REFURBISHMENT
CONCRETE REPAIR AND PROTECTION OF CHIMNEYS AND COOLING TOWERS

BUILDING TRUST

SIKA – YOUR PARTNER

Since more than three decades Sika has been a reliable partner with cooling tower contractors supplying products and systems on all continents. Sika has shown the Power Industry we are a partner, they can trust. The products and systems used in new cooling towers and retrofitted structures are thoroughly tested in Sika laboratories before being independently checked. Sika materials are further proven by independent body to withstand the harsh weather conditions in the real environment.

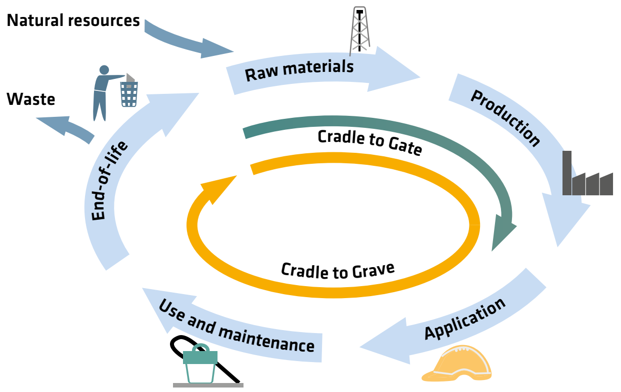
CONTENT

SIKA'S LIFE CYCLE ASSESSMENT APPROACH

Life Cycle Assessment (LCA) is a standardized method to assess and compare the inputs, outputs and potential environmental impacts of products and services over their life cycle. LCAs are increasingly recognized as the best way to evaluate the sustainability of products and systems.

Sika carries out LCAs according to the ISO 14040 series and the Standard EN 15804. The impact assessment methodology used is CML 2001. The data for the Sika LCA is based on public databases, such as those from ecoinvent, the European Reference Life Cycle Database (ELCD) and PE-GaBi, plus the specific data from Sika production plants and products.

Sika evaluates all impact categories and resource indicators deemed as important according to the relevant standards.



Cumulative Energy Demand (CED), Global Warming Potential (GWP) and Photochemical Ozone Creation Potential (POCP) are considered to be most relevant for concrete repair and protection:

- Cumulative Energy Demand (CED) is the total amount of primary energy from renewable and non-renewable resources.
- Global Warming Potential (GWP) is the potential contribution to climate change due to greenhouse gases emissions.
- Photochemical Ozone Creation Potential (POCP) is the potential contribution to summer smog, related to ozone induced by sunlight on volatile organic compounds (VOC) and nitrous oxides (NOx).

SUSTAINABLE REFURBISHMENT OF COOLING TOWERS

Sika LCAs on refurbishment strategies for cooling towers are based on a 'Cradle to Grave' approach. Potential environmental impact of products for concrete repair and protection are investigated from raw material extraction, production, application and use to final disposal at end of life. Construction and end-of-life scenario of the reinforced concrete structure itself are excluded.

Natural Draft Cooling Tower Refurbishment Scenarios 20'000 m²

	Scenario 1 **Cost orientated**	Scenario 2 **Retrofitting with durable system**	Scenario 3 **Durability orientated**
Initial construction	No protection	No protection	Full protection with proven coating and adequate surface preparation
After 20 years	Full refurbishment Inadequate surface preparation highly solvented coatings	Full refurbishment proper surface preparation proven protective coatings	Refreshing coat only
Every 10 years	Full refurbishment as after 20 years	No requirement	No requirement
Every 20 years		Refreshing coat only	Refreshing coat only

SUSTAINABLE REFURBISHMENT OF COOLING TOWERS

Sika's well proven and durable protective system (scenarios 2 & 3) allows a reduction in the frequency of refurbishment while having a significant reduction on the three impact categories and a lower material input.
Advantages of scenario 3 over scenario 2 is the better flexibility for correct application of the protection system at the time when the tower is erected.

Scenario 1: Polymer modified cement protective coating system

20 years | 10 years | 10 years | 10 years | 10 years

No Protection | Full refurbishment every 10 years

Scenario 2: Retrofitting with durable system

20 years | 20 years | 20 years

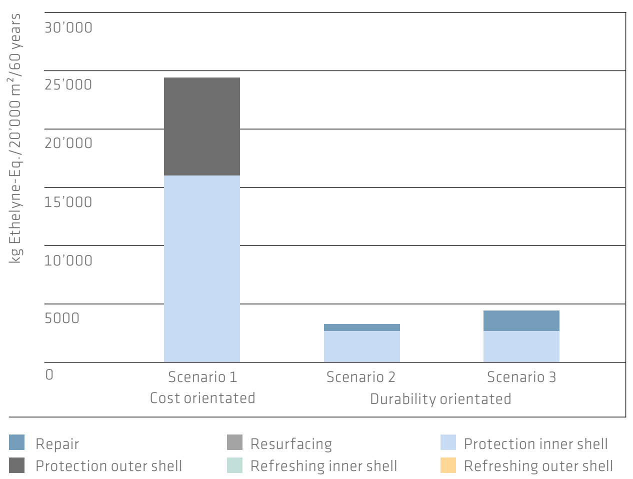
No Protection | Full Refurbishment | Refreshing coat

Scenario 3: Durability oriented system

20 years | 20 years | 20 years

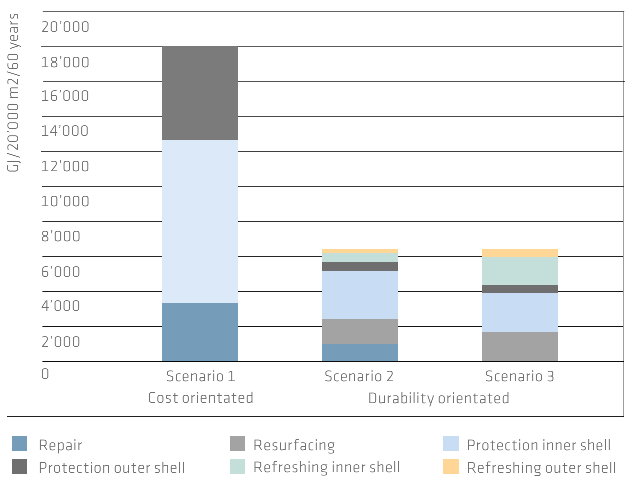
Full Protection | Refreshing coat every 20 years

Photochemical Ozone Creation Potential (POCP)



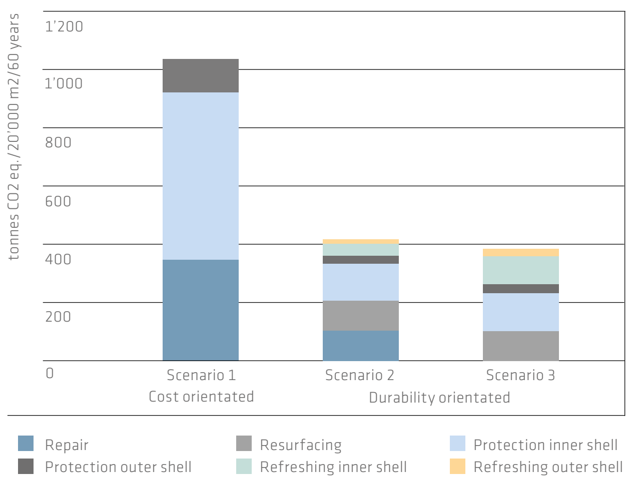
The higher impact of **scenario 1** is due to the use of heavily solvent containing coating system.
The difference between the scenario 1 and the other two is around 20'000 liters of Ethylene equivalent over the life cycle period of 60 years.
➔ This is equivalent to a saving of more than one drum of pure solvent a year.

Cumulative Energy Demand (CED)



Scenarios 2 and 3 have significant lower CED than scenario 1. This is due to a greater resource efficiency (lower material consumption over the whole life cycle).
➔ This is equivalent to a saving of 1'300 liter of oil per year.

Global Warming Potential (GWP)



The greater resource efficiency of **scenario 2 and 3** allows saving of 600 tons of CO_2 over the life cycle of 60 years.
➔ This is equivalent to a saving of 77'000 km a year (compared to the limit of the European Union of not more than 130 g of CO_2 per km targeted for 2015).

CONCLUSION

Overall savings for the plant owner with positive incidence on sustainability:

The appropriate strategy can have a beneficial impact:
- by reducing the frequency of refurbishment cycles
- by improving the resource efficiency and the environmental performance of the refurbishment process
- by providing a more sustainable solution

CHIMNEYS AND THEIR EXPOSURE

REINFORCED CONCRETE CHIMNEYS are high-rise and slender specialized structures. They are normally built by specialists to high standards of engineering with strict quality control of the concrete.

Traditionally, concrete chimneys were not provided with any additional surface protection.
For many years site assembled precast concrete sections or continuous slip-forming concrete on site were used in chimney construction. However, even with strict quality control it is always likely that there will be some site difficulties, e.g. during the concrete placement, finishing or assembly, some elements will move out of place and form voids, suffer grout loss, reduce cover thickness or be physically damaged.

