CONCRETE
SIKA PRECAST TECHNOLOGIES

BUILDING TRUST

SIKA WET PRECAST TECHNOLOGY

...will change your construction durability dramatically

CONTENT

INTRODUCTION

Sika Precast Technologies

In the precast concrete industry, a concrete element producer sells a finished technical product, though its quality and surface appearance are the producer's calling card.

The precast concrete element producer bears responsibility for technical performance, compliance to standards and durability of products. The production process for precast concrete elements is increasingly industrialised, and efficiency is essential.

Because they execute the entire production process, precast concrete element manufacturers encounter a myriad of requirements. In addition to being efficient the production process should be sustainable and environmentally friendly, holding the CO^2 footprint of the product to a minimum. Besides ecological concerns, health and safety of workers also continues to grow in importance.

Structural design and construction with precast concrete elements requires versatile chemical products, from wet precast production to erection on site.

Sika, a full range supplier, meets the diverse complexity of the entire precast concrete element production and construction process with solutions for all requirements.

SIKA WET PRECAST TECHNOLOGY

Introduction

IN THE PRECAST CONCRETE INDUSTRY, A CONCRETE ELEMENT PRODUCER SELLS A FINISHED TECHNICAL PRODUCT, THOUGH ITS QUALITY AND SURFACE APPEARANCE ARE THE PRODUCER'S CALLING CARD The precast concrete element producer bears responsibility for technical performance, compliance to standards and durability of products. The production process for precast concrete elements is increasingly industrialised, and efficiency is essential.!

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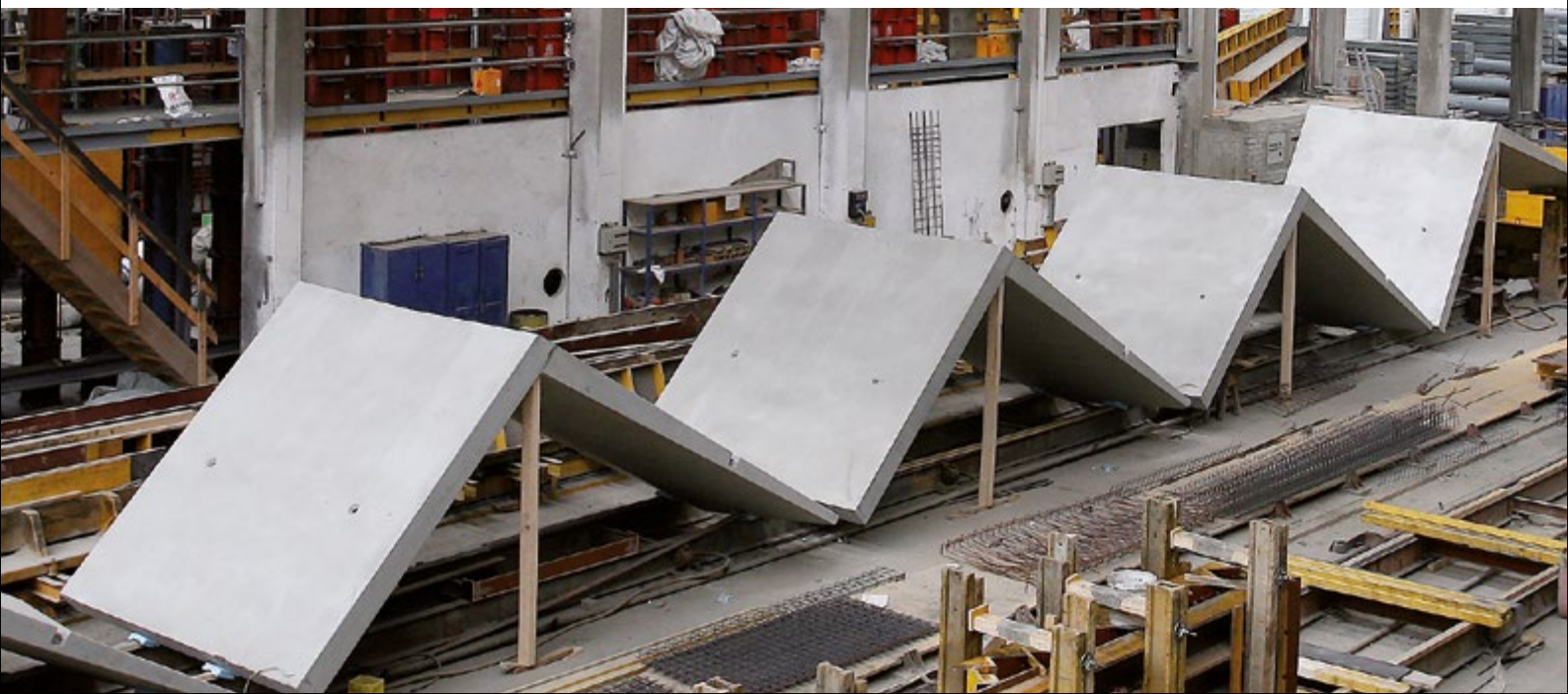


