



# REFURBISHMENT

## Sika® FerroGard® GALVANIC AND HYBRID ANODE TECHNOLOGIES

CONCRETE CORROSION CONTROLLED FOR UP TO 50 YEARS

# REDUCING MAINTENANCE COSTS AND EXTENDING THE LIFE OF REINFORCED CONCRETE

**REINFORCED CONCRETE IS A VERSATILE** and very durable construction material. However chloride and carbonation induced corrosion of the reinforcing steel can result in significant concrete spalling.

Furthermore, the traditional patch repair of spalled concrete is rarely successful when the remaining concrete has a high concentration of chlorides. Unless all this chloride contaminated concrete is removed, which is generally impractical,

rapid deterioration adjacent to patch repairs occurs due to the incipient anode effect. In a short space of time this leads to more spalling, which then needs to be repaired.

## THE INCIPIENT ANODE EFFECT

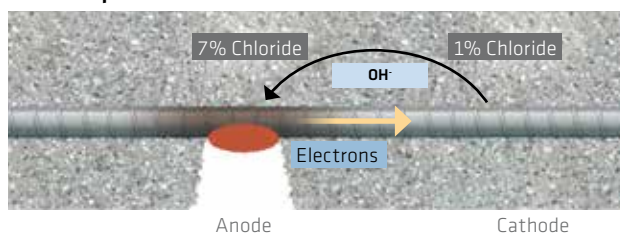
The poor performance of traditional patch repairs in chloride contaminated concrete is due to a phenomenon known as the incipient anode effect.

While all of the concrete of a structure may be chloride contaminated, and therefore all of the reinforcing steel may be in a potentially corrosive environment, corrosion is only initiated at specific discrete locations. This is because corrosion of the reinforcing steel is an electrochemical reaction (as shown below), in which there is:

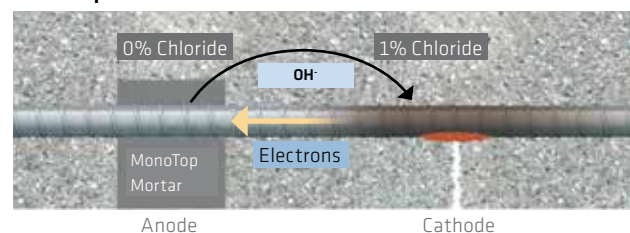
- An anode – the 'actively' rusting site where rust forms, eventually cracking and spalling the concrete.
- A cathode – where the steel is protected cathodically and hydroxide ions are produced, further improving corrosion protection.
- A flow of electrons along the rebar from the anode to the cathode, and a flow of hydroxide ions through the concrete from the cathode to the anode.

The steel at the cathode is effectively protected from corrosion by the electrochemical reaction despite it being in a high chloride environment.

### Before repair



### After repair



### AFTER REPAIR

The patch repair of the spalled concrete involves the removal of the damaged, chloride contaminated concrete and its replacement with fresh, non-chloride contaminated Sika MonoTop® concrete repair materials. The original anode has

effectively been removed and the original cathode is no longer protected by the electrochemical corrosion process. Corrosion of the reinforcing steel adjacent to the patch repair, in what was formerly the cathode, is immediately initiated. This is called the incipient anode effect.

The use of galvanic anodes, incorporated into traditional patch repairs, is proven to significantly extend the time to next maintenance, reducing on-going maintenance costs and extending the life of the structure.

## Sika® FerroGard® GALVANIC ANODES

Sika provides several repair solutions to asset owners to cost effectively repair and protect reinforced concrete. These include high quality concrete repair mortars, crack injection resins and surface coatings complying with EN1504. Corrosion inhibitor FerroGard®-903 has been applied to numerous structures to prevent and slow reinforcement corrosion.

In 2014 Sika has launched the Sika® FerroGard® range of galvanic and hybrid anodes to provide asset owners with even

greater protection against reinforcement corrosion, further reducing ongoing maintenance costs and further extending the life of assets.

Sika® FerroGard® galvanic anodes are a cost effective addition to the range of concrete repair options, and can be used locally in patch repairs, targeted at specific high corrosion risk areas of structures, or installed over large areas for widespread corrosion protection and control.

## PEACE OF MIND FOR YEARS TO COME

Sika® FerroGard® anode systems do not need extensive monitoring or maintenance, and do not need permanent power supplies. However, for additional peace of mind, simple monitoring equipment can be installed to provide data on the ongoing performance of the anodes.

