TOTAL CORROSION MANAGEMENT (TCM®) for Reinforced Concrete

BUILDING TRUST

TOTAL CORROSION MANAGEMENT

(TCM®)

The global leader in concrete repair and protection, corrosion inhibition and structural strengthening systems. All are supported by the most highly trained and experienced sales and technical support network in the industry.

FULL RANGE OF PRODUCTS:

- Sacrificial anodes
- Surface-applied inhibitors
- High performance coatings
- Reinforcing steel coatings
- Concrete repair mortars
- Waterproofing systems
- Mixed systems (combination of the above)

Your Sika sales representative can offer these combined solutions to support your complete project requirements for corrosion management.

SIKA TOTAL CORROSION MANAGEMENT SUMMARY

PRODUCT	BEST USE	TARGET	INITIAL COST
Sika FerroGard 901	New Construction and admixture to any repair mortar	Protect anodes and cathodes throughout the structure or “ring anode” and added protection in repairs	$
Sika CNI	New Construction	Protect anodes throughout the structure	$
Sika FerroGard 903, 908	Low to medium chlorides, carbonation, early maintenance, ring-anode treatment, reduce moderate existing corrosion	Protect anodes and cathodes throughout the structure, reduce active corrosion	$
Sikagard Coatings	Preventative on existing structures. Supplement to Sika FerroGard 903 and Sika Galvashield	Prevent ingress of chlorides, carbonation and water	$
Sika FerroGard 650,670, 675	Ring-anode protection; high chlorides where inhibitor may be limited	Protection of steel adjacent to patch, “ring anode” prevention	$ $

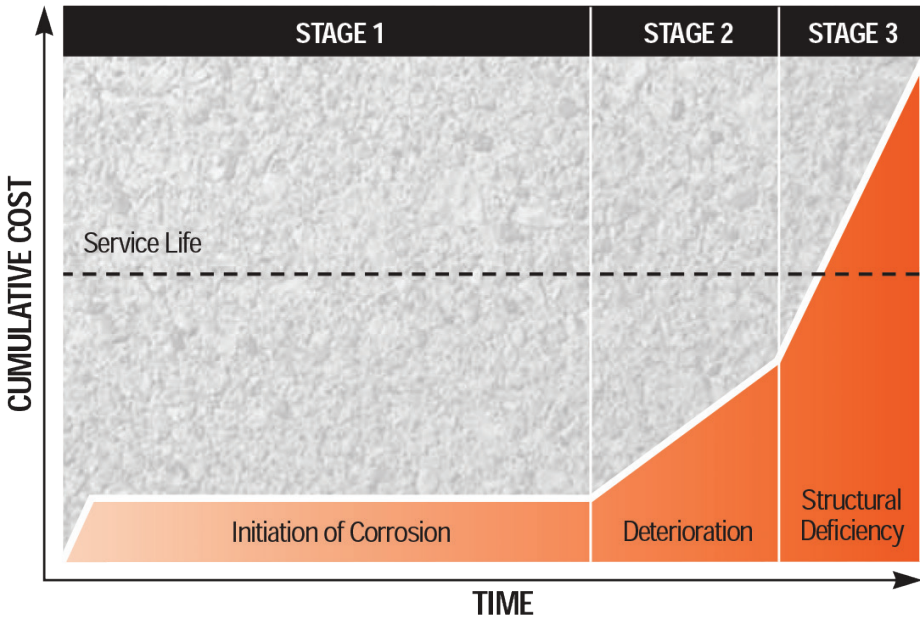
IGNORING CORROSION IS NOT AN OPTION

COST OF CORROSION GROWS OVER TIME

- 3% of GDP each year attributed to corrosion
- 27.5% of US bridges are structurally deficient or functionally obsolete*
- Condition of infrastructure rated a D+ by ASCE*

*Ref. ASCE 2003 Progress Report

TIME / COST MODEL



This diagram depicts the maintenance cost of a structure versus time.