CONCRETE CONCEPT

Innovations like Self Compacting Concrete offer amazing advantages

The concrete concept drives a precast concrete element production process and has essential impact on process timing. Concrete production, installation and curing must therefore be kept as short as possible. This has consequences regarding concrete technology. Requirements influencing precast concrete production are excellence of concrete surface appearance, high compressive strength and high durability. The production steps of batching and mixing, transport, compaction and finishing must also be considered within a concrete concept.

With advanced concrete technology and suitable admixture application, adequate workability, rapid installation and subsequent fast strength development of the concrete can be ensured whereas fast strength development is critical for swift production. Application of innovative concrete mix designs such as Self Compacting Concrete (SCC) offer further advantages. Besides rapid installation, vibration work can be eliminated, substantially improving the working environment in a precast concrete factory.

The latest concrete admixture technology can improve concrete production
and achieve the following advantages:

- Cost efficient concrete mix designs
- Production of high strength, highly durable concrete
- Application of Self Compacting Concrete
- Reduction or elimination of heat or steam curing
- Sustainable and environmentally friendly production

SUPERPLASTICISER TECHNOLOGY

Latest superplasticiser technology offers solutions to all precast production challenges

High strength concrete types are used increasingly in the precast concrete business. The quality of the final element, and thus the quality of the concrete, play central roles. Concrete quality and durability are therefore constantly improved. Precast concrete plant processes are evermore industrialised. Timing is more and more important. Concerns regarding factory working environments are rising. Innovative technologies and concrete types such as Self Compacting Concrete are being utilised, which result in improved working conditions, since vibration work is eliminated and noise thereby significantly reduced. Superplasticisers based on polycarboxylate ether (PCE) technology contribute to these developments and factors. Their application is becoming indispensable.

The Sika® ViscoCrete® product range is an innovative polycarboxylate based admixture technology capable of offering solutions to all precast concrete production challenges. The application of Sika® ViscoCrete® can ensure substantial water reduction with adequate workability and slumplife in combination with fast early strength development. Sika® ViscoCrete® technology enables the design of polymers in direct regard to fresh and hardened concrete performance. Furthermore, technologies can be combined, allowing easy adaptation of solutions to changing production circumstances.

ACCELERATION

Accelerated hardening in combination with resource-friendly production

THE CONCRETE HARDENING PROCESS IS A TIME-CONSUMING STEP WITHIN PRECAST CONCRETE PRODUCTION.

On the one hand it is important to reduce the hardening time, which is almost always carried out with the application of heat or steam curing – both highly energy-consumptive measures. On the other hand energy efficient and environmentally friendly production processes are gaining importance. Production must be both cost effective and have a small CO^2 footprint. With sound concrete mix design, innovative superplasticiser technology and powerful accelerator technology, the whole production process can be significantly optimised and the energy consumption for heat or steam curing respectively can be either reduced or even eliminated.

SikaRapid®-1 offers accelerated hardening with no loss of slump life. As a result this technology provides solutions for accelerating performance of all concrete types according to different production conditions. Optimised hardening performance of concrete can reduce or eliminate heat or steam curing, speed the turnaround of formwork, making it more efficient and ultimately increasing productivity.

EXAMPLE TUNNEL SEGMENT PRODUCTION

In tunnel segment production there are two key parameters. It is extremely important on one hand to realise a specified early strength, while on the other tunnels as complex constructions must fulfill the highest requirements with regard to durability. The concrete performance regarding these two demands can be enhanced with the SikaRapid®-1 technology.

