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CONSERVING A TERRA-COTTA CORNICE

A treatment report by Conservation Solutions, Inc., on a terra-cotta cornice adorning the Capitol Building in San Juan, Puerto Rico, shows the potentially catastrophic effects of corrosion in a marine environment, and offers some innovative solutions to the problem.

by Joseph Sembrat, *Head Conservator and President of Conservation Solutions, Inc.*

Conservation Solutions, Inc., was contracted by the government of Puerto Rico to assist Pablo Quinones of OPQ & Associates in the investigation of the main terra-cotta cornice at the base of the dome of San Juan's Capitol Building.

CSI subcontracted the services of Martin Weaver, President of Martin Weaver and Associates International Conservation Consultants (MWAICC), who performed investigative work and partial disassembly of a 6-ft. section of the cornice. This was done in order to prevent the collapse of this section of the cornice, determine the cause and nature of the failure, better understand the materials and techniques used in its construction, and provide the architect with various design solutions, cost estimates, and assistance with the writing of specifications.

The Capitol Building of Puerto Rico was inaugurated on February 11, 1929, as the seat of the Legislative Branch of the Puerto Rican Government. A vast marble staircase faces Ponce de Leon Avenue and gives access to the building to the south. Eight Corinthian columns rise at both main entrances and seven imposing doors give access to its interior at the north and south. At the center of the structure there is a rotunda which extends upwards to the three floors of the building, and in the center of the first floor there is a display case which has the original Constitution of Puerto Rico permanently on display. The cornice adorns the base of the dome which rises at the center of the building on an octagonal drum.

To help understand the condition of both the terra-cotta anchoring system and the concrete substructure that supports it, and to assist the clients in their portico-restoration project, CSI conducted an on-site investigation of the terra-cotta cornice and concrete substructure from scaffolding. CSI and Martin Weaver performed written and photographic documentation of the work and provided field drawings to OPQ & Associates.

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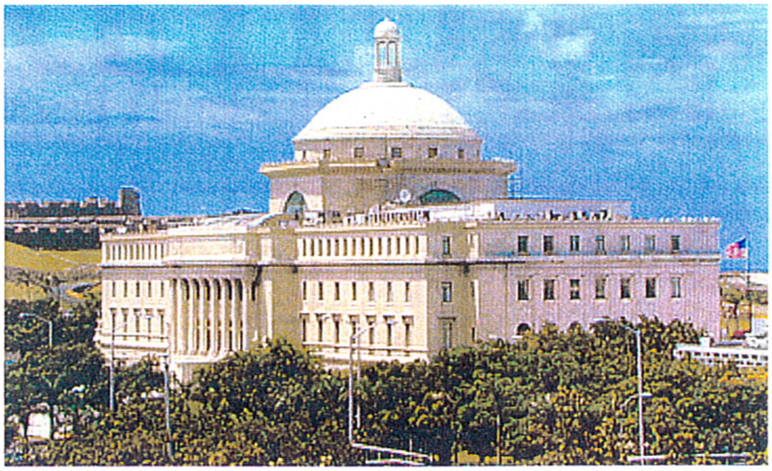
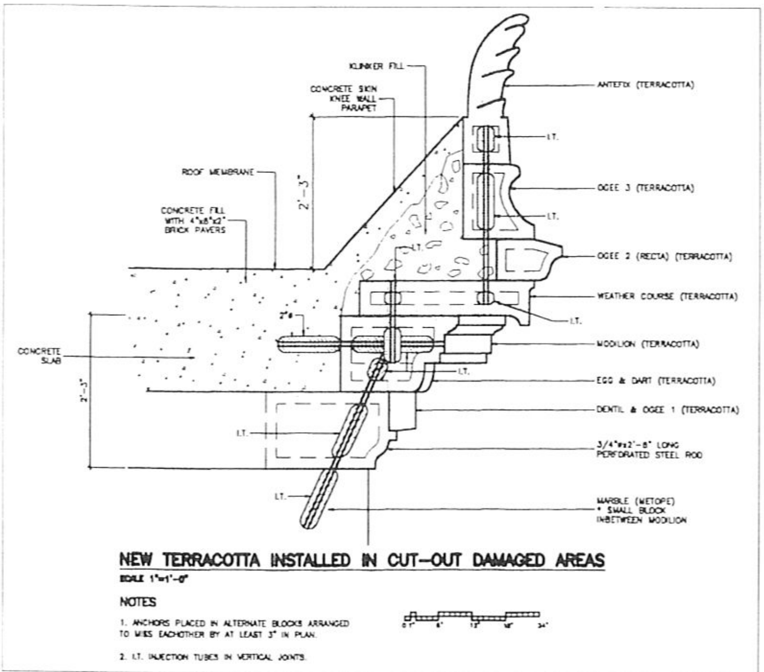


Puerto Rico's Capitol Building, or "El Capitolio," in San Juan, was completed and inaugurated in 1929. A major port city, San Juan faces the Atlantic Ocean to the north. This marine environment was a major factor in the dangerous corrosion of the anchoring system of the building's terra-cotta cornice.