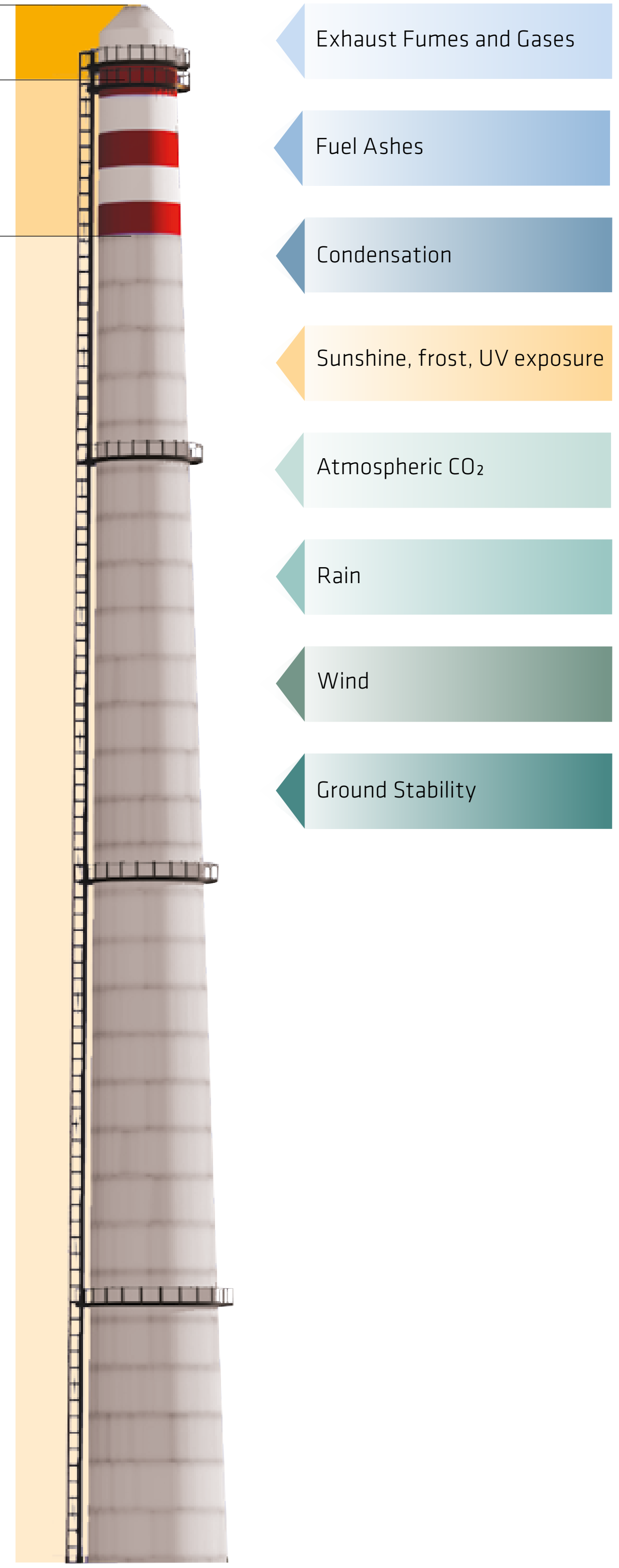
The use of high-strength concrete with its relatively low slump-flow or flowability also means that it can be difficult to compact. By nature and shape of the structure, the freshly placed concrete in these structures on site is always difficult to cure correctly.
Chimneys are very exposed to aggressive influences on their external surfaces due to the exposed locations where these structures are built, their height above nearby structures and of course their function. The internal surfaces are normally fully lined or channelled and therefore protected.

The aggressive external influences include:
- Atmospheric carbonation
- Frequent wetting and drying
- Freeze-thaw cycles (the result of increased wind chill)
- High thermal variations and thermal gradients in sunlight
- Chlorides from marine atmospheres (even miles inland due to prevailing winds)
- Exhaust gases and condensates
- Influencing of neighboring chimneys

The potential for concrete damage from these exhaust gases containing varying levels of acidic sulphurous (SOx), nitrous (NOx) and other aggressive materials is probably the greatest overall threat, even when modern flue gas desulfurization equipment is fitted.

The exposed external surfaces of chimneys are normally subdivided into zones, according to their level of exposure to these gases and other potentially damaging influences.

ZONE
1
2
3



ZONE 1
The top or head of the chimney and its upper shaft (0.2 – 1.0 of the diameter, minimum 5 m)
- High potential exposure to exhaust gases
- High thermal variations (sunlight and exhaust)
- High wind and weathering (possible airborne chlorides)
- Frequent risk of condensation
- Possible fuel ash

ZONE 2
The middle of the chimney shaft (0.2 – 0.4 of the height)
- Medium potential exposure to exhaust gases (including neighbouring chimneys – high atmospheric CO_2)
- Medium thermal variations (sunlight and exhaust)
- Medium wind and weathering (possible airborne chlorides)
- Medium of condensation

ZONE 3
The lower shaft (the remainder of the height to the ground)
- General industrial area atmosphere
- Rain and weathering (possibly limited by other structures – can accelerate carbonation)

Note: With adjacent chimneys Zone 1 and Zone 2 of the surface both become larger.

COOLING TOWERS AND THEIR EXPOSURE

"COOLING TOWERS" are exactly as their name suggests, structures for water re-cooling, although they do not necessarily have to be large physical "natural draught" towers. The name is also used for smaller cellular coolers or hybrids, which combine a smaller natural draught structure with a mechanically ventilated system of cooling the flow to retain the condensates.

Large reinforced concrete, natural draught cooling tower structures can be as tall or even taller than many chimneys. However, due to their design and function, they have a very much larger surface area with a much lower mass to surface area ratio.
Unlike chimneys, both the internal and external concrete surfaces of cooling towers are exposed to aggressive influences. The external exposure and the potential damage are therefore similar but the internal surfaces are usually in much greater danger.

THE EXTERNAL EXPOSURE
The external surfaces are exposed to very similar aggressive influences like chimneys. However, due to their much larger circumference and diameter with a much lower mass to surface area, they are at much greater risk of cracking. This is due to settlement and adverse thermal gradients developing from thermal variations imposed on the surfaces.

EXPOSURE CLASSIFICATION
In terms of their exposure, the external surfaces of cooling towers can therefore also be divided into the same three zones as chimneys:

ZONE

1

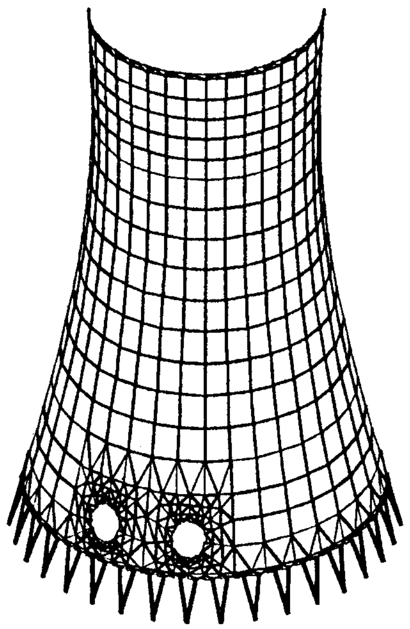
The top of the shaft and around the annulus from the top down approximately 5 m irrespective of the structure's diameter.

2

The central area which is from 5 to 30 – 50 m down, dependent on the diameter of the structure.

3

The rest of the height to the ground which is usually equivalent to around 70% of the total surface area.



THE INTERNAL EXPOSURE
The internal surfaces of cooling towers are also very large and exposed. Even though they are constructed with acid-resistant concrete, it has been recognized that they must be given additional surface protection. This is due to their direct exposure and contact with the exhaust gases and condensates, which are often aggressive and acidic at a pH as low as 2.5.

Sika has been the preferred partner with the pioneering specialist engineers, contractors and access equipment manufacturers, producing tailored products and systems for these very specific applications.

The level and degree of exposure and potential damage to the different areas of the internal surface are firstly dependent on the internal level, location and direction of the flue gas discharge points.

Secondly, it is dependent on whether the cooling tower is fitted or has been retrofitted with a modern flue gas desulfurization equipment, to greatly reduce and in some cases almost eliminate the aggressive and acidic contents of the exhaust.

Additionally by design, natural draught cooling towers always have a relatively large opening at the top and therefore at least some of the internal surfaces are exposed to direct solar radiation

This includes UV light which is very aggressive to most types of epoxy resin coatings, such as those that are normally used as chemically resistant coatings. Special products are therefore required to be able to withstand this combined exposure inside cooling towers.

The total "loading" on the internal surfaces is also variable according to the daily position of the sun and the direction of the plume (reducing solar radiation but increasing exhaust gas attack on the contact areas). Obviously this effect gradually reduces vertically down the inside of the tower. However, at the top it also increases the potential for thermal variations and potentially damaging adverse temperature gradients that can lead to cracks within the concrete walls.
Internal exposure of induced draught cooling towers is less aggressive but the temperature is often raised to around 50°C that bring additional stress to the concrete.

1 Severe combined exposure of multiple adjacent cooling towers and chimneys at power stations and industrial complexes.

2 Specialist equipment and materials are required for all of the internal works in these structures.

3 Severe internal exposure to aggressive gases and chemicals aggravated by direct UV light exposure and thermal variations at the top.