The fulfillment of the first target could be achieved by incorporating heat curing in the tunnel segment production concept. In order to reach an early strength of more than 25 MPa it was necessary to apply a heating sequence of more than 5 hours. With the application of SikaRapid®-1 the hardening process of the concrete was optimised, with the result that approximately 150 minutes of heating could be eliminated.

At the same time the early and final strength requirements were attained. Moreover the durability of the tunnel segments was improved as the concrete peak temperature was limited to less than 60 °C. Thereby a significant reduction of more than 25 °C concrete temperature could be realised. Overall the energy consumption of the tunnel segment production process could be substantially reduced. This approach demonstrates a high degree of sustainability.

CASE STUDY

Manchester Metropolitan University, Manchester

Sika concrete admixtures were incorporated in the concrete mix for the production of black precast concrete panels, produced by Thorp Precast for the new Business School and Student Hub building at Manchester Metropolitan University.

The panels are a prominent aesthetic feature of the structure, with some surfaces being highly polished, so a good surface finish was essential. To achieve this, the concrete had to be produced to a high standard. Incorporating the Sika admixtures in the mix helped reduce efflorescence and the number of blow holes within the finished panels, which greatly reduced wastage and the amount of finishing required. The concrete was also designed to self compact, which eliminated the need for noisy vibration of the panel moulds in order to mechanically compact.

The £75 million building was constructed by Sir Robert McAlpine as part of the University's estates investment strategy, and is designed by award winning Feilden Clegg Bradley Studios to be at the forefront of green development, and has been certified 'excellent' under the BREEAM environmental assessment scheme.

The modern 20,000m^2 Business School and Student Hub will provide a state of the art learning environment for 5,000 students and 250 teaching staff, together with social spaces where students from all faculties can meet and socialise bringing a new central focus to the expanding campus. It comprises three separate admission and teaching blocks ranging in height from four to eight storeys.

The building has been shortlisted for "Project of the Year' in the 2012 Building awards.

LARGE QUANTITIES, HIGH QUALITY AND EXCELLENT DURABILITY

The semi-dry precast concrete industry manufactures large quantities of finished concrete products with high quality surface appearance and excellent durability. Select combinations of process and concrete technology are employed to efficiently manufacture semi-dry precast concrete products of various shapes, textures and colours.

Due to the high durability requirements and rapid industrialised production process, it is necessary to achieve a high degree of compaction in as short a time as possible. SikaPaver® products significantly improve both the manufacturing process as well as the quality of semi-dry precast concrete products. Furthermore it is possible to reduce efflorescence or even incorporate water repellent behavior with the application of SikaPaver® AE technology.

SIKA SEMI-DRY PRECAST TECHNOLOGY

Key for efficient semi-dry precast concrete production is the targeted combination of fresh concrete with a high degree of compactability as well as yielding instant shape accuracy following compaction, meaning a high green strength.

SEMI-DRY PRECAST CONCRETE PRODUCTS ARE IN USE EVERYWHERE

PAVERS

BUILDING BLOCKS

PIPES AND MANHOLES

CURBSTONES AND EDGINGS

The compactability ensures a fast production of high quality, durable concrete products, whereas a high green strength reduces damage to finished goods as well as rejects.

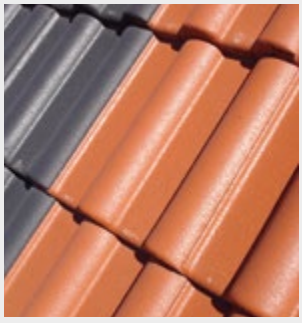
To develop a cost efficient concrete mix design with enhanced compaction characteristics it is essential to make use of plasticisers or compaction aids. The effectiveness of compaction aids derives from reduced surface tension of the water in the concrete mix. This results in improved wetting of the binder particles, and thus a substantially improved compaction performance of the fresh semi-dry concrete.

Technologies incorporated in compaction aids can be lignosulfonates, surfactants and polycarboxylate ether (PCE) as well as suitable combinations of these materials. The Sika® Plastiment® and SikaPaver® product ranges represent Sikas compaction aid technologies offering performance scaled for various production conditions.

