



# Surface-Applied Corrosion Inhibitors for Concrete Balconies

by Steve Poling

One of the most frustrating moments for a condominium owner is being hit with a major special assessment to repair balconies and walkways. Many times the “visual” damage seems minor—just a few pieces of concrete that are “popping up” or some cracking in the concrete. At the board meeting (the one everyone attends!), you hear that there is significant corrosion damage that needs immediate attention.

Most of the condominiums built along the coast are constructed of steel-reinforced concrete. These structures are designed to withstand hurricane force winds but nature is damaging them in another way. Steel-reinforced concrete exposed to marine environments can result in rusting or corroding of the reinforcing steel and spalling of concrete. Excessive corrosion of reinforcing steel can lead to loss of load bearing capacity and eventual structural failure. Because of corroded steel inside the concrete, a building that originally could withstand a Category Four or Five Hurricane may no longer be able to do so.

**Chloride-Induced Corrosion Is the Problem**

The Florida Department of Transportation (FDOT) considers any reinforced concrete structure built within a half mile of saltwater to be in an "extremely aggressive corrosion environment." This is because chlorides (or salt) originating from these bodies of water are carried by airborne moisture, wind,

and rain onto the structures and, over time, migrate to the steel reinforcement inside. The chlorides and moisture in the concrete then cause the steel to corrode. This corrosion process consumes the steel needed for the structural integrity of the building. In an attempt to avoid chloride-induced corrosion on new bridges built in aggressive environments, FDOT currently requires special construction techniques that are not practical in condominium construction.

It takes time until cracks, spalls, delaminations, and loss of structural capacity occurs to your building. How fast this occurs is determined by the rate at which the steel corrodes and by the concrete's ability to withstand stress. Florida's high temperature and humidity accelerates the corrosion process. Slowing down or even stopping corrosion will extend the service life of a structure but might not prevent all future cracks, spalls, and delaminations. This is particularly true if there was significant corrosion of steel before it was stopped, if the concrete is exposed to extraordinary stresses such as flexing of cantilevered balconies, or if there is inadequate concrete cover over the steel reinforcement to withstand the stress.

**Common Methods to Reduce Corrosion and Spalling**

There is now a better understanding of corroding steel in concrete, and we know why some methods to reduce corrosion and spalling work better than others. Reinforced concrete that has been exposed to the elements becomes a non-uniform material containing different corrosion environments. The common methods that work well to prevent corrosion in new construction often do not work nearly as well at reducing corrosion once it has begun. It should also be noted that it is usually much less expensive to address corrosion earlier in a building's life rather than later.

There are three main methods used to reduce or stop corrosion of steel in existing concrete structures:

Waterproof coatings and sealers are relatively easy to apply and can be very effective in new construction or before the corrosion process has begun. They are applied to the top surface of the concrete and the best products prevent water and chlorides from ever reaching the steel. Depending on the situation and type of material, coatings and sealers can cost from fifty cents to five dollars per square foot or more of concrete surface



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area. It was once thought that waterproof coatings and sealers would be as effective at reducing corrosion in existing structures as they were at preventing corrosion on new structures. Unfortunately, that is not the case. After corrosion has started, the steel in non-repaired areas can continue to corrode and concrete can continue to spall even after the surface of the concrete is waterproofed. Keeping additional water and chlorides from entering the concrete does not effectively address the existing corrosion problem.

This can result in a significant amount of concrete repairs being required again in as little as three to five years. Research has shown that using coatings and sealers can range from being totally ineffective up to about 65 percent effective in reducing active corrosion of steel inside chloride contaminated concrete.

Cathodic protection is the second method that has the ability to stop corrosion of steel, not just reduce it. Compared to other methods used to reduce corrosion, cathodic protection requires a greater level of expertise and consequentially is expensive (often over twelve to fifteen dollars per square foot of concrete surface area). It is an active process in that a low voltage current is used to create an electron flow that protects the steel reinforcement from corroding. It is critical that the system be maintained and inspected yearly. If the power is lost (like after a hurricane), the system won't be effective. Like all systems, even if no additional corrosion takes place, it is possible for some minor concrete spalling to occur in areas of previously corroded steel. Because of potential damage that it can cause to the reinforcement, cathodic protection should not be used on post-tension structures.

