbus (Indiana) and Indianapolis submitted proposals. The final selection was the team of professionals that had been working on the project since 2014. Louis Joyner Architect, Ratio Design, Arsee Engineers, and The Engineering Collaborative were chosen. Their familiarity with the work required, and their demonstrated expertise, weighed heavily in their favor. Final investigations and designs began and plans and specifications were prepared.

On December 1, 2022 bids were opened from 5 prospective companies. F. A. Wilhelm Construction from Indianapolis was selected and they began on-site work in March of 2023. Wilhelm's knowledge and history of working on high-rise buildings certainly provided them the experience and tools to attack this project. Their tower platform lift system contributed significantly to the project's success.

During the early months of 2023, Wilhelm developed final work plans, submitted applications to the various government permitting agencies, ordered specialty materials such as limestone panels for the tower, brick and other materials. Specialty contractors were engaged to complete electrical, mechanical and plumbing details. A company was also sourced to stain the new exterior bricks so they would match the old when the project was complete.

March 5 – April 15

The First Christian Church Tower on March 5, 2023.



Wilhelm begins to move construction equipment to the site to start the renovation process.



In the photo above, the tower platform is being set up. This technology is safe, efficient, a time and money saver.



By mid-April, Wilhelm had begun removal of the “zipper”, a vertical line of openings on the west tower wall while the lift platform was being installed on the north face. Interior structural steel was starting and other materials for the project were arriving.

April 18 - May 12



During early stages, much work was done to stiffen the clock chamber on the inside of tower by adding structural steel that supported the north and south walls. The existing brick framework around the windows on the east and west side walls was being torn down for

reconstruction at the same time. The original intent was to remove these steel members once the planned work in the bell chamber was complete, but the engineers decided to leave them in place to improve the tower's rigidity.



Two potential exterior brick repair contractors constructed brick and mortar samples for review. One was selected by the Architect. New brick, along with salvageable existing brick, was used to reconstruct the tower grid and patch other areas on the tower exterior walls.



Above, is a sample of the limestone block, reviewed by the architect, for use in the vertical zipper on the west wall and grid openings on the east and west bell chamber walls. Minor revisions were made before the final blocks were cut for use. The limestone originated in southwest Indiana. This photo shows only one section of the zipper panel. The final panel consists of one solid limestone block of four of these panels that were trimmed with brick.



The exterior brick rework on the clock face wall began. The horizontal rows of brick that can be seen in the left photo on the clock face wall just above the clock, are bricks placed in a "header" position, also shown in the right photo. This pattern is common throughout the church. The six rows of brick in between the header rows are laid in the "stretcher" position. When all mortared together the header rows tie the brick face back into the tower structure for strength and structural integrity.



The fourth work platform was completed on the south face allowing work to proceed on all four sides of the tower. The four platforms could be tied together to all move up and down the tower simultaneously or individually if necessary. In each platform there was a smaller section that could operate independently from the main platform. This allowed the bricks and other materials to be raised and lowered to the ground in a safe manner but keeping the main platform section in place.

May 15 – 19



The face brick that was salvageable was removed from the tower exterior then inspected and cleaned for reuse. Approximately 70% of the original brick was able to be reused. This resulted in the need to stain and color match less of the new bricks with the old. In the above photo, the recovered brick was stacked and protected in shrink wrap. The limestone coping, adjacent to the construction building, was cleaned and later returned to the top of the tower's parapet wall. Bricks in the foreground were waiting for review.



A truckload of dry premixed cement and aggregate was received and unloaded for use. Obtaining it this way allowed for better quality control and color consistency.



Large batch mixers were set up to allow for blending cement, sand, and water creating the necessary mortar in both strength and color for brick replacement and tuck pointing.

May 22 – 26



The brick window framework from the east side of the tower around the "window" openings was completely removed to allow for installation of the structural steel frame in the clock chamber. This steel remains in place and will "stiffen" the upper third of the tower. From this same photo, workers are seen removing the clock face.



The clock face is readied for transport to a company in Missouri for cleaning and painting.

June 5 – 16



Just below the platform in the photo above, bricks were removed (dark spots) because they were cracked or damaged beyond repair. New bricks were mortared in their place.



In the photo above, workers have started installing the interior concrete block wall on the east side of the clock chamber. This wall and its companion wall on the west side, further

strengthened the upper third of the tower. These walls were faced with a brick grid and limestone panels, replicating the original window layout.



