REFURBISHMENT STRUCTURAL STRENGTHENING WITH SIKA SYSTEMS

BUILDING TRUST

COMPETENCE YOU CAN TRUST

Sika provides you with a depth of knowledge from our 'state-of-the art' technical expertise and global practical experience to produce virtually tailor-made solutions for the repair, refurbishment and improvement by strengthening of your existing buildings and civil engineering structures. This includes fully compatible products and integrated systems to suit almost every project and site requirement. Sika customer advice and support is second to none, from concept, through design and detailing, to practical installation and successful completion on site. This is all based on more than 100 years of experience on large and small projects all over the world.

CONTENT

EXTENDING FUNCTIONAL SERVICE LIFE

THE USE OF A BUILDING OR CIVIL ENGINEERING STRUCTURE may change throughout the course of its service life, as for example its whole function can change, loads can increase and/or higher building standards are required and the structure must be made compliant. Sika provides fully comprehensive solutions with complete systems for all kinds of structural strengthening and improvement. Whether increasing the bending, shear or impact resistance, tested and proven Sika systems are available for use on reinforced concrete, steel, wood and masonry load-bearing structures.

TYPICAL APPLICATION

COLUMN STRENGTHENING

BEAM STRENGTHENING

PRE-STRESSED STRENGTHENING

SEISMIC UPGRADING /EARTHQUAKE DAMAGE REPAIR

INCREASING IMPACT RESISTANCE

CRACK PREVENTION/REDUCTION

PROVEN PERFORMANCE AND DURABILITY

Sika Structural Strengthening Systems have been tested extensively internally and externally, under many different conditions to ensure their long-term performance in different environments for:

- Long-term fatigue
- Artificial ageing
- Exposure in alkaline environments
- Installation under dynamic load

Worldwide success with the completion of countless individual large and small projects over the last decades demonstrates the performance, reliability and durability of Sika Strengthening Systems. This is quality you can trust.

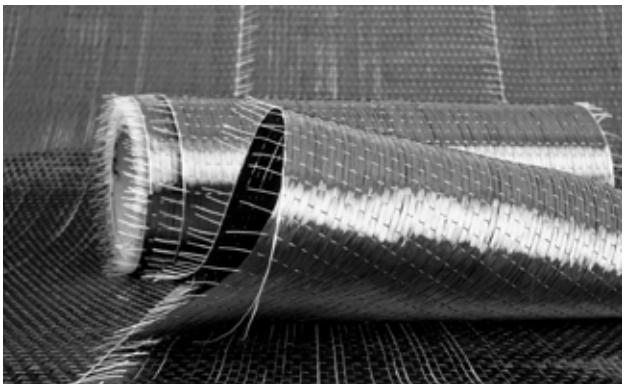
SIKA FOR EXCELLENCE IN STRUCTURAL STRENGTHENING

Sika brings sustained added value to building and civil engineering structure owners, their consultants and contactors. Sika provides technical assistance through every step of the project, from condition survey and developing the initial strengthening concept through to the successful completion and handover of your project.

SIKA – YOUR PARTNER ON SITE

- Global market leader in building and construction chemicals
- Highest technical expertise and practical experience in concrete refurbishment and structural strengthening
- Excellent reputation with leading contractors and authorities

SIKA VALUE ENGINEERING AND INNOVATIONS



- High performance integrated products and systems that can boost and improve the capacity, efficiency, durability and aesthetics of buildings and other structures – to the benefit of our customers and a more sustainable development
- Sika trained and experienced specialist contractor networks

UNIQUE SIKA SOLUTIONS FOR SPECIAL CONDITIONS

- Solutions for almost all different application requirements
- Controlled working, curing and hardening times for different climatic conditions
- Special end-anchorage solutions for use in lower strength concrete and other substrates

PROVEN SIKA SYSTEMS AND APPLICATION TECHNIQUES

- Over 40 years of experience with structural bonding and strengthening systems and techniques
- Products and systems with extensive internal and external testing and assessment
- Highest international standards of production and quality control

