

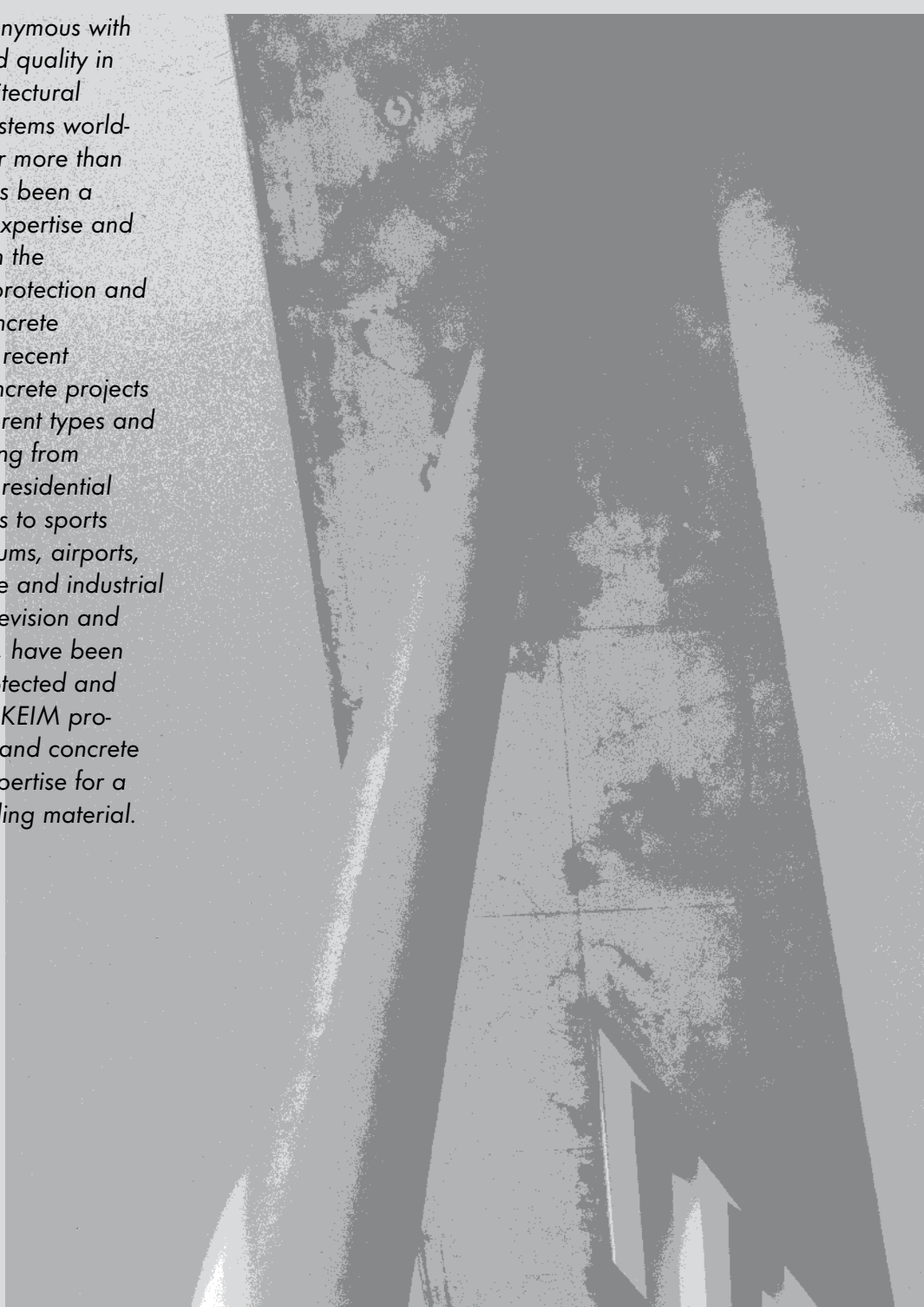


# KEIM CONCRETAL®

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PROTECTION AND BEAUTY FOR CONCRETE.  
THE MINERAL SOLUTION.

*KEIM is synonymous with reliability and quality in mineral architectural protection systems world-wide and, for more than 30 years, has been a byword for expertise and experience in the renovation, protection and design of concrete structures. In recent decades, concrete projects of many different types and scales, ranging from housing and residential developments to sports stadia, museums, airports, administrative and industrial buildings, television and radio towers, have been restored, protected and finished with KEIM products. KEIM and concrete – mineral expertise for a mineral building material.*





# Concrete – making the mind's daring structural designs a reality

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## Concrete - »king and servant in construction«

It soars to huge heights and bridges massive spans. It is present above and below ground and has had a greater impact on the architecture of the last century than any other material. The former President of Germany Theodor Heuss described it as the »building material of the century«, while for the world-renowned Italian architect Pier Luigi Nervi it was both »king and servant in construction«. What we're talking about here is of course concrete, the most modern and economical building material of our time.