A third sample (farthest right) of brick and mortar was built for color comparison to the existing combination on the exterior of the 81-year-old tower. The intent of the matching effort was to minimize the number of new bricks that would need to be stained.

June 19 – 23



Tower reconstruction progressed well. The interior block wall on the eastern side of the upper third of the tower was completed and tied into the original north and south walls. Wilhelm completed the parapet wall (perimeter wall above the roof) on the east side.

June 26 – 30



Water and its freezing and thawing over the tower's life, had caused a significant amount of damage high on the tower's NW corner in and around the zipper. The weakened brick was removed and the architect, engineer and contractors devised a fix using stainless steel cable, rebar and epoxy mortar to stabilize the existing wall. The damaged sections were rebuilt and tied together forming new stable wall sections.



A mockup, built of reclaimed bricks and new stained bricks was placed adjacent to the tower for comparison of color, texture and pattern.

July 3 – 14



Wilhelm continued the tower reconstruction, with both the east and west upper inner concrete masonry unit (CMU) walls or more commonly known as concrete block walls, completed. These new walls, in the upper chamber, are significantly more complex than what is seen from the outside. As the concrete blocks were being laid up, two three-quarter-inch diameter reinforcement bars were laid horizontally in between every fifteenth course of block. These bars were then epoxied into twelve-inch-deep holes drilled into the existing brick on the adjacent wall. On the same course, two three-quarter-inch diameter rebar were mortared into the entire width of the new north and south block walls. The result being the existing north and south brick walls are now tied together with this steel reinforcement across the width of the new east and west concrete block wall. In addition, at every four feet up the new and old wall corners, a four-foot stainless steel cable was drilled one foot into the existing brick wall, then turned ninety degrees and extended three feet and epoxied into channels cut into the new concrete block wall starting at the floor level of the clock chamber to the roof.

Holes for vertical rebar were drilled into the existing brick wall at the base of the new CMU wall every eight inches and the rebar was epoxied into place. Concrete block was then laid over the rebar horizontally across the face in eight-inch courses resulting in vertical steel bars in each of the block cavities from the bell tower floor to the roof. All of the block center cavities were filled with mortar as the wall construction continued.

After curing, the result is a solid CMU wall reinforced vertically and horizontally and tied into the existing north and south tower faces. These walls were then covered with new limestone and brick emulating the original tower grid openings. This design and build resulted in a significantly stronger and more stable structure.



This photo shows the inside of the tower with the new steel bracing, surrounded by temporary scaffolding, that was permanently attached to the wall on level E, which is just below the clock chamber. This steel along with the new steel structure in the clock chamber will help to further strengthen the whole tower.

July 17 – 28



Concrete block walls on the east and west faces were completed along with the parapet walls, at the top of the tower, on all 4 sides. Structurally this was a major milestone. The walls and inner support steel that were added in the clock chamber and level immediately below, greatly improved the tower's stability. In the photo above, you can see where "new" bricks were patched in (appear as light-colored bricks) to the areas just below the block wall

where damaged bricks were removed. The dark spots on the tower, just below the area with the new bricks, are where old broken or spalled bricks were cut out and were waiting for replacement. These areas were cleaned and stained to match and blend in with the original brick.



The exterior of the new parapet wall at the top of the tower, was eventually faced with new bricks.



A closeup photo of exposed brick at the top of the tower was typical of the conditions found on the north and south faces. The bricks that were placed in a header position remained unless they were damaged beyond repair. The outer course of horizontal or stretcher bricks were removed and replaced with new or reconditioned bricks. When courses of new stretcher brick were added back, all of the joints were cleaned, filled with new mortar, repointed, struck and cleaned again. These were stained to match the old brick if

necessary. The pins and spiral anchors can be seen, in the above photo, were repairs added over the years to help hold the original brick and mortar together.

July 31 - August 11



At this point, the load bearing portion of the top third of the tower or clock chamber, had been reconstructed.

Work then began on the interior. Each of the floors between the first and bell chamber, have openings that were covered with steel grating. In the photo below, the grating had been removed to allow construction materials to be easily elevated to the upper tower sections.



Over the years the grating and frames had corroded and needed to be replaced. These were removed along with the rusted steel ladder between floors. New galvanized steel frames, gratings and ladders were installed. In addition, new lighting at each level was put in place

along with drainage piping from the roof to the sump pit in the lowest level. The photo above was taken from the first level looking up through the openings in each floor to the roof.