OVERVIEW OF SIKA STRUCTURAL STRENGTHENING SYSTEMS

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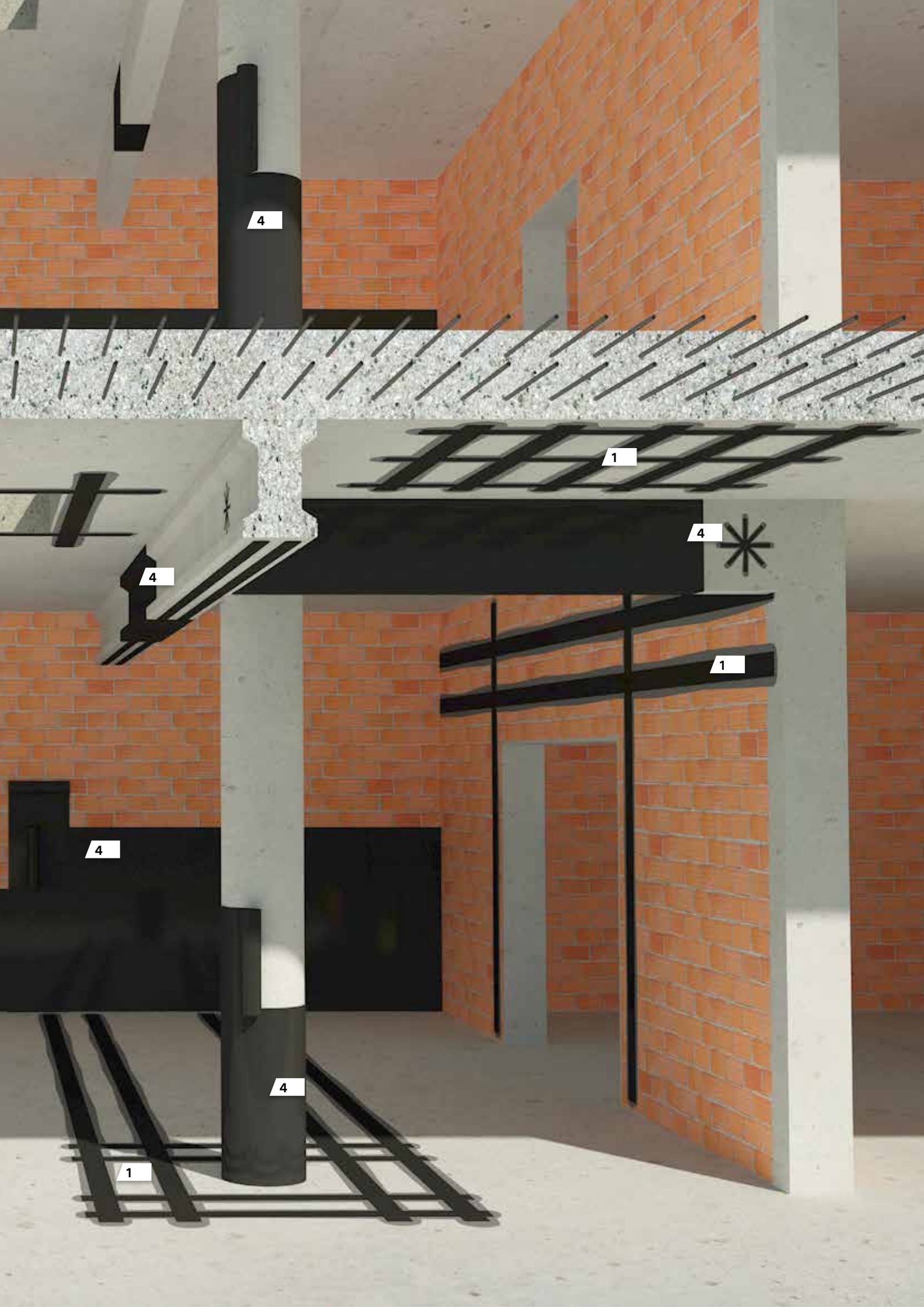
Sika CarboDur® System

