



SENTINEL-GL

The Solution for Corrosion of Steel in Concrete



CORROSION OF STEEL IN CONCRETE

Corrosion of embedded reinforcing steel is a major cause of deterioration in concrete, incurring billions of dollars in repair costs annually. All too frequently, rehabilitation with conventional patch repair fails to provide a long-term solution and can contribute to the overall problem.

Passive by Nature

By composition, concrete normally has an alkaline environment that causes embedded steel to "passivate". The passive oxide film that forms on the surface of the steel protects rebar from corrosion. When contamination from carbonation, chlorides or other aggressive ions in the surrounding concrete reaches the level of reinforcement, the passive layer is destroyed. Rebar corrosion begins and eventually leads to cracking of the concrete cover. As corrosion continues and delamination develops, the concrete cover breaks up further and a pothole or spall is formed. Additional stresses, such as freeze/thaw cycles and pounding traffic, expedite the process.

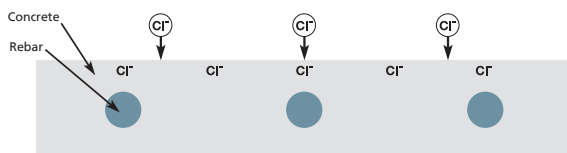
A Vicious Cycle

The problem is compounded when cracking and spalling concrete is rehabilitated with a conventional patching repair. Loose concrete is removed and the hole is filled with a mortar material. This chloride-free patch accelerates the corrosion process in the chloride-contaminated concrete surrounding the repair area. Patching in this manner becomes a never-ending process. This vicious cycle is known as "the anode ring effect"

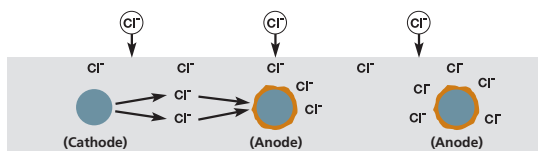
The Euclid Chemical Company offers SENTINEL-GL, an advanced cathodic protection device designed to combat the "anode ring effect".



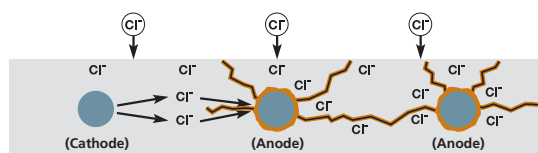
HOW IT HAPPENS...THE ANODE RING EFFECT



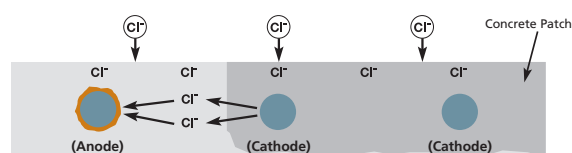
1. Chlorides begin to penetrate the concrete, usually as a result of exposure to deicing salt or sea salt. At this point, a protective layer of gamma ferric oxide protects the embedded reinforcing steel.



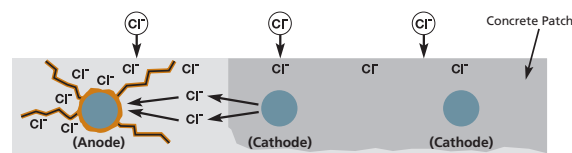
2. As contamination progresses, chloride concentration levels at the surface of the reinforcing bars exceed threshold limits for corrosion (about 0.04%, or 1.1 lbs/yd³). The protective oxide layer on the steel is destroyed leaving the rebar vulnerable to corrosion. An electrochemical corrosion cell is then established. The anodic reaction is the oxidation of iron to iron oxide, or rust. The cathodic reaction is the reduction of oxygen. Electrons released at the anode move through the reinforcing bars to the cathode. The circuit is completed by chloride ions moving through the concrete toward the anode.



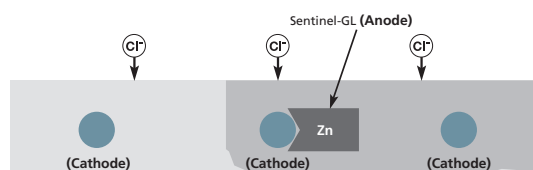
3. Rust, the product of corrosion, occupies several times the volume of the parent steel. This volume expansion puts tremendous tensile stress on the concrete. Cracking develops when this stress exceeds the tensile strength of the concrete. Delamination occurs when cracking is interconnected between bars. As corrosion continues, the concrete cover breaks up further, and eventually results in the formation of a pothole or spall.