KEY STAGES IN THE CONCRETE REFURBISHMENT PROCESS

THE SUCCESSFUL REPAIR, PROTECTION AND CORROSION MANAGEMENT of reinforced concrete chimneys and cooling towers always requires an initial professional assessment and an appropriate detailed condition survey.

Some access and even some refurbishment works can take place while these structures are in service. But inspection and assessment work of external zone 1 and most of the internal surfaces of cooling towers, which are integral part of the power production, can normally only be done during switch-off, boiler servicing or upgrading works.

The costs of any extended closure or downtime are extremely high, due to the complex national grid infrastructures, power transmission changes and the other works required. This will always lead to great time pressure, to complete the project on time. However, it is essential that a full professional assessment is carried out prior to repair and protection works.

To do otherwise is short-term and a false economy, as serious structural damage could follow, possibly putting the structure completely out of commission for a long period and endangering people and other structures in the vicinity.

The second stage is the design, execution and supervision with technically correct repair "principles" and "methods", using products and systems which for optimum results and long-term cost effectiveness, should be selected according to the new European Standard EN 1504-9.

KEY STAGES IN THE CORRECT REPAIR AND REFURBISHMENT PROCESS:

1. ASSESSMENT OF THE STRUCTURE
A condition survey by qualified and experienced people to include the condition of the structure and its surfaces, including visible, non-visible and potential defects.

2. IDENTIFICATION AND DEGREE OF THE CAUSE(S) OF DAMAGE
A review of the original construction details and any previous refurbishment works, plus analysis and diagnosis from the condition survey to identify:
- Damage due to concrete defects or attack (mechanical, chemical or physical types)
- Damage due to reinforcement corrosion (carbonation or chloride attack)

3. DETERMINATION OF REPAIR AND PROTECTION OBJECTIVES AND OPTIONS
Owners and engineers always have a number of options for deciding the appropriate refurbishment strategy to meet the future requirements of the structure. With chimneys and cooling towers, the most limiting factors are usually the difficulties for future access, plus the likelihood and consequences of any falling concrete or structural failure.

4. SELECTION OF APPROPRIATE REPAIR PRINCIPLES AND METHODS
In accordance with EN 1504-9 the appropriate "repair principles" should be selected and then the best "method" of achieving each principle can be defined.

Following this selection, the performance requirements of suitable products are defined, using European Standards EN 1504 Parts 2 to 7 in conjunction with Part 10, which also provides guidelines for the work preparation and site application including quality control. On these substantial structures with their very specific exposure and damage potential, the materials selected must also be tested and proven in these very specific conditions.

5. FUTURE MAINTENANCE
As with all refurbishment projects, the need and likely time schedule for future inspection and maintenance should be defined. Complete and fully detailed records of the works undertaken must always be maintained.

SIKA PRINCIPLES IN ACCORDANCE WITH EUROPEAN STANDARD EN 1504

SIKA IS THE GLOBAL MARKET AND TECHNOLOGY LEADER in research, development and production of concrete repair systems for all types of buildings and civil engineering structures.

Sika is the preferred partner of specialist engineers, contractors and access equipment suppliers focused on these important structures.

All products and systems for concrete repair and protection needed for this demanding application are produced by Sika fully in accordance with the European Standard EN 1504. This includes products for application in all of the different exposure and climatic conditions that can be required to repair and protect chimneys and cooling towers all over the world.

Sika provides a complete package of documentation to assist chimney and cooling tower owners, engineers and contractors with the right selection of repair principles, methods and products, the production of specifications and tender documents.

The experienced Sika Technical Services Department is also available to train site engineers and contractors in the use and application of the products and systems.

Sika provides extensive independent testing with all relevant approvals and certificates for all materials. This provides maximum confidence for everyone involved in these challenging projects. An equally extensive portfolio of succesfully completed reference projects around the world.

Sika systems are available to meet all individual requirements of chimney and cooling tower structures. Whatever damage has occurred, whatever future exposure requirements and wherever in the world the projects are located.

Chimneys and cooling towers in close proximity require technically correct repairs in accordance with EN 1504-9. Creative possibilities in conjunction with using technically correct repair and protection are also possible with the advanced Sika systems.

ASSESSMENT OF TYPICAL CAUSES AND EFFECTS OF DAMAGE

DAMAGE DUE TO CONCRETE DEFECTS OR ATTACK

CHEMICAL
- Aggressive exhaust gases
- Condensation leaching

Severe corrosion of concrete and then of the steel reinforcement internally, despite a previously applied coating (coating was inadequate).

PHYSICAL
- Thermal movement cracking
- Adverse thermal gradient cracking
- Freeze/thaw action
- Shrinkage (from hydration)
- Erosion

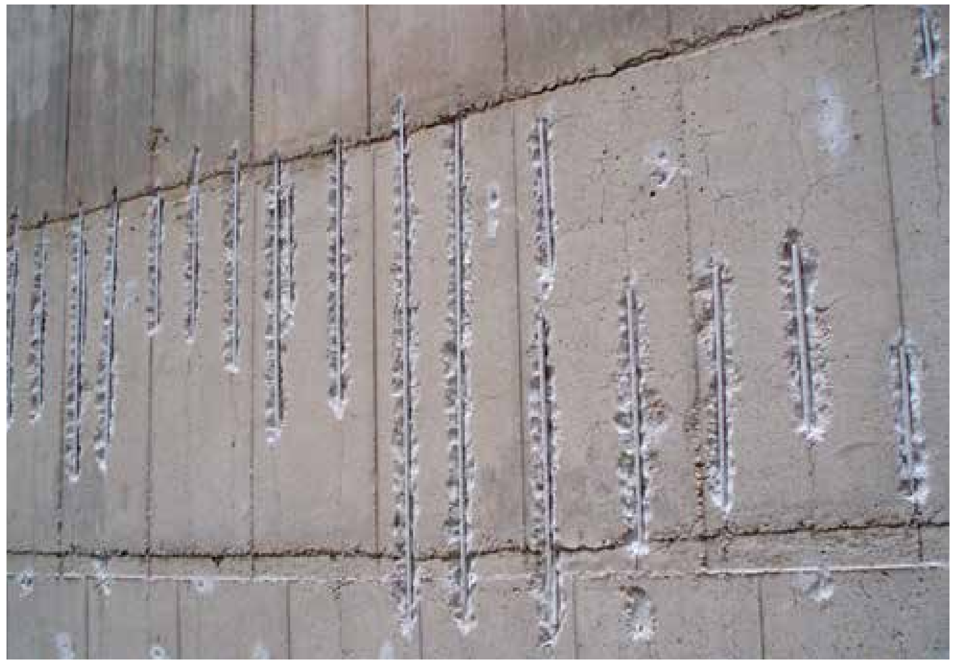
Chimneys in direct sunlight indicating variations in thermal exposure which are further exacerbated by the effects of the downward flow of hot exhaust gases during periods of temperature inversions.

DAMAGE DUE TO STEEL REINFORCEMENT CORROSION

CARBONATION
Atmospheric carbon dioxide ingress (loss of alkaline protection).

$Ca(OH)_2 + CO_2\ CaCO_3 + H_2O$

Carbon dioxide from the atmosphere penetrates progressively into the concrete and reacts with the calcium hydroxide in the pore liquid. This eventually reduces the protective alkalinity around the steel, allowing corrosion to start in presence of water. This phenomenon is often associates with low concrete cover.



General corrosion induced by carbonation aggravated with low concrete cover issue.

CHLORIDES AND ACID GASES
In these structures corrosion of the reinforcement can also occur due to attack from chlorides in marine atmosphere. However, the steel is far more frequently attacked directly by the acidic exhaust gases in conjunction with carbonation of the surrounding concrete. This means that the steel corrosion is accelerated and spalling, plus erosion increases.

Carbonated concrete with spalling over corroded reinforcement accelerated by the steel being attacked by the acidic exhaust gases.

CONCRETE REPAIR AND PROTECTION REMOVAL OF DAMAGED CONCRETE

THE FIRST STAGE OF THE WORK ON SITE is to remove the damaged concrete and then to clean any exposed steel reinforcement.

Break-out and removal of damaged concrete areas marked for repair in the condition survey.

Any exposed steel reinforcement should be cleaned to remove rust and corrosion products. EN 1504 Part 10 recommends the steel be prepared to Sa 2 1/2 (if barrier coating is applied) or to Sa 2 (if active coating is applied). These denominations are originally from a Swedish Standard but now adapted into an international standard ISO 8501-1.
Any method of steel surface preparation may be used, with grit blasting normally recommended as the best and the fastest, particularly with the larger areas of steel that can be exposed on cooling towers.
This cleaning and preparatory work should all be carried out in accordance with the site works and application guidelines of EN 1504 Part 10 Section 7, which can also be referred to for additional information.

In most situations it is best to first carry out a program of surface cleaning works, usually working from top-down. That surface preparation will remove any lose or severely damaged concrete. This action may expose additional area of damage that will subsequently require treatment.

As a general rule concrete removal should be kept to a minimum, particularly any sound concrete. However, where actively corroding steel reinforcement is present, it must be fully exposed to beyond its corroding length and around its full circumference. To allow cleaning and preparation, a distance equivalent to the bar diameter and a minimum of 12.5 mm is normally required.
For this work on these relatively thin structures, it is particularly important to use only new, sharp chisels or precision-controlled hydro-demolition equipment to prevent any non-scheduled puncturing or cutting through of the walls.
The breaking out must be kept fully under strict control and continuous monitoring by the responsible engineer.