2
Sika CarboStress® System

3
Sika CarboShear System

4
SikaWrap® Fabric Strengthening System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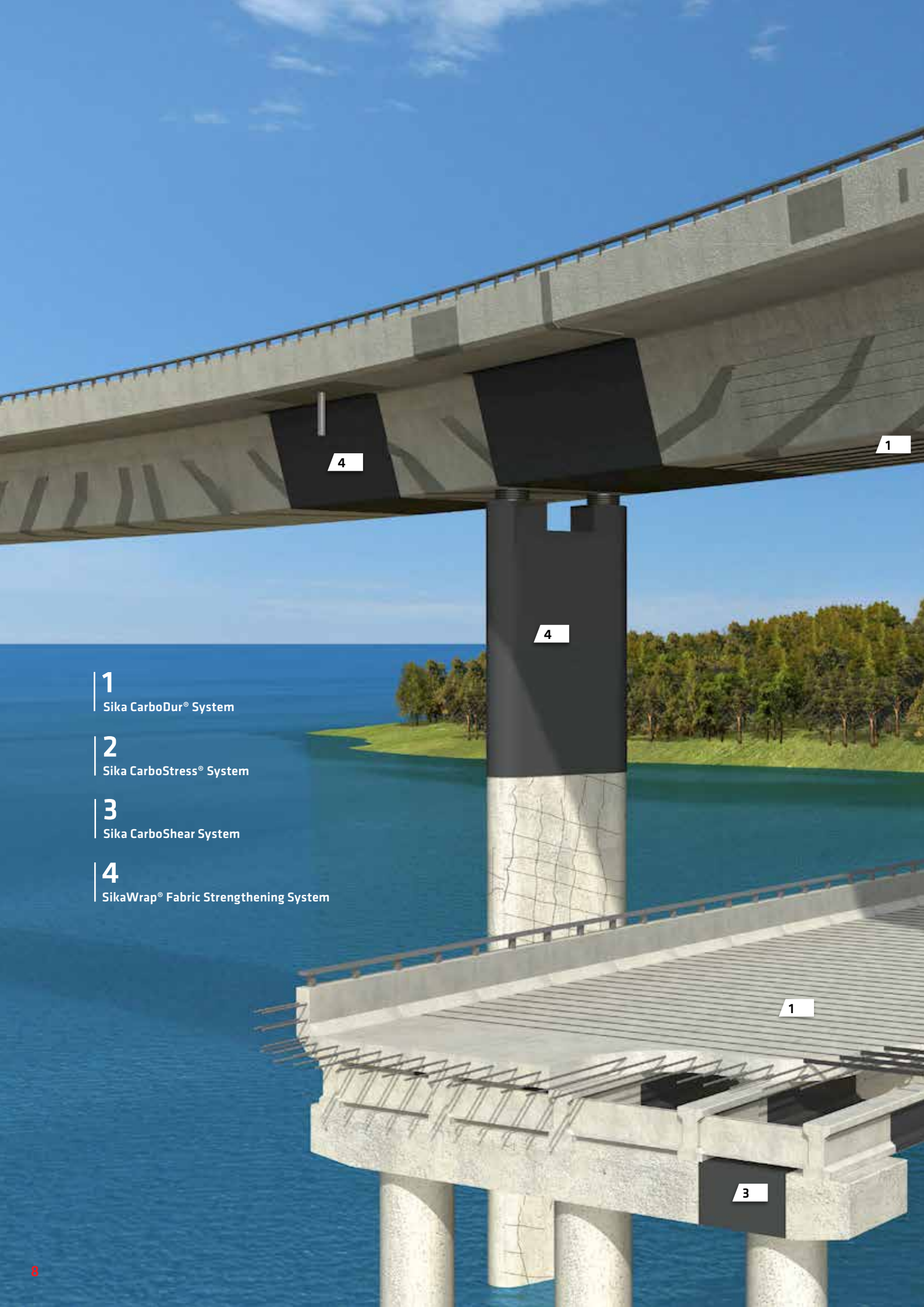


1
Sika CarboDur® System

2
Sika CarboStress® System

3
Sika CarboShear System

4
SikaWrap® Fabric Strengthening System


2
3
4
4

Sika CarboDur® SYSTEM

More than 20 years' experience with installations all over the world

THE SIKA CARBODUR® SYSTEM is one of the most established and well-proven, carbon-fibre-reinforced polymer (CFRP) based structural strengthening solutions worldwide. It consists of Sika CarboDur® CFRP plates and rods, plus the structural epoxy resin based adhesives Sikadur®-30 and Sikadur®-30 LP. This simple and reliable, high performance system is easy to apply and provides outstanding long-term durability in service.