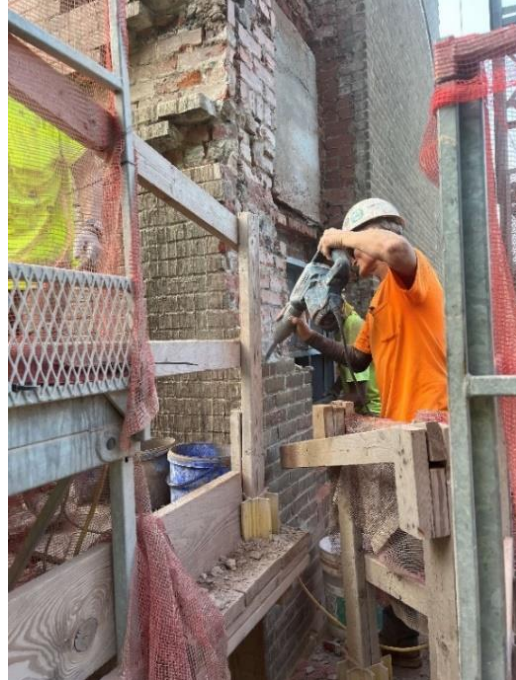


New bricks (left) arrived and were stained prior to installation to closer match the original tower. These pieces were used to rebuild the frames around the zipper windows and trim the limestone panels in the clock chamber grid. Others supplemented the original brick and filled in where damaged bricks were cut out and removed from the tower walls. Some bricks were stained prior to installation and then stained again or "touched up" in place after installation was complete.

August 14 – 25



Wilhelm continued to remove and replace brick on the faces of the tower. In the photo on the right, one can see the new bricks surrounded by a lighter colored mortar. These bricks and mortar were later cleaned and stained to match the original surrounding masonry.



The tower's NW corner adjacent to the zipper openings had deteriorated much more than the other three corners. In the early years of the tower's existence significant cracking was observed in this area. Engineers determined this was due to the impact that the original openings had on the overall tower structure. The remedy, installed in the mid 70's, was to

pour-in-place a concrete backup patch behind the zipper on the inside of the tower from the first floor to just below the bell chamber, as seen just left of center in the photo below.



The thinking was that this patch would stop, or at least slow down, the damage to the tower from the movement which was causing this corner to undergo more damage and consequently repairs, than in the other three.

The impact of the motion to the zipper frames, corner brick and the masonry on the north face, can be seen in the photo below where the damaged face brick was removed. Also, the concrete patch placed on the inside of the tower zipper is evident along with the corroded zipper lintels.



The original zipper repair plan, was to replace the horizontal steel lintels with new and then add the brick frame for the limestone panels. After seeing the damage underneath the face

brick in and around the zipper, the engineers developed a new fix that required the removal of the steel lintels entirely. These were not replaced.



As a result, a new continuous reinforced concrete block wall was installed up the NW corner openings and attached to the original zipper fix inside the tower.

August 28 - September 8



New limestone panels to replicate the pattern of the openings in the zipper (left) and upper chamber (right) were cut to replicate the original appearance.

September 11 - 22



Work continued to rebuild the zipper (left photo above) and the adjacent brick along the NW corner of the tower. A close-up photo (right above) illustrates the water damage and freezing and thawing harm that was the result of the original open grid construction. The brickwork below the damaged area is new.



Workers were on site (left photo) staining the new bricks that were interspersed with the original bricks and added to those that were salvaged and cleaned for reuse. Bricks with the diagonal cuts, (right) were being stained in preparation for use in the corners of each

limestone panel in the zipper and upper clock chamber. Once in place on the tower walls, final staining was completed on bricks in areas where necessary to better match the original.



The east face of the tower was power washed (left photo) to remove all of the dust and debris that accumulated during initial stages of the renovation. This was done to ensure that smaller cracks (right) were visible so repairs could be made. These cracked bricks were saw-cut ("black lines" on the bricks) for removal. Additional cleaning was completed prior to the final staining process.



This is a close-up of a limestone zipper panel and its new brick trim (rowlock course) that was placed to appear as four separate panels when complete. Only one stone panel, which weighs about 1000 lbs., was set every day so that the mortar between the bricks and panels

could cure and strengthen. The new concrete block wall, that can be seen behind the panel, is new and was attached to the original concrete patch. Stainless steel clips can be seen at the top of the limestone. These attach the panel to the block wall while the perimeter brickwork was completed.

