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THE RAILINGS THAT DIDN'T AGE GRACEFULLY

By Bob Cusumano

A thirty year old condominium along the ocean in Palm Beach decided to renovate. Extensive concrete repair was necessary due to the many years of salt impregnation that had penetrated through the concrete caused rusting of the reinforcing steel. At that same time it was decided that the existing decorative aluminum walkway railings would be removed from the building, repainted and later reinstalled when the concrete work had been completed.

The railings had been repainted many times with traditional coating systems which included zinc chromate primer and alkyd enamel finish coats. Although the railings were in relatively good shape considering the many years of marine exposure, there was some isolated oxidation and paint delamination evident. It was decided that all of the existing coatings would be removed by chemical stripping and then a new high performance paint system consisting of an epoxy primer and a catalyzed urethane top coat would be applied.

The concrete work was completed, the railings were stripped, repainted and reinstalled. Within six months, severe corrosion had been noted on extensive areas of the railings. The corrosion and paint delamination was much worse than what had been apparent before repainting of the railings was performed.

Upon visiting the site, we noted that the railings consisted of wrought aluminum uprights and horizontal rails to which cast aluminum decorative panels had been welded (photo #1).

Photo 1

After examining several areas, it was determined that the decorative cast panels had widespread paint delamination and were severely corroding. In fact, so much so, that in several instances the metal could be crushed and broken with your bare hands. There was a white powder present beneath the delaminating paint, later analyzed to consist primarily of aluminum oxide, a common corrosion product and the metal rough and discolored as shown in photo #2. It was also noted that the adjacent wrought aluminum rails had blisters in the paint. When the blisters were broken, the aluminum beneath was bright and shiny with no evidence of corrosion or the white aluminum oxide powder.

Photo 2

This combination of observations suggested that galvanic corrosion was occurring. Galvanic corrosion occurs when two different metals are physically or electrically connected and are placed in an electrolyte, that is a liquid that is capable of carrying an electric current. Batteries are based on this scientific phenomenon. Based on their metallurgical properties, one of the metals will be less "noble" than the other and will become the anode. Corrosion and consumption of the metal occurs at the anode. The other, more "noble" metal becomes the cathode. At the cathode, no corrosion occurs. Instead, the chemical reaction that takes place causes hydrogen gas to form.
In our instance, it appeared that the cast decorative aluminum panels were the anodes and the wrought uprights and rails were the cathodes. The moist, marine atmosphere present at this south Florida location served as the electrolyte. The fact that the panels were welded to the rails and uprights put them in electrical continuity with each other, so galvanic corrosion was indeed possible.

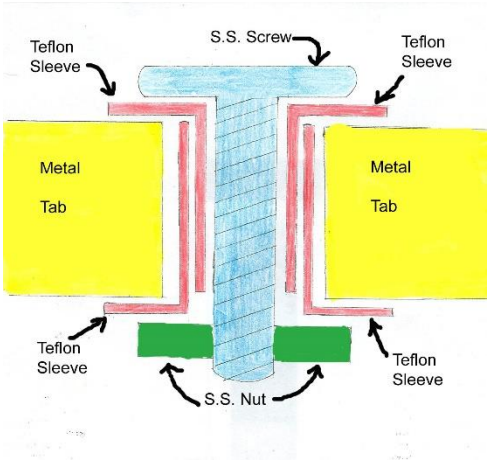
In order to test the validity of this theory, an electrical meter was used to measure any current that existed. Probes were fastened to the bare areas of the rails and panels and significant electrical current was measured at all areas tested.

This explained the reason why the corrosion was occurring, but did not explain its severity. Since all of the metal components were aluminum, there would only be a slight metallurgical difference between the wrought rails and uprights and the cast panels. Yet, the severe corrosion experienced suggested that additional factors came into play. It was decided that a trip to the aluminum shop where the railings had been stripped and repainted might prove productive. Indeed, it did.

The shop foreman explained the processes used for stripping the old paint from the railings and the subsequent surface preparation performed. We were then shown the production line where the railings were subsequently painted. As a part of the process, after each coat of paint was applied, the railing sections were baked in an oven to achieve a quicker paint set. As it turns out, this was the final piece of the puzzle.

Most aluminum alloys contain traces of other metals to improve their physical properties. Usually, these metals are evenly distributed throughout the metal. Metals consist of individual grains, which are usually of microscopic size. One exception is bright galvanizing, where the individual grains of zinc are easily seen. In our case, the aluminum panels contained copper. When subjected to prolonged heat followed by natural cooling, a process known as aging can occurs. During aging, the copper migrated from within the individual grains to the grain boundaries. This caused each individual metal grain to become a galvanic cell with the resultant metal oxidation being called intergranular corrosion. In this case the temperatures achieved and the time of exposure was sufficient to result in aging and explained the catastrophic destruction of the panels.

The remedy was an expensive one and unfortunately cost the contractor a bundle. All of the decorative panels were cut out of the railings and discarded. New panels of a particular composition were ordered. The new panels had tabs for fastening them to the rails rather than being welded. It was important to electrically isolate the panels from the rails so that galvanic corrosion would not again occur. To accomplish this, a stainless steel screw was encased in a teflon sleeves containing a built in washer at each end. This assembly was passed through a hole in each tab. When the nut was tightened, the screw and nut were electrically isolated from the panel, with the result being that the panel and the adjacent rail were also electrically isolated. Under this condition, galvanic corrosion cannot occur. The schematic drawing shows how this was accomplished.



At the time of this writing, the new panels are now 12 years old and are still in good condition. In this instance, one unfortunate step in the painting process resulted in a severe and costly coatings failure.