

FINALIST—
2020
PROJECT OF
THE YEAR

HISTORIC CATEGORY

DAYTON ART INSTITUTE

DAYTON, OHIO

SUBMITTED BY LRT RESTORATION TECHNOLOGIES

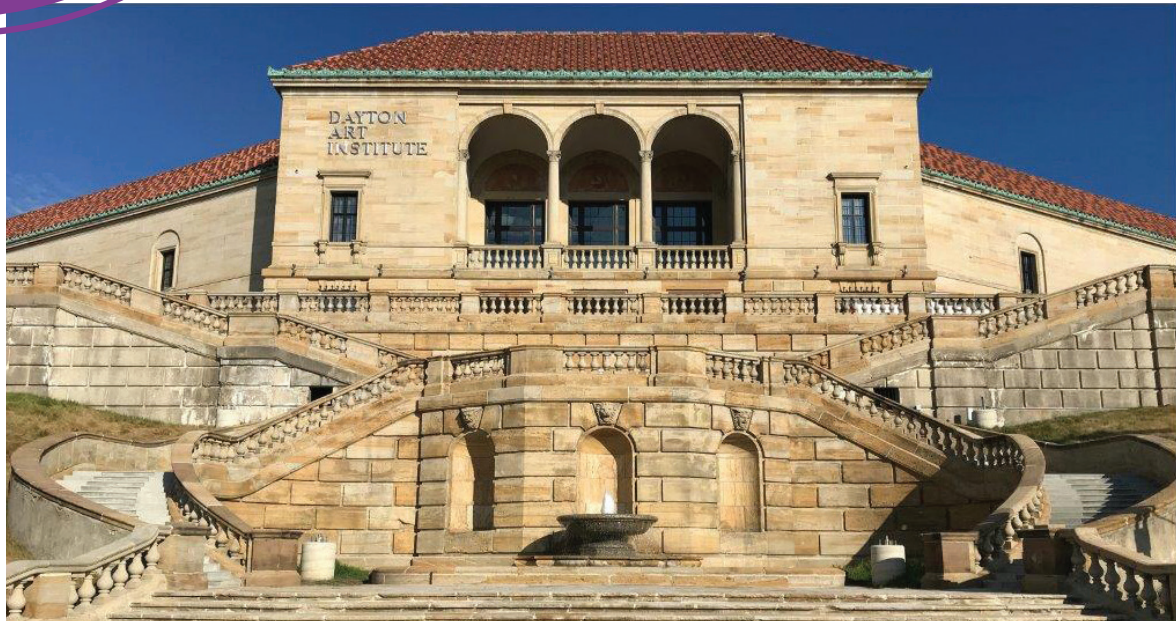


Fig. 1: Grand entry staircase project at the Dayton Art Institute

The Dayton Art Institute is Dayton, Ohio's art museum. The Dayton Art Institute project (Fig. 1) was brought to light to revitalize a historic structure in the heart of Dayton. The project sought to revamp the grand staircase that once saw the foot traffic of hundreds of patrons throughout its lifetime since the 1930s.

BACKGROUND

Construction of the original 60,000 sf (5575 m²) facility was completed in 1930 with a later addition in 1997 that added 35,000 sf (3250 m²) of exhibit space. The building was modeled after the Villa d'Este near Rome and the Villa Farnese at Caprarola in Italy, both examples of sixteenth century Italian Renaissance architecture. The building was placed on the National Register of Historic Places in 1974.

The original construction included a grand entry staircase into the original main entry (Fig. 2). The entry stair was originally constructed with a board formed, square bar reinforced, concrete structure with a variety of structural masonry blocks and masonry veneer panels. The stairs were constructed on a stair-stepped structural slab with original flagstone stair treads and risers.

Original installers gave the architecturally exposed concrete a sandblasted-exposed aggregate finish (Fig. 3). Sandblasting was first patented in 1870, but this structure would be one of the first that utilized such a finish. The only other way the unique finish could have been created was with the use of a steel protective frame and use of a bush hammer. There are no known records of how this was achieved on this building in 1927-1930.

The Dayton Art Institute, located within the Rust Belt, was subjected to 90 years of extreme freeze-thaw cycles and heavy winter de-icing. Concrete air entrainment was later developed in the 1930s and wasn't utilized during the original construction. Concrete air entrainment increases the durability of the concrete by helping withstand continual freeze-thaw cycles. The original flagstone stair treads and risers were replaced during a previous restoration project, with poured concrete treads and risers, using the original 1930 structural slab without waterproofing between the old and new slabs (Fig. 4).

