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# Conservation of the Iwo Jima Monument Parris Island for the United States Marine Corps

*Claudia G. Chemello and Paul Mardikian, Terra Mare Conservation, LLC, Charleston, South Carolina; and Joseph Sembrat and Mark J. Rabinowitz, Evergreene Architectural Arts, Inc., District Heights, Maryland*


Figure 1. The Iwo Jima Memorial in Arlington (left, Famartin CC BY-SA 4.0, Creative Commons License) and the Iwo Jima Monument at the Marine Corps Recruit Depot Parris Island during the X-ray survey (right) https://en.wikipedia.org/wiki/Marine_Corps_War_Memorial

## Abstract

The Iwo Jima Monument located at the Marine Corps Recruit Depot Parris Island, South Carolina, is a one-third scale model of the well-known United States Marine Corps War Memorial, also known as the Iwo Jima Memorial, in Arlington, Virginia, sculpted by Felix Weihs de Weldon (see Figure 1). The monument represents six Marines raising the flag of the United States on Mt. Suribachi, Japan, during the battle of Iwo Jima in World War II. The monument is a depiction of a famous Pulitzer Prize-winning photograph of the raising of the second flag of the United States by Associated Press photographer Joe Rosenthal. The Parris Island monument, also sculpted by Felix de Weldon, is made of steel reinforced concrete set into a concrete base and predates the larger and more famous bronze memorial in Arlington, Virginia. It was erected on the Parris Island Depot parade ground in 1952 and dedicated in September of that year.

In 2014 and 2015-16, the authors were contracted by the Depot to carry out two major interventions to restore the sculpture. The first intervention was a technical analysis of the monument using X-radiography, 3-D laser scanning, and visual inspection, providing a detailed condition assessment of the sculpture with recommendations for conservation treatment. The assessment revealed advanced deterioration of the sculpture caused by severe cracking of the concrete from corrosion of internal rebar, continuous ingress of water, dissolution of the clay core, and the application of impermeable and inflexible coatings preventing the escape of moisture from the saturated concrete.

The second intervention was to undertake a major restoration campaign to stabilize the sculpture which is

described in this paper. Based on the technical analysis and detailed visual inspection, seventy-one high priority areas of the sculpture were opened up for treatment. The treatment included removal of all coatings and previous repairs, removal of saturated and failed core material and replacement with a new composite grout, corrosion mitigation and replacement of failed rebar, application of a migrating corrosion inhibitor, crack and surface repair, repair of the flagpole, and the application of a new coating system appropriate for concrete. The challenging environment on Parris Island added considerable obstacles for long-term stabilization.

This monument holds significant value to the Marine Corps representing all Marines who bravely died in service to their country. The second flag-raising on Iwo Jima was one of the most documented events in Marine Corps history and so compelling an image that it was chosen by them to represent that past, and their sacrifices in the memorial. Conservation and preservation encompassed not only the physical materiality of the monument, but also the rich emotional ties it has to the Marines and the rich culture, history and *esprit de corps* of Parris Island.

## Background and History

Born in Vienna, Austria, in 1907, de Weldon was already a renowned sculptor in Europe before immigrating to the United States in 1938. He enlisted in the Navy during World War II, serving as the official naval artist for naval aviation (Ness, Oral history interview). While serving at the Patuxent River Naval Air Station in Southern Maryland, de Weldon viewed a photograph of the flag-raising at Mount Suribachi, Japan. The image captivated de Weldon, who began sculpting a model on the day the photo was released. His model galvanized war-weary Americans, helping prompt them to buy billions of dollars in war bonds.

De Weldon would turn Rosenthal's famous 1945 image of the second flag raising into several scale models, working with the three surviving soldiers from the battle, Rene A. Gagnon, Ira Hayes and Harold Schultz, to model their faces in clay. His work ultimately produced the 32-foot tall Marine Corps War Memorial in Arlington, Virginia. De Weldon was a prolific sculptor of more than 2000 public monuments that are on display on seven continents, including Antarctica. More than 30 of de Weldon's monuments survive in the Washington area alone, but the Iwo Jima Memorial is the most well-known, visited by an estimated 1.5 million visitors each year (National Park Service, History of the Marine Corps War Memorial).

