John J. Earley's Mosaic Concrete

Meridian Hill Park and Edison Memorial Tower

by Anne E. Weber, Paul E. Gaudette, and Robert F. Armbruster

Concrete is most often thought of as a utilitarian and structural material, but in the first half of the 20th century, an innovative craftsman named John J. Earley recognized the aesthetic potential of the material and developed a process that resulted in the construction of several remarkable structures. In monuments such as Meridian Hill Park in Washington, DC (1914-1936), and the Edison Memorial Tower in Edison, NJ (1938), Earley produced ornamental precast and cast-in-place concrete with exposed aggregate in modulating colors that exploited the plastic qualities of concrete for architectural expression.

Meridian Hill Park is the first project in which Earley used his distinctive architectural concrete, and he continued to develop it over the next 20 years. The Edison Memorial Tower represents the aesthetic and structural capabilities of the fully developed material.

The Earley Studio

John J. Earley apprenticed as an architectural sculptor in the studio of his father, James Earley. The studio was adept in the use of traditional materials such as stone, clay, plaster, stucco, and later, portland cement. Upon James's death in 1906, John assumed control of the studio at age 25.[1]

The studio treated concrete as an artist's medium with the aggregate providing color and visual texture. Earley realized that he could use his skill to manipulate the concrete in its plastic state to make it affordable and adaptable.[2] As Earley Studio's production staff mastered this phase of the concrete-making process, they advanced beyond traditional formulas for mixing and placing concrete and explored new ways to respond to architectural challenges.

The studio's production methods required rigorous discipline to achieve the extraordinarily high quality that Earley demanded, yet the artisans enjoyed the freedom to make small adjustments to optimize results.[3] Earley discovered ways to combine aggregates of many colors to achieve visual effects similar to traditional mosaics. By collecting different colors of rock and ceramic, crushing each to uniform sizes, and blending the colored stones into mixtures, his staff created combinations with vitality and luminance.[4] To create polychrome mosaics in a single casting, they used small ridges on the surface of the molds to separate each distinct colored concrete mixture.[5]

Innovations in Exposed Aggregate Concrete at Meridian Hill Park

The creation of Meridian Hill Park, now a National Historic Landmark, was recommended by the 1901 McMillan Commission report on the park system of Washington, DC. Encompassing a steeply sloping 1700 ft (520 m) long plot, it commemorates the placement of the American Meridian established in Pierre-Charles L'Enfant's plan for the city. Based on Italian Renaissance gardens, the park's cascade, terraces, fountains, and mall overlook the White House and Washington Monument. The designers realized that natural stone was too costly for construction of the park's built features, so the Earley Studio was hired to create mockups for the garden's walls; the studio used reinforced concrete with a finish coating of stucco.

The mockup of the concrete wall had a lackluster appearance. The artisans tried to treat the wall's surfaces with different textures, but the results were still unsatisfactory. They then tried to remove the forms while the concrete surface was soft enough to use wire brushes to expose the aggregate within the concrete. The wall's appearance immediately took on an attractive sense of size, color, and texture.

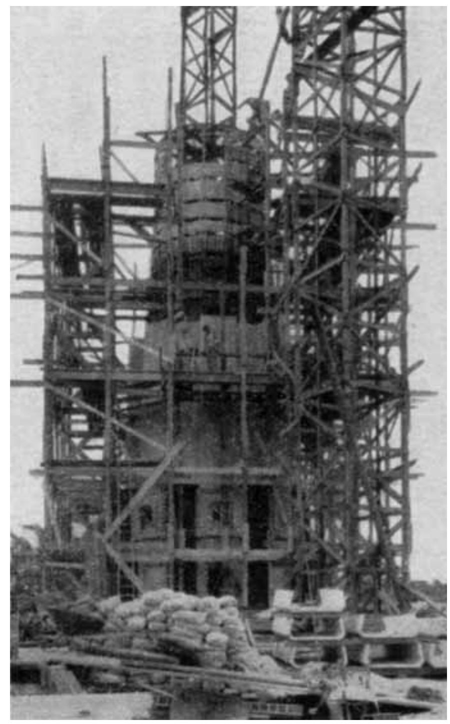
The second phase of construction involved a 300 ft (90 m) long balustrade and arched entrance. The exposed aggregate concrete used previously couldn't render the finely scaled architectural details. Earley's staff incorporated a mixture of river gravel and concrete sand in the first phase of concrete walls to create a well-graded aggregate varying in size from 2 in. (50 mm) to sand. The second phase design required a distinctive regular pattern, similar to the uniform pieces of stone or tile used in a mosaic. Earley reasoned that if he used smaller gravel, he might achieve the intended effect.