The concrete structural and topping slab experienced extreme damage from environmental changes, constant

de-icing to keep the museum patrons safe, and the lack of maintenance. The slab showed signs of extreme deterioration to the point of easily crumbling in one's hand. Eventually in 2011, the grand staircase was deemed unsafe and barricaded off to the public (Fig. 5).

REPAIR DESIGN AND PROGRAM

Because the grand staircase was historic, it was imperative that the final look be identical to the original construction with the added safety of the concrete treads and risers. Matching the original dimensions and profiles exactly was crucial. Prior to stair demolition, the stairs were 3-D scanned and 3-D photo documented (Fig. 6). This allowed for a high-resolution pre-construction documentation with a Google Maps navigation ability and produced a Revit model to assist with the final riser formwork design.

A program was designed to repair the structural slab, install new stair topping slabs, clean and repair the masonry, install new fountain equipment, and perform adjacent landscaping work to clear the overgrown hillside. The fountains had not been operational since the late 1960s.

The original repair plan was to replace the topping slab and perform various localized concrete repairs to the structural slab. Due to the severe deterioration, there were concerns that a traditional localized concrete repair process could not be achieved and that replacement of the structural slab would occur regardless. An alternate plan was proposed to perform a full structural slab replacement as a cost savings to the owner, using the more advanced construction methods of today.

A major challenge for the project was that the original construction utilized very small 18 in x 18 in (450 mm x 450 mm) access holes between the structural foundation walls. This created a permittable confined-space condition to access any areas below the stairs. A cost-effective replacement technique where the structural slab could be replaced was planned, and the formwork and shoring could remain in place after the pour was completed.

A steel support structure was designed that utilized a sacrificial 16-gauge galvanized G90 composite steel decking that could support the structural slab during the pour without additional shoring (Fig. 7). Countless meetings and discussions went into the overall design to ensure the unique formwork could be safely achieved, while also making ease of constructability a top priority for the field. This was a huge challenge because of the existing stair radii and slopes.

Custom bending angles to anchor to the walls would be an extreme challenge and would be cost-prohibitive. After many meetings with the structural engineer, the final design was developed utilizing short attachment angles with a center relief cut installation so the angle could be field-bent for both the inner and outer wall, creating convex and concave curves (Fig. 8).

Protection was placed prior to demolition for the historic elements and some stone pieces were salvaged, labeled, and stored onsite for the fountain and waterproofing work that was scheduled to occur. Sand-protection with plywood covering was also installed to protect the lower historic flagstone steps that were to remain in place during the renovation project.



Fig. 2: Original staircase during construction



Fig. 3: Original exposed aggregate finish



Fig. 4: Condition of the existing structural slab with topping slab removed, illustrating the lack of waterproofing between the slabs



Fig. 5: Pre-construction condemned staircase



Fig. 6: 3-D scan of the grand staircase prior to construction

The existing deteriorated topping slab and structural slab were removed by conventional chipping methods. Extreme care was used to ensure no damage occurred to any of the historic elements.

After the structural slab was removed, the foundation walls were sounded, marked, and evaluated by the structural engineer. These walls were in surprisingly good condition and only required a total of 76 sf (7 m²) of vertical concrete repairs. More concrete repairs were performed in preparation for the fountain waterproofing installation that occurred on the vertical walls.



Fig. 7: Aerial view of the composite steel formwork

After the structural vertical repairs were performed, the perimeter angle support structure and structural beams were installed. Prior to the decking being installed, the fountain plumbing equipment room, drain plumbing, and electrical conduit were installed. Efforts were implemented that allowed all trades to work with the structural slab removed, ensuring a more pleasant and safer work environment. After the decking was installed, the areas below would again be a permit-required confined space.

The decking design and installation were major challenges that even challenged the steel shop drawing detailer with some extensive changes. After meetings with the structural design team, the plan was to create mini sections of decking that started and stopped at the structurally sound foundation wall sections. The thought process worked on the blueprints, but on the jobsite, it was obvious that the extreme slopes, curves, and rigid decking required various field modifications to overcome.

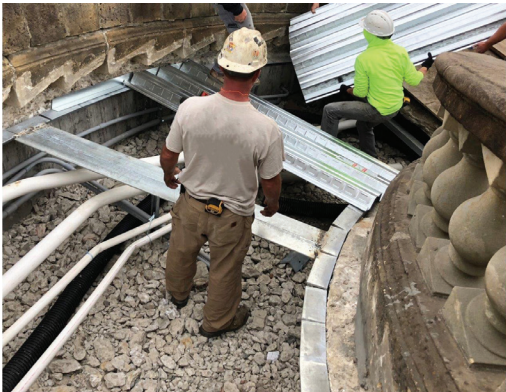


Fig. 8: Short attachment angles with center relief cut that follow the curvature of the staircase

The structural erector came up with some ideas at various locations to perform real-time adjustments on some of the perpendicular angles, raising and lowering them a few inches at various locations to ease the angle changes, while still maintaining the required structural slab thickness.