The surface appearance of finished semi-dry precast concrete products plays an important role since appearance as a mark of quality is the producer's calling card. On the one hand it is of vital importance to achieve a high degree of compaction, since this has a direct influence on the surface appearance. On the other hand it is possible to reduce efflorescence with the SikaProof® range. This implies application of a hydrophobic agent. The hydrophobic action of SikaProof® products prevents water absorption and water transport in any capillary pores, which effectively reduces efflorescence.

LANDSCAPING ELEMENTS

CONCRETE TILES



ROOF TILES

HOLLOW CORE SLABS

ENHANCED COMPACTION AND STRENGTH DEVELOPMENT WITH SikaPaver®

COMPACTION

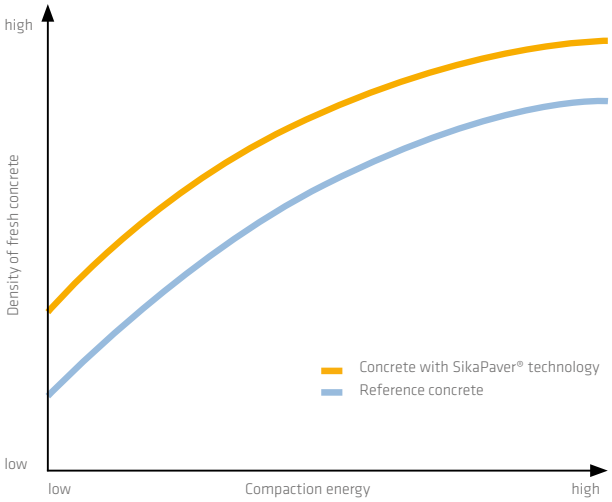
The compactability of fresh semi-dry concrete represents the driving factor in a semi-dry precast concrete production. With improved compaction the following advantages can be achieved:

- Fast production with high output
- Improved quality of products
- Higher green, 1-day and final strength
- Fewer rejects and claims
- Reduced efflorescence
- Increased durability
- Enhanced frost and freeze/thaw resistance
- Dense concrete matrix
- Smooth flanks

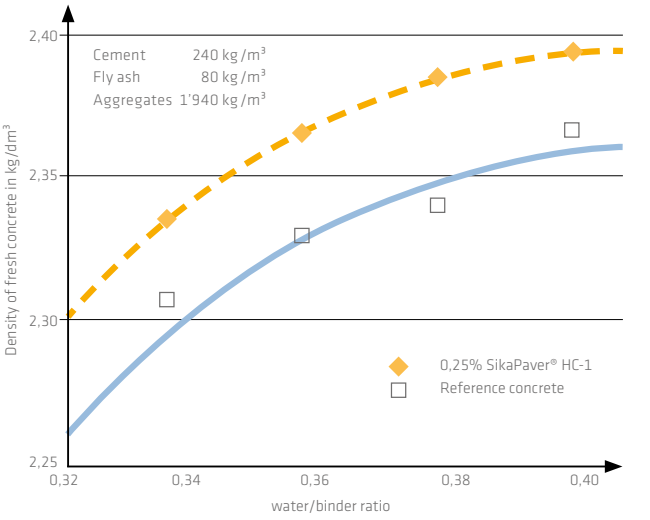
Compactability can be positively influenced by several different factors such as constituent materials, grading curve, water and cement content (water/binder ratio) as well as the applied admixture technology.

The significant influence of SikaPaver® technology results in measurably higher fresh concrete densities across all water/binder ratios. In addition, the production process becomes more efficient with application of SikaPaver® products, because with a defined amount of compaction energy a higher fresh concrete density can be attained.

Easy to compact semi-dry concrete with SikaPaver® technology.



Improved compactablity of a semi-dry concrete mix with the application of SikaPaver® HC-1.