In addition to the exterior work, new sump pumps were installed in the towers lower level. Rainwater, from the tower's roof and the green space in the church courtyard, collects in a wet well below the tower floor and is pumped to the city's storm water system. New lighting and pump controls were added.



To prevent moisture from collecting on the tower's interior during the spring and fall and to prevent the interior brick from spalling, an opening was created in the wall at the lower level for a ventilation fan and louvers to be installed.

September 26 – October 6



The zipper was completed and Wilhelm focused on adding the limestone panels in the clock chamber grid. At this point work was happening on all four sides of the tower and the interior.



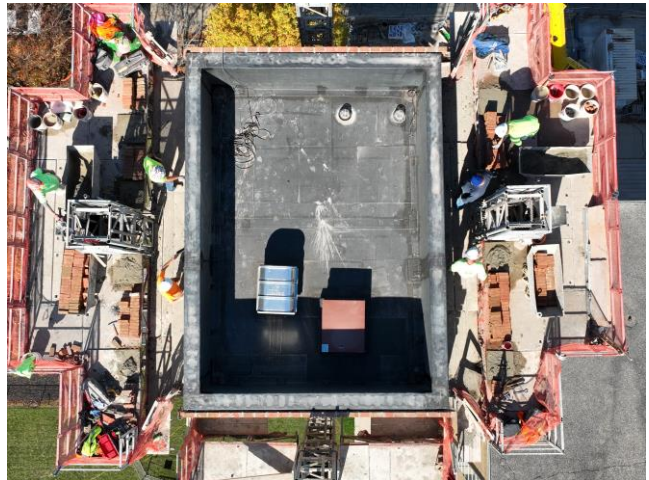
The bricks in the hopper (left photo) were reclaimed, inspected for damage, cleaned and then hoisted to the work platforms for reuse. The pallets of shrink-wrapped bricks in the background are new and will be mixed with the old and stained to match. The right photo shows the crane lifting the hopper of bricks to the platform.

October 10 – 23

The clock face was sent to a company in St. Louis where it was cleaned, refinished, then returned and reattached to the tower wall. New hands were cast and installed on a modern drive unit replacing the original Seth Tomas clock works. The new clock is now able to be controlled and adjusted from the ground level using a cellular phone.



The completion of the brick masonry on the parapet walls and the corners of the outer clock chamber were completed. Wilhelm bricklayers finished their work around the parapet (left photo below). The right photo is looking straight down on the tower from above, with the new rubber membrane roof in the center and work platforms on the east and west faces.



The sheen on the tower in the left photo below, is the result of water from power washing to remove all of the dust, mortar and dried on saw cut dust from the various repairs completed on the brickwork. The right photo is a closer view of the washing process. The power washing removed construction debris and allowed the best comparison between original and new bricks before final staining.



November 6 – 17

The focus then turned to staining the new bricks that were placed in the tower wall. The photo below is the south side of the tower: the staining and minor repairs were completed and the scaffolding removed.