Proven Long Term Solutions	■ Extensive use and monitoring in numerous different applications for more than 20 years
Fast Installation = Minimal Down Time	■ No additional plate preparation work and one product for surface filling, priming and bonding
(In)-Visible Strengthening	■ External surface and near surface mounted applications (NSM) ■ Additional overcoating or mortar cover possible
Whole System = One Supplier	■ Including matrix resin of the plates, the bonding adhesive and the protective coatings where required

Sika CarboDur®

For externally bonded and near surface mounted (NSM) flexural strengthening of concrete, steel, timber, masonry and glass fiber structures.
Sika CarboDur® plates and rods are carbon fibre reinforced polymers produced by a pultrusion process to have precisely defined properties and performance; all in accordance with tight specifications and quality control procedures. The materials are widely used for the flexural strengthening of dynamic and statically loaded buildings and other structures including bridges, beams, ceilings and walls, for both negative and positive moments.

FLEXURAL STRENGTHENING:

Positive moments
- Park decks
- Buildings
- Bridges

Negative moments
- Bridge decks
- Flat roofs
- Curved substrates

NEAR SURFACE MOUNTED (NSM) APPLICATION

The embedding of Sika CarboDur® pultruded rods or plates into concrete, timber or masonry substrates has many advantages:

- Superior end anchorage
- No extra protection necessary as embedded
- No aesthetic impact
- Installation in weak or cracked substrates is possible
- Application is possible on flat and curved substrates
- Available as different profiles (rectangular or round) and dimensions to suit

HIGH STRENGTH END ANCHORAGE

When Sika CarboDur® plate ends are prepared with a 'scratch coat' of Sikadur adhesive and embedded into the same slab or a perpendicular slab or column, up to 100% of the plate strength can be anchored into the substrate. The plate ends are also secured and any damage or peel-off anchorage failure is avoided. This unique anchoring system for Sika CarboDur® CFRP plates has been tested extensively by independent external test institutes and is also the same system that is used for the anchorage of CarboShear profiles.

PROVEN DURABILITY

Sika Strengthening Systems have been tested for durability under many demanding conditions to ensure long-term performance in different applications and environments:

Long-term creep test: A concrete beam, strengthened with a steel plate applied with Sikadur® adhesive was loaded to 80% of the expected failure load back in 1971 and maintained ever since. The deflection has been stable for the past 40+ years with a very small amount of creep. This test is ongoing and conducted by an independent institute.

Artificial ageing: Samples of Sika CarboDur® and SikaWrap® were exposed to artificial ageing for 500 days. The test results before and after this exposure showed no changes or deterioration in the tensile, pull-off and lap shear strengths of the installed systems.

Exposure in an alkaline environment: Coated and uncoated Sika CarboDur® plates were fully immersed in a highly alkaline solution. The strength of the coated samples decreased 10 % after the first 90 days, and leveled out at a total strength loss of 14% after one year of exposure. While the results are hard to translate and interpret for real life environmental conditions, the positive result makes a strong argument for the durability of these Sika Strengthening Systems in alkaline environments.

Installation under oscillating dynamic load: Sika CarboDur® plates can be installed under oscillating dynamic load with no decrease in the strengthening capacity of the system (extensively tested by an independent external institute).

Sikadur®-30 AND -30 LP EPOXY RESIN ADHESIVES

More than 50 years of practical experience on demanding projects with Sikadur® adhesives

THE UNIQUE COMBINATION of excellent adhesion to many different substrates as well as to the Sika CarboDur® CFRP plates, plus high stiffness and low creep makes Sikadur®-30 and -30 LP adhesives the ideal materials for secure application of the strengthening system.

All-in-one Product	■ Serves as the primer, levelling mortar, putty and adhesive ■ Fast and cost effective application
Extensively tested	■ Fully in accordance with the requirements of EN 1504-4 and FIP ■ Full system testing at independent Universities and institutes ■ Additional extensive in-house testing under extreme conditions

Sikadur®-30 LP also has two additional important advantages:

Extended pot-life and open time	■ Suitable for application at ambient temperatures up to 55 °C
Higher maximum service temperature	■ When cured at elevated temperatures

Sika CarboHeater

Rapid curing device: Allows up to 50 times faster curing of Sikadur®-30 and -30 LP
This innovative and patented device that is exclusive to Sika was specially designed for:

Rapid Installation	■ Minimal area disturbance ■ Minimal down time
Application in cold conditions	■ Precisely controlled adhesive curing
Installations with higher service temperatures	■ Maximum service temperature up to + 80 °C (only with Sikadur®-30 LP) ■ Ideal for structures in hot climates with direct sunlight ■ Ideal for hot environments in production and process facilities or power stations etc.