4. The conventional means of repairing such damage is to remove the loose concrete and fill the hole with a patch material. The steel in the patch soon becomes cathodic due to the absence of chlorides while the steel surrounding the patch becomes anodic, and a new corrosion cell is formed. This common event is known as the "anode ring effect".



5. Concrete cracking soon develops outside the patch, and repairing becomes a never-ending process. In fact, repair in this manner is now known to actually aggravate the corrosion process in the areas surrounding the patch. Minimum electrical resistance and maximum driving potential result from placing chloride-free and chloride-contaminated concrete immediately adjacent to each other. This "anode ring effect" may result in cracking and delamination in as little as 18-24 months following the repair.



SOLUTION: SENTINEL-GL is installed in the patch area on any size of reinforcing bar. The zinc anode in SENTINEL-GL becomes a sacrificial anode, delivering self-generating protective current and making surrounding steel cathodic, thus preventing corrosion of reinforcing steel.



THE SENTINEL-GL SOLUTION

SENTINEL-GL provides state-of-the-art cathodic protection against the "anode ring effect". Cathodic protection is routinely used to prevent corrosion of ships at sea, and law requires that interstate pipelines and underground storage tanks be cathodically protected. Utilizing an innovative, proprietary design, SENTINEL-GL applies cathodic protection technology to steel reinforced concrete structures to prevent embedded rebar corrosion.

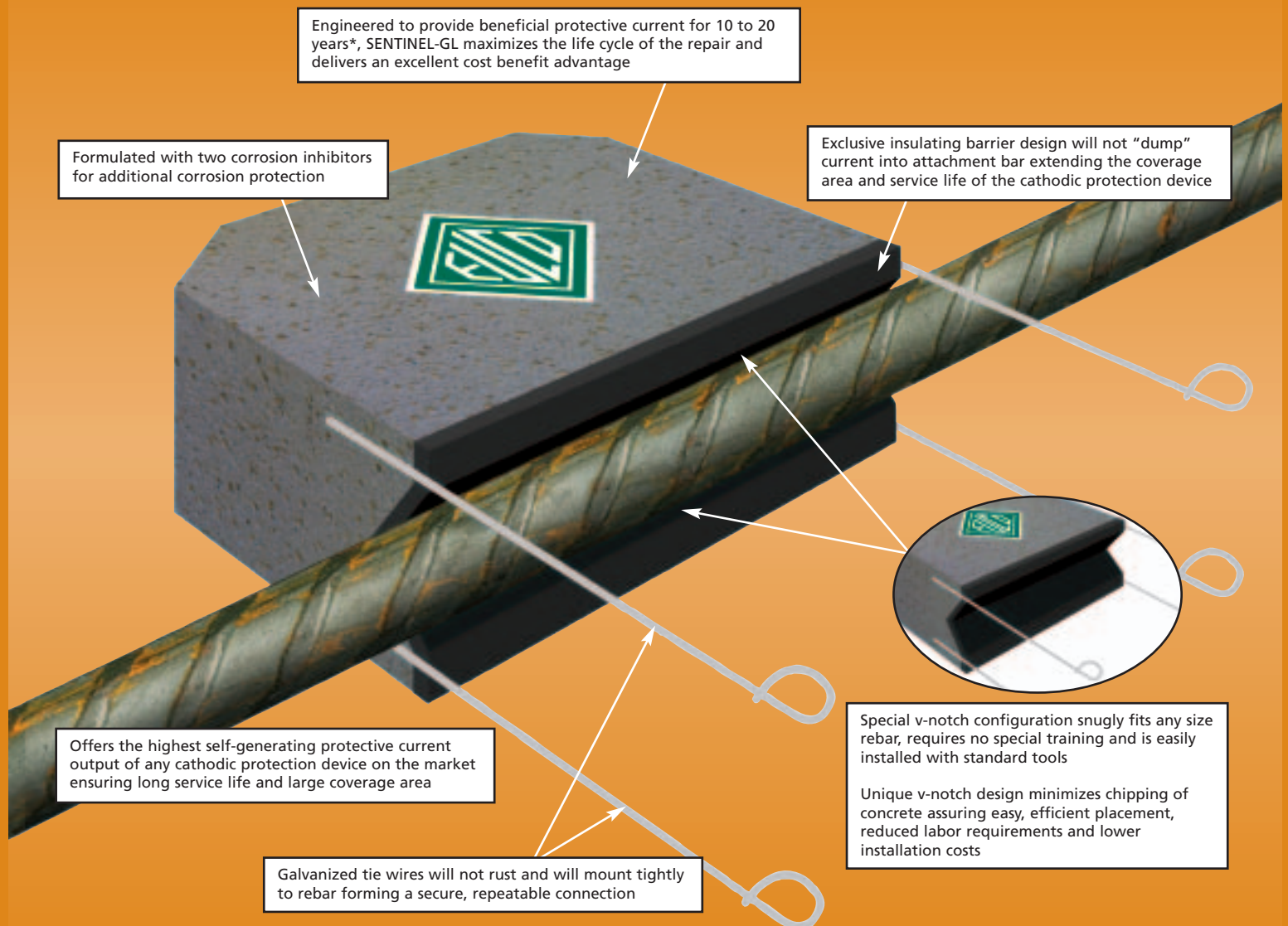
SENTINEL-GL uses a zinc anode to deliver long-lasting protection and offers numerous advantages when used according to the manufacturer's specifications. When a direct electrical connection is made between the zinc and steel, galvanic current flows spontaneously so there is no