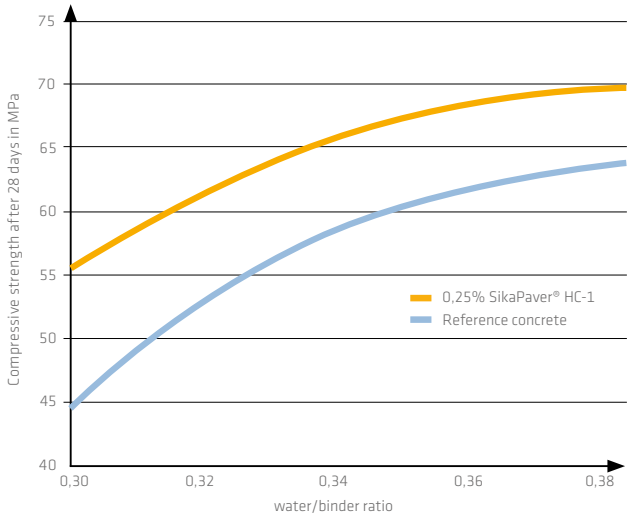
STRENGTH DEVELOPMENT

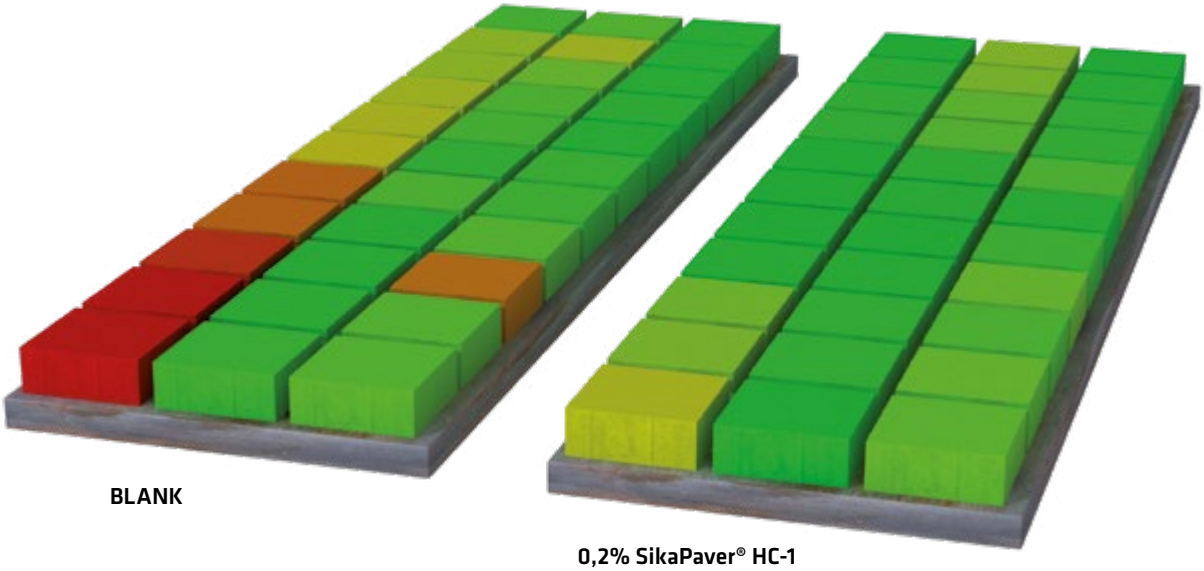
The specialised semi-dry precast concrete manufacturing process requires that fresh concrete products have an initial strength immediately upon compaction. This so-called green strength is crucial in guaranteeing the shape accuracy of produced elements and thereby their quality. Green strength results from the combination of compactability and cohesiveness of fresh concrete. It has direct influence on product damages and rejects.

After curing, semi-dry precast concrete products must already have sufficient one-day strength, because the products are usually transported, packed and stocked at this time. In order to reduce damage and rejects within the production process the sure achievement of a target one-day strength is essential for the whole production process.

The final strength of precast products is important to ensure the required durability of the semi-dry concrete elements, since in many cases the products must withstand significant loads during their lifecycle. A high degree of compaction as well as hydration of the cement are the influencing factors effecting the early strength development and final strength.

Substantial strength increase with SikaPaver® HC-1 across a range of water/binder ratios.





BLANK

0,2% SikaPaver® HC-1

Improved strength variations on one board in a semi-dry precast paver production with application of SikaPaver® HC-1.

low strength — high strength

REDUCES EFFLORESCENCE AND IMPROVES DURABILITY SikaProof®

Durability considerations also play a major role in the semi-dry precast concrete production process, because depending on the finished product it must withstand high loads, e.g. from traffic, frost or freeze/thaw attack.