The Iwo Jima Monument located at the Marine Corps Recruit Depot Parris Island (MCRD PI) is a one-third scale model of the large bronze memorial in Arlington, Virginia (see Figure 1). The original one-third scale model was sculpted in de Weldon's Washington, DC, studio in 1945. A plaster mold was made from the model to produce additional sculptures. Only three concrete versions of the sculpture survive. One additional version exists at Marine Corps Base Quantico based on the original model and carved from limestone. The first and original of the three concrete versions was previously exhibited and is now believed to be in storage. This version belongs to The War Museum, a virtual online museum run by Rodney H. Brown, in New York (Brown, The War Museum). The second is at the MCRD PI, and the third is at Cape Coral, Florida.

### *History of Restoration*

Previous repair campaigns had been carried out on the sculpture in attempts to address water ingress into the monument and prevent cracking and breakdown of the coatings. These campaigns began as early as 1956, four years after the sculpture was dedicated (Miller, 2013). Repairs were again undertaken in 1961, when the sculpture was coated with 'preservative epoxy paint' (Miller, 2013). In 1964, the repair called for reinforcement of the statue with a 'stronger than steel material' (most probably a polyester-based auto body filler such as Bondo) and finished with a 'permanent covering that would enable the monument to stand forever.' In 1972, more repairs were carried out and a bronze colored lacquer coating was applied. In 1998, a work authorization approved additional repair using a two-component epoxy grout to fill the cracks (VersaCrete, Fil-Eze #424), followed by repainting with one coat of 'automotive primer' followed by two-coats of Dupont Centari automotive acrylic enamel ("Shadow Gold"). It is unclear who carried out these early repair campaigns. Additional assessments and recommendations for treatment were carried out in 1999 by Thomas & Denzinger Architects of Charleston, and in 2013 Patricia Miller of 2 Arts Conservation, LLC.

In 2014 a technical analysis of the sculpture was carried out using X-radiography, 3-D laser scanning, and visual inspection (Chemello, 2014). A team of conservators led by Terra Mare Conservation (TMC), X-ray and 3-D scanning specialists from Jan X-ray Services

and Creaform, and a structural engineer from Bennett Preservation Engineering PC (BPE) completed the assessment and provided a report to the MCRDPI with recommendations for conservation treatment based on the results of the inspection. The report unequivocally indicated that the sculpture was deteriorated, the core material was completely saturated, the steel reinforcing was corroding and that restoration was needed. It was not until the detailed technical inspection was carried out that the extent of the deterioration and corrosion of the rebar was documented, and a clear and realistic strategy for long-term preservation of the monument could be recommended.

### *Fabrication*

The sculpture appears to have been fabricated by packing clay around a welded steel reinforcing system to which the prefabricated concrete shell was attached. On top of the clay a green-pigmented mortar with medium-sized aggregate was packed around the clay and rebar system. Galvanized steel mesh was placed on top of this layer and then another layer of green mortar with medium sized aggregate was placed on top of it and the surface was carved and sculpted before the cement was fully cured. The concrete shell was then attached to the rebar and clay form. Wood, polyurethane foam and other materials were found inside the sculpture when we opened it up, but it was unclear if these were used by de Weldon or are the result of a later restoration effort. The shell, approximately one inch thick, was most likely fabricated by pressing the concrete into a mold, allowing the sections to be as lightweight as possible.

## Condition

As discussed above, either immediately after fabrication or soon after completion, the sculpture received a primer and finish coat of paint. Shortly after exposure to the environment of Parris Island, the sculpture began to develop cracks and fissures allowing pathways for water to penetrate the concrete, saturating the mortar/clay core (see Figure 2). The surface was subsequently coated with thicker and less permeable coatings in an attempt to fill the cracks and stop the deterioration. The cracks were filled with various patching materials including polyurethane foam, polyester resin, Portland cement, wood, and caulk. Unfortunately, despite repeated maintenance and repainting campaigns, the deterioration continued owing to excessive water intrusion. The internal clay was continuously wet in the high humidity at the site (often above 75% RH) and unable to completely dry out, and the constant entry of water caused leaching of mortar onto the surface. The rebar armature was severely compromised due to severe corrosion. Thermal stress due to continued cycles of heating/cooling and wetting/drying also contributed to the cracking. In general, deterioration was more severe on the lower part of the sculpture owing to gravity, particularly on the lower torsos, legs and feet, but was also prominent on the hands around the flagpole and on all skyward-facing surfaces.