As time goes by the cost of repairing a structure increases at a faster rate as the steel corrodes and the concrete deteriorates.

START WITH THE CONDITION SURVEY

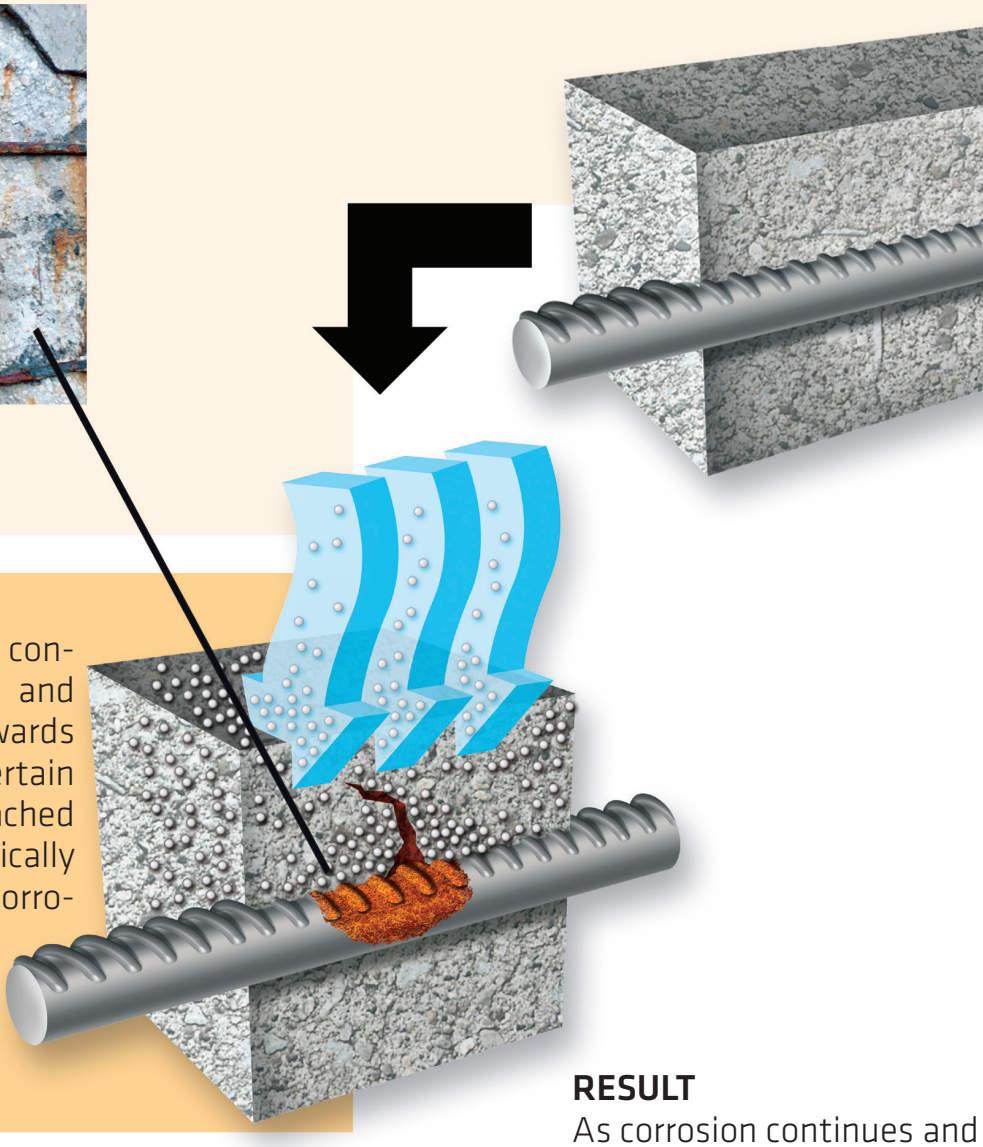
A thorough condition survey is critical to ensure a successful repair & protection project. This testing should always be conducted by a qualified professional.