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## Resurgence in concrete construction

Whether reticently plain or breath-takingly bold, concrete presents many different faces to the world. It determines the character of individual structures or entire residential areas and has an influence on cityscapes and working environments. Once regarded as grey, uniform and ugly, concrete's image has been poor for some time. But times are changing. In recent years, thanks to new techniques and innovative processes, not only has the quality of concretes improved, but there are also more options for making creative and attractive use of these materials. As in the past, concrete is still distinguished by a huge loading capacity, shapeability and versatility, but now a vast range of visual effects and textures may also be achieved. The particular aesthetics of fair-faced concrete surfaces are

increasingly being recognised and appreciated by planners and architects.

Concrete, like other building materials, is nevertheless also exposed to the ravages of time. As a result of a lack of awareness regarding the inter-relationships between chemistry, building physics and structural design, errors were made in building with concrete, in particular in the 1950s and thereafter, the consequences of which have been evident for some time. The complexity of the patterns of decay and their causes must be matched by an equally nuanced approach to renovation in accordance with not only the technical but also the aesthetic objectives of the architect. This brochure provides a nuanced response to this problem and indicates efficient and economic solutions.

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## Preserving and providing lasting protection for concrete



## Concrete – proper handling of a modern building material

### Structural influences

Concrete as we know it today has been in existence for more than 100 years. It was the idea of the gardener Josef Monier to make flower pots of cement mortar lighter and more durable by embedding wire netting, so laying the foundations for the development of the composite material steel-reinforced concrete. The combination of the compressive strength properties of concrete with the tensile strength of steel has proved outstandingly successful in all areas of construction. Reinforced concrete is made on site or in a factory using manual methods. As a result, quality and durability are more highly dependent on the care taken during processing than is the case with a »finished« building material. This, together with environmental exposure, is the reason for the issues surrounding concrete decay.

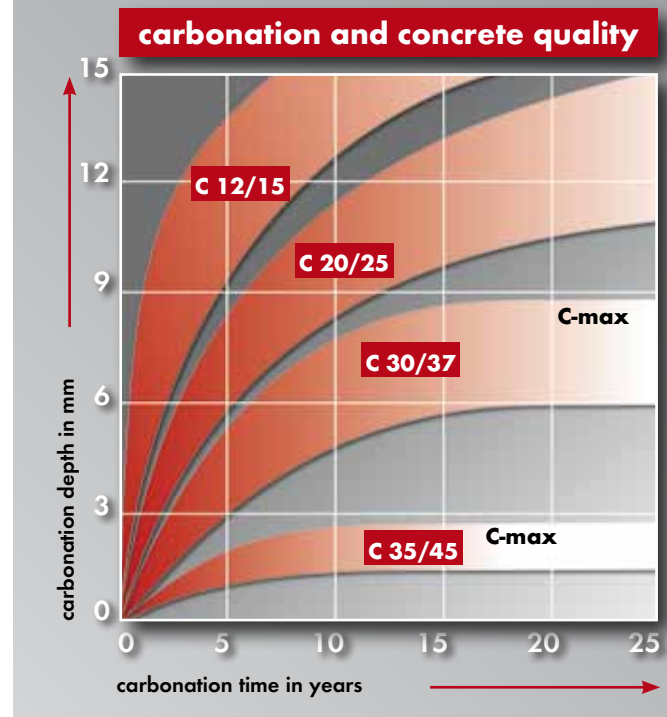
### Concrete hardening

Concrete hardens chemically. The reaction between the clinker and the

mixing water gives rise to crystalline hydrate phases (including calcium silicate hydrates etc.) and calcium hydroxide, resulting in an alkaline environment with a pH value of 12 to 13. In a stable, highly alkaline concrete, a passivation layer forms on the surface of the reinforcing bars which, despite exposure to oxygen and moisture, protects the steel from corrosion.

When made properly, high-quality concrete does not suffer decay other than normal surface weathering. Decay is almost always attributable to errors made in manufacturing, planning or during use and to the fact that in previous decades the mechanisms underlying decay were insufficiently well understood. It is normal for alkalinity to fall in concrete exposed to a central European atmosphere. The calcium hydroxide of the cement reacts with atmospheric carbon dioxide to form calcium carbonate, which incre-

### Long-term behaviour of concrete



ases strength but reduces the pH value to below 9.5. This is of no significance in high-quality concretes with correctly positioned reinforcement as the depth of penetration is only slight and the reinforcement layer is not reached. It has been scientifically demonstrated that, in good concrete, the carbonation process comes to a complete standstill after a certain amount of time (C<sub>max</sub>). In the case of poor quality concretes and inadequate depth of cover, carbonation may reach the reinforcement. Once the pH value drops below 9.5, the passivation present on the surface of the steel is eliminated. If sufficient water is present, rusting may occur on the steel. Since rust has a larger volume than steel, the overlying layer of concrete suffers spalling. Steel corrosion in concrete is an electrolytic process which only takes place if sufficient water is present in liquid form. Rust damage does not occur on concrete surfaces in dry areas, as the water necessary for electrolysis is not present.