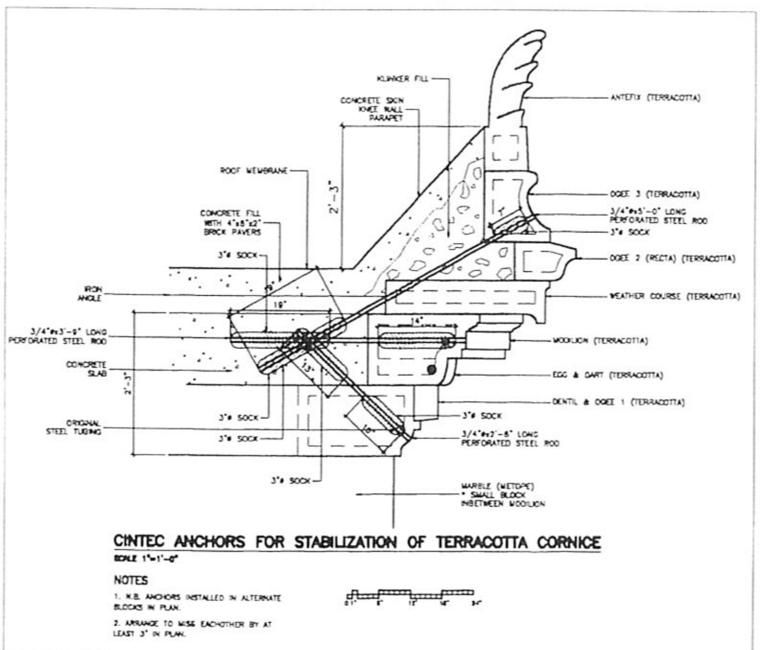
The poor condition of the terra-cotta cornice is evident in this view. The separation of the terra-cotta units is due to not only the failure of the anchoring system, but also the expansion of the corroded material.

A worker is seen here cutting the mortar joints between the terra-cotta blocks in preparation for the disassembly of the cornice.

Once the cornice had been partially disassembled, the materials and techniques used in its construction could be easily identified. Note the clinker concrete, or "cindercrete," between the terra-cotta blocks and the brick backup material, and the severe deterioration of the steel supports. CSI recommended that all new steelwork be AISI Type 316 stainless steel, a non-corroding type, which is essential in this chloride-rich maritime environment.



Conservation Solutions, in collaboration with the project architect and conservation consultant Martin Weaver, designed these two new anchoring systems for the cornice. The design for the dismantled section (above) uses AISI Type 316, non-corroding stainless-steel rods in a grout-injection anchor system by CINTEC. Small injection tubes are positioned in the joints between the terra-cotta units for inflation with grout after assembly. The stabilizing anchors (below) are designed to be installed in-situ by means of a different type of CINTEC grout-injection system, also using AISI Type 316 stainless-steel rods.



Most importantly, we disassembled approximately 6 feet of the cornice to reveal its construction and its anchoring system. We also exposed a portion of the parapet decking to determine the condition of the underlying concrete substructure. In collaboration with the architect and Martin Weaver, a new anchoring system was designed. We also worked with the noted terra-cotta manufacturer, Gladding, McBean, to determine which sections of terra cotta would need to be replicated.

Finally, after our investigative work was done, CSI made the opening in the cornice watertight.

Following observation of severe cracking and movement at the corners of the main terra-cotta cornice of the octagonal lower drum of the dome, it was jointly decided to erect scaffolding and to carefully make an exploratory opening into the terra-cotta work.

The purposes of this intervention were to establish if the cracking and movement were evidence of a dangerous situation, to establish the types, locations, and conditions of the hidden steel support structure and anchors, and to establish the type, location, and condition of the reinforced concrete sub-structure.

We selected the southeast corner of the octagonal lower drum, apparently the area of the cornice with the worst conditions, as the best site for our investigations. Pablo Quinones and Martin Weaver had noted what appeared to be evidence of severe damage in this same area in 1998.