SURVEY GENERALLY CONSIST OF PERFORMING ANY NUMBER OF THE FOLLOWING TESTS:

- Spall and delamination survey
- Chloride and carbonation testing
- Reinforcement mapping and cover measurements
- Half-cell potential contour mapping
- Corrosion rate assessment

The results of these tests should be the basis for selecting a repair and protection strategy that will meet the project requirements.

THE ROOT CAUSES OF CORROSION

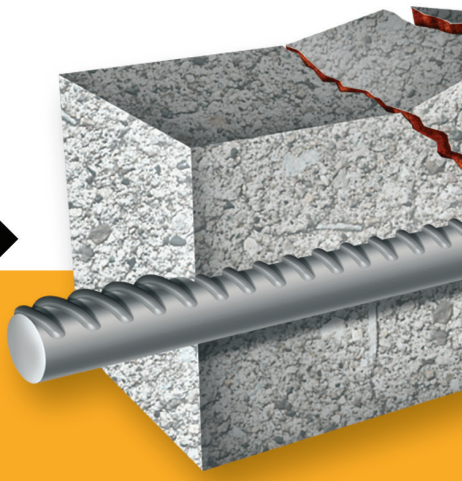


CHLORIDES

Chlorides accumulate near the concrete surface due to wetting and drying effects, then diffuse towards the reinforcement. When a certain threshold concentration is reached at the surface of the steel, (typically about 1.5 lb./cy of concrete) corrosion may start. This problem is commonly found on horizontal surfaces such as bridge and parking decks as well as in all elements of marine structures.

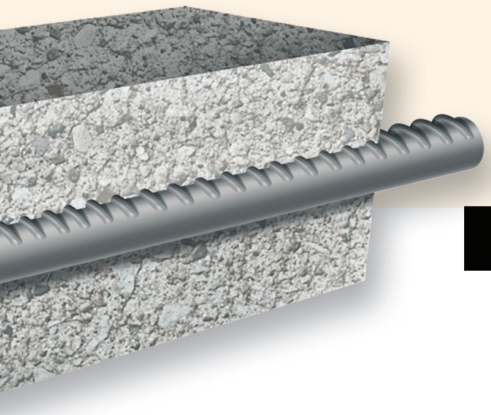
RESULT

As corrosion continues and this causes the concrete to

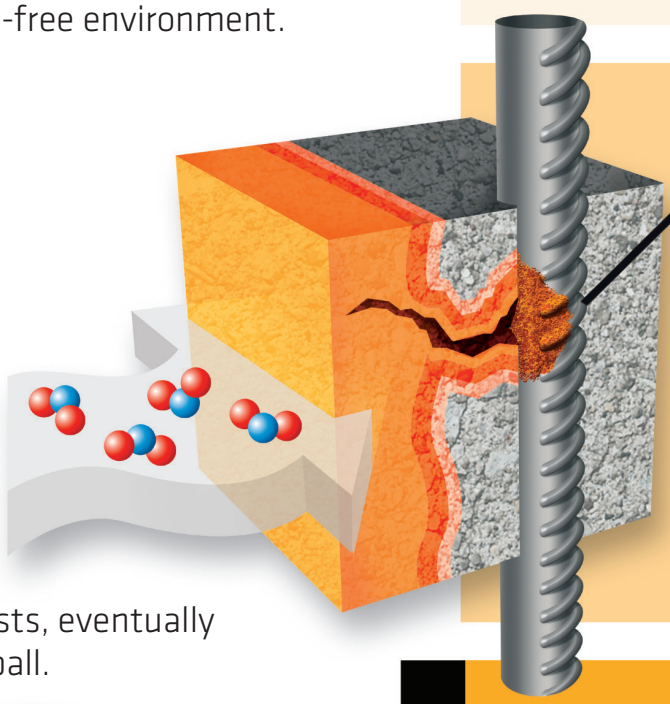


REPAIR AND PROTECTION OPTIONS

- Repair & protect with Sika repair mortars, Sika FerroGard corrosion inhibitors and a Sikagard sealer or coating or Sikadur protective membrane
- Galvanic protection with Sika FerroGard anodes