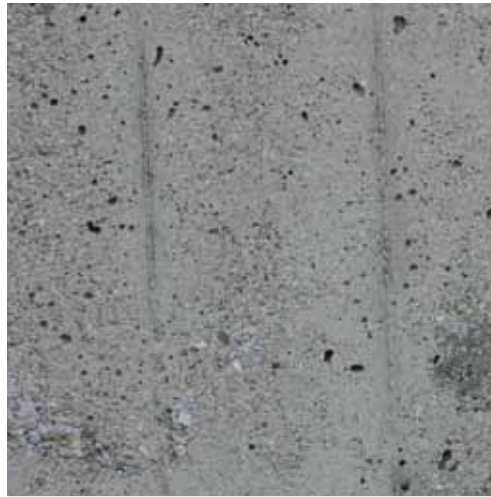
Potential causes of concrete decay may be introduced during manufacture. For example, incorrect water/cement ratios, poor compaction, leaky shuttering and insufficient curing cause increased concrete porosity and thus greater permeability to water, oxygen and carbon dioxide. In addition, the steel reinforcement is often not carefully set in place. Absent spacers, reinforcing baskets displaced in the shuttering, warped mats etc. result in inadequate depth of cover and thus rust damage.

**Decay**



# What causes concrete decay ...

Even concrete, formerly promoted as being »forever«, is not spared from decay. Various external influences, processing or manufacturing errors, shortcomings in design or combinations of these factors may result in serious concrete decay. The only way to avoid such decay is to recognise the problem and provide protection in good time.



## Weathering



Even good quality concrete surfaces suffer attack from normal weather over the course of time. The cement paste layer is slowly broken down, shuttering board textures disappear and pores are opened up, so increasing the ease with which water and pollutants can penetrate. The surface of the concrete loses aggregate and suffers erosion. Moss and algae start to grow, causing a deterioration in appearance and increasing the effects of decay.



## Water



The water absorption characteristics of concrete are determined by its porosity. Hairline cracks and rock pockets may considerably increase water absorption. A high level of water absorption may even result in structural destruction of the concrete on exposure to frost. Water ingress causes rusting on reinforcement parts located in concrete which has already undergone carbonation. Water accumulating under impervious plastic coatings may result in increased corrosive damage.




### **Depth of concrete cover**



The minimum depths of concrete cover over steel reinforcement specified in the standard are frequently not observed. The reinforcement is frequently much too close to the surface of the concrete. In this case, rust damage will inevitably occur even if concrete quality is otherwise good.



### **De-icing salt**



De-icing salts, which mainly consist of chloride salts, are a major hazard to concrete. If sufficient water is present, chlorides may cause serious rust damage to the reinforcement even in uncarbonated concrete (chloride corrosion).



### **Shortcomings in design**



Design faults, e.g. unsealed joints, incorrect handrail attachment, absent or non-functioning drainage, lack of expansion joints or the like, may also cause considerable decay in isolated areas.

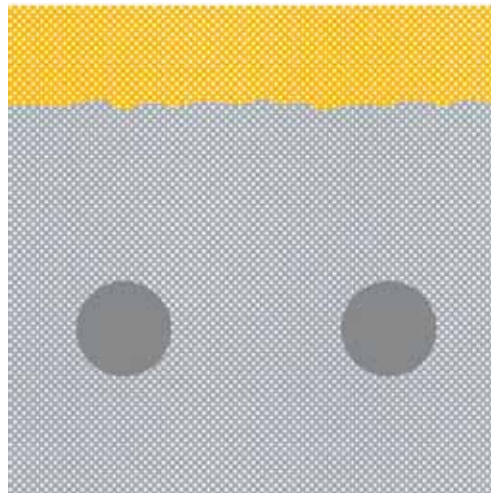
# Concrete diagnosis

## Assessment of shortcomings and investigation of causes of decay

The regulations governing concrete repair require a thorough investigation of the causes of decay and other shortcomings prior to starting any repair work. A technically appropriate repair plan guaranteeing a lasting repair cannot be devised until this preliminary investigation has been carried out.

Important investigation criteria for selecting the ideal protective surface treatment include measurement of carbonation depth, measurement of depth of concrete cover and testing for structurally harmful salts.

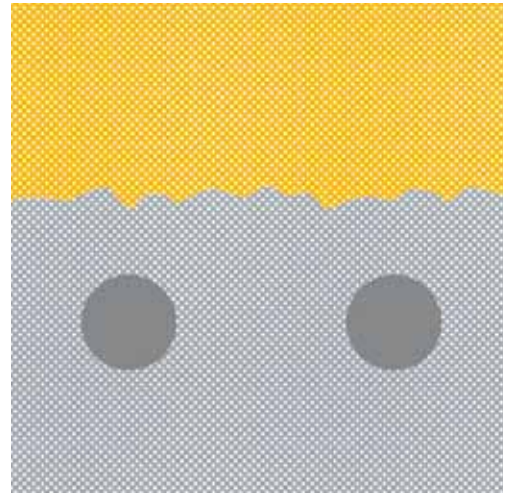
The results of the investigations make it possible to distinguish between very different conditions of the concrete, which each require specific protective surface treatments.