In marine environments where the concrete has previously been exposed and contaminated by chlorides (even when they are at some distance from the sea due to a combination of the structure's height and prevailing winds), the concrete and the steel surfaces should be washed with clean water to remove the chloride deposits. The cleaned and prepared concrete surface should be free from dust and any other contaminants.

1 Removal of damaged concrete from inside a cooling tower.
2 Concrete removal behind the steel bars to ensure room for corrosion protection to be applied.
3 Corroding steel exposed after concrete removal.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PROTECTION OF STEEL REINFORCEMENT

EXPOSED STEEL
The protection of the cleaned, exposed reinforcement is achieved by isolating the reinforcement from the surrounding concrete. This uses a coating that is an electrical insulator to prevent both metal cations escaping from the steel and hydroxyl, or other anions arriving at the steel surface.

Sika has several products for this purpose; all using active corrosion inhibitors. The selection of the most appropriate product is dependent on the chemical exposure level and the concrete replacement being used, plus the extent and volume of steel to be treated.
Particularly suitable for the use on large exposed steel areas, which is frequently required on cooling towers:
Sika MonoTop®-910 for the one-component Sika MonoTop® repair mortars.
SikaTop® Armatec®-110 EpoCem® for use in highly corrosive environments with all Sika repair systems, where it provides an excellent barrier to chloride ion diffusion and penetration.
The coating must be applied around the full circumference of the steel bars and to beyond the areas that were corroding and wherever there is inadequate or insufficient concrete cover.
These conform with EN 1504 Part 9 Principle 11 (CA) Control of anodic areas: Method 11.1 Painting reinforcement with active coatings and comply with EN1504 Part 7 reinforcement corrosion protection.

EMBEDDED STEEL
Additional protection can also be provided to steel that is not actually exposed, but is at risk of corroding, i.e. in carbonated concrete. This is done by the application of Sika® FerroGard® corrosion inhibitors.

Sika® FerroGard® products are based on aminoalcohol technology. These are known as "mixed" or "dual" inhibitors because they act on both the anodic and cathodic areas of the steel surfaces.
Sika® FerroGard® forms a mono-molecular passivating film or barrier layer over the surface of the steel. This prevents the escape of metallic cations and the arrival of any hydroxyl, or other anions.
Sika® FerroGard® inhibitors can be surface applied as the penetrating impregnation Sika® FerroGard®-903+. This product can easily be applied to both repaired and non-repaired surfaces to prevent or significantly reduce the rate of any future steel corrosion. Corrosion inhibitor technology can also be used as an admixture. Sika FerroGard®-901 can be added in new concrete for large replacement or in repair mortars.

This conforms with EN 1504-9 Principle 11 (CA) Control of Anodic Areas, Method 11.3 Applying corrosion inhibitors in or to the concrete.

Steel reinforcement prepared and protected with Sika MonoTop®-910 ready for repair mortar application.

REPLACING AND RESTORING DAMAGED CONCRETE

SIKA PRODUCES A COMPLETE RANGE of repair concretes and mortars, which are specifically designed for restoring or replacing the original profile and function of the damaged concrete. These include cement-bound, polymer modified cement-based and polymer epoxy resin based products, according to the specific applications and performance requirements.
All are in accordance with EN 1504-9 Principle 3 (CR) Concrete Restoration and compliant with EN 1504-3 Class R4.

APPLYING REPAIR MORTAR BY HAND

Sika provides an extensive range of pre-batched hand applied mortars and systems for localized patch repairs. This includes chemically resistant materials to protect against the aggressive influences of acidic gases and liquids.

Sika hand placed repair mortars include the following:

- Sika MonoTop® – pre-bagged, one-component, polymer and non-polymer modified, cement-based, hand applied mortars.
- Sikadur® – pre-batched, epoxy resin based chemically resistant mortars.

RECASTING/POURING REPAIR MORTARS AND CONCRETES

Typical recasting repairs, which can also be described as "pourable" or "grouting" repairs, are employed when whole sections or larger areas of concrete replacement are required. For example: in the replacement of all, or substantial parts of tower or chimney sections.
This method is also very useful for the complex structural supporting sections, which can also present concreting or concrete replacement problems due to restricted access or congested reinforcement.

The most important criteria for the successful application of this type of products are their flowability and their ability to move around obstructions. Additionally, they often have to be poured in relatively thick sections without thermal shrinkage cracking. This is to ensure that they can fill the desired volume and areas completely, despite the restricted access and application points. Finally, they must also harden to provide a suitable finished surface, which is tightly closed and not cracked.

Sika produces suitable recasting and pourable products and systems including:

- Sika MonoTop® – pre-bagged one-component, polymer and non-polymer modified cementitious pourable repair mortars.
- SikaCrete® SCC – pre-bagged silicafume enhanced self-compacting concrete (SCC).
- Sika® ViscoCrete® – admixture SCC technology for large volume, pumped and high density concrete replacement.
- SikaRapid® – technology for high early strengths or continuous replacement concreting at low temperatures.


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1 Hand applied Sika MonoTop® repair mortar.
2 Typical large damages to be repaired using dry spray technique.

SPRAY APPLIED REPAIR CONCRETES AND MORTARS

Spray applied materials are particularly useful for large volume concrete replacement, for providing additional concrete cover, or in any areas with difficult access for concrete pouring.

In addition to traditional "gunite" dry spray systems, there are also "wet spray" machines. These have lower volume outputs, but also much lower rebound and they produce less dust than dry spray machines. Therefore, they can also be used economically from powered access equipment, for smaller areas, or for the application of repairs in more sensitive areas.

Sika produces quality controlled and pre-batched machine applied mortars, specifically for use in both of these methods of "spray" application.

The most important application criteria for all of these materials are minimal rebound, their high-build properties and also their non-sag layer thickness. Application with minimal or easy finishing and curing requirements is also important on these structures due to their difficulties in access.

Sika spray applied mortar systems are polymer and/or silicafume enhanced for increased durability:
The SikaCem® and SikaCrete® ranges of "dry" sprayed mortars, with both polymer modified and cement-bound products with the capability of being sprayed over large distances and up to 180 m high with the correct equipment. The dry spray equipment can be provided by Sika Schweiz AG, Aliva Equipment.

SikaCem® Gunite®-133 is particularly suitable for large scale "dry sprayed" repairs on these structures because of all its high density and low permeablity, plus its excellent strength correlation in service (compressive, tensile and e-modulus).

The SikaCrete® and Sika MonoTop® ranges of "wet" spray applied mortars also include both polymer modified and cement-bound products.

The fiber-reinforced Sika MonoTop®-412 NFG is particularly suitable for the high demands of localized repairs because of its high-build, low shrinkage, polymer modification and ease of use.

SPRAY APPLIED MATERIALS ARE PARTICULARLY USEFUL FOR LARGE VOLUME CONCRETE REPLACEMENT.


2


3


1

1 Internal application of Sika spray applied repair mortars in a cooling tower refurbishment.
2 Difficult shaped support structures easily repaired with SikaCem® Gunite 133.
3 Sika Aliva dry spray equipment in operation applying SikaCem® Gunite 133 inside a cooling tower.

LEVELLING AND RESTORING THE CONCRETE SURFACE

CHEMICAL PROTECTION OF CONCRETE involves the application of coatings or treatment of the surface. It is a fundamental precondition for the success of a coating that the surface is not only clean, but also uniform and free of surface defects, otherwise these will simply be reflected through the coating. For example, most defects, voids or uneven areas previously damaged by attack or produced as the result of surface preparatory work, could all allow the entry of aggressive agents behind the coating.

The treatment and closure of these surface defects is therefore necessary to ensure complete, uniform and defect-free application of a protective coating system. This type of product is also commonly known as a surface levelling mortar and a surface sealing mortar. A surface smoothing coat should be suitably matched to the substrate condition, together with its subsequent exposure and overcoating requirements. Sika produces a wide range of products for this purpose on chimney and cooling tower surfaces.

LEVELLING OF EXTERNAL ZONE 2 AND ZONE 3 SURFACES

Due to the very large external surface areas involved in Zone 2 and 3, it is difficult to apply a levelling mortar in these areas. In these zones to maintain the durability despite the lack of resurfacing work, a combination of hydrophobic primer and protective coatings can be used. The combined system is included in several different approved protection systems for the protection of concrete façade surfaces in Germany and France (referenced as OS2 per DIN V 18026 and included in the recommendations of NF P 95-103-14)..

If resurfacing is nevertheless required, the polymer modified cement-based surface levelling mortar Sika MonoTop®-723 N is then the most cost effective and appropriate product for this purpose on external surfaces of chimneys and cooling towers.

LEVELLING OF EXTERNAL ZONE 1 AND THE INTERNAL SURFACES

This surface requires chemical protection. Therefore, adequate surface preparation shall be performed prior to apply the protective coatings. Sikagard®-720 EpoCem® is the best product for this purpose. Sikagard®-720 EpoCem® is a thin layer levelling mortar based on a combination of epoxy resin and cement binders. As such its properties provide the best advantages of both systems. Sikagard®-720 EpoCem® needs no additional curing and enables rapid overcoating with vapour-tight, abrasion and/or chemically resistant coatings. It is therefore extremely suitable for use in Zones 1 (and Zone 2 if or where deemed necessary) of the external surfaces, together with all of the chemically exposed internal surface areas.