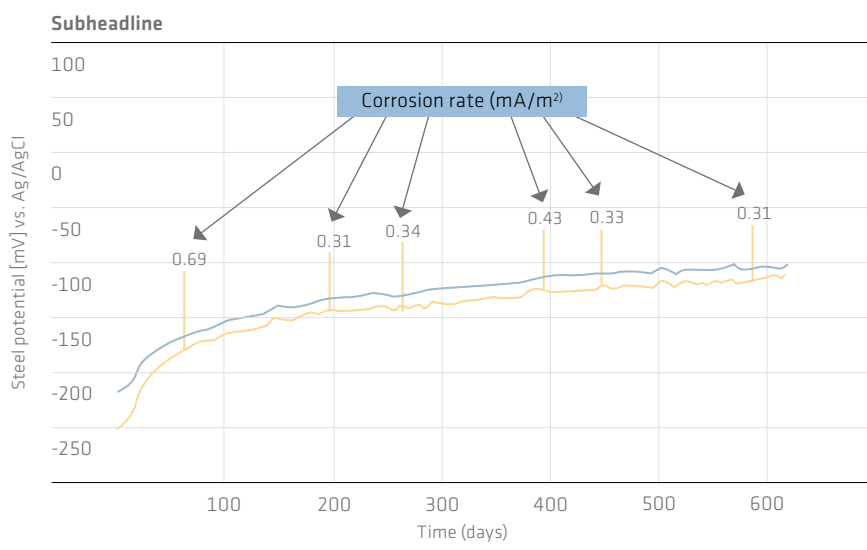
### STRUCTURE HEALTH MONITORING

Sika's monitoring equipment allows long term assessment of corrosion susceptible areas of your structures. Not only will you be informed about the extent of any corrosion damage and potential solutions, but will be offered the security and confidence that comes with understanding the real condition of the structures.

### MONITORING ANODE INSTALLATION

Installed anode systems can be monitored using remote or manual data-logging systems. These systems enable observation of any changes in the state of the steel by recording steel potentials (using Sika® FerroGard® MN-15 RE reference electrodes) and the current passed to the steel by the anodes.

It is also common to calculate corrosion rates and anode life-times using features of the data-logging system and collected data, giving the client peace of mind in knowing that the structure is fully protected from corrosion.



- The Monitoring System can be installed at the same time as the anodes, minimising downtime and cost
- The system allows real-time access to structure data from Day 1 – providing peace of mind that the structure is protected
- Data provided in a standard spreadsheet – makes analysis straight forward
- Structures can be monitored for timely repairs – further reducing maintenance costs

# THE Sika® FerroGard® Duo HYBRID ANODE RANGE

**Sika® FerroGard® Duo ANODES** may be placed throughout large areas of concrete to provide widespread corrosion protection and control. In many cases they provide an attractive alternative to impressed current cathodic protection.

Sika® FerroGard® Duo is a hybrid treatment, as it uses the same embedded anode in both an Impressed Current and Galvanic Current role. For a short period (typically one week), a high current density is applied using a fixed voltage power supply. This has the effect of halting corrosion by rendering the environment at the steel surface less aggressive.

Following the impressed current phase, the anode is connected to the steel galvanically in order to maintain the steel in a passive condition for the remaining life of the structure. In this phase no power supply or control equipment is required, ensuring initial installation and on-going whole life running costs are minimal.



## Sika® FerroGard® Duo

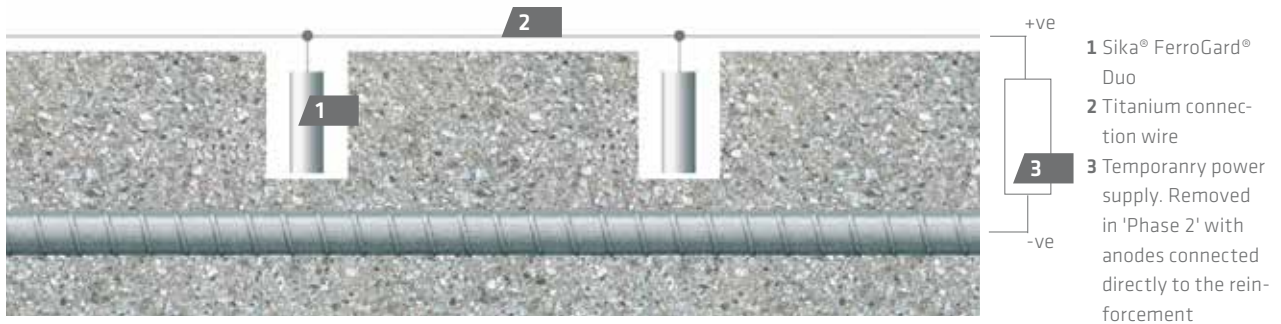


- Provides long term corrosion protection – minimising ongoing maintenance costs and extending the life of the structure.
- Does not require long term connection of power supplies and control equipment – ensures low running costs – may be an attractive option for remote structures.
- May be targetted at specific areas or over an entire structure – ensures cost effective protection.
- Avoids the need to break out large areas of contaminated concrete – reduces environmental disruption and avoids the need for structural propping.
- Does not cause hydrogen embrittlement – can be used on prestressed concrete structures.