1

**Good concrete quality,  
good depth of cover**

Carbonation depth amounts to only a few millimetres and cannot extend as far as the reinforcement. Carbonation protection (CO<sub>2</sub>-proofing) is not necessary even in the long term. Where concrete quality is good, carbonation is slight and comes to a complete standstill over the course of time, with the depth reached being known as the »maximum carbonation depth«. The reinforcement has lasting protection.

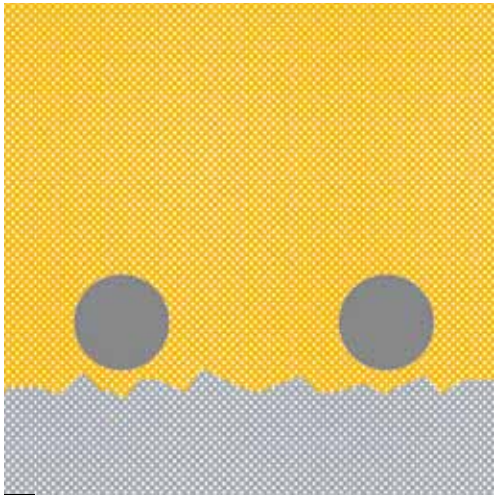


2

**Moderate concrete quality,  
possibly shallow depth of cover**

Carbonation has nearly reached the reinforcement layer. Carbonation protection is necessary in order to stop further progress. If carbonation penetrates deeper and reaches the reinforcement, the protection of the passivation layer will be eliminated. If carbonation is stopped, the protection of the passivation layer will be retained.

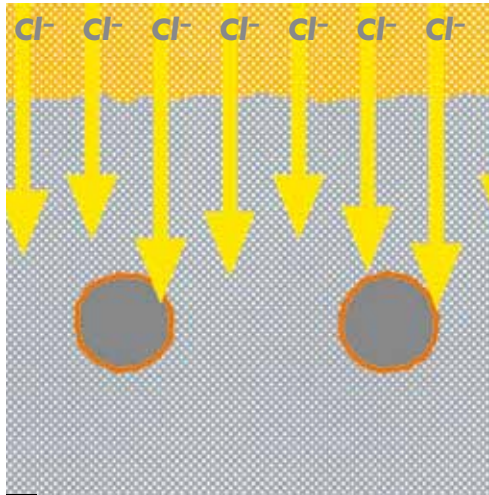




3

**Poor concrete quality or shallow depth of cover**

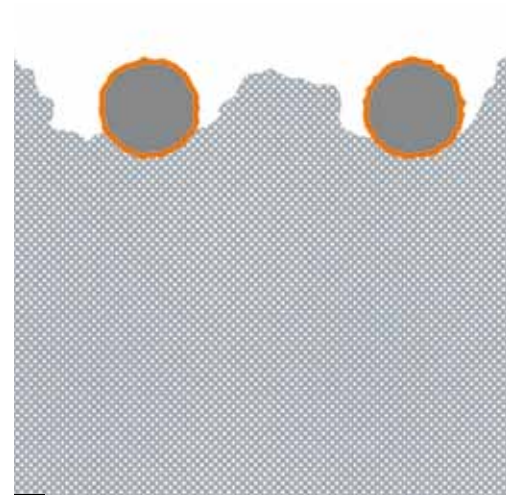
The majority of the reinforcement is located in the already carbonated zone of the concrete. In this case, carbonation protection would be too late and is thus pointless. The primary goal of surface protection is to protect the reinforcement from corrosion. If the concrete has already undergone carbonation, corrosion can only be prevented by waterproofing.



4

**Chloride corrosion; good or poor concrete quality**

Carbonation is slight, but corrosion nevertheless occurs due to the influence of chloride. A protective treatment which prevents penetration of chloride salts is required. Chloride corrosion may occur in as yet uncarbonated concrete even where concrete quality is good.



5

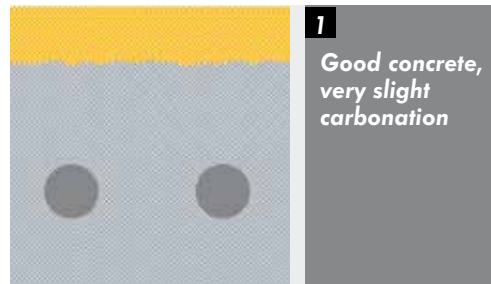
**Inadequate depth of cover**

The reinforcement is close to or right at the surface of the concrete over the entire area (rusting). Additional cover with spray mortar/shotcrete is required. The material is so thoroughly compacted by the spraying process that it cannot undergo carbonation. Carbonation protection is thus not required.