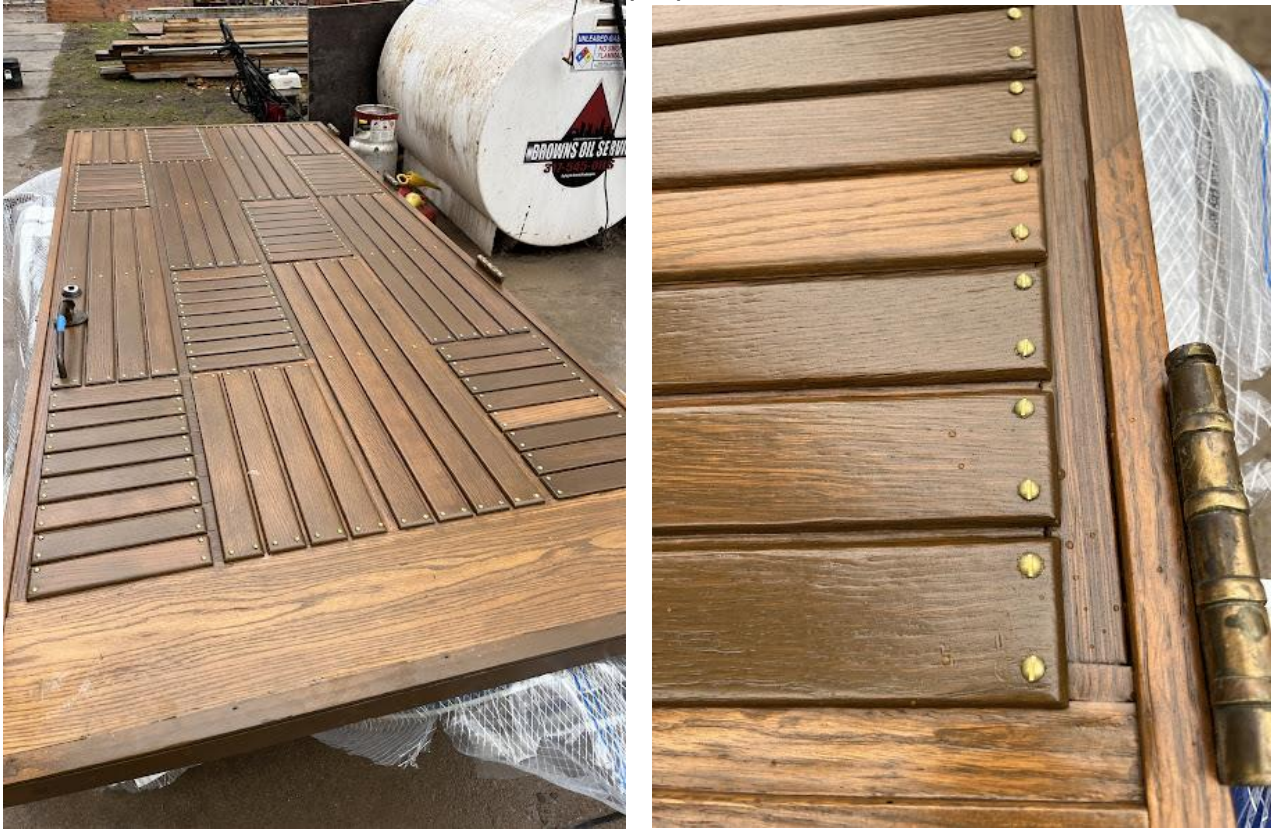
November 20 – 24

As noted earlier, significant structure of square tubing was added to the 5th floor and bell chamber above it. This was to strengthen the uppermost portion of the tower to minimize movement.



Earlier photos showed this ironwork from the exterior but the photo above shows it from the bell chamber floor looking up.

The tower door was returned after its refurbishment. A section that had been modified years ago, to accommodate a fan installed to aid in the tower's ventilation, was repaired and the door refinished. The door is shown below in preparation for reinstallation.



Note in the photo on the right, how the slots in the brass screws all line up and down. This feature is throughout the church and a unique and clever detail expressing the workmanship of the time of the church's original 1942 construction.

November 27 – December 1

Work continued to focus on the clean-up and putting things back together. Some of the limestone step treads into the courtyard were removed to accommodate the base of one of the work platforms. Wilhelm employees are seen replacing those stair pieces below. In the same photo, four darker gray limestone panels, on the vertical wall just above the kneeling worker, were replaced because of their poor condition.



Below (left) is a photo of the new clock drive unit. It is entirely enclosed in the white cylinder, which is about the size of a gallon paint can. The mechanism is controlled from a cell phone app and will automatically change time between daylight savings time and standard time. The new clock was started on 11/28/2023 at 10 AM. The photo on the right is the original Seth Thomas clock movement installed in 1942.



In the lowest level of the tower, a fan was installed (right photo below) to pull air into the tower and push it up through the interior to be exhausted. The space within the tower is now monitored for temperature and humidity. Air is tempered by an electric heater on the first floor as it flows up through the tower. This will prevent moisture from condensing on the interior walls especially in the spring and fall. The left photo is the new brickwork covering the damper on the south side of the tower's base.



The tower door was reinstalled after being rebuilt to its original design. An exhaust fan that had been installed in earlier years and attached to the door to help extract moisture from the tower interior, was removed. This photo also shows the new brickwork just above the door where a rusted lintel was replaced.



December 4 - 8

Except for final cleanup, the work on the tower was done. The focus was replacing the plaza area and curb in front of the church. Earlier in the project Wilhelm and Louis Joyner worked together to develop a recipe for a concrete mix that would replicate the existing plaza in both color and texture. The old concrete was demolished and hauled away for disposal. New concrete was installed six inches thick directly in front of the tower and stairway to the courtyard to allow for maintenance of that area and possible deliveries to the lower levels of the church by large trucks. The plaza area in front of the steps to the church entrance out to the street is four inches thick.



