Issue No. 15 / February 2006

Sika in Structural Repair

Construction

Knowledge and Experience in the Structural Repair of Concrete Structures

Fifteen Years Performance - Still Going Strong

Sudbury House, a 25 storey tower block in the centre of Wandsworth, was constructed in 1972, but signs of spalling concrete were evident within only 10 years, a result of inadequate reinforcement cover.

Following an extensive survey by Mitchell McFarlane and Partners, it was recommended that any repair systems should have a lifespan of 15 years to first maintenance.

The **Sika Icoment®** was chosen as the system offering the reference credentials, track record and test data. The contract was undertaken in 1986, with all tenants remaining in occupation. All spalled and carbonated concrete was removed, followed by preparation and priming of the exposed steel, mortar repairs, levelling coat and application of protective coatings.

In 1997, an appraisal was carried out on the repairs and coatings. Mitchell McFarlane and Partners undertook a visual inspection, finding no evidence whatsoever of debonding, peeling, blistering or embrittlement. No evidence of cracking or spalling could be detected. Small local areas of **Sika Icosit® Elastic** coating were removed, and were still found to be elastic and have a thickness greater than the minimum originally specified.

Four cores were taken and sent to Taywood Engineering for analysis. The results show that the coatings remained breathable, and an excellent retention of carbon dioxide diffusion resistance, even after 10 years exposure.

The report concludes that the concrete damage had been successfully repaired, and the protective coatings had halted the progress of carbonation, thus preventing any further deterioration or damage.

System Approach Solves Key Issues

This five storey Northampton car park had been suffering from increasing deterioration of the reinforced concrete decks. Built in 1973, recent monitoring had shown significant chloride attack to the reinforcing steel within the concrete structure.

An initial monitoring stage allowed a full understanding of where and what the corrosion issues were for this structure. The refurbishment work was carried out by specialist contractors Makers UK Ltd, working for Mears Facility Management, term maintenance contractors for Northampton Borough Council.

A ribbon anode Cathodic Protection system was installed to completely stop steel corrosion in the most critical areas. **Sika FerroGard® 903**, a surface applied corrosion inhibitor was applied locally, to reduce steel corrosion and add protection to the reinforcing steel in other areas. A remote monitoring system on a virtual private network was installed to allow the client to have a full picture of the structural condition of the car park.

Sikafloor® specialist car park decking systems were then applied. The **Sikafloor®** systems are approved in accordance with the German Rili-DAfStb Standard for car park waterproofing.

Soffits and pillars were repaired using the **Sika MonoTop®** concrete repair system. Environmentally friendly **SikaColor® 671W** anti-carbonation decorative coating was applied to all surfaces.

Quality and Durability in Concrete Repair and Protection

Sika has been at the forefront of Concrete Repair and Protection technology since the 1920's. From the development of **Sika** waterproof mortars in the 1920's and 1930's, through epoxy and polymer latex modified repair mortars in the 50's and 60's, Sika have been pioneers in the field.

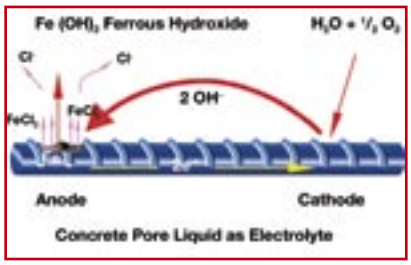
Sika introduced the first complete Repair and Protection system in the 1970's with reinforcement primers, bonding bridges, repair and levelling mortars, plus protective impregnations and coatings. In 1996, **Sika** introduced **Sika FerroGard®-903**, an impregnating corrosion inhibitor to protect against latent damage, further proof of Sika's continuing commitment to continuous innovation and technical leadership.

Many **Sika** systems are BBA approved, guaranteeing the quality and durability of their products. As further proof of the efficiency and performance of the **Sika** Concrete Repair and Protection Systems, independent quality and durability reports on structures from the UK and Europe can be found in the Durability Document available from **Sika Limited.**

This document demonstrates real projects where **Sika** Systems are still working over 15 years after installation.

What Goes Wrong with Reinforced Concrete

Concrete has been used since Roman times and has been proven as an extremely durable material. The problems only really occur when reinforcement is used within it. The reinforcement corrodes which, in most cases, is an expansive reaction which in turn creates a force on the cover concrete; when this force exceeds the tensile capacity of the concrete it cracks and a spall will form. In some cases rapid pitting corrosion can occur which can dramatically reduce the cross sectional area of the bar without the visual indication of spalling.



When Does Steel Corrode in Concrete

New concrete has a pH of about 13 which makes it an alkaline material. The alkalinity of the concrete provides protection to the passivating layer of iron oxides at the surface of the steel. The reduction of the alkalinity of the concrete due to effects such as carbonation will allow this passivating layer to be broken down. The penetration of chloride in the form of salts can also break down this layer.

What is Corrosion

Corrosion occurs when an electrical cell is formed. For it to form an anode, a cathode and an electrolyte is needed. The anode and cathodes are sites on the steel bar, with the corrosion occurring at the anode. The electrolyte is the pore water within the concrete.