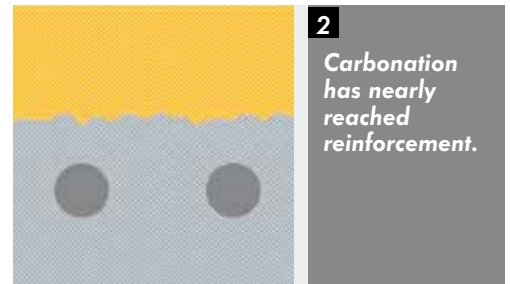
# Grades of protection and product solutions

A protective treatment for concrete surfaces is in principle selected on the basis of concrete quality and the external stresses to which it is exposed. In the case of high-quality concretes used in building construction, such treatments in general simply provide weather-proofing.

In the case of lower quality concrete and severe exposure to pollutants, the emphasis is always on protecting the reinforcement from corrosion. Which grade of protection is to be applied is determined by an analysis of the actual state of the object.



**1**  
Good concrete,  
very slight  
carbonation



**2**  
Carbonation  
has nearly  
reached  
reinforcement.

## Grade of protection: Weather-proofing

### Mode of action:

Thanks to their consolidating action (silicification), silicate coatings can provide long-term weathering protection and weather-proofing for the concrete surface. Shuttering board textures can be strengthened and so secured. Weather protection can be further enhanced by additional water-repellent substrate treatments.

### Product solutions

**KEIM Concretal-Lasur**  
low-pigment or opaque

**KEIM Concretal-W**

usable as additional water-proofing:  
**KEIM Silangrund**  
**KEIM Silan-100**

## Grade of protection C: protection from penetration of CO<sub>2</sub> from the air

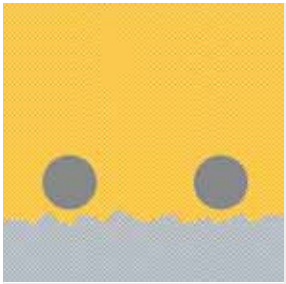
### Mode of action:

The surface of the concrete must be sealed in such a way that gaseous CO<sub>2</sub> cannot penetrate (gas-tight coating). The pores and blowholes of the concrete surface cannot be closed simply by applying a coating. If CO<sub>2</sub>-proofing is to be effective, pores and blowholes must always be closed by filling (full-cover filling) prior to application of the coating.

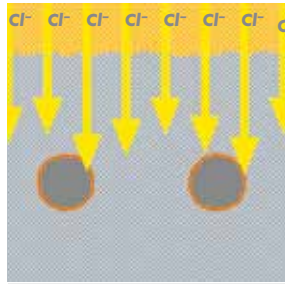
### Product solutions

**KEIM Concretal-Feinspachtel**  
with **KEIM Concretal-C**

usable as additional water-proofing:  
**KEIM Silan-100**  
**KEIM Hydrophobin-2000**



**3**  
Reinforcement is already in the carbonated zone.



**4**  
Severe chloride contamination



**5**  
The reinforcement is close to or right at the surface of the concrete over a large area.

**Grade of protection W:  
Water-proofing**

**Mode of action:**

Suppression of the electrolytic corrosion process by reducing the water content in the concrete (antirust protection by keeping the concrete dry).

1. The coating must prevent water (rain) penetration by exhibiting strong outward water-repellency.
2. The coating must exhibit very good water vapour permeability from the inside outwards, so preventing any build-up of water in the concrete. It must be straightforwardly possible for any intrinsic moisture or water which has penetrated from behind through defects, joints etc. to diffuse out again.

**Product solutions**  
**KEIM Concretal-W**  
**KEIM Concretal-C**  
**KEIM Silan-100**  
*(alone or with coatings)*  
**KEIM Concretal-Lasur**  
*in conjunction with*  
**KEIM Silan-100**  
**KEIM Concretal-Feinspachtel**  
*may be used for additional blowhole sealing.*

**Grade of protection:  
Chloride-proofing**

**Mode of action:**

Chloride salts are transported into the concrete by water. Chloride-proofing thus means water-proofing. The coating must prevent the penetration of chloride-contaminated water by exhibiting strong outward water-repellency. There must also be good vapour diffusion from the inside outwards in order to keep the concrete dry, so preventing any chlorides which are already present in the concrete from becoming active.

**Product solutions**  
**KEIM Concretal-W**  
**KEIM Concretal-C**  
**KEIM Silan-100**  
*(alone or with coatings)*  
**KEIM Concretal-Feinspachtel**  
*may be used for additional blowhole sealing.*

**Grade of protection:  
additional cover**

**Mode of action:**

Additional cover with concrete replacement is necessary for lasting protection. Additional cover in layer thicknesses of 1–3 cm is normally applied by spraying (spray mortar or shotcrete). Spray impact compacts the material so strongly that, with good concrete, virtually no carbonation occurs. Specific carbonation protection is thus not required. A surface coating is applied for reasons of appearance and as weather protection/weather-proofing.

