University of Virginia Jefferson Rotunda Rehabilitation

The Rotunda stands on the lawn of the original grounds of the University of Virginia (UVA) in Charlottesville and is the most important individual architectural work of Thomas Jefferson, founder of the university in 1819. Designed when Jefferson was over 70, it was modeled after the Pantheon in Rome. He designed it to represent the "authority of nature and power of reason." At 77 ft (23.5 m), the Rotunda is half the diameter of the Pantheon. It was the centerpiece of the Academical Village, which was Jefferson's vision of students and professors living together in a community of learning.

Jefferson designed the Rotunda and submitted plans to the university in 1821. It was still under construction when he died in 1826. Initially, classrooms and lecture halls were located in suites of oval rooms that divided up the first two floors while the library was placed on the domed third floor. The original Rotunda construction cost $57,773 (about $1.5 million in 2014 dollars).

The stairs leading to the south portico were not built until 1832. There were originally two south wings containing exercise rooms (the "gymnasia"). In 1841, these wings were enclosed and converted to classroom space in response to the increased university enrollment. From 1851 to 1854, the Annex, or New Hall, a four-story wing with a basement, was added to the north side to provide additional classroom space as well as an auditorium and laboratory. Also in 1854, two 7,000 gallon (26,500 liter) tanks were installed in the cavities of the bricks supporting the dome to provide water to the Academical Village.

In 1895, a fire broke out in the Annex due to faulty wiring, and the Rotunda was entirely gutted, leaving only the brick walls intact. University students were able to save the life-size marble likeness of Jefferson as well as a portion of the books from the library and some artwork. The original wood dome was replaced by a tile dome in 1898. The rebuilt interior, designed by Stanford White, had only two floors, with a larger, two-story dome room. The Annex was not rebuilt, however, White added the north portico and esplanades to match the south wings. Capitals supporting the portico were rough cut and installed in 1899 and not carved in place in 1904.

More Recent History

Alderman Library opened in 1938, replacing the Rotunda as the primary university library. Further restoration of the interior, a $136,373 project (about $1.8 million in 2014 dollars) overseen by Stanislaw Makielski, included the creation of a ground-level covered passage called the cryptoporticus in the south wing and marble replacing the previously sandstone steps on the south side of the Rotunda.

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Exposed hand excavated underpinning pits

In 1976, during the U.S. Bicentennial, a $2.4 million renovation was undertaken in which the Rotunda interior was gutted and completely restored to Jefferson's original design. The dome copper roof was also replaced with white-painted galvanized steel panels and the oculus in the center was replaced.

Today, there are plaques on the south side of the Rotunda that list the names of UVA students who were killed in the Civil War and World War I. Plaques on the north side list UVA students who were killed in World War II and the Korean War. Doctoral students defend their dissertations in the North Oval Room and the Dome Room hosts many university events. With the successful preservation of its historical details during numerous renovations and restorations, it is one of only three modern man-made sites in the U.S. designated as a World Heritage Site by UNESCO (the other two are the Statue of Liberty and Independence Hall).

Current Restoration

The current restoration work on the Rotunda started in 2012 and is scheduled to be completed in 2016. The first phase consisted of replacing the steel-panel dome with copper, restoring the roof oculus and making cosmetic improvements to the exterior.

The second phase will cost $42.5 million and consists of significant structural changes. These include replacing the north and south portico roofs, replacing the Dome Room ceiling, constructing an underground room to house mechanical systems, and adding new marble capitals supporting the north and south porticos.

Berkel was tasked with the design and construction of an excavation support system to allow building the interior and exterior below-grade mechanical basement as well as temporary support for excavation and renovation in the east oval room, east courtyard, east elevator, southeast terrace office and northeast terrace office. Additionally, Berkel was tasked with designing and constructing a steel shoring tower system to temporarily transfer roof loads of the north and south porticos to the foundation below while allowing unobstructed access for the old capital removal and new capital replacement by Rugo Stone subcontractors. The capitals were carved from 9,000 lb (40 kN) blocks primarily by computer-controlled lathe and finished by hand into 6,300 lb (28 kN) capitals. The 16 capitals took 9 months to carve and install and match Jefferson's original capitals in color and carving.

