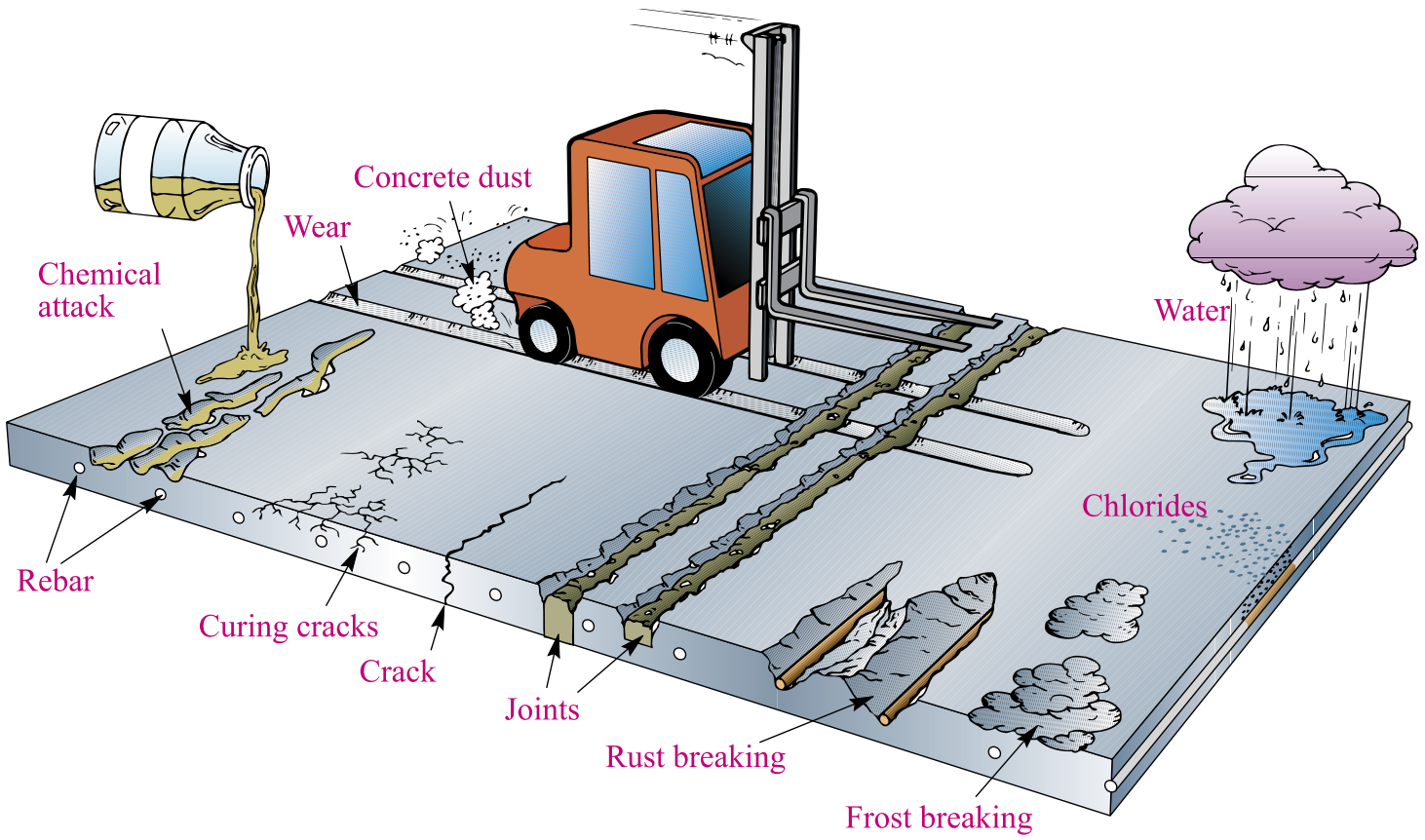


Repairing and protecting concrete

A number of companies and personnel within the European Industrial Group have worked with the reparation and protection of concrete over the last 20 years. During this period we have developed a unique State of the Art competence in the specific area.