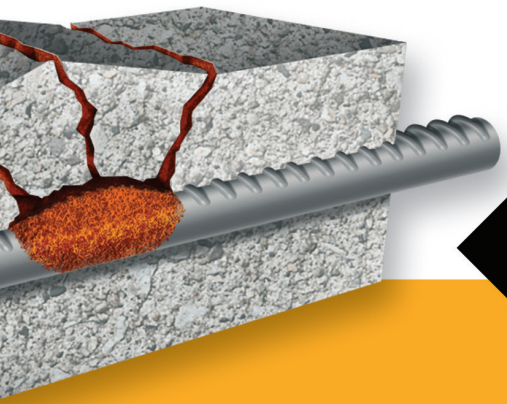


INTITIALLY
Steel protected in a high-alkaline, chloride-free environment.



CARBONATION
Carbonation can reduce the pH of the concrete to less than 9.5, minimizing the corrosion protection usually provided to reinforcement by an alkaline concrete. Carbonation is commonly found on vertical surfaces such as building facades and balcony edges. Carbonation is also found on horizontal surfaces.

the steel rusts, eventually crack and spall.



REPAIR AND PROTECTION OPTIONS

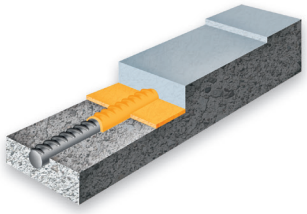
- Repair & protect with Sika repair mortars, Sika FerroGard corrosion inhibitors and a Sikagard sealer or coating or Sikadur protective membrane
- Galvanic protection with Sika FerroGard anodes

SIKA FULL SYSTEM REPAIR AND PROTECTION

1 TREAT ANY EXPOSTED STEEL

Sika Armatec® 110 EpoCem protects against corrosion and improves the bond of repair mortars.

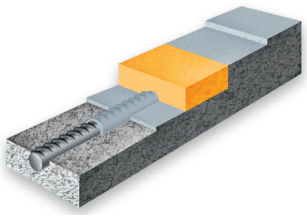
- Protects reinforcement in a high alkaline cementitious environment and adds “effective” cover
- Contains corrosion inhibitors
- Can be applied to the damp surfaces
- Increases barrier to water and chlorides
- Fully compatible with load transfer requirements



2 REPAIR THE SPALLS

Sika repair mortars are easy-to-use “pre-packaged” for replacing the concrete in spalled areas.

- Wide range to suit application requirements
- High quality
- Low shrinkage
- Excellent bond
- SikaTops contain the penetrating corrosion inhibitor, Sika FerroGard® 901



CASE STUDY

PROJECT
Algonquin Hotel, New Brunswick, Canada

DESCRIPTION OF STRUCTURE
This internationally respected seaside hotel was completely rebuilt in 1915 after the original wooden structure built in 1889 burned to the ground. The hotel is constructed of reinforced concrete, has four and six story sections as well as a 90 foot tower.

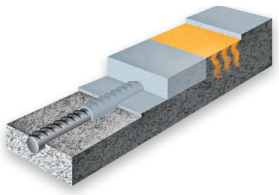
PROBLEM
Beach sand and sea water were used in the concrete mix. Shallow rebar and a very aggressive salt water sea environment all contributed to accelerated corrosion of the reinforcing steel. Freezing and thawing was also a major contributor to the problems which required annual maintenance to the façade. Eventually, structural components of the building were damaged.

SOLUTION
Repairs were completed in between the busy seasons which run from May through September. SikaTop 111 and 122, polymer-modified repair mortars were used to repair the spalls. SikaTop 121 was used as a leveling coat to ensure a good surface for the coating. SikaTop 144, a cement based waterproofing coating, was used to protect all unrepaired areas of the building and to help hide the completed repairs. Finally, Sikaflex-1a, a one-part polyurethane, elastomeric sealant was used to seal joints at windows and door frames as well as control joints.