The Earley Studio selected river gravel from 1/8 to 1/4 in. (3 to 6 mm) in diameter and added just enough sand and cement to fill in the space between the gravel. Earley also realized that if he screened the sand to one-tenth the size of the pebbles, then the larger gravel would fit together more tightly. The results were spectacular and unlike anything seen before.[5] These "gap-graded" mixtures boosted Earley's success because they yielded a new type of exposed aggregate concrete with uniform texture, consistent appearance, and a refined pattern.[6]

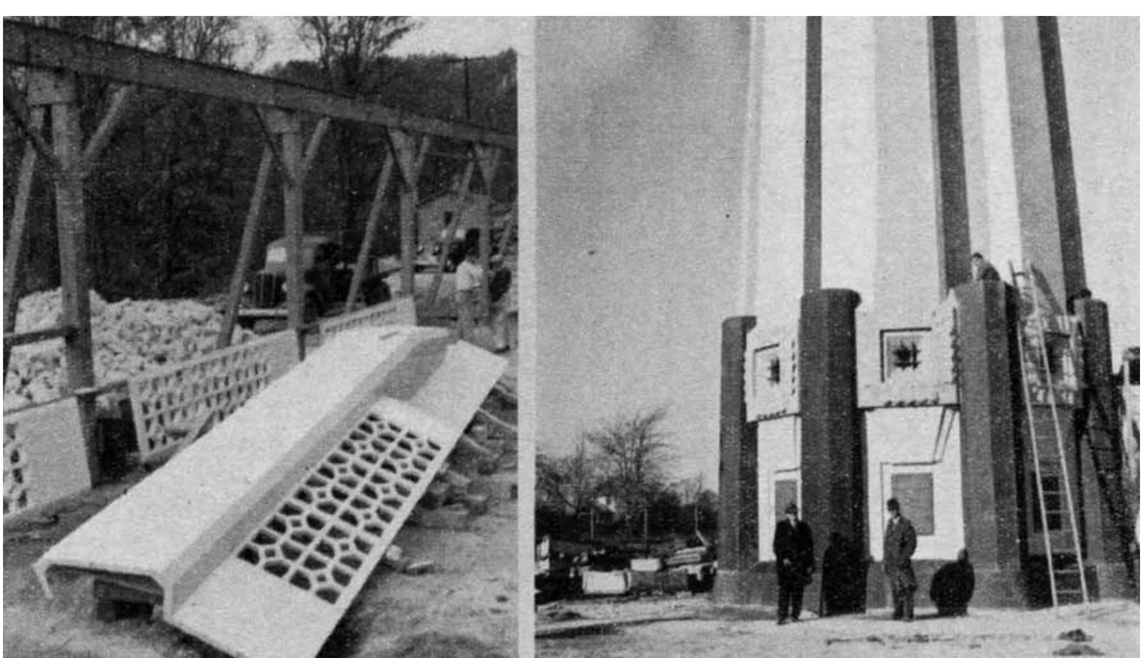
Meridian Hill Park clearly shows the evolution of the Earley Studio in the years between the construction of the retaining walls (1915-1916) and the gap-graded concrete of the balustrade (1917-1936). Both used cast-in-place and precast concrete in a variety of colors and textures.

Earley's insights, experiments, and tests were based on his craftsman's sense of the physical material and its properties. He understood that methods for casting and finishing should be adjusted to suit each application.[7]

The processes he used at Meridian Hill were then applied elsewhere. To create Lorado Taft's monumental sculpture for the Fountain of Time in Chicago, IL, for example, Earley Studio used a porous inner mold to absorb water from the concrete that was placed into the mold. Earley reasoned that this would reduce the concrete shrinkage and help the surface details stand out in strong, sharp relief. In the dome of the Baha'i House of Worship (1930), Earley created some of the first architectural precast concrete panels installed on structural steel framework. The principles and techniques that the studio developed remain industry practices to this day.