In our yearly meetings we have noticed that advisors and consultants in the Nordic countries some times give the wrong recommendations. Thus, the recommended product does not give the required effect and the process turns out to be more expensive than necessary.

We think it is utterly important that we inform each other about where and how our products should be used as well as where the products and methods have been unsuccessful. By doing this we can inform our customers and the consultant companies about better methods and products.

Through our net of customers we cover the most varied branches such as hydro electrical power plants, nuclear power plants, pulp and paper mills, foundries, chemical factories, the food industry, sewage plants and sugar plants. Our work cover floors, walls, roofs, joints, wire tanks, foundations, surroundings, settling basins, bridges, chimneys, screw pumps, dams, cracks etc.

We buy our products straight from the manufacturers without the use of a middleman.

By doing this we can offer quality products at reasonable prices while using our own trademark MSS.

We have more than 80 different products to choose between in order to provide the best possible repair and protection of concrete. Some of these are:

- **Impregnation**
- **Crystallization**
- **Anti-carbonation**
- **Epoxy**
- **Acrylic**
- **Polyurethane**
- **Cement based**
- **Fast curing**
- **1200°C**
- **400 MPa**
- **Composites for surface protection**
- **Carbon fibre composites for strengthening**

One single product cannot solve every problem on its own.

The concrete needs to be examined to see what has caused the damage and additional information needs to be obtained from the customer.

Concrete damages

The concrete becomes damaged when water, chlorides, chemicals, wear or heavy traffic affects it (which can be carbonated (neutralised)).

The steel rebars start to rust which eventually will lead to rust blasting.

Impregnation

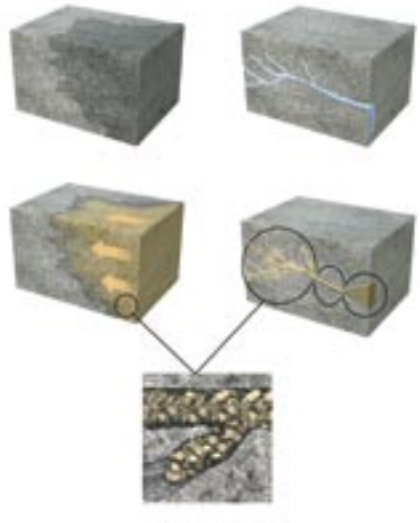
Then we treat the surface of the material. The material penetrates the concrete from a few millimetres to a few centimetres, depending on how porous the concrete is. The surface becomes both waterproof and diffusion open. The method requires minimal preparation.

Crystallization

The material penetrates deeper into the concrete which becomes waterproof, diffusion open and strengthened.

The method has been used since the beginning of the 1990s and been applied to several millions of m2.

A number of independent tests have been carried out, which show that the crystallization method functions as promised by the manufacturer.



Crystallization penetrates the concrete through the capillary power in pours and cracks in order to stop further leakage. The chemicals crystallize (these are non-poisonous and are approved as drinking water) and prevent the spread of moisture within the concrete.

The concrete becomes:
- **Waterproof**
- **Diffusion open**
- **Stronger**

Anti-carbonation
This is a method which has been developed through crystallization. The material protects the concrete from water while it is still diffusion open. The material is available in the most common colours and the manufacturer offers a 10 year warranty for outdoor application.

Good protection at a reasonable cost
The biggest gain with impregnation, crystallization and anti-carbonation is that the steel rebar is protected; otherwise the steel rebar would rust because of carbonatization which is caused by water moisture and chemicals. These tree products provide a good protection against chloride and soft chemicals at a reasonable cost. Furthermore they also stop the breakdown.

Application analysis
The first thing we do when the concrete is damaged is to carry out an application analysis. This makes it possible to see what has caused the damage and which method to use. Often the damage is so severe that we can see both the ballast and the rebar only by looking at the concrete.
The questions we (and our customers) need to ask are:

What has caused the damage?
Water Chlorides Damp
Chemicals Wear
Heavy traffic
Thermal shock
Temperature
- How deep is the damage of the concrete?
- What life cycle do we want to attain?
- What is the reparation time?