Sika CarboStress® SYSTEM

Post-tensioned strengthening

ACTIVE STRENGTHENING OF STRUCTURES as a replacement for damaged steel prestressing cables, seismic retrofitting, or for installation on cracked concrete surfaces.

The concept of post tensioning: a force is applied to create permanent stress in a structure, so it can withstand the working load more effectively, or with less total deflection. In conventional post tensioning, the load is applied through steel tendons within the concrete structure. With the Sika CarboStress® system, the advantages of the Sika CarboDur® CFRP plates and regular post tensioning are combined to form a unique external active strengthening solution.
The Sika CarboStress® system has an excellent track record with considerable experience from more than 400 major strengthening projects that have been successfully completed all around the world. This system has been used to increase the service load capacity, strengthen and reinforce many different structures including bridges, industrial facilities and high-rise buildings.

Fast and flexible Installation	■ Minimal breakout required ■ Tendon assembly on-site
Thin tendons	■ Cross-over installations are possible
Very lightweight tendons	■ Ideal for difficult access sites and structures
Standardized and tailor-made system solutions	■ Alternative anchoring solutions ■ Suitable for different tendon lengths and substrates

Sika CarboShear SYSTEM

L-shaped CFRP profiles for simple shear strengthening

A UNIQUE SIKA SOLUTION for external shear strengthening of T-beams. The shear capacity of reinforced concrete-beams can be significantly increased by externally applied Sika CFRP strengthening systems. The ideal solution is the unique Sika CarboShear L-shaped CFRP profiles, which are bonded onto the beam and anchored into the top slab, with the Sikadur®-30 and -30 LP structural epoxy resin based adhesives – Simple, but highly effective and efficient shear strengthening.

Sika CarboShear L-shaped profile

- Easy and fast installation
- Pre-prepared end section to provide excellent anchorage
- Low thickness, easy to overcoat
- Available in four dimensions
- The length of both legs can easily be adjusted
- No drilling through the top slab is required

Strengthened T-beam

- Sika CarboDur® plate system for flexural strengthening
- Sika CarboShear L-Profiles for shear strengthening
- Anchorage of Sika CarboShear profile legs in the top slab
- Overlapping with Sika CarboShear links for improved end anchorage of the Sika® CarboDur® plates

Since the end anchorage section of the Sika CarboShear L-Profile is pre-prepared on site, any leg length is possible. With the different Sika CarboShear L-Profile sizes available, structural beams of up to 140 cm in height and 140 cm width can be strengthened.

INSTALLATION OF Sika CarboShear L-Profiles

Sika CarboShear L-Profiles are mostly used as an alternative to a fully CFRP fabric wrapped beam configuration for shear strengthening. They are installed on rectangular T-beams and anchored in the top slab, without the need to cut all the way through the slab. The overlap under the beam connects the profiles to form a U-shaped strengthening system, similar to a traditional reinforcing stirrup. This configuration provides a highly effective shear strengthening solution.

Scratch coat with Sikadur®-30 adhesive

- Pre-prepared on site and fully cured before installation
- Effective anchoring of the full CFRP profile strength

Anchoring holes

- Cut into the top slab where required and to avoid main reinforcement by core drilling or special saws

Grafton Bridge, Auckland, New Zealand

SikaWrap® FABRIC STRENGTHENING SYSTEM

For structural column confinement, strengthening of weaker concrete, masonry, natural stone and timber structures

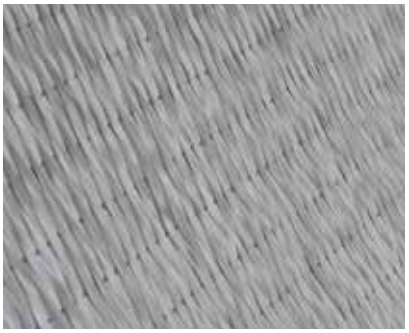
THE SikaWrap® FABRIC STRENGTHENING SYSTEM is comprised of unidirectional, carbon or glass fibre fabrics and Sikadur® structural epoxy resin based, impregnating resins. These unique combinations provide a wide range of strengthening and upgrading solutions to meet the many varied demands of different projects and applications.