DURABILITY
It is important moreover that semi-dry concrete products sustain their technical performance and appearance over an extended length of time, since this reduces and avoids maintenance costs.

On the one hand the durability of the semi-dry concrete can be enhanced with a high degree of compaction, since the ingress of water and pollutants is reduced with increased concrete matrix density. On the other hand the application of SikaProof® technology products substantially reduces capillary water absorption through hydrophobic action.
In addition, frost and freeze/thaw resistance of semi-dry concrete products can be significantly increased with the application of SikaPaver® technologies; their service life is thereby prolonged.

EFFLORESCENCE
The phenomenon of efflorescence challenges semi-dry precast concrete producers daily. It generally occurs with certain ratios of calcium hydroxide and water in the presence of air, whereby these conditions arise through the combination of concrete mix design, the curing process and stocking.

Measures for improvement can include the adjustment of the mix design or change in storing conditions to namely protect the stocked concrete products from rain and dew. To effectively reduce efflorescence and to ensure a constant, durable concrete surface quality it is necessary to apply an anti-efflorescence admixture: SikaProof® technology. Within the SikaProof® technology range, available products combine a strong plasticising effect, improved compactability and powerful hydrophobic action, thus offering efficient anti-efflorescence treatment.

BRIGHT COLOURS WITH SikaPaver® AND Sika Colorflo®

The architectural design of streets, parking lots, pedestrian areas and other places with semi-dry precast concrete products offers a wide array of design opportunities. With different shapes, textures and colours the versatility of semi-dry precast concrete products enables creation of aesthetic living environments.

COLOUR APPEARANCE

The colour appearance of concrete depends on many factors:

- Cement content and colour
- Water content (w/c ratio)
- Pigment dosage, particle size and dispersion
- Colour of aggregates
- Concrete pore structure
- Surface texture
- Efflorescence
- Compaction aid

A change in the water content as small as w/c 0.02 is already clearly visible. Higher water content leads to lighter cement matrix. Typical variations in the semi-dry concrete production process such as water/binder ratio, cement content and achieved compaction affect the colour of the finished products. These variations can be balanced with the application of SikaPaver® technology.

W/C 0.30 **W/C 0.35** **W/C 0.40**

COLOUR CREATION

Sika's ColorFlo® system allows concrete to be accurately, economically and permanently coloured in a great variety of colours and with this offers a sustainable and attractive way to design concrete elements.

Coloured concrete places the highest demands regarding uniformity on the concrete ingredients as well as a professional manufacture and flawless processing of the concrete. Sika possess well-founded expertise accumulated over decades across the entire breadth of concrete technology. A technically correct and economically profitable concrete formula is our way of attaining customer benefit and trust.

Sika® ColorFlo® Liquid Colours are pre-dispersed iron oxide pigments in water with high pigment solids content. Products in powder form are also available for delivery. A targeted selection of primary colours and nearly endless blending possibilities allow preparation of concrete in the most diverse colour tones. A wide palette of mixing and dosing systems ensures the proper employment of the colours. For a constant colour appearance, the concrete mixer should be loaded to a minimum of 40% capacity and same mix design, water/cement-ratio, compaction and Curing have to be ensured.

FORMWORK PREPARATION

High quality with innovative mould release agent technology

The use of mold release agents is imperative for production of long-lasting, high quality concrete products. Agent application must be fast, safe and easy. Only mold release agent technology adapted to the production process offers safe, thin-film application and ensures high quality concrete surfaces. Ease of thin-film application is crucial, because film thickness is decisive for achievement of high quality concrete surfaces.

The Sika® Separol® product range offers technologies for fast, safe and easy thin-film application of oils. Based on various technologies, the product range can fulfill the comprehensive and specific needs of differing production conditions. Optimal results in release performance and high quality surface appearance can be achieved with Sika's water-based emulsion technology Sika® Separol®-W.
Concrete Production

SUPPORTING PRODUCTS Sika® Separol®, Sika® MonoTop® AND Sikagard®

BOARD PROTECTION

Semi-dry products are manufactured in a heavy block making machine. The concrete is compacted in a mould due to the pressure of the tamper head and the parallel vibration below the transportation board. These special boards can be made of wood, coated wood, plastics or steel. They are of highest importance for the quality of the semi-dry products: deformation of the board and defects in the surface of wood boards reflect on the bottom side of the precast elements which can lead to claims. But the boards themselves have a value which needs to be maintained.