The most important aspect when repairing and protecting damaged concrete is to choose the right product and carry out a thorough surface preparation.

If the damage is less than 6 millimetres we use a moisture resistant primer that forces out the moisture, which allows us to repair the concrete with composite materials. It is a common method that makes it possible to apply the composite products on damp concrete. The concrete does not need to dry and often there is no time for that. Concrete damage over 6 millimetres is repaired with fast curing cement based products which reach C 50 within two to four hours. After that the renovated area is covered with a suitable surface protection depending on the medias chemical composition, pH, temperature, wearing particles, heavy traffic, etcetera. We have the ability to protect the concrete with products that have unique characteristics such as:
Temperature resistance 1200°C
- Pressure resistance 400MPa
- Resistance to hydrogen peroxide
- Resistance to aggressive acids and alkalis

The concrete is often exposed to and demolished by aggressive chemicals.
A number of different materials have been used to protect the concrete but most of these have not been good enough. Today, products and methods have been developed to withstand most of the chemicals that are used in the industry, up to 200°C

The illustration shows where carbon fibre composites can be used to strenghtening concrete constructions.

THE PICTURE shows a floor that is exposed to many different kinds of media and varied temperatures.

It is very important to carry out a detailed examination of the floor in order to see what the floor has been exposed to and what kind of chemicals it will be exposed to in the future. After the examination we are able to recommend the right product and the right surface preparation.

During the 90s Ultra High Performance Concrete (UHPC) was developed and launched. It has proven to be the perfect product for the protection of concrete, when the concrete is exposed to heavy wear and pressure. It has been used in heavy traffic areas, machine workshops, terminals, parking decks and even floors in the food industry.

Ultra High Performance Concrete (UHPC) has some remarkable characteristics such as:

- Pressure resistance 160-400 MPa
- Tensile strength 10-30 MPa

If the floor and other constructions are defective as foundation, the Ferrorplan system is used. This increases the following:

- Tensile strength to 100-300 MPa
- Bending strength to 100-400 MPa

The outer area in the chip bins consists of concrete or is lined with steel. Various types of media such as chips, bark, bark acid, forest residue, etcetera, causes heavy wear. Together with our customers we have discovered that there is an unnecessarily high number of break downs and maintenance, the reason being that the wrong material was used in the chip bins.

Composite technology has shown to be suitable for reparation and upgrading of the chip bins within the concrete. The right products adhere to damp concrete and resist the wear and acid attack in these areas.

Equipments of metal in this atmosphere are often damaged by the media. However, it has been possible to repair and protect the metal with composite technology.

The protection of the outer area has an adhesion of > 15 MPa and is resistant to wear and acid attacks.

Other equipments that have been repaired and upgraded in the surrounding area of the chip bins, with similar metal damage caused by wear and acid attack, are transport screws, tubes and conveyors amongst others.

This has resulted in lower maintenance cost and fewer breakdowns in a large number of plants.

Silos, chimneys, water towers, walkways and other buildings/constructions carbonate because of weather, acid rain, chlorides, etcetera. It is important to protect the assets by cleaning, repairing and shielding in time, before much larger and more costly repairs have to be carried out.

One of the two bridges that joins the island Tjörn with the mainland on the Swedish west coast has been strengthened with carbon fibre composite.

The concrete in the stock chest vat had disappeared...

”COMPOSITE IS THE FUTURE”

Over five days the walls in the stock chest should be rebuilt with fast curing cement based repair material and then ccoated with composites.

”Composite coating in pulp stock chests is the future. I can’t think of a better solution; I expect a life cycle of many years...”

Stig Johansson of Smurfit Kappa Kraftliner in Piteå is absolutely certain; the tiled pulp stock chests are out-dated.