Needle beams for column removal

Regional Geology

Charlottesville is located along the western edge of the Piedmont Physiographic province, in an upland area of the Piedmont Plateau, and is underlain by metamorphic rocks. Site characterization information provided for project design indicates that the area is underlain by the Lynchburg Formation of the Precambrian Age, which is described as "fine grained sediments, metamorphosed in part, varved-like layers of graphitic and sericitic schist and thick beds of quartz biotite gneiss."

Residual soils in the area are weathered in place from the underlying bedrock and typically consist of highly-weathered clay soils near the ground surface. The soils typically transition to less weathered silts and sands with depth. An intermediate geomaterial, sometimes referred to as partially weathered rock, or PWR, is typically encountered between the residual soil and underlying intact bedrock. PWR is typically defined as material having standard penetration test (SPT) N-values of greater than 100 blows-per-ft (100 blows-per-305 mm). Because of the ancient folding and faulting of the underlying bedrock and the variable weathering of the materials with heterogeneous mineralogical composition and various fracturing, the depth to intact bedrock can vary dramatically within short distances. Similarly, the depth and thickness of cohesive and cohesionless soil layers as well as PWR can also be highly variable. It is common to find lenses of PWR or unweathered rock within the soil profile. Both the residual soil and PWR often contain remnants of the relic structure of the parent rock from which they have weathered.

Local Subsurface Conditions

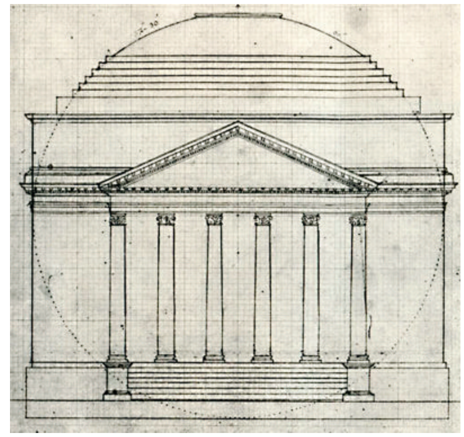
The subsurface profile at the project site consists of surface organics, fill materials with residual soils and some PWR comprising the majority of the subsurface profile. The surface organics were encountered within 3 in to 4 in (76 mm to 100 mm) of the ground surface and were described as typically being comprised of a dark-colored "soil material containing roots, fibrous matter and/or other organic components." Soils estimated to be non-natural fill material were encountered below the surficial organics in some locations across the site to depths from 2.5 ft to 8.5 ft (0.7 m to 2.6 m) below drilling grade. The fill materials were typically described as reddish-brown elastic silt, typically moist to wet, with varying amounts of sand, clay and gravel with SPT N-values ranging from 2 blows-per-ft to 12 blows-per-ft (12 blows-per-305 mm).

The weathered-in-place residual soils at this site were encountered under the fill soils and extended to the boring termination depths. These residual soils were generally described as elastic silt and sandy silt with varying amounts of sand transitioning to silty sand with depth. Visual classification included descriptions of the residual soil as orange-brown, reddish-brown and gray in color, and the moisture state described as moist to wet. SPT N-values in the residual soil were reported as ranging from 10 blows-per-ft to 58 blows-per-ft (10 blows per 305 mm to 58 blows-per-305 mm).

PWR was typically not encountered at this site to the explored depth of 30 ft (9.1 m). A lens of PWR was encountered in one boring at a depth of 21 ft to 23.5 ft (6.4 m to 7.2 m). Residual soil was then encountered below the PWR lens to the final explored depth of the boring. PWR was encountered in one boring at a depth of 8.5 ft (2.6 m) below drilling grade and continued to auger refusal, indicating possible intact bedrock, at about 15 ft (4.6 m) below installation level.