## Treatment

Several priorities for guiding the restoration of the sculpture were identified by TMC in collaboration with the project team and the MCRDPI. The main goals of the restoration were to re-establish the structural integ-

Figure 2. The monument before treatment showing failed coatings and surface cracking.

rity of the sculpture, reduce the rate of future deterioration and preserve as much original material as possible while respecting the memorial's artistic and historic significance. Recommendations for treatment were guided by these goals and included components of both restoration and conservation which were necessary for the complexity and scale of the project, and in keeping with memorial's historical significance.

Treatment strategies comprised:

- removal of the numerous inappropriate coatings and patching materials
- removal of the outer concrete shell to expose the internal clay/mortar
- removal of the wet internal clay core and replacement with an appropriate mortar compatible with the existing materials of fabrication
- replacement or corrosion mitigation of the severely corroded rebar
- rebuilding of the excavated areas
- surface patching, crack injection and final surface repairs where needed to close entry points for water ingress
- repair of the flagpole
- application of a new advanced coating system.

### *Coating Removal*

Prior to coatings removal, the paint was tested for the presence of lead and asbestos and none was found. Coatings were removed in two separate phases. The first phase was undertaken by Ultra High Pressure Projects, Inc. (UHP) using a water based paint stripper. This was followed by wet blasting carried out by the authors to remove the extremely hard impervious coatings.

Eleven layers of paint were removed with Sea to Sky SPC-202 water-based paint remover. The paint remover was applied to the surface and covered in plastic film overnight to soften the paint, as seen in Figure 3. The softened coatings were then removed mechanically with plastic scrappers and the sculpture was thoroughly rinsed with water to remove residues. This sequence was repeated several times as needed to soften and remove the multiple paint layers. After paint removal, a thick impermeable coating still remained on the surface. This was originally thought to be the surface of the concrete, as it was green in color. Testing revealed that this was actually a thick combination of polyester and epoxy materials, almost completely covering the surface. In places, this coating was sculpted to conform to the surrounding surface, and clearly had been applied in an attempt to stop water infiltration and repair the numerous cracks and surface defects.

The impermeable coating was removed in the second phase by wet blasting using recycled crushed glass. About 1.2 tons of fine glass media were used during this process and approximately 95% of the coating was removed. In some areas, such as deep recesses, undercuts, and in places where the coating was extremely thick, the coating was reduced in thickness but was impossible to fully remove without damaging the concrete surface. The coating in these areas was further reduced in thickness using hammers and chisels as well as pneumatic tools. Old repairs and infills were also removed as far as possible using mechanical methods.

### *Opening up the Sculpture*

Although the number of areas where the sculpture would be opened up for treatment had been predetermined from the X-ray survey carried out in 2014, it was unclear whether this intervention would be enough to stabilize the sculpture; these concerns were central to the conservation planning process. As a 'per square foot' estimate was requested by the client, identifying the treatment areas prior to opening up the sculpture was difficult. Work ultimately took place in two phases once a better understanding of the level of deterioration was visible after coating removal and a full assessment of the sculpture was possible.

Based on the 2014 X-ray survey which identified areas of definite or probable rebar corrosion, 21 areas were identified as priorities for excavation. These areas were predominantly located on the lower legs of the figures (see Figure 4), where cracking and deterioration were widespread, as well as several areas on the upper back of Hayes, on the hands around the flagpole, and where the flagpole enters the body of Block.

Following wet blasting and access to the entire surface, 50 additional problem areas were targeted for opening and treatment. Most of these were connected to the areas originally identified as high priority, extending the areas of treatment further into the sculpture. Despite the extended scope of work, the restoration of the sculpture was restricted to obvious areas of instability.

### *Removal of Core Material to Expose Reinforcing Steel*

The internal core and rebar were accessed by cutting through the concrete outer shell layers using a diamond blade fitted to 4 ½" and 7" electric grinders (see Figure

Figure 3. During coating removal.