need for an external power supply, DC wiring or conduit. This results in reduced installation, monitoring and maintenance costs.

With a unique v-notch configuration, SENTINEL-GL is specifically engineered for easy, efficient placement on any size of reinforcing bar. SENTINEL-GL can be placed beside the reinforcing bar eliminating the need to fully excavate for installation beneath the rebar. This SENTINEL-GL design feature reduces labor requirements dramatically resulting in significant cost savings.



KEY SENTINEL-GL FEATURES



*Current required to completely prevent corrosion of steel in concrete will vary with conditions, as will effective service life.



SPECIFYING SENTINEL-GL

SENTINEL-GL can be specified to prevent corrosion in reinforcing steel for rehabilitation of existing concrete structures. These include parking garages, bridge decks, piers and deck supports, retaining walls, condominiums and apartments. Specifying the use of cathodic protection is more effective if it can be applied early in the process, rather than as a last resort. In the case of rebar corrosion, the specified cathodic protection product should meet the following industry standard requirements.

A cathodic protection device should be demonstrated to deliver a protective current equal to or greater than 0.4 milliamps after 90 days as certified by an independent testing laboratory. The test should be performed in an environment that is maintained at room temperature and about 55% relative humidity. In addition, the test should be conducted in a concrete test block containing not more than 0.3 ft². (0.028 m²) of reinforcing steel. **SENTINEL-GL has been tested accordingly and conforms to this specification requirement.**



A second specification consideration concerns the insulation barrier. Cathodic protection devices should incorporate an insulating barrier designed to prevent excessive dumping of protective current into the attachment reinforcing bar. Excessive dumping of current will reduce the coverage area and service life of the cathodic protection device. SENTINEL-GL has an exclusive v-notched insulator that prevents this condition, as well as provides additional cost savings in reduced labor requirements since SENTINEL-GL can be placed alongside

the reinforcing bar. This v-notch design minimizes the amount of concrete that must be chipped out to properly place the cathodic protection device.

In order to take full advantage of cathodic protection technology to most effectively prevent corrosion in reinforcing steel, specify a cathodic protection device in combination with low resistivity repair mortars. Low volumetric resistivity is necessary for products used with cathodic protection devices in which protective current is required to pass through the repair mortar. As a result, cathodic protection should be specified as a system. This comprehensive approach typically yields the best results. The Euclid Chemical Company recommends that its specially formulated line of patching mortar materials be used with SENTINEL-GL as a complete corrosion prevention system. These repair products meet the resistivity requirement demanded of cathodic protection mortars, which requires a measurement below 15,000 ohm-cm when measured after 28 days.

Depending on the repair application, The Euclid Chemical Company offers the specifying community a variety of options and provides technical support on an array of specially formulated repair mortars to use with the Sentinel-GL as a total corrosion inhibiting solution.

For additional information on SENTINEL-GL and corrosion inhibiting mortars consult the technical data sheet, installation procedures, or contact The Euclid Chemical Company.



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An **RPM** Company

The Euclid Chemical Company, founded in 1910, is today a worldwide supplier of quality products and services for the concrete and masonry industry. Marketed under the EUCO name, we offer a full line of admixtures, repair and maintenance products based on the latest technologies. We provide complete specification assistance and laboratory support as well as on-site service for guidance on proper product usage. EUCO materials are warehoused in over 200 locations in the USA and are available world-wide through international affiliates.

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