PROTECTIVE SURFACE COATINGS

PROTECTION OF EXTERNAL SURFACES FOR EXPOSURE IN ZONE 1

In Zone 1 the concrete surface must always be levelled and sealed to ensure that a uniform and defect-free, protective coating system can be applied. Sikagard®-720 EpoCem® with its unique properties is ideally suited for this purpose in Zone 1 areas – as outlined on page 20.

These are the most severely exposed areas of the external surfaces, so the coating system must also be extremely resistant to the aggressive influences to ensure its durability in most situations: Sika® Icosit®-2406 is used as the priming and intermediate coating on the sealed and levelled concrete surface. This is a low-solvent, high-build epoxy combination. It is followed by two coats of SikaCor® EG-5 a colored, chemically resistant and UV color stable, polyurethane top coat.

IN ZONE 1 THE CONCRETE SURFACE MUST ALWAYS BE LEVELLED AND SEALED.

SikaCor® EG-5 is available in all official aircraft warning colors worldwide, which are often required for safety reasons at the top of chimneys and cooling towers.

On surfaces that are potentially subject to future movement and cracking: Sikafloor®-390 is used as the coating system. It is a flexible high-build epoxy-based material with medium crack-bridging abilities, then Sikagard®-363 is applied as the colored (aircraft warning colors available) and elastic, crack-bridging, polyurethane top coat that also has high UV stability and excellent chemical resistance.

All mentioned Sika® materials comply with the requirements of EN 1504-2.

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3

1 Locally repaired surface ready for levelling on the left and afterwards on the right.
2 Application of Sika MonoTop®-620 levelling mortar onto the patch-repaired concrete surface prior to coating.
3 The concrete surface without pore filling and levelling but reated with hydrophobic primer (zone 2 and 3).

Aircraft warning colors using SikaCor® EG 5 as the top coating in zone 1 of a concrete chimney refurbishment.

Sika protective coatings being applied to the external surfaces (all zones) of a cooling tower.

PROTECTIVE IMPREGNATIONS AND SURFACE COATINGS

PROTECTION OF EXTERNAL SURFACES FOR EXPOSURE IN ZONES 2 AND 3: First a hydrophobic impregnation is applied to produce a water-repellent surface. The pores and capillary network are not completely filled, but only lined with the hydrophobic material. This works by reducing the surface tension of liquid water, preventing its passage through the pores, but still allowing each way water vapor diffusion.

Sika produces a full range of hydrophobic impregnations and systems for the protection of the exposed larger areas of Zones 2 and 3 according to EN 1504-2. These include:

- The Sikagard® range of silicone, silane and siloxane based hydrophobic impregnations, which are used to penetrate deeply and provide a liquid water-repellent surface, but still allowing water vapor diffusion.
- Sikagard®-680 S, an acrylic resin-based surface coating, which blocks surface pores against the entry of water and carbon dioxide, thus effectively halting carbonation, whilst water vapor diffusion can continue. This product is also particularly useful and suitable for application in the difficult environmental conditions of high humidity and/or low temperatures.
- The Sikagard®-500 range of waterproofing and anti-carbonation systems are also elastic and crack-bridging. They serve to accommodate thermal and dynamic movement in the structure, particularly where it is subject to wide temperature fluctuation.
- The combination of a Sikagard® hydrophobic impregnations (e.g. 2 x Sikagard®-700 S or 1 x Sikagard®-740 W) followed by Sikagard®-680 S anti-carbonation coating.

The combined system is frequently used for the larger lower areas of Zone 3 on chimney and cooling tower external surfaces. Where the steel reinforcement has good concrete cover, this combined system can be used without a prior levelling coat as the Sikagard® hydrophobic impregnations prevents water penetrating behind the Sikagard®-680 S coating through blowholes etc. and causing problems. This also conforms to the OS2 classification of the German Federal Regulations for concrete protective coating systems and the French standard Repair and strengthening of concrete engineering structures – Treatment of cracks and protection of concrete – Specifications for the technique and materials used.

1

2

3

1 Creative designs are also possible with Sikagard® protective coatings.
2 External coatings can be exposed to exhaust gases from adjacent chimneys
3 Abseiling specialists applying Sikagard®-680 S.

PROTECTION OF THE INTERNAL SURFACES OF COOLING TOWERS

As with Zone 1 (external surfaces) the repaired internal surfaces must always be levelled and sealed prior to application of the final protective coating system. The ideal material to achieve this on internal surfaces is again the unique Sikagard®-720 EpoCem® (please refer to page 20).

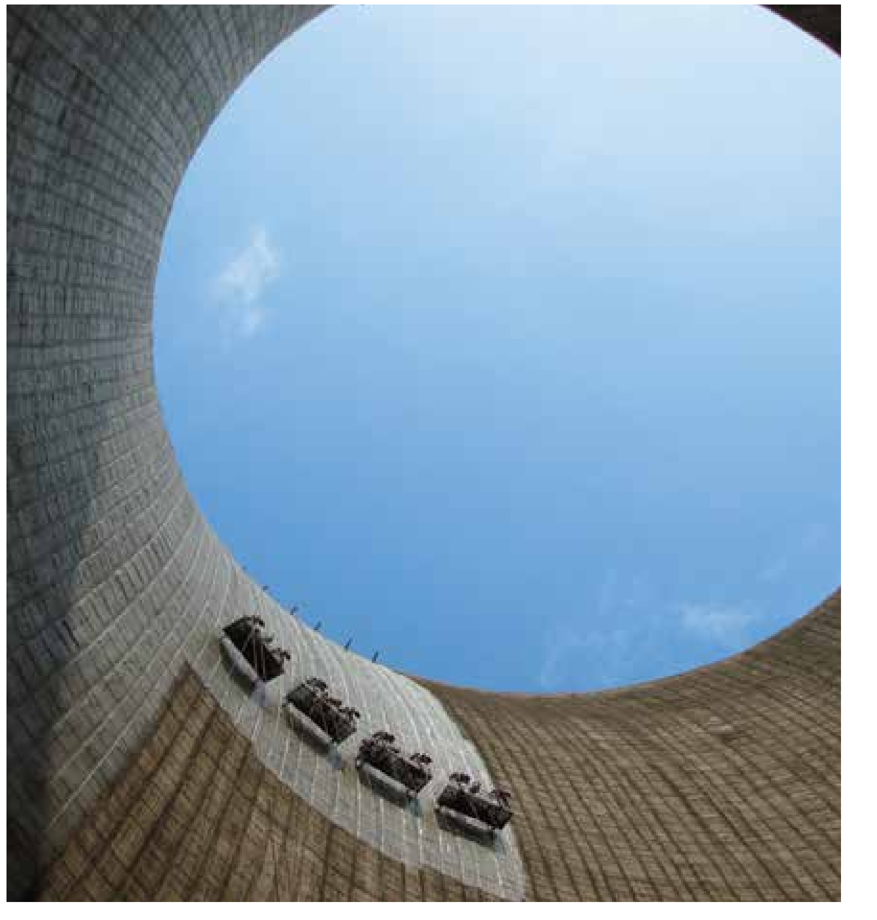
The protective coating system to be used internally is dependent on whether or not the tower has a modern flue gas desulphurization equipment installed. The products to be used are actually the same, but with the FGDS system installed, the chemical exposure is much lower and so only a single base coat is required:
Sika Icosit®-2406 is the ideal two-component, pigmented and chemically resistant epoxy resin based coatings. This product has a long proven history of use in cooling towers and it is externally tested and controlled.

However, the top section of the tower is accessible to exposure from both diffusive reflection and direct solar radiation, which both attack polymer-based coatings. The degradation process is photo-catalytically accelerated by the combination of the UV part of the radiation and components of the flue gas, especially any nitrous and nitrox material (NOx).

The system to be used in the upper zone consists of either one or two coats of Sika Icosit®-2406 followed by Sikgard®-363. This polyurethane based product combines UV and chemical resistance.

Whenever the temperature in the tower exceed 35°C (often the case for induced draft towers), special epoxy resin Sika® Permacor®-3326 EG H that resist up to 65°C in wet condition shall be used.

THE REPAIRED INTERNAL SURFACES MUST ALWAYS BE LEVELLED AND SEALED PRIOR TO APPLICATION OF THE FINAL PROTECTIVE COATING SYSTEM.



Application of the Sika Icosit®-2406 protective coating system from specialist powered access cradles.

Close-up of the freshly applied Sika® Icosit®-2406 epoxy protective coating system demonstrating excellent covering and sealing ability.

REMEDIAL TREATMENT SOLUTIONS FOR CRACKS AND JOINTS

DUE TO THEIR SLENDER STRUCTURES AND HARSH ENVIRONMENTS, chimneys and cooling towers are frequently prone to cracking in the concrete. At the base of cooling towers, the containment basins can also often require the repair and sealing of leaking cracks as part of their overall refurbishment.