As the careful cutting away commenced at the cornice's upper level, we found that the cornice was backed-up by a mass of "clinker concrete" or "cindercrete." This material is based on an aggregate of furnace ash and large fragments of clinker. Its use has been suspended for many years because the large quantities of sulfur compounds present in the ash and clinker have been found to cause severe corrosion of adjacent steel in the presence of moisture.

After removal of the cindercrete from the adjacent area, the cutting-out proceeded and it was noted that the movement of the terra cotta was beginning to accelerate. The terra-cotta mass at the corner — probably weighing in excess of 500 lbs. — was pulling away from the main mass of the cornice by active diagonal cracks propagating down on either side of the corner. The unstable mass was immediately secured by ropes and temporary supports and was carefully cut apart and removed.

Water had penetrated down into the cornice, and all its steel structural supports and anchors had been totally destroyed by corrosion. The total failure of the structural-support steel and anchor system had led to the structural failure of the cantilevered, and now unreinforced, terra-cotta cornice. The only reason that it had not collapsed was a combination of the cohesive and frictional effects of the mortar and brick fragments used as back-up to the hollow terra-cotta units.

Moisture had entered via open joints and cracks and, to a lesser extent, through leaks in the roof above and behind the cornice.The reason for the extreme corrosion of the steel was a combination of chlorides from sea spray and the sulfuric acid formed when saline moisture saturated and then passed through the contaminated cindercrete. The corrosion had been so severe that it was no longer possible to establish the exact dimensions of any of the former steel elements. Some had disappeared totally, leaving only rusty stains in the terra-cotta work.

It should be noted that any corrosion of embedded steel is associated with massive expansion of the corrosion products. In the case of the Capitol Building, this expansion had resulted, and will continue to result, in the shattering of the immediately adjacent terra cotta. Thus, all stabilization, conservation, and restoration work must involve the removal of all corroding steel and/or the prevention of any further corrosion and associated expansive effects. All new steelwork must be AISI Type 316 stainless steel, which is non-corroding in the chloride-rich maritime environment present here. AISI Type 304 stainless steel is attacked by chlorides and cannot be used here under any circumstances because it will corrode.

On the basis of our observations, we concluded that in any and all locations where the terra-cotta cornices show evidence of cracking and movement, with open joints and possibly rust staining on the lower surfaces, then this terra-cotta work has had all, or most, of its structural-support steel and anchoring system so severely corroded that it is either totally gone or is so seriously deteriorated that the whole cornice, or parts thereof, are liable to become dangerous and could collapse suddenly and without further evidence of failure.

The extreme nature of the deterioration process was such that it will inevitably lead to catastrophic failure, with collapse of the terra cotta onto, and possibly through, the openings in the roof below. Accordingly, we recommended that all cracked and deformed areas of the cornice should be carefully dismantled as soon as possible. Shattered terra-cotta units should be replaced with high-quality matching new units from a well-established terra-cotta manufacturer such as Gladding, McBean of California. This firm has been in continuous practice since before the erection of the Capitol and is known for the high quality of its architectural terra cotta.

The dismantled corners should be rebuilt using AISI Type 316, non-corroding stainless-steel rods in a grout-injection anchor system by CINTEC, specially designed with small injection tubes positioned in the joints between the terra-cotta units for inflation with grout after assembly.

Undamaged areas of terra cotta may be stabilized in-situ by means of a different type of CINTEC grout-injection anchor system, also using AISI Type 316 stainless-steel rods. It will be necessary to open up a series of areas in the terra-cotta work at random locations to determine if, in fact, the apparently undamaged terra cotta can be safely stabilized in this way.

Once the water has been prevented from getting into the top of the cornices and other details, and the CINTEC in-situ stabilization system has been applied in diamond-tipped core-drilled holes, the crucial factor then will be whether any existing embedded steel can be left in-situ. All in-situ stabilization work must involve dry-drilling with advanced air-cooled drilling equipment. Under no circumstances can water-cooled drilling systems be used because of the danger of the water causing further deterioration.

It was recommended that a complete condition survey of all the terra-cotta work should be carried out as soon as possible to locate any other dangerous areas which may already exist. ■

Joseph Sembrat is President and Head Conservator of Conservation Solutions, Inc., District Heights, MD. The firm specializes in theconservation of historic structures, monuments, sculpture, and fountains in such materials as metal, stone, and terra-cotta.