3 PROTECT FROM FUTURE OR LATENT DAMAGES

Sika FerroGard® 903 and 908 corrosion inhibiting impregnations penetrate and protect not only the repair area, but also the surrounding concrete from future corrosion due to latent damages.

- Active cathodic and anodic passivation
- Totally nitrite free (non-toxic)
- Can penetrate up to 3" in 28 days
- Easy to apply



4 VERTICAL PROTECTION FROM FUTURE CARBONATION/CHLORIDE EXPOSURE

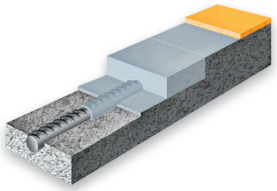
Sikagard® 550W, 670W, and 570 are protective and decorative high performance coatings which protect the entire structure from the harmful effects of carbonation, water ingress and chlorides.

- 550W and 570 bridge dynamic moving cracks
- 670W is capable of light foot traffic
- Effectively halts carbonation
- Breathable
- Prevents water and chloride ingress
- Enhances the appearance

5 HORIZONTAL WATERPROOFING PROTECTION

Sikalastic® 710/715/735 AL one component waterproofing traffic system and Sikalastic® 720/745 AL two component waterproofing system

- Excellent crack-bridging properties
- Impervious to water and deicing salts
- Excellent resistance to abrasion and wear



CASE STUDY

PROJECT
Cleveland Police Parking Garage, Cleveland, Ohio

DESCRIPTION OF STRUCTURE
Two-story, below grade parking facility built in the 1970's located in downtown Cleveland.

PROBLEM
After years of exposure to deicing salts, the heavily reinforced slab-on-grade was contaminated with a high level of chlorides. As a result of steel corrosion, delamination of concrete was prevalent throughout.

SOLUTION
The delaminated concrete, which was approximately 50% of the 50,000 sf slab-on-grade, was removed to sound concrete. Embedded corrosion rate monitoring was installed in order to monitor both the immediate and long-term effectiveness of the repairs. The exposed reinforcing steel was cleaned. Sika Armatec 110 EpoCem, a three component, epoxy-modified rebar coating and bonding agent was applied to the exposed steel to provide added protection and to the substrate to assist in bonding. Ready mix concrete was used given the easy access and volume of repairs. Sika FerroGard 903, a surface-applied, penetrating corrosion inhibitor was applied, in particular, to mitigate active corrosion in the unrepaired areas of sound concrete which was also contaminated with chlorides. Sikadur 22, Lo Mod, a low modulus, medium viscosity, 100% solids, epoxy resin binder was squeegeed out over the entire surface to a thickness of approximately 3/16" to provide an excellent surface barrier to prevent infiltration of future water and chlorides. Black beauty aggregrate was broad-cast into the wet epoxy for skidresistance and aesthetics.

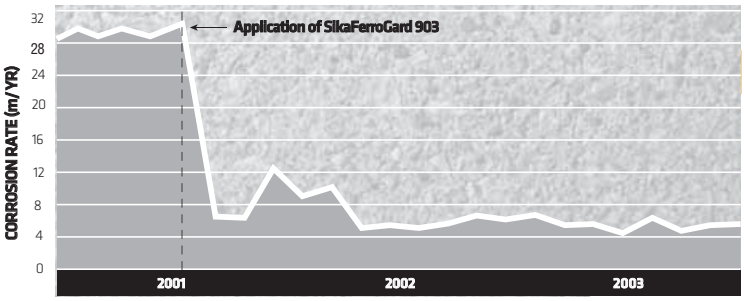
Sika FerroGard® 903

DESCRIPTION OF TECHNOLOGY
Surface-applied corrosion inhibitor that contains amino alcohols, organic and inorganic inhibitors.