It can be considered as a small problem but in the paper industry it is utterly important. If a pulp with sufuric acid begins to leak, it should be taken with due consideration. If the concrete begins to crumble and mix with the pulp the problem gets even worse. Quality problem and production stop is just around the corner.

TRADITIONALLY there are three different types of pulp stock chests. They are casted in concrete and are either painted or covered with a polyester material (plastic). Another common method is to cover the inner walls with tiles. These materials have a limited life cycle.

”We have both plastic coated and tiled stock chests at Kappa. But they don’t last forever”, Stig Johansson explains.

”The problem with tiles is that the joints split. The sulphuric acid penetrates the area under the tiles and begins to dissolve the concrete, which disengages the tiles from the concrete and the concrete particles that are mixed with the pulp. This reduces the quality and increases the risk for unplanned shut downs and breakdowns in pumps and bearings etcetera. The stock chest is a very important link in the chain of paper production”.

ANOTHER important factor is time. Simply there is not enough time to renovate the stock chest by replacing damaged tiles.

”Previously this could be done during the summer shutdown, which last four weeks. Now we don’t have time; the stop cannot last longer than five days. Then everything has to be all set for restart”, says Stig Johansson.

Composite is not a new method for Kappa and Stig Johansson.

”We have used composite to repair stock chests before, when the joints of the tiles have disengaged. But for the first time we coated a complete stock chest with composite; approximately 400 m2”.

It was Greger Sohlman at Industrial Development who received the contract. It was done on time; in five days the whole stock chest was both repaired and coated and is now expected to last many years.

”I wouldn’t be surprised if we replaced the tiles with composite in the future, in all our stock chests. Quite simply because it lasts for so long. I really believe in this method.”

ANOTHER stock chest had tiles instead of polyester, but this made no difference. It was still necessary to do something about it as the joints were in such a bad condition. The media had begun to penetrate the joints and the area behind the tiles, which made the tiles disengage from the concrete. Furthermore 200 millimetres of the concrete wall had disappeared...
”If we had used conventional methods it would have been necessary to close the paper mill. It would not have worked to replace the tiles or use plastic material, as this would have taken far too long”, Greger Sohlman stresses.

Stig Johansson agrees:

”We didn’t have enough time; it had to be five days. In this time the vat would have had to be repaired and attain a new protective layer”.

It was far from simple, considering that 20 centimetres of the concrete had simply disappeared; dissolved by the aggressive sulphuric acid.

“There was only five centimetres left of the wall, Greger Sohlman says, and starts to explain how it happened:

“Because sulfuric acid is added to the pulp, the temperature rises to over 70°C. The high temperature, in combination with the media, creates a very aggressive environment. The media penetrates and begins to dissolve the concrete. It is therefore the combination of temperature and in this case sulphuric acid which is the “bad man” in this drama. The result is that the concrete simply disappears.

WITHIN FIVE days Greger Sohlman and his group did not only have to coat the stock chest with composite, but also rebuild the concrete wall to regain its original thickness.

”We used a material called fast curing MSS 470. It hardens very quickly (equivalent to a C50 concrete). After four hours it was possible to coat with the composite directly. We did the job within the contracted time” Greger Sohlman was pleased to confirm.

And Stig Johansson is just as pleased; not only with the fact that both stock chests have achieved a substantial upgrading, but also because he had avoided the problem of concrete particles within the pulp.

”The problem with the paper industry today is that the system is more closed with higher temperatures and more added chemicals” Greger Sohlman explains. “This can give a number of strange results both in the system and in the additional equipment. If they are painted or coated with plastic, the stock chests crackle due to its age, the high temperature and the media. The joints are the tiles weakest points.

”This is why it is so important to take all the conditions in to consideration (media, temperature etcetera) so that we can use the right product on the right spot.

Today we have a wide selection of products (from cement based to composites) for both concrete and metal, which are mutually compatible. This allows us to protect concrete and metal in i.e. stock chests and towers. This is done at temperatures up to 200°C with full chemical resistance, in a very short shutdown time.”