Subsurface water was not encountered during drilling operations or upon removal of the drilling tools. A monitoring well was installed at the site to a final depth of 30 ft (9.1 m) below installation level. No water was observed in the well during the monitoring period.

New capitals for north and south portico



Original drawing of the Rotunda by Thomas Jefferson

Excavation Support

The finished floor elevation of the new basement for the mechanical room was 10 ft to 14 ft (3 m to 4.3 m) below the interior finished floor and existing site grade. Interior and exterior brick masonry walls, dating back to the original construction in the early 1800s as well as subsequent restorations in the mid and late 1800s, were supported with continuous underpinning shafts. These shafts were hand dug to depths up to 18 ft (5.5 m) below finished-floor level. The shafts were reinforced, filled with 4,000 psi (27.6 MPa) strength concrete, and dry packed for completion.

The condition of the brick and mortar was extremely poor in many locations. The project team was concerned that bricks could loosen and fall during the underpinning process, comprising a significant safety risk. As excavation of each

South portico tower support

Temporary shoring

pit commenced, a temporary wood shelf was constructed to provide support for the existing brick footing and protect the workers below. Berkel constructed 94 pits, and the total excavated soil volume was approximately 730 cu yd (560 cu m).

The exterior east courtyard excavation required three-sided temporary support within 5 ft to 7 ft (1.5 m to 2 m) of the northeast and southeast terrace office structures located just east of the Rotunda. The at-grade historic brick structures along with a marble colonnade breezeway to the east of the proposed excavation were supported without concrete pit underpinning. The contract documents called for a subcontractor-designed-and-constructed temporary excavation support system consisting of drilled soldier piles, timber lagging and interior bracing. This was all to be constructed in an area with no open access for equipment other than by heavy crane lift. The contract documents also set the maximum allowable differential settlement between adjacent structure monitoring points at 0.25 in (6.4 mm) to prevent cracking in the historic brick for all project areas.

To create an access point with about 10 ft (3 m) of width and headroom, Berkel installed needle beam support for a section of the colonnade breezeway roof structure. This allowed limited columns to be removed by others providing sufficient access for a Boart Longyear tieback drill to gain access to the courtyard. In lieu of drilled solider piles, Berkel augered 16 in (406 mm) diameter holes on 5 ft (1.5 m) centers and installed wide-flange soldier beams in each augered hole. The space between the soldier piles and the sides of the augered holes was backfilled with lean-mix grout. The design team also approved the proposed alternate to the interior bracing called for in the contract documents. Berkel was given permission to install temporary tiebacks in lieu of the interior bracing to eliminate future conflicts with excavation and concrete operations. Lateral support of the soldier-pile and lagging system was provided by one level of temporary, post-grouted bar anchors.

An overhead view of the excavation support

Temporary Portico Support

Berkel's structural engineering team designed eighteen 3 ft by 7 ft plan (0.9 m by 2 m) by 30 ft (9.1 m) tall tubular towers. The tower design was coordinated with the elevated track trolley system used by Rugo Stone to remove and reinstall the new capitals. Each tower weighed approximately 2,500 lbs (11.1 kN) and was designed to limit the bearing stress to under 200 psi (1,380 kPa) to avoid distress to the aged foundation. In addition, deflections were limited to 0.13 in (3.2 mm) under all loading conditions. To achieve this, the towers were designed and constructed with adjustable screw legs. Once the needle beams were installed, the towers were hydraulically jacked, as required, to offset deflection and remain within project deflection limits. Berkel subcontracted Clemons Fabricators out of Richmond, Va., and ADD Equipment from Gretna, Va., for the fabrication and tower erection work.

Berkel credits the project team of the Whiting Turner Contracting Company, Robert Silman Associates, 1200 Architectural Engineers, John G. Waite Associates and Froehling & Robertson, as well as the University of Virginia for the cooperation that allowed for the successful completion of the underpinning and support portion of the restoration of this historic structure. The authors would further like to acknowledge Jeremy Kress, SungJe Chi, Miguel Rayes, Josh Carr and Scottie Carr for their contributions to the project design and implementation.