HOW IT WORKS
Sika FerroGard 903 is designed to penetrate hardened concrete, attach by adsorption to the reinforcing steel, form a protective layer on the steel resulting in the reduction of the corrosion rate.

BEST USE
- Low to medium chloride content (typically less than 6 lb./cy at the level of the steel)
- Early maintenance
- Budget constraints
- Protection of areas particularly outside the area of the repairs
- Depth of steel and cover concrete permeability allow for adequate penetration

CORROSION RATE VALUES



TEST DATE
Monitoring and data provided by C-Probe Technologies Ltd.
(MAVERICK BEACH RESORT)

CASE STUDY

PROJECT
Maverick Beach Resort, Ormond Beach, Florida

DESCRIPTION OF STRUCTURE
The Maverick Beach Resort, built in the early 1970's, is a seven story, cast-in-place, conventionally reinforced concrete structure with a masonry façade located on the beach.

PROBLEM
The balconies had been removed and replaced in 1987. This large building; however, continued to suffer from corrosion accelerated by chlorides. The source of the chlorides was salt spray from the sea water.

SOLUTION
Delaminated concrete primarily along the edges of the elevated walkways and the columns was removed and repaired. Sika MonoTop 611, a one-component, polymer-modified, silica fume enhanced pumpable, pourable repair mortar was used along the walkways and SikaTop 123, a two-component, polymer-modified, non sag mortar containing Sika FerroGard was used for the column repairs. Achilles IES remote monitoring probes provided by C-Probe Technologies were installed to monitor the performance of the repair system. Sika FerroGard 903, a surface-applied, penetrating corrosion inhibitor was applied, primarily, to mitigate active corrosion in the unrepaired, chloride-contaminated areas of otherwise sound concrete. A waterproofing coating was also applied to prevent future ingress of moisture and chlorides and to prevent the steel's environment from getting increasingly worse.

Sika FerroGard®908

DESCRIPTION OF TECHNOLOGY
Sika® FerroGard®-908 is a duel-functional surface-applied, corrosion inhibitor that contains silane and amino alcohol inhibitors.

HOW IT WORKS
Sika FerroGard 908 is applied to the concrete surface, reduces active corrosion, increases resistivity of concrete and repels additional water and chloride ions.

BEST USE
Sika® FerroGard®-908® is recommended for steel-reinforced concrete, pre-stressed, precast, post tensioned concrete or concrete in marine environments. Common applications include:

- Bridges and highways exposed to corrosive environments (deicing salts, weathering)
- Building facades and balconies
- Parking garages
- Piers, piles, and concrete dock structures
- Vertical, horizontal and overhead surfaces
- As part of Sika's system approach for buildings and civil engineering

CASE STUDY

PROJECT
Mazza Galerie, NW Washington DC

DESCRIPTION OF STRUCTURE
This parking garage accommodates those who visit the Mazza Galerie in NW Washington DC, a luxury retail, dining, and entertainment complex. The structure was built in 1978 and spans 4 levels below grade.

PROBLEM
The interior garage decks beneath the popular Mazza Gallerie have been exposed to many years of water and deicing salts carried in with the busy traffic frequenting the retail stores. Severe corrosion of the cast-in-place concrete reinforcement developed causing cracking and spalling of the concrete. This damage was concerning to the health of the structure and unappealing to the patrons.

SOLUTION
Areas of spalled and delaminated concrete were completely removed and replaced with full depth ready mix concrete. The entire area was shotblasted to prepare the surface. Sika FerroGard 908, a dual-functional corrosion inhibitor was then sprayed to penetrate the concrete particularly to treat the areas undergoing latent corrosion where the steel reinforcement was in an elevated concentration of chlorides. Next all the joints and cracks were sealed with Sikaflex 2c NS EZ Mix, a polyurethane-based, elastomeric sealant. To complete the protection and create a seamless, bright, and attractive appearance, the Sikalastic 720/745 AL Gray traffic bearing membrane was installed. This coating system will stop further entry of water and deleterious elements while enduring the pedestrian and vehicular traffic. To ensure the quality of the repair and protection strategy, corrosion rate monitoring is performed by a corrosion consultant. It is expected that corrosion rates will remain passive.