Sika Separol® W-series are solvent free oil emulsions to be used as protection for all types of board. They reduce the adhesion of concrete on all types of boards while avoiding oil stains on the concrete and facilitate the board cleaning. Applied on wooden boards, they regulate the moisture content in the wood and prevent the planks from separating. Consequently, the wooden boards remain perfectly flat and maintain their smooth surface without regrinding of the surface.
Sika Separol® W-series provides reliable protection against decay of the boards and ensures highest quality of the semi-dry concrete products.

REPAIR

The semi-dry precast concrete quality and surface appearance are the producer's calling card. Nevertheless in the semi-dry precast concrete production process, surface defects and broken or spalled edges are unavoidable. The repair of these defects has to be carried out with a repair mortar that is easily and rapidly applicable as well as having high durability. Moreover a defect should not be visible following repair, which implies a crack-free appearance and similar colour and texture to original concrete of the repair mortar. These requirements can be fulfilled with Sika® MonoTop® repair mortars.

PROTECTING

In order to prolong durability, ensure the brightness of coloured semi-dry concrete elements and avoid the formation of dirt and moss, a protective should be applied. This applies especially after a subsequent cleaning process. The easily and quickly applied Sikagard® range ensure the longevity of precast concrete elements and the surface appearance can be significantly improved for an extended period of time.

DESIGN AND PROTECTION OF CONCRETE SURFACES

Flexible processing of concrete surfaces fulfills innumerable customer requirements

Fair-faced concrete surfaces are looked on as aesthetic only if their pleasing appearance endures. Thus the design of a desired surface appearance extends beyond basic design criteria to the curing of concrete surfaces within precast concrete production. During the hardening process, unprotected concrete surfaces dry out prematurely. In order to avoid this effect concrete surfaces can be protected with Sika® Antisol®.

Regarding the design of concrete surfaces different requirements can be of interest, which are almost always diverse and individual. The fulfillment of individual expectations with regard to concrete surface appearance can be attained through the following measures or a combination thereof:

:

- Finishing of surfaces instantly after concrete installation
- Deliberate selection of formwork surface
- Subsequent treatment of concrete surfaces
- Composition in terms of colour

Sika supports diversity with selective application of products and technologies. While Sika® ColorFlo® opens opportunity for concrete colour design with different tones, it is possible to realise fascinating exposed aggregate concrete surfaces with the application of Sika® Rugasol®. Mechanically treated or handcrafted, structured concrete surfaces are often underestimated and characterised by a high degree of surface appearance quality. This appearance can be reached with a broom finish or special trowel treatment on a concrete matrix which is prepared with SikaFilm®.

To bring the design of molded concrete surfaces to perfection the interaction of concrete mix design, installation technique, formwork type as well as concrete compaction has to be considered with highest priority. High quality concrete surfaces can be achieved with the correct application of a suitable Sika® Separol® technology or with Sika® PerFin® already in the concrete mix design. Based on the Sika® ViscoCrete® technology it is possible to realise complex architectural shapes as well as slender, aesthetic concrete elements with a dense reinforcement.

REPAIR AND PROTECTION

Fast and easy repair of defects and extended longevity with Sika products

The precast concrete element surface appearance is the calling card of a precast producer. This places high quality requirements on the precast concrete production process. Nevertheless surface defects and broken or spalled edges are unavoidable in production. The repair of defects requires a repair mortar that is easily and quickly applied as well as being highly durable. Moreover, defects should not be detectable following repair; the mortar must present a crack-free and adequate concrete surface appearance. These requirements can be fulfilled with the Sika® MonoTop® repair mortar range.

In order to prolong the durability, ensure the brightness of coloured concrete elements and avoid the formation of dirt and moss, a protective system should be applied. The Sikagard® range of protective systems, easily and rapidly applied, ensures the longevity of precast concrete elements, and the surface appearance can be significantly improved for an extended period of time.