How Can We Slow Corrosion Down

There are several ways to slow down corrosion on existing structures:

▲ Restore Passivity of Reinforcement	- Break out and repair all carbonated or chloride contaminated concrete with **Sika® MonoTop®** Concrete Repair System
▲ Increase Resistivity of Concrete	- Application of SikaGard range of concrete coatings to limit moisture with concrete. **SikaGard® 550W** can provide 15-20 years before major maintenance is required
▲ Control of Both Cathodic and Anodic Locations on Reinforcement	-Application of **Sika FerroGard®** as a surface applied corrosion inhibitor
▲ Cathodic Protection of the Steel	- This is the only way to stop corrosion and can be installed using impressed current systems

Monitoring Proves Performance of Applied System

Olympia House in Newport, Gwent, is the home of HM Passport Office. C-Probe Technologies Ltd were commissioned to test the performance of **Sika FerroGard® 903** corrosion inhibitor which was applied during a concrete repair programme that was carried out in 1996.

Damage to the stairwells and the pre-cast panels had been caused by carbonation and to a lesser extent, chloride attack. Corrosion rates were recorded by C-Probe prior to repairs being started. Repairs were carried out using the **Sika MonoTop®** Concrete Repair System, and in addition, **Sika FerroGard® 903** corrosion Inhibitor was applied, as added protection to the steel reinforcing within the concrete.

SikaGard® 550W elastomeric anti-carbonation coatings were applied to the external panels.

Data was collected by C-Probe, to demonstrate performance of the inhibitor on the steel reinforcing surface, using linear polarisation probes embedded at discrete location around the building.

Results have shown that on average corrosion rates were reduced from base by 90-95% after 15 months, and that this is sustained, and in fact reduced still further after three and a half years. This demonstrates that since first application, **FerroGard® 903** is still maintaining a good level of protection to the steel.

Proactive Approach to Maintenance for Reinforced Concrete

Due to a fault in the initial build process, the high profile Itchen Bridge in Southampton required remedial works to ensure its future integrity. During original construction of the bridge, which opened in 1977, the reinforcement cage had moved, reducing cover on the soffit generally, and where drip details were present, the cover was very low or zero.

The complete structure was treated with **Sika FerroGard® 903** corrosion inhibitor using low-pressure spray. **FerroGard® 903** penetrates the concrete to form a protective film around the internal reinforcing steel. This provides additional protection against potential future corrosion.

Sika concrete repair systems were chosen for this project. Drip detail infill was carried out using high pressure water jetting, and **Sika MonoTop®** mortars were used to repair the prepared areas. In critical areas, **SikaGard® 675W** was applied over the repairs to conceal the colour variation of the repair to the original concrete.

Where Can I Find Out More

The BRE have produced Digest 444 'Corrosion of Steel in Concrete' and it covers the durability, assessment and investigation and protection/remediation of reinforced concrete structures. Parts of this document also form the new European Standard EN1504 which is soon to be published.

‘Curb Appeal’ Improved

Dukes Keep, a prestigious office development in Southampton, had been constructed with insufficient concrete cover to the reinforcing steel in the pre-cast concrete panels, and was looking the worse for wear.

Carbonation of the concrete and the aggressive coastal environment had caused ingress of chlorides and the problem was made worse by the failure of the joints between the concrete panels.

The building was refurbished using **Sika** systems in 1997. Damaged concrete was removed, and the ‘napped’ fluted concrete panels were repaired using the **Sika MonoTop®** concrete repair system.

To ensure the long term integrity of the structure, **Sika FerroGard® 903** corrosion inhibitor was applied, followed by **SikaGard® 550W** elastic anti-carbonation coating as a final protection.

Joints between the panels were re-sealed with **Sikaflex® Pro-2HP** one part polyurethane joint sealant.

University of Surrey Testing

Research has been carried out into the performance of corrosion inhibitors for reinforced concrete structures. The research was undertaken on a variety of different concrete grades that are typically found within UK construction.

Steel corrosion within the concrete was then accelerated by allowing a chloride solution to saturate the concrete. The corrosion rates were measured before surface application of the **Sika FerroGard® 903** and then monitored for a period of up to 50 days afterwards.

The testing concluded that the application of **Sika FerroGard® 903** decreased the corrosion rate of corroding bars to values typical of passive steel. The time to achieve this reduction increased with the depth of cover and concrete quality.

On-site testing gives independent confidence that **FerroGard® 903** will reduce corrosion when it reaches the steel. This can be used in conjunction with on-site testing to prove penetration of **FerroGard® 903** to the depth of steel.

FerroGard Testing Kit

Tick Box for More Information

Fax Back to: 01707 329129

Sika FerroGard® 903 Brochure ☐

Concepts Brochure ☐

▲ **Site** Visit Required ☐

Concepts for Car Park Structures ☐

Durability Document ☐

▲ Technical Seminar Required -suitable for CPD accreditation ☐

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