1 Structural bonding of cracks to restore structural integrity with Sika® Injection resin.
2 Crack-sealed with Sikaflex sealant and overcoated with Sikagard®-680 S protective coating.

All concrete repair and protection works must therefore take account of the position and size of any cracks and joints in the concrete. This means investigating their nature and cause, then understanding the extent of any movement and its effect on the stability, durability and function of the structure.

Therefore, this is an important part of the condition survey and the identification of the nature and degree of the damage in these structures. Cracks in the concrete can obviously give aggressive gases and liquids direct access to the embeded steel reinforcement.
Then, the most suitable Sika system of resealing and bonding can be selected. Sika® Injection systems include both low and high pressure materials, designed for application with different types of equipment, according to the requirements. Sika produces different viscosities and grades of the synthetic resins in the Sika® Injection range. All products are solvent-free. Depending on products they can be used in both dry and damp conditions. They have all high chemical resistance, but different penetration capabilities to suit the nature, width and extent of different cracks.

NON-MOVING CRACKS
These are cracks that have been formed by initial shrinkage e.g. they need only to be fully exposed and repaired / filled with the appropriate Sika® repair mortar, or Sika® levelling mortar, as outlined for surface defects on page 20. The selected surface treatments can then be safely applied successfully over these cracks.

As outlined on page 22, fine surface cracks with a total movement of up to 0.3 mm can be safely repaired, then sealed and their movement accommodated by the elastic, crack-bridging coatings from the Sikagard®-500 Elastic range.

CRACKS TO BE TRANSFERRED TO A JOINT
Where the structural engineer has directed that an existing crack should be treated to function as a movement joint in the structure, it needs to be sealed at the surface to prevent the ingress of any further aggressive agents. It can be sealed with the Sikaflex® range of joint sealants, primarily based on one-component polyurethane and Sika® AT polymers designed for easy application, high movement capability and excellent durability.
Sika also produces special overbanding and crack-sealing, jointing materials for this application such as the Sikadur®-Combiflex® System. This is a special combination of Sikadur® epoxy resin adhesive and Sika modified hypalon strip that is extremely elastic. It can accommodate different joint and crack widths, excessively wide joints or joints that are contaminated with failed sealants. It is also very chemically resistant and suitable for exposure to many aggressive chemicals, including those in exhaust gases. This means that the Sikadur®-Combiflex® system is particularly good for use in the important lower containment basin areas.

STRUCTURAL REINFORCEMENT AND STRENGTHENING

ANCHORING OF ADDITIONAL OR REPLACEMENT STEEL REINFORCEMENT IN THE CONCRETE:
The selection of the appropriate size and configuration of such reinforcement and the locations where it is to be fixed or anchored, must always be determined by the structural engineer. The fixing points or anchorages into the concrete should then be designed, produced and installed in accordance with EN 1504 Part 6 and all of the relevant European Technical Approvals (ETA).

Sikadur® adhesives have extensive independent testing certificates, approvals and references on major power and infrastructure projects all over the world.

Sika® AnchorFix® cartridge-packed adhesive fixing system, includes epoxy and epoxy acrylate based anchoring adhesives.

Sika® AnchorFix®-2 is ETA-approved for structural applications and it is particularly suitable for fast, secure and chemically resistant bonding of new or replacement additional steel reinforcement into the structural concrete of chimneys and cooling towers.

EXTERNAL STRENGTHENING BY PLATE OR FABRIC BONDING:
Structural strengthening by bonding of external plates is carried out in accordance with the relevant national design codes and EN 1504-4. The exposed surfaces of the concrete to receive the externally bonded reinforcement should be thoroughly cleaned and prepared. Any weak, damaged or deteriorated concrete must be removed and repaired, to comply with EN 1504 Part 10 Section 7.2.4 and Section 8.

In 1990 Sika started working with modern composite materials, particularly glass, aramid and carbon fibres. These are now used extensively for structural strengthening works as Sikadur® epoxy adhesive bonded mortar, as Sika CarboDur® preformed plates or as SikaWrap® fabric sheets which are built up and moulded on site with Sikadur® epoxy resins.

PRE-STRESSING (POST-TENSIONING) OF SIKA CARBODUR® PLATES:
The extensive expertise and experience that Sika has gained with these materials also led to the exciting development of pre-stressing systems and techniques for post-tensioning applications with the Sika CarboDur® plates. These include the Sika CarboStress® system.

The innovative Sika CarboHeater allows the plate bonding systems to be installed on site at low temperatures or it can accelerate the adhesive's curing for rapid installations, with only minimal downtime. With this innovation, the strengthening works can be carried out with only short overnight closures or during the winter which is not possible without heater.

1 Sika CarboDur® CFRP plates being bonded with Sikadur® epoxy adhesive directly to the repaired external concrete surface at the top of a cooling tower for increased restraint.
2 Sikadur® adhesive application to the Sika CarboDur® plate.
3 Easy application of the Sika CarboDur® plates from powered access cradles.

ADDITIONAL SIKA SOLUTIONS STEEL COATINGS FOR CORROSION PROTECTION

DURING THE CLOSURE AND OUTAGE of concrete chimneys and cooling towers for substantial refurbishment works, the opportunity is usually taken to renew or refurbish the associated structural steelwork and other ancillary steel equipment.

This can include walkways, railings, water storage tanks and other different types of equipment in and around the structure.

These steel surfaces are exposed to the same aggressive conditions from the exhaust gases and condensates, UV light exposure and weathering. This means that the steel surface exposure is similar to the concrete in the zone classification of the external areas and also internally within cooling towers, dependant on its position. This exposure can be classified as at least according to ISO 12944 part 2 "Heavy Industrial", which therefore also requires durable and effective corrosion protection.

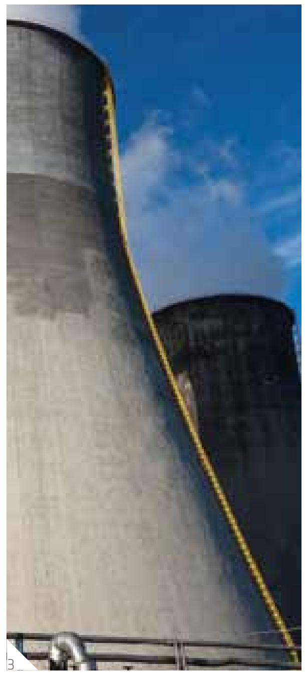
DURABLE CORROSION PROTECTION

For this durable level of corrosion protection to be achieved in this aggressive environment, the steel surfaces must all be prepared by blast cleaning to a standard equivalent to ISO 12944 part 1 Sa 2½.

Sika produces all of the necessary products to meet the stringent protection and durability requirements in these situations, with all relevant systems approvals and certification. These systems include active primers and then the intermediate and top coats according to the specific structure requirements, designed for use in shop and/or site applications.

The SikaCor® coatings range also includes materials for direct application to exposed galvanized steel and aluminium surfaces.

- For functional equipment and its associated structural support steel surfaces with chemical contact and exposure: The Sika Poxitar® System is specifically designed for these extreme conditions. It is based on epoxy resin combinations.
- For structural steel and functional equipment surfaces with normal industrial area atmospheric levels of chemical exposure: The Sika® Poxicolor® System is particularly suitable for this due to its high-build properties and it is also based on epoxy resin combinations.
- For the steel surfaces with the highest potential stress from both chemical and UV exposure in service, together with visual appearance requirements: The SikaCor® EG System, including SikaCor® EG-5 polyurethane resin based top coating, is used extensively and successfully around the world on this type of structure for durable protection in these conditions.



1 SikaCor® steel coatings and Sikafloor® concrete protection applied to ancillary equipment and surfaces.
2 Associated equipment protected with SikaCor® steel coatings for durable corrosion protection.
3 Galvanized steel ladders protected with direct application SikaCor® coatings.

CONSTRUCTION AND PROTECTION OF NEW STRUCTURES

THE OLD SAYING THAT "PREVENTION IS BETTER THAN CURE", IS CERTAINLY ADVISABLE WITH CHIMNEY AND COOLING TOWER CONSTRUCTIONS.

Sika Icosit®-2406 epoxy coating applied inside a cooling tower.
Right: Slip-forming a new concrete chimney base structure with Sika® ViscoCrete® technology.

Achieving durable construction with surface protection from the start, following the old saying that "prevention is better than cure", is certainly advisable with chimney and cooling tower constructions.
Both of these types of structure are now normally built by slip-forming or similar climbing form methods. These all involve working to achieve almost continuous steel fixing, concrete pouring and then the early release and movement of the formwork.
The concrete is almost always pumped into the slip-forms and therefore it is required to be extremely fluid for pumping and placement around the dense reinforcement. Yet it must also be suitable to achieve the high early strengths required to allow the formwork to be safely moved as soon as possible.

HIGH PERFORMANCE CONCRETE

This is exactly what can be achieved with Sika® ViscoCrete® superplasticizer technology. In combination with Sika-Rapid® technology, the necessary concrete consistency and performance can now be produced in all of the different climatic conditions around the world. This allows high quality construction in all geographic locations, plus the construction work can continue uninterrupted through-out the year, without costly delays in the winter. To achieve a dense, closed concrete surface for maximum durability, it must be cured correctly and efficiently. However, this is particularly difficult on slip-formed surfaces which can easily dry out too quickly. This can result in lower surface strengths, increased porosity and reduced quality. The risk of surface shrinkage and cracking will be increased.