After the decking was installed and the structural slab was poured (Fig. 9), the next challenge was the riser formwork (Fig. 10). The intent was to pour the structural slab and risers at the same time. The challenge was the limited amount of material that could be kick off to and anchor the formwork, so plans were modified. Everything surrounding the stairs was historic masonry, so anchoring into it was not an option. It was opted to pour the structural slab to help ease some of these challenges and allow for more formwork anchor locations. This helped, but with the curved stairs, the pours still needed to be limited to small sections. Each stair section was broken into two (2) smaller pours so that the straight formwork kickers could be utilized.



Fig. 9: Crews working on the graded slope of the grand staircase

The owner later requested that recessed boxouts be formed and installed for future donor plaques to be installed at every riser, totaling 116 risers. This was also a challenge because there was limited area to work, due to matching the original stair riser height of 5 ¼ in (133 mm). Some concrete was left above and below the plaque boxout so that the

nosing edge would not break off during normal wear, while creating a plaque boxout large enough to satisfy the owner's requirements.

After much discussion and planning, 41 in (1041 mm) wide x 3 ¼ in (82 mm) tall boxouts with 45-degree beveled edges were installed (Fig. 11). Everything possible was done to help prevent damage to the stair nosing through the normal use of the stairs while also making the owner happy. Overall, these stairs were planned out and poured in eighteen (18) separate pours that matched the original historic measurements.

To fully complete the project, the masonry stone railing was cleaned and tuckpointed along with the lower flagstone. The fountain waterproofing was installed using waterproofing and top coating in a "restrained gold" color. The adjacent overgrown landscaping was removed and replaced with sod, with future plans for more elaborate landscaping and lighting to be installed once more funds became available.

CONCLUSION

Overall, the project was a success and provided the owner with a safe, structurally sound staircase that has been brought back to its former intended glory. The stairs now accent the beautiful historic museum building (Fig. 12). The total contract amount was roughly US \$1.7 million. The project duration was May 2019 through March 2020.

This project is an example of contractors, design teams, and owners successfully and consistently working together to improve on designs of the past without changing the fundamental aspects of the project that make it unique and historic. The project incorporated modernized and improved products and techniques to give new life to the structure to be enjoyed for centuries to come. This unique and complex project used innovative and collaborative efforts to ensure a safe workplace and a happy customer.



Fig. 10: Detailed formwork and anchoring



Fig. 11: Recessed boxcuts in stair risers for donor plaques

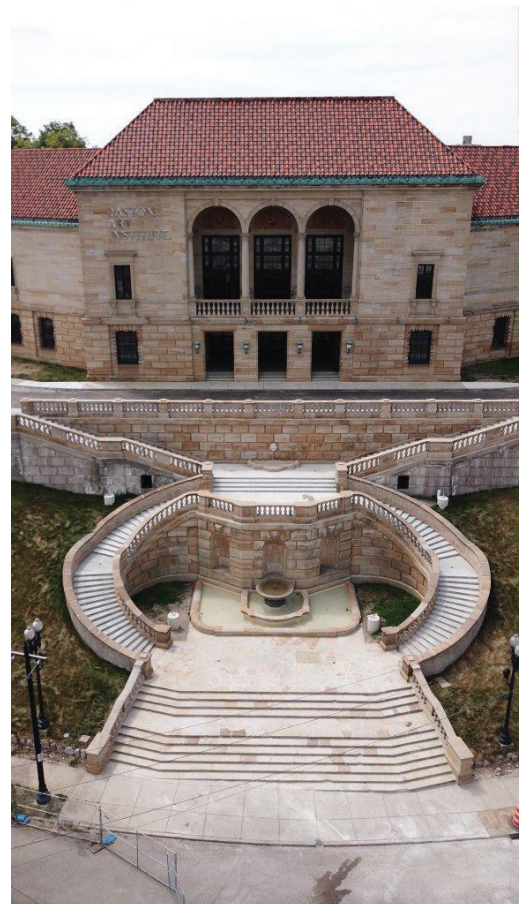


Fig. 12: Completed grand entry staircase project

The Dayton Art Institute

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