## HOW DOES IT WORK?



### PHASE 1 – SHORT-TERM IMPRESSED CURRENT

The application of the 7 day high current density treatment has the effect of halting corrosion activity on the reinforcing steel surface. It achieves this by moving corrosion to the installed anodes whilst reinstating the alkaline environment at the steel.

### PHASE 2 – LONG-TERM GALVANIC CURRENT

Following the high current density treatment, the anodes are connected directly to the steel via the already installed XLPE coated titanium wire to pass a galvanic current without the need for a power supply. This has the effect of maintaining the environment created during Phase 1, preventing corrosion for years to come.

### HOW LONG WILL IT LAST?

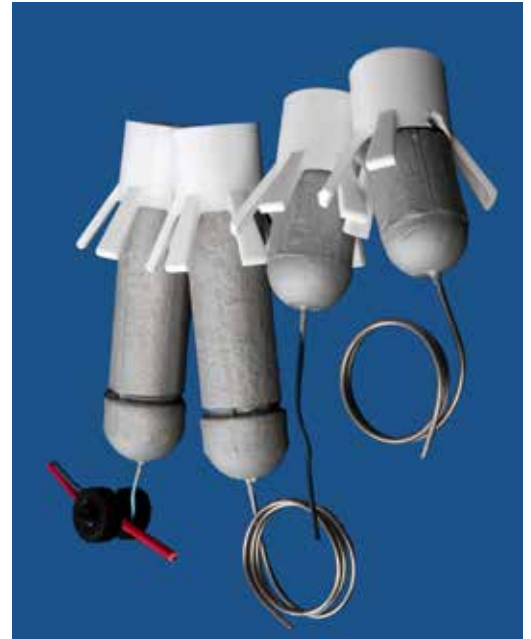
The anodes are made from a sacrificial metal and will corrode (be consumed) in preference to the reinforcing steel. From knowledge of the steel density and the total charge passed by the anodes, the consumption rate can be extrapolated and system lifetime predicted. The lifetime of the anode system will depend on air temperature, moisture and chloride content of the concrete. This means that system lifetime predictions are made on a structure by structure basis; however typical installations will have a lifetime range of between 20 and 50 years.

# THE Sika® FerroGard® Patch GALVANIC ANODE RANGE

**GALVANIC ANODES REDRESS** the electrochemical imbalance induced through removal of the contaminated concrete in patch repairs. Sika® FerroGard® Patch anodes corrode preferentially to the surrounding steel protecting it from further deterioration due to the incipient anode effect.

Rather than the traditional approach of attaching galvanic anodes to exposed steel in the patch repair, Sika® FerroGard® Patch anodes are located within the parent concrete. Protective current is delivered directly to the steel outside the patch which is at greatest corrosion risk as opposed to clean steel within the patch repair.

As Sika® FerroGard® Patch is installed in the parent concrete, there is no compromise in the quality of the concrete repair material or primers used in reinstatement, providing a very efficient and unique solution for combating the incipient anode effect in the host concrete.



## Sika® FerroGard® Patch GALVANIC ANODE RANGE



- Prevents corrosion from incipient anodes. This improves the durability of patch repairs, reduces ongoing maintenance costs and extends the structure's service life.
- Sika® FerroGard® Patch anodes are placed outside the immediate repair area and right where they are needed for controlling incipient anode corrosion – ensures efficient performance and enables bonding primers and high resistivity mortars to be used.
- Anodes have a lifetime of 15 to 30 years depending on the corrosion conditions – ensures long term protection against incipient anode corrosion.
- Connection to power supplies and system maintenance is not required – no running costs.
- Sika® FerroGard® Patch anodes do not require presoaking with water – ensures reliable installation.
- Sika® FerroGard® Patch anodes are installed into drilled holes – reduces the amount of concrete break out required – and reduces installation costs.