Earley's last major project, the Edison Memorial Tower, was created with a sophisticated blend of concrete aggregates.[8] The precast concrete panels feature a sequence of color gradations: the darkest color is at the bottom and the lightest is at the top



The panels for the Edison Memorial Tower were precast in Earley's studio in Virginia and shipped to the site in New Jersey.[8] Concrete grillages were installed over the loudspeakers at the top and bottom of the tower

With its concrete heavily deteriorating, the state of New Jersey hired Mills + Schnoering Architects, LLC, to restore the Edison Tower. Field investigations in 2009 revealed that some panels, mostly the ones at the top, had to be completely replaced *(Photo courtesy of Mills + Schnoering Architects, LLC)*

The concrete panels at the top of the Edison Tower are white with a cobalt blue color so they match the color of the sky. Closer inspection reveals the scale of the Pyrex replica of the light bulb. The light bulb will also be cleaned as part of the restoration process *(Photo courtesy of Mills + Schnoering Architects, LLC)*

Refining the Craft: Edison Memorial Tower

The Edison Memorial Tower was Earley's last major project and illustrates the studio's mature and more sophisticated artistic blending of aggregates to create a progressive sequence of color gradations. Twelve different concrete mixtures were required for the 117 ft (36 m) high fluted shaft, which is topped by a 25 ft (8 m) high Pyrex replica of the Edison lightbulb. The Tower is located at the site of Edison's workshop in Menlo Park, NJ (now Edison Township), and was constructed of concrete to commemorate Edison's interests in the material. The tower also includes loudspeakers integrated into the concrete at the top and base, honoring Edison's contributions to reproduction and reinforcement of sound.

The Earley Studio took the concept of precast thin-slab panels to another level of economy. At the Edison Monument, Earley used 2 in. (50 mm) thick mosaic panels as stay-in-place exterior forms for the reinforced concrete structure. The 10 to 17 ft (3 to 5 m) tall panels were produced in the Earley Studio in Rosslyn, VA, and shipped to the tower site in New Jersey. The panels were cast with wire loops extending from the back surface every 2 ft (0.6 m) on center; they were then set into position using cork gaskets in the joints between panels. Reinforcing steel for the structural concrete wall of the tower was installed behind the panels. Internal wooden formwork was then assembled and tied through the wall to the precast panels' wire loop anchors. The cavity between the precast panels and formwork was filled with structural concrete, and the precast mosaic concrete panels were thus permanently integrated into the wall assembly. To finish the exterior, the cork gaskets were removed and the joints pointed with mortar. Precast mosaic concrete grillages were also constructed over the loudspeakers at the top and bottom of the tower.

From the base of the tower to the top, the mosaic panels transition from amber to cream to brilliant white to, ultimately, white panels tempered with cobalt blue that stand out against the sky. Earley combined three colors of aggregates for each panel to create a painterly effect. To create the dark panels at the base of the towers, he added two values of black ceramics to black glass because, in his words, "One value of black is always monotonous." He also added ceramics so that their matte finish would soften the light reflected from the broken glass surfaces. In addition, he included a small number of red glass particles to "decorate the surface and make it interesting when seen from near at hand."[8]

Restoration

Earley's concrete, while durable, is subject to the same types of deterioration as any other concrete and presents some unique restoration challenges. In 2009, restoration projects began at these two significant Earley works. At both locations, the concrete ranged in condition from very good to severely deteriorated, with some panels reduced almost to rubble. These two projects illustrate the range of issues involved in the restoration of this material.

Field investigations at the Edison Memorial Tower revealed a range of deterioration caused by two factors: corrosion of the embedded reinforcing steel and cycles of freezing and thawing *(Photo courtesy of Mills + Schnoering Architects, LLC)*

Meridian Hill Park's design is based on Italian Renaissance gardens. It was one of the Earley Studio's first projects and it's the first place where the artisans used exposed aggregate concrete *(Photo courtesy of Mills + Schnoering Architects, LLC)*

A corroded reinforcing bar behind the exposed aggregate concrete facing of the Edison Memorial Tower *(Photo courtesy of Mills + Schnoering Architects, LLC)*

The National Park Service has been engaged in a phased restoration of Meridian Hill Park since 2001. In 2009, the state of New Jersey embarked on the Edison Memorial Tower's restoration.