Surface applied corrosion inhibitors are promising because, like coatings and sealers, they are easily applied to the surface of the concrete

but reduce corrosion of steel in chloride contaminated concrete. Their biggest advantage is their relatively low cost (as little as one to two dollars per square foot of concrete surface area). Depending on the type of product, over 90 percent corrosion reduction can be achieved on actively corroding structures. By way of comparison, surface applied corrosion inhibitors can achieve over 90 percent of the corrosion protection of cathodic protection for less than one tenth of the cost. The properly selected inhibitor is passive in nature and does not require ongoing commitment or expense by the owner to make sure it is working. Surface applied corrosion inhibitors can be used on all types of reinforced concrete structures including post-tension, precast, and cast-in-place concrete that uses standard rebar.

A surface applied corrosion inhibiting treatment can be the most cost-effective method to reduce corrosion of steel in reinforced concrete. There are several types of materials being promoted as surface applied corrosion inhibitors. Some have been proven to perform much better than others so it is important to select the right one. The most effective surface applied corrosion inhibitor is based on silane chemistry, the same family of chemicals required in the latest Florida Building Code if balconies are to be built with reduced concrete cover over the steel.

**Contractors and Engineers Recognize Benefits**

Terry Howard, president of Gulf Coast Waterproofing

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Company in Oldsmar has seen the benefits of using a silane-based surface applied corrosion inhibitor first hand. Says Howard: "At first, I was skeptical about applying a chemical to the surface of concrete to reduce the corrosion of steel inside. But we have done condominium projects over the years where a corrosion inhibitor was used on some areas of concrete and not others. The areas treated with the inhibitor had little or no concrete spalling a few years later but the areas that were not treated had significant concrete spalling."

Kerns-Whitehouse and Associates, Inc. (KWA), a Structural Engineering Consulting firm with offices in Tampa and Port Orange, has had similar experiences. They have specified a silane-based surface applied corrosion inhibitor for restoration and waterproofing projects on over sixty condominiums and parking structures since 1999. According to Roy Kerns, president of KWA: "We have found this type of corrosion inhibitor to be very effective simply from the fact that there have been very few call back complaints or observed recurrences of corrosion induced spalling since the restoration work was completed."

In 1999, KWA specified a silane-based corrosion inhibitor on Bahia Del Mar IV Condominium Parking Garage, a waterfront restoration and waterproofing project in south St. Petersburg. The inhibitor was applied by a contractor to the two elevated decks of the steel reinforced concrete parking garage. No other surface coating was applied to the parking garage decks. KWA completed a condition survey of this same parking garage in 2008 and particular attention was paid to any concrete spalling that was present. On the top deck, exposed directly to

the weather, there were some new spalls, each with an average size of less than one square foot. This worked out to approximately one square foot of new spall for every 2357 square feet of top deck area. According to Kerns: "The silane-based corrosion inhibitor appeared to have provided a high level of protection to the concrete parking garage deck, with a level of spalling on both new and previous repair areas much below what would have been expected."

KWA also specified a silane-based surface applied corrosion inhibitor on the Atrium Condominium, a twenty-two story building located on Bayshore Boulevard in Tampa. The product was applied to 113 of the 168 steel-reinforced concrete



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balconies during restoration work that was completed in 2002. A polyurethane waterproofing membrane was also used on the exposed surface of those 113 balconies. In 2008, restoration work began on 29 of the balconies not restored in the 2002 project. KWA conducted a condition survey of the original 113 balconies and again paid particular attention to how the inhibitor and waterproofing system had performed. There was not a single concrete spall observed that was caused by reinforcing steel corrosion. The few concrete spalls that were observed were on previously patched areas and not due to additional corrosion. According to Kerns: "The combination of the surface applied silane-based corrosion inhibitor with waterproofing membrane and caulking displayed outstanding performance in preventing reinforcing steel corrosion and any resultant concrete spalling."

Using the proper corrosion inhibitor as part of a concrete restoration project greatly reduces future corrosion and the resulting spalling. Maintenance and inspections of the reinforced concrete structure are still necessary but their cost can become part of the condominium's annual budget. The reason for using a surface applied corrosion inhibitor is to provide better protection for your building and to prevent or at least postpone special assessments for major concrete restoration projects well into the future.

*Steve Poling is the president of Matco Supply in St. Petersburg, Florida. He is the local sales representative for Evonik Industries. For more information, visit [www.protectosil.com](http://www.protectosil.com).* ■



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