**Product solutions**  
**KEIM Concretal-Mörtel-R** *by wet mortar spraying*  
**KEIM Concretal-Lasur**  
**KEIM Concretal-W**  
*Usable as additional water-proofing:*  
**KEIM Silangrund**  
**KEIM Silan-100**  
*Usable for prior surface smoothing:*  
**KEIM Concretal-Feinspachtel**



## **KEIM protective concrete paints – unique performance:**

Concrete decay and grades of protection, on the one hand, and achieving architectural aims, on the other, often seem to be mutually exclusive. Specifications with regard to design, appearance, conservation and protection are not mutually exclusive - on the contrary we not only want but are also able to provide effective protection for concrete while retaining its mineral character. Using mineral protection products KEIM Concretal final coats are unique in design.



### **KEIM Concretal-W** **Sol-silicate paint to DIN EN 1062,** **Protective concrete paint to DIN EN 1504**

**Grade of protection:**  
**Water-proofing, chloride-proofing**  
**and weather-proofing**

#### **Convincing advantages:**

- Protection from steel corrosion and frost damage thanks to elevated water-repellency
- Protection from chloride corrosion due to absence of water transport
- Lightning fast redrying of concrete thanks to extremely low  $s_d(H_2O)$  value ( $< 0.02$  m)
- Consolidation of concrete surface thanks to the chemical reaction of the silicate binder with the substrate
- Elevated protection from weathering and wear thanks to surface consolidation
- Absolutely lightfast thanks to pure mineral pigments (Fb Code A1)
- Minimal soiling thanks to antistatic and non-thermoplastic binder
- Retains original concrete appearance thanks to mineral matt surface
- Simple to renovate - no stripping required for remediation

**Unique:**  
**elevated water-proofing +**  
**elevated water vapour diffusion +**  
**elevated weather-proofing +**  
**matt surface**



## **KEIM Concretal-C**

**Sol-silicate acrylic paint to DIN EN 1062,  
Protective concrete paint to DIN EN 1504;  
complies with ZTV-ING**

**Grade of protection:  
CO<sub>2</sub>-proofing, water-proofing,  
chloride-proofing**

### **Convincing advantages:**

- Protection from steel corrosion and frost damage thanks to elevated water-repellency
- Protection from chloride corrosion due to absence of water transport
- Lightning fast redrying of concrete thanks to extremely low  $s_d(\text{H}_2\text{O})$  value ( $< 0.07 \text{ m}$ )
- Protection from progressive carbonation due to elevated CO<sub>2</sub> tightness
- Long-term colour stability thanks to pure mineral pigments (Fb Code A1)
- Greatly reduced soiling due to very largely antistatic and non-thermoplastic binder fractions
- Retains original concrete appearance thanks to mineral matt surface

(KEIM Silan-100 and KEIM Concretal-C comply with OS-B of ZTV-ING or OS 2 of RiLi-SIB. KEIM Concretal-Feinspachtel and KEIM Concretal-C comply with OS-C of ZTV-ING or OS 4 of RiLi-SIB.)

### **Unique:**

**elevated water-proofing +  
elevated water vapour diffusion +  
elevated CO<sub>2</sub>-proofing +  
matt surface**



## **KEIM Concretal-Lasur**

**Sol-silicate thin layer paint to DIN EN 1062  
for opaque or low-pigment coatings for  
surface finishing of fair-faced concrete**

**Grade of protection:  
Weather-proofing**

### **Convincing advantages:**

- Perfect levelling of repair surfaces or fair-faced concrete surfaces with an uneven appearance
- Good water-repellency when applied opaque
- Complies with requirement for »water-proofing« grade of protection to DIN EN 1504 in combination with KEIM Silan-100
- Lightning fast redrying of concrete thanks to extremely low  $s_d(\text{H}_2\text{O})$  value ( $< 0.02 \text{ m}$ )
- Consolidation of concrete surface thanks to the chemical reaction of the silicate binder with the substrate
- Elevated protection from weathering and wear thanks to surface consolidation
- Absolutely lightfast thanks to pure mineral pigments (Fb Code A1)
- Minimal soiling thanks to antistatic and non-thermoplastic binder
- Retains original concrete appearance thanks to mineral matt surface

### **Unique:**

**perfect concrete surfaces  
faithful to the original +  
elevated weather-proofing +  
elevated water vapour diffusion +  
good water-proofing**



## Appearance and design

### Shape and colour

Concrete, with its many and varied shapes and surface textures and colours, has a substantial influence on our built environment. Planners and builders are also increasingly focusing on design features. The particular aesthetics of fair-faced concrete surfaces have long been used and held in high regard as an important design element.