Sika FerroGard® 650, 670, 675

DESCRIPTION OF TECHNOLOGY
Embedded galvanic anoded for corrosion protection of reinforcing steel in concrete structures.

HOW IT WORKS
Sika FerroGard galvanic anodes consist of a zinc core surrounded by a specially formulated cementitious mortar. The zinc core corrodes preferentially to the surrounding rebar, providing galvanic corrosion protection to the reinforcing steel.

BEST USE
- Inserted into drilled holes within sound concrete
- Targeted corrosion control at "hot spots"
- Installed in a grid pattern provides general corrosion protection
- Highly chloride contaminated concrete

CASE STUDY

PROJECT
The North Claredon Garage, Chicago, Illinois

DESCRIPTION OF STRUCTURE
This garage is a 44000 ft2 structure that spans 3 levels below grade. It is located on N. Claredon Ave in uptown Chicago, and was built in the late 1970s.

PROBLEM
Upon visiting the site in 2014, there were extensive areas of spalling. After sounding each of the horizontal slabs, it was determined that over 2500 ft3 of the slabs needed repair. A combination of chlorides and moisture was determined to be the root cause of the spalling.

SOLUTION
The goal of the project was to repair and protect the garage from further corrosion. First, the steel reinforcement was cleaned. This was followed by the installation of Sika FerroGard 670, zinc anodes. The anodes were used for the protection of reinforcing steel in concrete, which were placed at perimeter locations in the patches noted by the engineer. In order to further protect against corrosion and improve the bond of the concrete, Sika Armatec 110 was applied to the rebar as well. The 4500 anodes were packed in SikaRepair 223, a one-component, cementious patching material, prior to concrete being placed. This corrosion protection approach was utilized in order to ensure the durability of the garage.

CASE STUDY LONGFELLOW TOWERS

PROJECT
One and Four Longfellow Towers

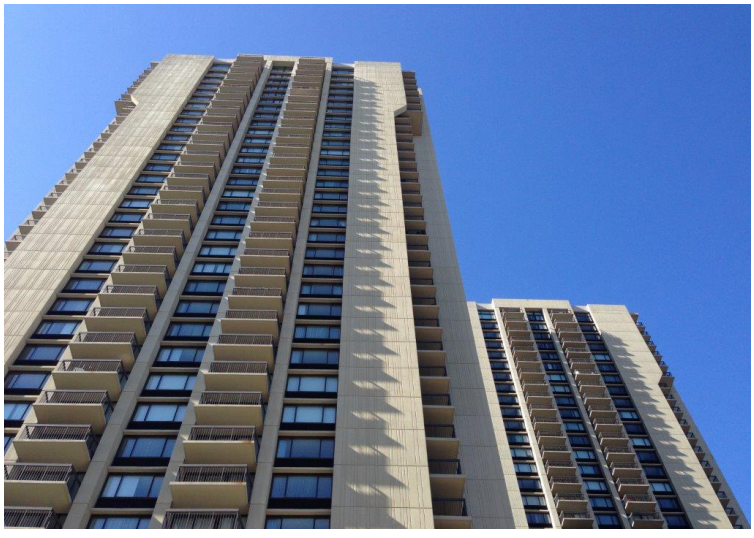
Description of Structure
The prestigious Longfellow complex is located in the heart of downtown Boston on the Charles River. This case study focuses on two 38 story apartment buildings which were constructed between 1970 and 1972.

Problem
Inspections conducted in 1997 identified numerous areas of spalls due to corrosion of the steel reinforcement. More recently, sealant joints at the sliding glass doors, ac units and windows were failing and allowing water to leak into the apartment. In 2001, inspecting engineers carried out a comprehensive investigation and determined spalling had increased by 25% since 1996. There was chloride contamination, carbonation and low cover throughout. In particular, exposed column faces, balcony edges and floor slab edges had the least cover and most spalls.