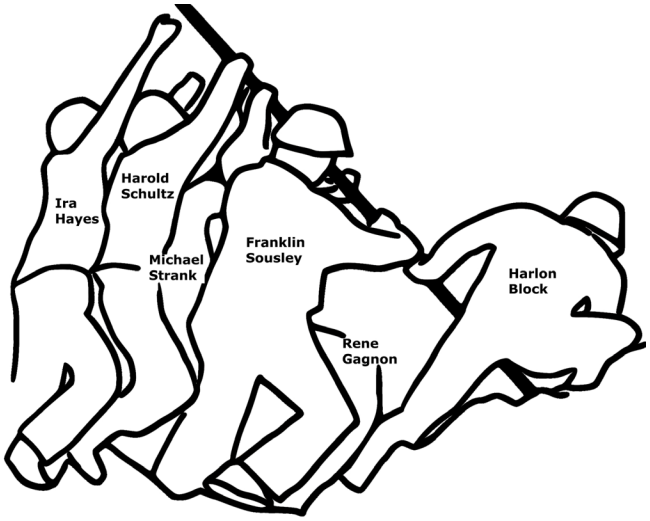


Figure 4. A diagram of the photograph indicating the six Marines who raised the second flag. Left to right: Ira Hayes, Harold Schultz, Michael Strank (†), Franklin Sousley (†), Rene Gagnon, and Harlon Block (†). «†» = killed on Iwo Jima. Source: Aeoris (https://commons.wikimedia.org/wiki/File:Raising_the_Flag_outline.svg), "Raising the Flag outline", https://creativecommons.org/licenses/by-sa/3.0/legalcode

5). Registration marks were made on the sections that were removed so that they could be reattached in their exact locations at a later date. These processes were documented in field drawings and photographs. Once sections of the outer shell were removed and the internal clay exposed, these areas were excavated using pneumatic chisels and other hand tools, and/or pressurized water at 3,000 psi with rotating nozzles. In some areas such as the left foot of Hayes, a particularly problematic area, water and loose clay core flowed out of the cavity after removing the concrete shell as excess moisture was retained inside the cavity. The clay core in this area was completely saturated.

### *Replacement or Treatment of Corroded Reinforcing Steel*

Corroded sections of steel rebar were accessible once the clay core was removed. Moderate to severe corrosion was visible on the majority of the accessible rebar. In parts of the sculpture that were particularly wet or damp, such as the feet of Hayes and Sousley, and the lower legs of Hayes, Sousley, Schultz, Strank and Gagnon, rebar showed extreme levels of corrosion with more than 50% of the bar thickness reduced (# 5/0.625 inch diameter and #8/1 inch diameter bars), as seen in Figure 6 at left. Rebar that were embedded in the wall of the concrete shell were often completely disintegrated. Some sections of rebar had become detached due to corrosion and readily fell out on excavation.

Corroded rebar armature was removed with a metal cutting wheel and replaced with new fiberglass rebar of the same approximate diameter, either # 3/0.375 inch diameter, # 4/0.500 inch diameter or # 5/0.625 inch diameter. The new rebar were lapped onto existing rebar with nylon zip ties, see Figure 6 on middle and right images. Where rebar were in direct contact with the concrete shell, they were secured to the shell with Sikadur®-31 (Sika) structural epoxy. Lapping extended to approximately 12 inches in each direction where feasible. Where possible, the rebar were either inserted into predrilled holes into an adjacent unexcavated clay core, or holes were drilled through to an adjacent excavated area and the rebar from one area joined to the rebar from the adjacent area for maximum strength and continuity. All replaced rebar were assessed by project structural engineer Craig Bennett from BPE during two site visits, and by photographs, to ensure that the new rebar were correctly attached to existing rebar and structurally sound.

Some rebar were not replaced due to being embedded in the concrete shell or were judged to be corrod-

ed to less than 50% of the bar thickness. These rebar were mechanically cleaned with steel brushes and small pneumatic chisels to remove loose, flaky corrosion and adherent mortar. Once clean, the rebar were blasted with fine crushed glass to a near-white level to remove corrosion products. After blasting, the rebar were coated with two coats of Mapefer 1K (Mapei) corrosion inhibiting mortar, applied by brush as seen in Figure 7 at left.