CONCRETE PROTECTION

Sika pioneered an innovative method of overcoming these difficulties, by applying a protective coating to the concrete surfaces immediately after striking. This is not by using so-called "concrete curing agents", but by the early application of the first or the primary coats of the special Sika protective coating systems. This is achieved with the physically hardening, acrylic-based Sikagard®-680 S for External Zones 2 and 3. For the external Zone 1 and as well as the inside of the cooling towers Sikagard®-720 EpoCem®, cement modified epoxy, can be used as resurfacings and early protections.
The secret of success with this concept is in the high moisture tolerance and displacement capabilities of the products, plus the penetrative capabilities of these special Sika® systems. This procedure has now become well known as "direct curing". This early-age coatings application also allows the concrete to achieve its maximum strengths and prevents any initial carbonation.

**EXTERNAL ZONES 2 AND 3 –
PROTECTIVE COATING SYSTEM FROM THE START:**

Use Sikagard®-680 S the single- component acrylic-based, pigmented anti-carbonation and water-repellent coating system. Alternatively as an external coating system with crack-bridging properties use coatings from the Sikgard®-500 Elastic range.

**EXTERNAL ZONE 1 –
PROTECTIVE COATING SYSTEM FROM THE START:**

Use Sika Icosit®-2406 solvented, two-component, pigmented and chemically resistant epoxy resin based coating. It is followed by two coats of SikaCor® EG-5, colored, chemically resistant and UV color stable, polyurethane top coat.

**INTERNAL SURFACES –
PROTECTIVE COATING SYSTEM FROM THE START:**

Use Sika Icosit®-2406 solvented, two-component, pigmented and chemically resistant epoxy resin based coating. Plus Sikagard®-363, as the UV and chemically resistant top coat, which should be applied in the solar exposed upper section.

CASE STUDIES OF REINFORCED COOLING TOWERS

EKO, GERMANY

THE PROJECT
EKO STEEL WORKS, EISENHUTTENSTADT, GERMANY
Owned by Arcelor, the world's largest steel producer, the plant had 4 natural draught cooling towers built in the early 1960's. Each tower was 55 m high with an average diameter of 33 m and a total combined internal and external surface area of more than 10,000 m².

THE PROBLEM
During the 1990's three of the towers became unsafe and had to be demolished, they were then replaced with costly forced-draught coolers. The fourth was also under threat in 2003 due to the extent of continuing concrete damage that had occurred. Traditional repair and strengthening techniques were considered to be impractical and extremely costly, therefore its demolition was also proposed. However, one of the leading German Consulting Engineers, Leonhardt Andrea and Partner (LAP), proposed an innovative solution.


Quality control of the concrete. Core drilling on the wall.


Autumn 2004, surface fully coated with Sikagard®-680 S concrete color.

THE SIKA SOLUTIONS
The solution involved using the latest Sika structural strengthening techniques from Sika Germany, in combination with the established Sika MonoTop® cementitious repair system and well proven Sikagard® protective coatings.
With this cost effective proposal the Cooling Tower was repaired and strengthened in 2004 and then resumed operations without major disruption to steel production and without the huge cost of demolition and replacement.
The repairs included hand applied patch repairs with the Sika MonoTop® System and large volume repairs with SikaCem® Gunite-212, which was dry spray applied.

Structural strengthening was readily achieved by using the extremely lightweight but incredibly strong SikaWrap®-200 C CRFP incorporating Sikadur®-330 impregnating epoxy resin adhesive. Protective coating systems were applied internally as the Sikagard® VGB approved system and externally with Sikagard®-680 S including over the fabric reinforcement to also improve the overall visual appearance.

GROOTVLEI, SOUTH AFRICA

THE PROJECT
GROOTVLEI POWER STATION, BALFOUR, SOUTH AFRICA
This coal fired power station has six 200MW power producing units that were first commissioned in 1969. However, due to the increased cost of coal and transport, three were mothballed in 1990. Then in 2005 it was decided to reopen these and also to refurbish the whole plant to meet increased power demands and the different economic situation. Full running of the plant is planned for December 2009.

THE PROBLEM
Due to the combination of all the usual reasons including carbonation and aggressive exhaust gas attack to the concrete, the cooling towers, support structures and also the main chimneys in the plant had suffered severe deterioration during 30 years of exposure. There were also a substantial number of structural cracks in the cooling towers resulted from a combination of loading and ground settlement/movement. These cracks allow water ingress in the concrete structures affecting the durability of the post-tensioned steel.

THE SIKA SOLUTIONS
The structural cracks in the concrete were sealed at the surface and then filled and re-bonded with the Sikadur structural epoxy injection system and the damaged concrete was patch repaired with the Sika MonoTop® hand applied system with SikaGrout®-214 for poured repairs. SikaTop® Armatec-110 EpoCem® was used as the steel reinforcement primer onto the prepared steel, where concrete spalling over corroding reinforcement had occurred to provide long term corrosion protection.
The external surfaces of the repaired cooling towers were protected with a Sikagard® hydrophobic impregnation and the external chimney surfaces were protected with Sikagard®-550 W coatings due to the more aggressive exposure and possible risk of future cracking from the adverse thermal gradients that can occur in service.


Crack Injection.

TUROW, POLAND

THE PROJECT
TUROW POWER STATION, BOGATYNIA, POLAND.
The Turow Power Station in Bogatynia, Poland, is the main energy supplier in this area at the borders of Poland, Germany and the Czech Republic. In the past the area was known as the 'Black Triangle' due to it's heavily polluted environment with up to 50 power plants within a 50 km radius. The environmentally aware residents of the area now have the aim to be known as the 'Green Triangle'.

THE PROBLEM
In 1988 one of the nine cooling towers in this power station collapsed due to the advanced deterioration of the reinforced concrete structure caused by the aggressive exposure. This triggered a major condition survey of all such structures in Poland to be ordered by the government – several were found to require immediate repair due to similar concrete damage and reinforcement corrosion.

The Turow No. 2 Cooling Tower was one that required immediate repair. Due to the authority's lack of experience in the repair of these structures, a well known specialist contractor in this field from Germany was appointed to carry out the work and develop the skills of local contractors for similar works in the future.
This specialist contractor used Sika as their repair materials supplier because Sika had worked successfully with them on earlier projects in Germany and elsewhere to develop and adapt products specifically for the special requirements on these structures.

THE SIKA SOLUTIONS

Cooling Towers	
Internally	**Externally**
Hand applied patch repairs using the Sika MonoTop® system	Hand applied patch repairs using Sika MonoTop® system
Large volume repairs using dry spray shotcrete modified with Sikacrete® PP1 TU	Large volume repairs using dry spray shotcrete modified with Sikacrete® PP1 TU
Internal protection with Sika® Icosit®-2406 epoxy coating	Sikagard®-700 S hydrophobic impregnation followed by Sikagard®-680 S and the elastic coating Sikagard®-550 W on areas at risk of future cracking
Chimneys	
Internally	**Externally**
Patch repairs using Sika MonoTop® system	Patch repairs using Sika MonoTop® system
Internal steel duct protection with Sika Icosit® Poxicolor and Icosit® Elastic system.	Zone 1 and into Zone 2: Sika Icosit® Poxicolor and Sikafloor®-363 Elastic
	Rest of Zone 2 and Zone 3: Sikagard®-700 S Hydrophobic impregnation followed by Sikagard®-680 S or Sikagard®-550 W

Due to the success of this initial project all of the cooling towers and chimneys at the power station in need of repair have used the same system for the past 18 years with Polish contractors now fully trained and competent in the works.
Up to now, more than 240 000 m² of concrete surfaces on these structures have been repaired with the Sika Systems at this plant.
In 2007, laboratory testing, assessment and an in-situ investigation were carried out by the Building Research Institute of Poland, to check the suitability and durability of the system used. Furthermore, an extended approval for the Sika systems was granted in Poland for these structures.

CASE STUDIES

KALININ, RUSSIA

THE PROJECT
KALININ NUCLEAR POWER PLANT, TVER, RUSSIA

The Kalinin Nuclear Power Plant is located in Tver` region near the town of Udomlya (~200 km away from Moscow). The plant was commissioned in 1985. Owner and operator is the State Company Rosenergoatom. Kalinin Nuclear Power Station supplies the majority of electricity in the Tver region and additionally serves Moscow, Saint Petersburg and Vladimir. The plant has four 150 meter tall cooling towers. In accordance with the latest regulations in nuclear sector, these structures were built to last at least for more than 50 years. Two newly built cooling towers were protected with Sika coating systems in 2009/10.

REQUIREMENTS FOR THE EXTENSION OF SERVICE LIFE OF EXISTING TOWERS

- Outside waterproofing of substructure of supporting columns
- Excellent corrosion protection of concrete shell (inside and outside)
- Corrosion protection of steel structures (pipes, access boards etc.)

THE SIKA SOLUTIONS

The high quality concrete admixtures Sika® ViscoCrete®-20 HE / 20 Gold were used to achieve the high concrete quality requirements. Some local concrete repair was needed and Sika MonoTop®-610 corrosion protection and Sika MonoTop®-612 patch repair mortar were used. Sika® Icosit®-2406 System was used as protection coating system of the inner concrete shell and precast concrete installed in the tower. The external surfaces of these new Cooling Towers were protected with 2 coats of Sikagard®-700 S hydrophobic impregnation followed by 2 coats of acrylic based coating Sikagard®-680 S BetonColor.