To protect steel tendon against corrosion, Sika can provide with the cement based grout injection SikaGrout®-300 PT a durable, well-proved solution to fill post-tensioning ducts

SEALING AND BONDING

Efficient erection and durable connections

The erection of structures and buildings out of precast concrete elements requires connection joints, which must be sealed to ensure function with respect to water tightness, air tightness and insulation properties. Sealing of joints should be carried out with an elastic sealant that is capable of compensating the movements of the concrete elements that occur due to changes in temperature. In addition, the sealant should be easily applicable on different substrates in changing ambient conditions. The Sikaflex® product range fulfils all the challenges of these requirements.

The Sikadur® product range offers various technologies for long lasting rigid bonding of precast elements, e.g. segmental bridge elements. Sikadur® can furthermore be used to rebuild broken edges and effectively repair defects.

SUSTAINABILITY AND COST OPTIMISATION

Sustainable production, saving energy and lowering CO_2 emissions continue to gain attention. Naturally these topics are growing in importance in the concrete industry, because cement and concrete production generate a large share of world-wide CO_2 emissions.

In the semi-dry precast concrete industry a number of measures help save resources. These include implementing optimised concrete mix designs in combination with innovative admixture technologies; this extends durability, resulting in reduced carbon footprint over the entire service life of semi-dry concrete products. The sustainability of the concrete mix design can be improved by reducing the cement and/or binder content, replacement of OPC by secondary cementitious material and the utilisation of recycled or manufactured sand and aggregates.

EXAMPLE: BINDER CONTENT OPTIMISATION FACILITATED BY SikaPaver® TECHNOLOGY

Good compactability and constant production of high quality products are targets of a semi-dry precast concrete production. Sufficient compactability of the concrete mix depends on the grading curve, suitable water/binder content and cement or binder content.

The following example shows how a semi-dry concrete mix was optimised with the target of attaining the required technical performance with improved cost structure of the mix while also reducing the carbon footprint of the production.

All mixes tested contained the same aggregate grading curve and water/binder ratio of 0.38 with a water content of 120 kg/m³. The improved binder content with concurrent application of SikaPaver® HC-1 offered cost advantages and reduced the CO_2 footprint of the produced products.

	Initial Mix	Optimised Mix 1	Optimised Mix 2
Cement	320 kg/ m³	240 kg/m³	240 kg/m³
Fly ash	0	80 kg/m³	80 kg/m³
SikaPaver® HC-1	–	–	0.25% b.w.o.c.
1 d strength	44	26	34
28 d strength	74	67	74
Cost per m³	41.6 €	38.4 €	39.6 €
		Net savings per m³	**2.0 € / m³**

SIKA FULL RANGE SOLUTIONS FOR CONSTRUCTION:

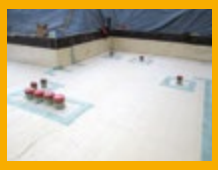
LIQUID APPLIED ROOFING

SINGLE PLY ROOFING

CONCRETE

CONCRETE REPAIR

STRUCTURAL STRENGTHENING



WATERPROOFING

JOINT SEALING

FAÇADE STRUCTURAL ADHESIVES

FLOORING

INDUSTRY

DISTRIBUTION

BUILDING TRUST

FOR MORE INFORMATION:

WHO WE ARE

Sika Limited and Sika Ireland Limited are part of the global Sika Group, specialising in the manufacture and supply of chemical based products. Sika have a leading position in the development and production of systems and products for bonding, sealing, damping, reinforcing, and protecting in the building sector and the motor vehicle industry. Sika has subsidiaries in 101 countries around the world and manufactures in over 200 factories. With more than 20,000 employees Sika generates annual sales of CHF 7.09 billion (£5.45bn). We are also committed to providing quality, service, safety and environmental care.

In the UK and Ireland, we provide market-leading solutions for concrete, waterproofing, roofing, flooring, refurbishment, sealing & bonding, and industry, and have manufacturing sites in Welwyn Garden City, Preston, Leeds and Dublin with more than 870 employees and a turnover of more than £260 million.

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BUILDING TRUST

CONCRETE & WATERPROOFING/SIKA PRECAST TECHNOLOGIES MARCH 2019

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