Fifth Street was reduced to one lane to allow the concrete trucks room to dispense the material and the finishers to work safely while forming and pouring the new curb.



December 11 – 15

Work continued on the plaza in front of the church. The sidewalk pours were two, two-day processes. On the first day, the concrete was delivered and placed within the forms, rough leveled with a screed, then troweled and bull floated to "smooth" it out, and edged. On the second day after the concrete set, it was cut with a diamond bladed saw into large sections which are relatively square. By doing this the concrete will crack in the joints, known as control joints, and not through the finished slab. The concrete was allowed to continue to cure or "harden" for about 4 weeks at which time it was near its maximum strength. The final step, on the second day of the pour process, was to power wash the finished surface. The new concrete was mixed with special agents and covered with large insulated blankets to prevent it from freezing as the initial curing took place.



Overall, with the new curb and plaza area, approximately 105 cubic yards or 12 truckloads of concrete were poured and finished over the 4-day period.

December 18 - 29

The tower construction went well, up to this point. As the project's end was in sight, Wilhelm ran into their first major hiccup. The newly poured concrete in the plaza area did not have enough accelerant admixture in the mix for it to set quicker than normal in the cold weather that was encountered. Without adequate accelerant, the concrete did not set properly and when it was power washed the next day, too much of the surface was removed exposing more aggregate than desired making the surface very rough. Also, the "softer" concrete was damaged along the freshly saw-cut control joints during the washing process. Because they were not satisfied with the quality of the concrete finish, Wilhelm immediately made arrangements to remove and replace the entire concrete plaza area. The two photos below are of the plaza with the unacceptable concrete, being removed.



The photo below is of the work being done re-pouring and finishing the plaza the second time. A different crew was brought in to complete this work and the concrete mix was modified to accommodate the cold weather.



January 2 – 19, 2024

Work on the tower and plaza finished. After the re-pouring of the concrete in and around the front of the church, Wilhelm worked cleaning up and removing equipment. The neighborhood and traffic flow returned to normal. The photos below are of the completed project.



Ground Level Interior



New grating, lighting controls, high efficiency lighting that is controlled by motion detectors have been installed. The new ladder is equipped with a safety cage and a personal fall arrest system

Levels B – D (Typical)



Levels B – D are identical and their floors are integral to the tower's structural strength and rigidity. The concrete "patch" in the NW corner, that runs from the first floor to just below the bell chamber can be seen in the right photo.

Level E



Level E is one floor below the bell chamber. New structural steel reinforcement was added along with new lighting, electrical conduit, galvanized grating and the storm drain.

Level F (Bell Chamber)



The bell chamber or uppermost floor received the most work. Steel was added as one of the first steps in the reconstruction. This was to provide stability and strength to the upper chamber while the windows and their brick frames were removed and the new concrete block walls were constructed. Also visible is the upgraded clock drive mechanism with close-up photos shown below.



Utility Level



Updated lighting, sump pump piping and pump controls were added to the utility level. In the photo on the right the opening for the new ventilation fan can be seen in the right photo prior to the fan's installation. The sump pumps are located below this floor in a wet well.

Summary

The tower was completed successfully. There were no injuries to any of the workers. The final cost was \$3.1 million vs. an original budget of \$3.2 million.

God certainly guided this project from inception to completion. He protected the workers from injury. The professionalism and expertise of the engineers and contractors that he provided were instrumental. He organized and guided a project team to plan and work on the tower renovation from day one. The interest and support from citizens of the community, state and nation could not have been gained without Him. Prayers, encouragement, resources and involvement of the First Christian Church congregation allowed it to be a success.

As a result of contributions of money and time from the various entities mentioned above, no debt was incurred.

First Christian Church Tower Project Team

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Jeffris Family Foundation – www.jeffrisfoundation.org
National Fund for Sacred Places – sacredplaces.org
Save America's Treasures, National Park Service - www.nps.gov
Southern Indiana Housing & Community Development Corporation - www.sihcdc.org
Heritage Fund of Bartholomew County - www.heritagefundbc.org
Indiana Landmarks - www.indianalandmarks.org
Landmark Columbus Foundation – www.landmarkcolumbusfoundation.org

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Masonry Cosmetics – Brick Staining
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Miller-Eads Co., Inc. - Electrical
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Multivista – Photography
www.multivista.com

Nading Mechanical Inc. – Plumbing, HVAC
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Skyline Fall Protection – Ladder Fall Protection
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Suppliers

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