**»Concrete is a very demanding material. The beauty of one's creation comes into being when the nature of the building material is honoured.«**

Louis I. Kahn

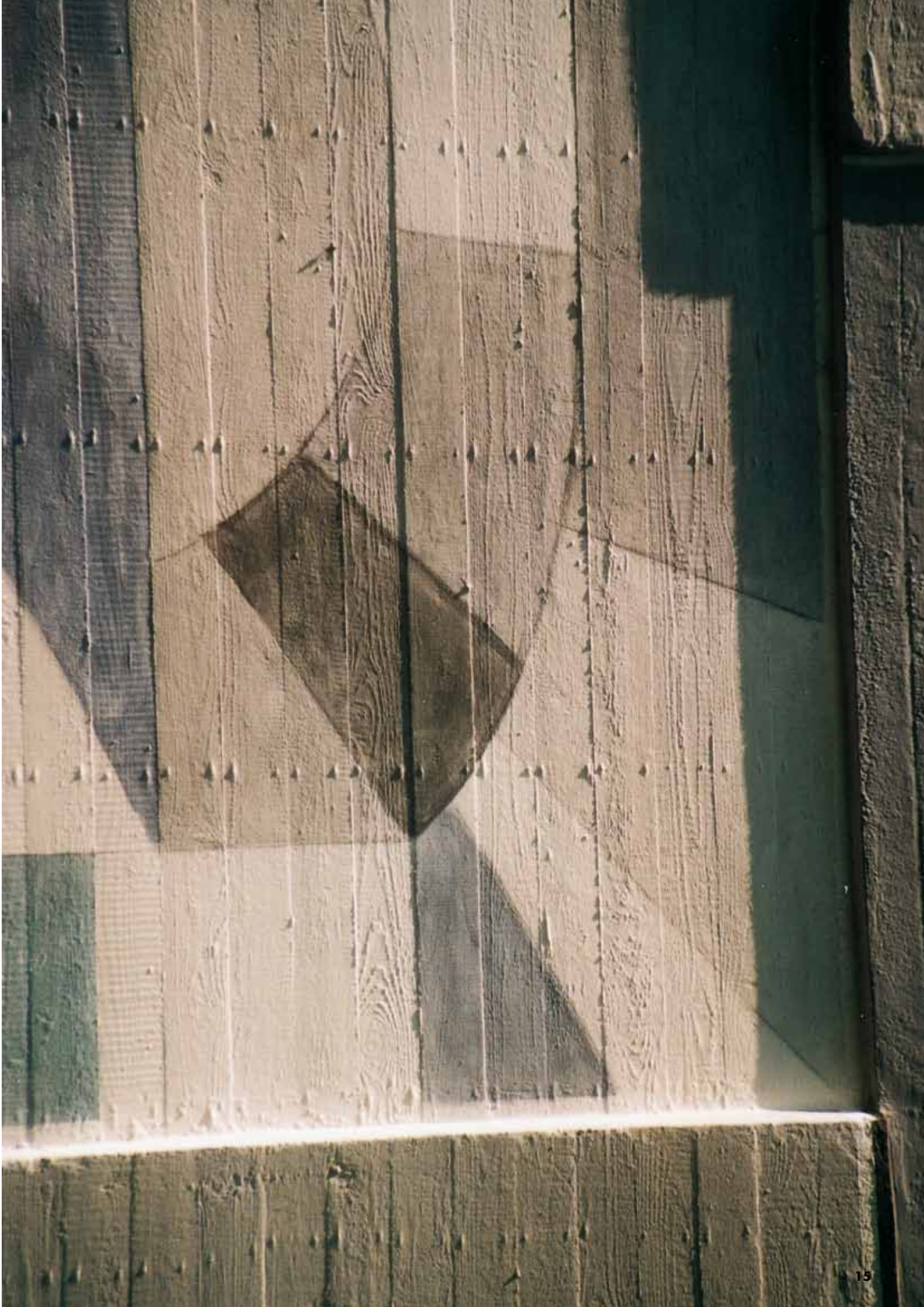
Protecting and finishing fair-faced concrete surfaces with suitable paint materials is always associated with two aspects: on the one hand, it is important to determine specific protection requirements in accordance with location and condition and to specify the suitable protective coat accordingly. At the same time, however, it is also important to take the specific requirements which apply with regard to the appearance of the concrete surface into account:

- Original concrete aesthetic
- Surface action and dimensions of structures and textures
- Mattness of the mineral building material concrete
- Colour play of the original concrete under different lighting conditions
- Tactile properties typical of the material

Concrete should remain concrete – even on the protected surface. The way to achieve this is as simple as can be – original properties can best be maintained by using related materials. Mineral concrete protective coatings for a mineral building material.