SikaWrap® Fabric Strengthening Systems deliver proven outstanding performance for:

Strengthening irregularly shaped structures and substrates

Note: Using a single layer of heavyweight fabric can sometimes be stronger and more cost effective than several layers of the standard lightweight fabrics

Carbon Fibre Fabric: SikaWrap® C
Active Strengthening: for constant or high loadings



Glass Fibre Fabric: SikaWrap® G
Passive Strengthening: for temporary loading and seismic event protection

SikaWrap® fabrics also including:
Aramid Fibre Fabrics, Special Bidirectional and Quadraxial Fabrics

TYPICAL STRUCTURAL APPLICATIONS

CONFINEMENT

- For structural members in compression
- To enhance load carrying capacity or ductility
- Multi-layer applications are possible

SHEAR STRENGTHENING

- Non-rectangular cross sections are possible
- End anchorages with SikaWrap® FX

SEISMIC STRENGTHENING

- Mostly using SikaWrap® glass fibre fabrics
- For passive strengthening solutions
- As an alternative to textile reinforced mortars (TRM)

WEAK SUBSTRATE STRENGTHENING

- For strengthening masonry, natural stone walls and other structures
- Flexural strengthening of weak concrete elements or structures

DRY AND WET APPLICATION

Dry application: For installation of lightweight fabrics up to 450 g/m²

- The Sikadur® impregnation resin is spread directly onto the prepared substrate, also filling small irregularities in the surface
- The dry fabric is placed on the resin and pressed on by hand
- The resin is worked into the fibre with a roller, always in the direction of the fibres
- When the fabric is fully impregnated, the excess resin can either be removed with a plastic scraper or additional resin can be applied for the installation of an additional layer

Wet application: installation of pre-impregnated fabrics heavier than 450 g/m²

- The Sikadur® impregnation resin is poured on a plastic sheet and the dry fabric placed on top of it
- The resin is worked into the sheet with a plastic roller until the fibres are completely impregnated
- The substrate is covered with a thin layer of the Sikadur® resin as a primer
- The 'wet' fabric is applied on the primed substrate and pressed on firmly with a plastic roller, thereby removing any entrapped air

SikaWrap® FX FIBRE CONNECTORS

Versatile end anchorage and NSM strengthening solutions

SikaWrap® FX Fibre Connectors are prepared dry bundles of Carbon or glass fibres which can be used in different configurations.

End anchorage of SikaWrap® fabrics
In shear strengthening with fabrics, preventing delamination of the fabric at the edges is the most critical problem. As fabric anchors, the SikaWrap® FX Fibre Connectors are installed into the substrate before and under the SikaWrap® fabric to optimize force transfer. The dry fibre bundles are partially impregnated, then inserted into drilled holes and spread out into slits cut into the surface.

Advantages:
- Improved connection of the SikaWrap® fabric with the substrate
- Anchorage and force transfer into beams or top slabs
- No cutting through top slabs is necessary
- Installation uses standard site anchoring equipment

Near Surface Mounted (NSM) Reinforcement
As a near surface mounted (NSM) strengthening system, the SikaWrap® FX Fibre Connectors provide new possibilities for the strengthening of irregular and dome-shaped surfaces. The SikaWrap® FX Fibre Connectors are impregnated with Sikadur®-300 or Sikadur®-52, and then installed into slits cut in the surface and also pre-filled with the resin.

Advantages:
- Strengthening of any substrate surface geometry
- Continuous tows, with no splicing necessary
- Ideal combination with end-anchorage solutions

Shear Strengthening
The SikaWrap® FX Fibre Connectors can also be used for the shear strengthening of beams – by replacing SikaWrap® fabric strips in complex and / or difficult access locations.

Advantages:
- Minimal breakout is required and only small holes need to be drilled
- Strengthening of any beam shape is possible
- Less substrate preparation is necessary

Sikadur®-330 AND Sikadur®-300

Sikadur® adhesives – proven quality and performance since 1960

MULTI-PURPOSE STRUCTURAL EPOXY RESIN based materials that reduce the working steps necessary for fast, easy and secure installation of SikaWrap® Fabric strengthening systems.