### *Application of Migrating Corrosion Inhibitors*

Following treatment of the corroded rebar, all excavated areas were treated with Cortec MCI®-2020, a water-based migrating corrosion inhibitor designed to penetrate through cementitious materials including concrete and mortar. MCI-2020 migrates in both liquid and vapor (gas) phases through the pore structure, forming a protective, molecular layer on embedded reinforcement. The MCI®-2020 was also applied to the entire sculpture and particularly to areas where rebar

Figure 5. Opening up the sculpture for restoration beginning with the left leg of Hayes (left and middle), and after removal of clay core and corroded rebar (right).

Figure 6. Treatment and attachment of new rebar inside Schultz at left and right and Sousley at center.

were buried in the sculpture and not fully accessible during conservation.

### *Flagpole Repair*

The base of the flagpole was an area of major concern due to the stress from constant movement of the pole (see Figure 7 middle and right image). After removal of the lower set of hands belonging to Sousley and Gagnon, the base of the pole was found to be extremely corroded and poorly secured to the sculpture. The pole is attached into the lower back of Block and is then connected to a much smaller diameter length of rebar which continues down into Block's body. A decision was made to cut the pole about 10 cm (3.94 inches) from the bottom, blast the pole with crushed glass and apply two coats of Mapefer 1K. The interior of the pole was also cleaned out and wire brushed as far as possible to remove loose corrosion products. After thorough drying of the coating, the base of the poll was reattached to the sculpture with five pieces of # 3 fiberglass rebar approximately two feet in length extending into the pole and into Block's back. The new rebars were secured in place with Sikadur®-31 epoxy. The hands of Sousley and Gagnon were reattached with Sikadur®-31 epoxy and remodeled with Planitop XS (Mapei).

### *Rebuilding of Excavated Areas*

After the clay core had been removed in targeted locations, and the rebar treated or replaced, the voids within the sculpture where the clay core had been removed were refilled. The rebar were first encased in Planitop XS to a minimum depth of 1" or entirely encased in narrow sections such as at ankles. Larger voids were then packed with a concrete mixture consisting of one part Type "N" cement, three parts sand, and three parts pea gravel. The concrete was either poured into the voids formed by the re-attached fragments or built up in several lifts to recreate missing sections up to 1" below the finish form (see Figure 8). After initial set, these areas were sculptured with Planitop XS as described below.

After all interior treatment had been completed, previously detached fragments of the concrete shell were reattached in their original locations and orientations. Fragments were aligned and adhered with Sikadur®-31 structural epoxy adhesive. Each face was coated with adhesive, which was mixed according to manufacturer's recommendations, and the fragments were set in plane with the existing sculptured forms. Joints were faired with additional epoxy if needed.

Some sections proved to be too friable and deteriorated to reinstall. These areas were built up using Planitop XS following original profiles and contours. The material was applied to a minimum 1" thickness atop the fills, allowed to stiffen during an initial set, and then leveled back to the finished forms. If multiple lifts were required, they were applied after a minimum of eight hours cure of the previous lift. The rifle of Schultz and the dagger of Hayes were also remodeled with Planitop XS due to loss of original material.

Final surface repairs and filling of cracks was achieved with Planitop XS or Sikadur®-31 depending on the repair required and the position of the fragments; final fairing of the assembled fragments was achieved with Planitop XS.

Some sections of the sculpture showed multiple campaigns of repairs that complicated restoration efforts. The two sets of hands at the flagpole were a messy accumulation of bulked polyester resin fills and insensitively executed repairs that only vaguely reflected the original sculptural form. In addition, one of the hands had been repaired with six fingers.

The movement and strain at the flagpole had damaged the original hands which were covered in thick layers of polyester resin and concrete to prevent the recurrence of cracks reappearing. The hands were removed for repair of the flagpole and then readhered with Sikadur®-31 epoxy. The insensitive repairs were removed and details remodeled with Planitop XS.

### *Coating*

After all repairs were completed, the sculpture was allowed to dry for a period of approximately 10 days to ensure maximum cure of all filled areas. During this time, an enclosure was constructed within the site scaffolding using polyethylene sheeting attached to a timber frame to provide environmental control. On the weekend prior to the start of coating, the space was conditioned to approximately 50% relative humidity and 75 degrees F. The controls remained in effect until the coating and the mineral stain (final surface color) were completed.