SikaCor® Zinc R and SikaCor® SW-500 System was applied as corrosion protection system for the steel elements inside the tower. Outside waterproofing of substructure of supporting columns was provided with 1-component and easy to apply bituminous mastic Igolflex® N.

LENINGRAD, RUSSIA

THE PROJECT
LENINGRADSKAYA NUCLER POWER PLANT-2, LENINGRAD, RUSSIA

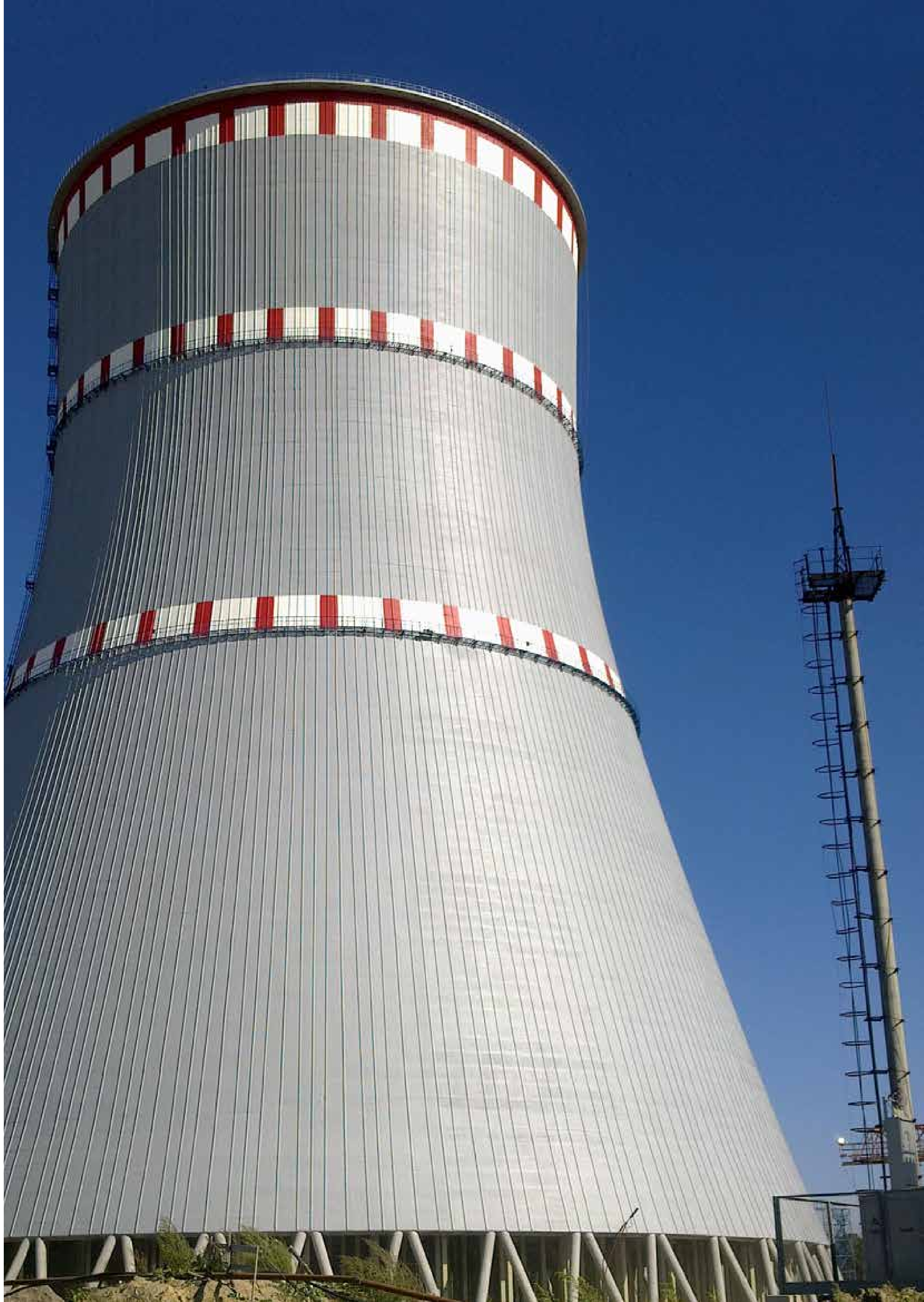
The Leningradskaya Nuclear Power Station is located near the Sosnoviy Bor town Gulf of Finland. Owner and operator of the plant is the State Company Rosenergoatom. This is a newly built plant, consists of four nuclear reactors and three huge natural draught cooling tower. By the end of 2013 two of cooling towers were built, one was in design process. One of newly built cooling towers was completely protected inside and outside with Sika coating systems. Steel pipes inside cooling tower were protected with corrosion protection systems. Sika material was also used for the waterproofing of the basement, protective coatings for basin and precast concrete inside cooling tower.

GOAL OF PROTECTION SYSTEM

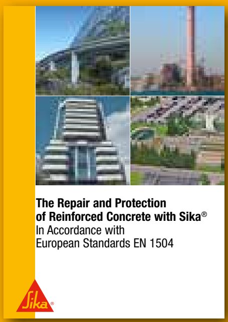
- Protective coatings for internal and exterior shells to extend the durability and makes the service maintaining easy and cost effective
- Durable basement waterproofing
- Corrosion protection of steel structures
- Protection of precast concrete

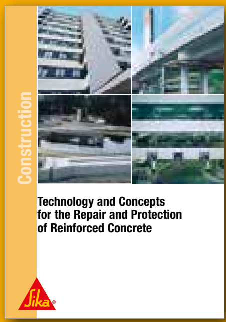
THE SIKA SOLUTIONS

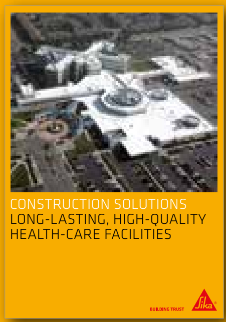
- The combined system of hydrophobic impregnation Sikagard®-700 S and acrylic-based protective coating Sikagard®-680 S BetonColor was used for the exterior concrete shell. For the inner concrete shell protection, epoxy coating system Sika ®Icosit®-2406 was used. In the zone accessible by the UV radiation, a final coat of PU coating Sikagard®-363 to provide the UV protection to the epoxy coating was applied.
- The waterproofing of the basin was provided by 1-part bituminous mastic Igolflex® N and PVC Sika® Waterbar were placed in the construction and expansion joints.
- Corrosion protective system for steel pipes and access boards provided by epoxy-based SikaCor® Zinc R as a primer and SikaCor® SW-500.
- Local concrete repair with Sika MonoTop® System.
- Precast concrete inside cooling tower was protected with Sika ®Icosit®-2406 System

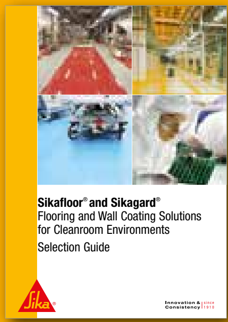


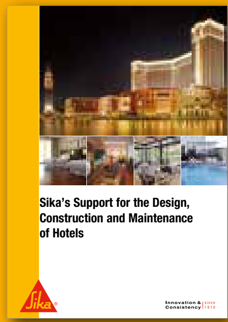
ALSO AVAILABLE FROM SIKA

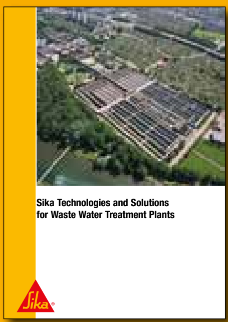


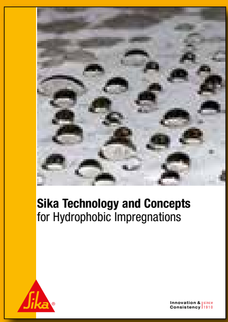


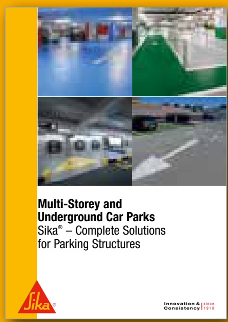


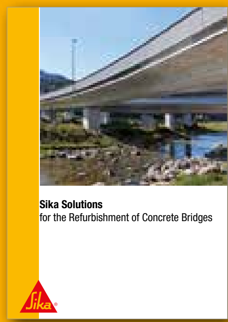












FOR MORE REFURBISHMENT SOLUTION INFORMATION:

WHO WE ARE

Sika AG, Switzerland, is a globally active specialty chemicals company. Sika supplies the building and construction industry as well as manufacturing industries (automotive, bus, truck, rail, solar and wind power plants, façades). Sika is a leader in processing materials used in sealing, bonding, damping, reinforcing and protecting loadbearing structures. Sika's product lines feature highquality concrete admixtures, specialty mortars, sealants and adhesives, damping and reinforcing materials, structural strengthening systems, industrial flooring as well as roofing and waterproofing systems.

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

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