Solution
A repair program was completed to fix the spalls and leaking joints and protect the building by mitigating active corrosion. The repair design required Sika MonoTop 615 repair mortar for the spalling. Reinforcing steel exposed while removing delaminated concrete was coated and protected with Sika Armatec 110 Epocem and leaking joints were sealed using Sikaflex 2c. Embedded corrosion rate probes were installed and corrosion was mitigated using Sika Ferrogard 903 surfaced applied corrosion inhibitor. The building was protected using Sikagard Elastocolor and Sikagard 550W elastomeric coatings. After the contractor completed a preview, an inspection engineer confirmed the project's compliance with design documents. Tower 4 was completed in November 2003 and Tower 1 was completed in November 2004.

Remote corrosion rate monitoring has been on-going since the project was completed in 2014. Corrosion rates in all areas remain passive. In March of 2015, more than 10 years after project completion, the buildings were visually inspected from the ground and photographed using high powered lenses. The coating is in excellent condition and there are no signs of any peeling, chalking nor corrosion. This confirms visually that corrosion remains low and that the repair strategy was successful.

Refurbishment being completed in 2004



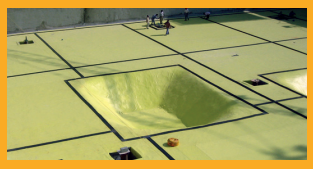
Current conditions of Longfellow Towers in 2015

SIKA FULL RANGE SOLUTIONS FOR CONSTRUCTION:

SEALING AND BONDING

REFURBISHMENT

ROOFING



WATERPROOFING

CONCRETE

FLOORING

Contact Sika:

Phone: 1-800-933-SIKA (Nationwide)

Website: www.usa.sika.com

All sales of Sika products are subject to Sika's current Terms and Conditions of Sale available at www.usa.sika.com or by calling 201-933-8800. Prior to each use of any Sika product, the user must always read and follow the warnings and instructions on the product's most current Product Data Sheet, product label and Material Safety Data Sheet, which are available at www.usa.sika.com or by calling Technical Services at 1-800-933-7452. Nothing contained in any Sika materials relieves the user of the obligation to read and follow the warnings and instructions for each Sika product as set forth in the current Product Data Sheet, product label and Material Safety Data Sheet prior to product use.
The sale of all Sika products are subject to the following Limited Warranty:

LIMITED MATERIAL WARRANTY

SIKA warrants this product for one year from date of installation to be free from manufacturing defects and to meet the technical properties on the current Product Data Sheet if used as directed within shelf life. User determines suitability of product for intended use and assumes all risks. Buyer's sole remedy shall be limited to the purchase price or replacement of product exclusive of labor or cost of labor.

NO OTHER WARRANTIES EXPRESS OR IMPLIED SHALL APPLY INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. SIKA SHALL NOT BE LIABLE UNDER ANY LEGAL THEORY FOR SPECIAL OR CONSEQUENTIAL DAMAGES. SIKA SHALL NOT BE RESPONSIBLE FOR THE USE OF THIS PRODUCT IN A MANNER TO INFRINGE ON ANY PATENT OR ANY OTHER INTELLECTUAL PROPERTY RIGHTS HELD BY OTHERS.

Our most current General Sales Conditions shall apply. Please consult the Product Data Sheets prior to any use and processing.

Sika Corporation
201 Polito Avenue
Lyndhurst, NJ 07071
Phone: 201-933-8800
Fax: 201-933-6225

Sika Canada Inc.
601 Delmar Avenue
Pointe Claire
Quebec H9R 4A9
Phone: 514-697-2610
Fax: 514-694-2792

Sika Mexicana S.A. de C.V.
Carretera Libre Celaya Km. 8.5
Fracc. Industrial Balvanera
Corregidora, Queretaro
C.P. 76920
Phone: 52 442 2385800
Fax: 52 442 2250537

BUILDING TRUST