A Keim Soldalit coating system was chosen for the Iwo Jima monument due to its compatibility with the substrate repairs and restoration mortars used on the sculpture as well as the original concrete surface. Keim coatings are based on a combination of silica sol and potassium silicate binding agents. They are formulated for mineral surfaces such as concrete and develop a chemical bond with the substrate creating excellent ad-

Figure 7. Coating of rebar at left and repair of the flagpole (middle and right).


Figure 8. Remodeling of the helmet of Hayes (left) and rebuilding excavated sections of Hayes' legs (middle and right).

hesion. The Keim system creates a lightfast and UV resistant coating with enhanced condensation resistance that is extremely durable and resistant to weathering, especially sunlight and wind-driven rain. The coating is also breathable and highly permeable to water vapor, allowing moisture to freely escape from the substrate, an issue of huge importance for the preservation of the sculpture.

The sequence began with a skim coat of Keim Concretal Feinspachtel applied by brush to correct surface imperfections prior to application of the new coating. The surfaces were treated with Keim Lime Remover to remove all traces of lime, then two flood coats of Keim Silan-100 water repellant treatment were applied with a low-pressure sprayer and brushes.

One base coat of Keim Soldalit Grob was applied by airless sprayer, (see Figure 9 left image). Grob is a textured silicate filler for base coats within the Soldalit system. The Grob was followed by one coat of Keim Soldalit color # 15198, applied by airless sprayer. The base coats were applied by UHP. The final colored top coat was composed of one layer of Keim Design Lasur metallic finish Color # 1001 & # 1003, 50/50, applied by brush followed by two layers of Keim Design Lasur, color # 14045 (see Figure 9 and 10). Lasur is a pigmented mineral stain, lightfast and extremely resistant to weathering similar to the rest of the Soldalit system.

The flagpole was mechanically cleaned and painted with two coats of Sherwin Williams direct-to-metal enamel paint in a bronze color. After coating, the Keim Design Lasur metallic finish was applied by brush in the same color as applied to the concrete surface.

## Emotional Dimension of the Work

Restoration and conservation work on this sculpture was akin to open heart surgery on a very sick patient. The sculpture was quite literally opened up to expose its internal deteriorated core, and at times the work load was enormous. Our vision of how the work would unfold and the excellent result we expected was not necessarily a vision that everyone who looked at the sculpture could understand, especially when the figures appeared almost unrecognizable. The very prominent location of the sculpture on the parade ground was one of the biggest challenges of the project as visitors to Parris Island are numerous, especially during graduation, and photographs next to the sculpture are common. Prior to commencing work, we removed several dog tags that had been placed on the monument, a practice which we believe continues. These were given to the Parris Island Museum.

Figure 9. Application of the final coatings, the base coat (left) and the metallic finish (middle and right).

Figure 10. The Iwo Jima Monument after treatment.

Requests for access to the sculpture were made not only from current Marines, but also from former Marines and their families, particularly during graduation. Some of the requests were made by former Marines who had deployed to Vietnam from Parris Island and who wanted to touch the sculpture again as they had done before deploying. The Commanding General of Parris Island also requested a tour of the work, and we were honored to be able to accommodate this. Common to all visits was an appreciation expressed for the work being undertaken, as well as a deep sense of the almost spiritual meaning that is represented by the sculpture. Such moments temporarily transcended our concerns for the preservation of the sculpture's fabric and conveyed an emotional aspect to the work that was quite unexpected (see Figure 10).

## Conclusion

Restoration of the Iwo Jima Monument for the MCRDPI was a challenging and complex undertaking. The sculpture was suffering significant deterioration that was causing enormous stress on the stability of the structure. Combined with the numerous inappropriate repair campaigns that had caused further damage to the concrete, and a continuously aggressive environment at the Depot, the challenge was greatly increased.

The sculpture's artistic and historical significance and the meaning of the moment depicted in de Weldon's portrayal of Rosenthal's historic photograph in many ways transcended the materials conservation challenges faced. In the face of such an important legacy, treatment strategies were guided by ethical practices in our field and included materials and methods that are sympathetic to the existing materials in character and appearance and should provide excellent long-term performance.

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