Field investigation of Meridian Hill Park included a survey of the existing condition of all concrete elements. These ranged from minor spalls and hairline cracks to disintegration of ornamental elements. The principal causes of deterioration of the concrete were corrosion of the reinforcing, which is sometimes located within 1/2 in. (13 mm) of the concrete surface, and damage due to cycles of freezing and thawing.

The survey of Meridian Hill Park identified 14 unique aggregates combined in 21 different concrete mixtures throughout the park. The necessary repairs included small hand-packed patches, cast-in-place repairs, precast replacement elements, and reconstruction of entire stairways. At the request of the National Park Service, a set of materials and techniques has been developed for the phased restoration. The replacement of an entrance pier was used to demonstrate the effectiveness of these protocols. Twelve concrete mixtures were selected for use in the initial phase of restoration.

Concrete cores were extracted from the Edison Monument for laboratory analysis to determine the causes of deterioration, to better understand the characteristics of the concrete, and to assist in the development of the mixture design for the architectural concrete repairs.

The mosaic concrete panels were made up of two primary layers—a face mixture and a backup mixture—

Concrete cores were taken from the Edison Monument to allow for laboratory analysis of the panel concrete. Panels were composed of a face mixture and a backup mixture. The panels served as the exterior forms for reinforced concrete that provides structural support of the monument *(Photo courtesy of Mills + Schnoering Architects, LLC)*

with a total thickness of approximately 2-1/4 in. (57 mm). Both mixtures were non-air-entrained, as would be expected of concrete of this vintage. Only limited evidence of alkali-silica reaction (ASR) was detected, but no deleterious expansion was observed. Samples removed from the buttresses at the base consisted of a concrete that contained red and black glass in the coarse and fine aggregates. No evidence was found that this layer of material had suffered from ASR or damage from freezing and thawing; however, the backup mixture behind this layer suffered from severe damage from freezing and thawing.

The field survey revealed that the structure and the mosaic concrete panels were generally sound, requiring only isolated patching. The lowest and uppermost levels of the monument were more severely deteriorated and damaged, and required full replacement of the precast concrete panels. The limited deterioration in the shaft of the tower was primarily the result of corrosion of embedded reinforcing steel or freezing-and-thawing deterioration at panel joints. The deterioration at the buttresses at the base of the monument was due to freezing-and-thawing deterioration of the concrete backup mixture.

The restoration goal is that the new repairs match the existing mosaic concrete as closely as visually possible and be similar in other aspects, such as compressive strength and permeability. In addition, repair measures should be selected that retain as much of the original material as possible, while removing an adequate amount of deteriorated concrete to provide a sound substrate for a durable repair.

A search for aggregate sources and development of a preliminary mixture design was performed as part of the design phase. As a part of the work, small preliminary shop samples were made to match the original concrete mixtures.

The first step will be to perform cleaning samples of the original concrete mixtures to determine the appearance to be matched. To match these various characteristics of the original concrete, trial mixtures will be developed and variations in the appearance and composition of the mosaic concrete will be taken into account. The techniques used for repair of the architectural concrete are similar to good practices used in conventional concrete repair, except that a higher level of experience and craftsmanship are required for the mixing, placing, and finishing of the mosaic concrete. In addition, more emphasis is placed on samples, mockups, and the review and approval process.

Conclusions

John Earley believed that, compared to other construction materials, concrete's affordability and versatility increased with a project's complexity.[2] He repeatedly proved this as his willingness to take bold risks attracted projects with increasingly greater challenges. As new projects stimulated the Earley Studio staff to achieve more than they had in the past, the studio's craftsmen developed fresh innovations for their concrete materials.

The restoration of Meridian Hill Park and the Edison Memorial Tower will be underway in 2011, and the test of the careful preparations described previously will come in this stage of the projects. Based on previous experience, the more knowledge that can be gathered in the design phase, the more smoothly the construction phase will proceed. Preparation by the contractors in development of samples and mockups before beginning on-site construction will also be crucial.

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Selected for reader interest by the editors.

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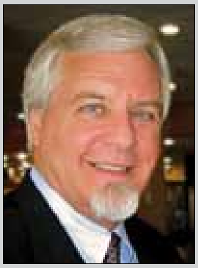

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