## HOW Sika® FerroGard® Patch ANODES WORK

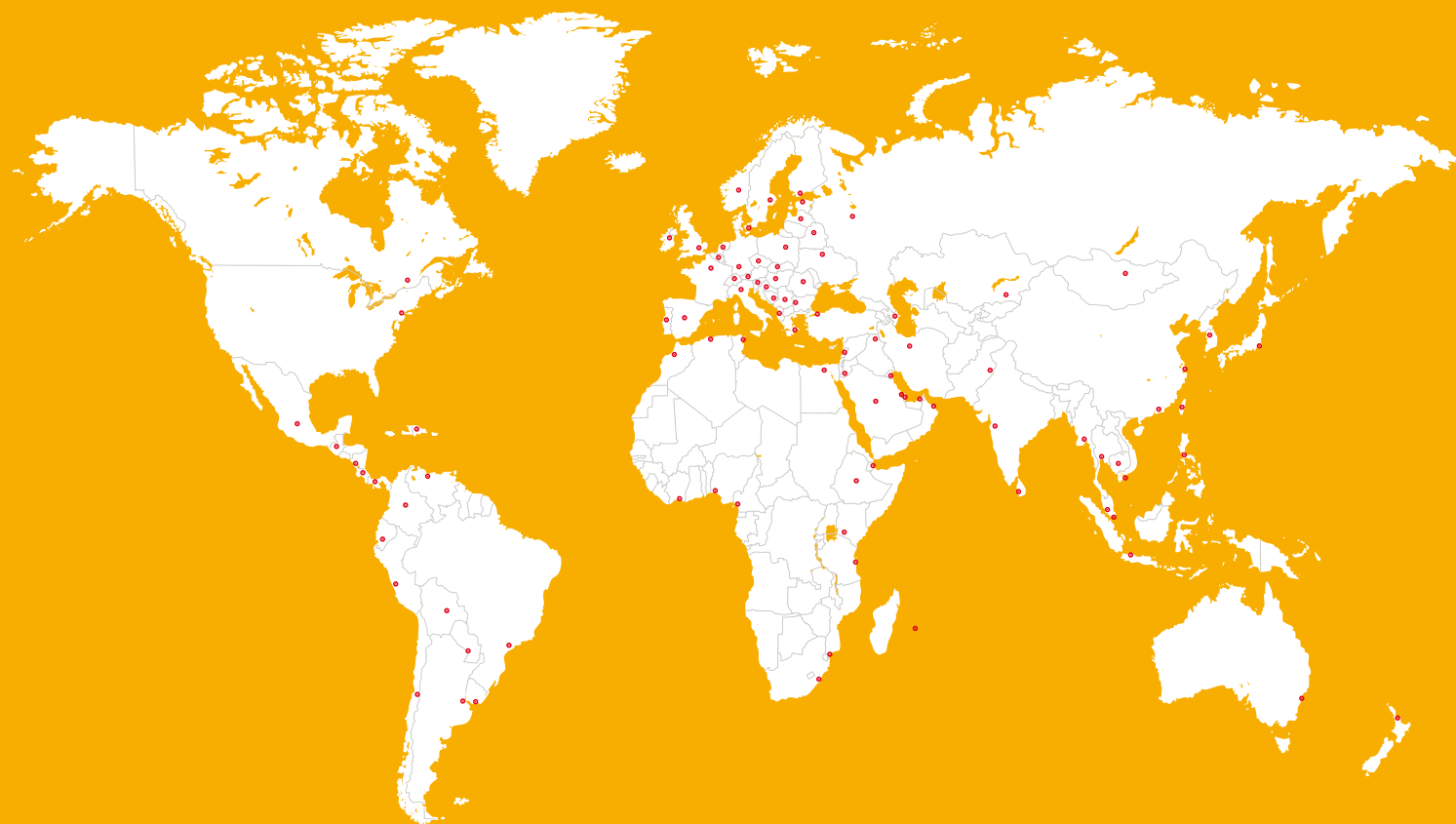


The Sika® FerroGard® Patch anode simply replaces the original corrosion anode, ensuring that the steel reinforcement in the vicinity of the repair remains cathodic – and protected from corrosion.

Sika® FerroGard® Patch anodes use the long established principle of galvanic protection to prevent or reduce the corrosion rate of steel reinforcement. When two different metals in a potentially corrosive environment are connected together one of them will corrode whilst the other is protected from corrosion. The relative positions of the two metals in the galvanic series determines which corrodes in preference to the other. By this principle the zinc in the Sika® FerroGard® Patch anodes corrodes in preference to the steel reinforcement.

Adopting Sika® FerroGard® galvanic anodes in the repair specification prevents the incipient anode effect from occurring. The reinforcement bar is cathodic in relation to the galvanic anode. The active zinc in the galvanic anode corrodes in preference to the steel to which it is attached, ensuring that corrosion is prevented.

# GLOBAL BUT LOCAL PARTNERSHIP



## FOR MORE Sika® FerroGard® INFORMATION:



### WE ARE SIKA

Sika is a specialty chemicals company with a leading position in the development and production of systems and products for bonding, sealing, damping, reinforcing and protecting in the building sector and the motor vehicle industry. Sika's product lines feature concrete admixtures, mortars, sealants and adhesives, structural strengthening systems, industrial flooring as well as roofing and waterproofing systems.

Our most current General Sales Conditions shall apply. Please consult the most current local Product Data Sheet prior to any use.



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