# Concrete and structure – vibrant design

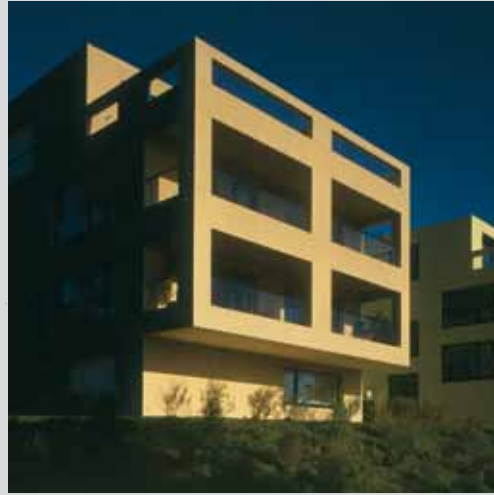








# Concrete, colour and light – a perfect symbiosis







# KEIM Concretal concrete repair

Two tried and tested systems are available for repairing areas of decay. All products are slightly polymer-modified, cement-bound building materials (PCC) which are made up only with water.

## Chiselling out, exposing, rust removal



1 Typical decay of inadequately protected concrete



2 Exposing corroded steel reinforcement



3 Cleaning the steel reinforcement by dry blasting with solid blasting media. Degree of rust removal, Sa 2½ to DIN EN 12944-4

## Concrete repair to the highest standards

Tested for all ZTV-ING applications and having a general technical approval test certificate, this system may be used in both industrial and building construction. The system components consist of: **KEIM Concretal-MKH** (corrosion protection and bonding bridge), **KEIM Concretal-Mörtel-R** (concrete replacement), **KEIM Concretal-Feinspachtel** (levelling filler).

## ZTV-Ing tested system structure



4 Apply two protective coats of KEIM Concretal-MKH to the derusted reinforcement, allowing at least 3 hours to elapse between coats. Apply first coat immediately after rust removal.



5 Prewet the broken away surfaces and then vigorously brush in KEIM Concretal-MKH as bonding bridge.



6 Fill defective areas with mineral KEIM Concretal-Mörtel-R in the moist bonding bridge. Layer thicknesses of 0.5–5 cm are possible, multiple layers must be used from a thickness of approx. 2.5 cm.



7 Smooth and texture match with mineral KEIM Concretal-Feinspachtel on a slightly prewetted substrate. Layer thicknesses of 1–4 mm are possible.



8 Apply two protective coats of KEIM Concretal-C. Two undiluted coats applied by brush, roller or airless sprayer.



## Chiselling out, exposing, rust removal



1  
Typical decay of inadequately protected concrete



2  
Exposing corroded steel reinforcement



3  
Cleaning the steel reinforcement by dry blasting with solid blasting media. Degree of rust removal, Sa 2½ to DIN EN 12944-4

## Concrete repair – simple and reliable

Specifically, carrying out concrete repairs straightforwardly, quickly and reliably means using only one product. The material provides corrosion protection, good adhesion means that a bonding bridge is not required and the elevated fines content means that the surface can be smoothed in a similar way to a filler. Areas of application are conventional building construction and also light-weight concrete objects. **KEIM Concretal-Universalmörtel-S** – one product for every job.



## One product for every job



4  
Fill defects with mineral KEIM Concretal-Universalmörtel in the prewetted substrate, use without specific corrosion protection and bonding bridge. Layer thicknesses of 0.5–5 cm are possible, multiple layers must be used from a thickness of approx. 2.5 cm. KEIM Concretal-Universalmörtel-S can be directly smoothed.



5  
Apply two protective coats of KEIM Concretal-W  
a) diluted priming coat  
b) undiluted finishing coat  
in each case applied by brush, roller or airless sprayer

# Concretal system solutions for tailored protection and

Intended application	Products	Functions													
		Removal of release agents	Stripping of existing coatings	Cleaning/prevention of algal growth	Corrosion protection and bonding bridge	Repair mortar	Concrete filler	Admixture for blowhole grouts	Water repellency	Consolidation	Sealing	Low-pigment finish	Opaque coating	Crack-filling preliminary coat	Diluent for Concretal W/ Concretal-Lasur
Cleaning	Betonschnellreiniger	●													
	Dispersionentferner aromatenfrei		●												
	Algicid-Plus			●											
Repair	Concretal-MKH				●										
	Concretal-Mörtel-R					●									
	Concretal-Feinspachtel						●								
	Concretal-Spezialvergütung							● <sup>1)</sup>							
	Concretal-Universalmörtel-S				●	●	●								
Water repellent treatments Consolidation Sealing	Silangrund								● <sup>2)</sup>						
	Hydrophobin-2000								● <sup>3)</sup>	●					
	Lotexan								● <sup>4)</sup>						
	Silan-100								●						
	Concretal-Fixativ									●					
	Concretal-Betonsiegel										●				
Coating systems	Concretal-Lasur											●	●		
	Concretal-W												●		
	Concretal-W-Grob													●	
	Contact-Plus													●	
	Concretal-Fixativ														●
	Concretal-Base														● <sup>6)</sup>
	Concretal-C												●		

<sup>1)</sup> together with Feinspachtel; <sup>2)</sup> only in combination with coating; <sup>3)</sup> only before application of Concretal; <sup>4)</sup> without any further coating; <sup>5)</sup> together with Silan-100; <sup>6)</sup> Dilution for Concretal-Lasur







**KEIMFARBEN GMBH**

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