All-in-one product	■ Primer, putty and impregnation resin ■ Fast, easy and secure application of SikaWrap® Fabrics ■ Extremely cost effective
Sikadur®-330	■ A 4in1 product: primer, void filler, impregnation resin and adhesive ■ Non-drip, paste like consistency ■ Multiple-layers and overhead application is possible ■ Fabrics are impregnation directly on the substrate surface ■ Protective coating or mortar overcoating is possible ■ Ideal for 'Dry' application of lightweight fabrics
Sikadur®-300	■ Very long open time ■ Impregnation by hand or saturator machine ■ Protective coating or mortar overcoating is possible ■ Ideal for 'Wet' application of heavy fabrics
Saturator machine	■ Option for more efficient fabric impregnation ■ Larger surface areas and heavy fabrics are possible ■ Less resin wastage ■ Fast and cost effective system installation ■ Especially suited for larger projects

BRIDGE STRUCTURES

Grafton Bridge, Auckland, New Zealand

AUCKLAND'S ICONIC GRAFTON BRIDGE, was the world's largest single span reinforced concrete arch bridge when originally built in 1910. Today it is recognized as one of the 100 most significant concrete structures in the world.

It has continued its history of innovation, by using Sika CarboShear technology for structural strengthening works that were required in 2010.

Sika CarboDur® CFRP plates were installed on the underside of the reinforced concrete beams to provide additional mid-span movement resistance. The Sika CarboShear L shaped CFRP profiles were then installed, in pairs, around the beams and up into the deck slab to improve the shear performance.

Almost 100 years after the bridge was built, this bridge strengthening was part of the 'Auckland Central Connector' project. This has provided the landmark structure with essential seismic resistance to modern standards, enabling it to withstand a one-in-1000-year earthquake, as well as increased capacity to carry higher volumes of bus traffic and to accommodate a possible future light rail transport system – all without altering the bridge's appearance or changing its heritage status.

The overall refurbishment work included:

- Strengthening the bridge columns using additional steel reinforcement
- Strengthening the bridge beams with Sika CarboDur® CFRP plates and Sika CarboShear L profiles
- Installing new, reinforced-concrete shear keys and deck links to resist horizontal seismic forces
- Removing green growth and repairing cracks in the original concrete
- Replacing the deck joints and bridge bearings

Sika CarboDur® strips and CarboShear L plates bonded to the concrete structure.

BRIDGE STRUCTURES

Sunshine Skyway Bridge, Tampa Bay, Florida, USA

THE SUNSHINE SKYWAY BRIDGE is one of the most widely recognized landmark structures in the USA.

With its signature bright yellow stay cables, the bridge design resembles a sailboat, with its towers holding up the triangular sails across Tampa Bay.

During routine inspections, an increase in shear cracking was observed, mainly on the exterior trestle span girders. The structure needed to be repaired and protected, not only to retain its strength and shear requirements, but also to withstand the aggressive marine environment.

In addition to the repairs by crack injection and damaged concrete replacement, the bridge also needed to be structurally strengthened to carry additional loads. Due to its many advantages over steel and other methods, the SikaWrap® fabric strengthening system was chosen to strengthen the girders. A bi-directional SikaWrap® fabric was installed in several layers around the girders, and the effectiveness of this approach was also confirmed by a full scale test prior to the installation. The resin impregnated fabric and exposed concrete surfaces were then covered and protected with a water-dispersed acrylic coating.

By detailed planning of the works and using well trained specialists experienced in working with these materials, the project was completed successfully and ahead of schedule. This refurbishment project also won the International Concrete Repair Institute (ICRI) 'Award of Excellence' in 2008.

International Concrete Repair Institute (ICRI):
Sika won the ICRI Award of Excellence in the Transportation Category in 2008.

BRIDGE STRUCTURES

Pumarejo Bridge, Barran, Colombia

THE PUMAREJO BRIDGE IS ONE OF THE LARGEST BRIDGES in Colombia.

Originally built in the early 1970's to allow development of the Northern Region of the country and to link Barranquilla City with the eastern side of the Magdalena River, it was listed as one of the best concrete structures in the country by the Colombian Ready Mixed Concrete Association in 2006.
However after three decades of exposure and service in this aggressive environment, the bridge was completely refurbished to repair areas of spalling concrete due to reinforcement corrosion, and also areas eroded with the loss of coarse aggregates from the columns in and just above the river level.

The refurbishment was undertaken in several stages in 2006 and 2008, and it was also decided to strengthen it in 2011. The repair works included removal of weak concrete, cleaning and protection of exposed steel reinforcement, concrete replacement with SikaTop® and EpoCem® systems after crack injection, steel jacketing around the columns, plus overall protection with an impregnating corrosion inhibitor and a protective coating.

Sika products and systems were selected and used exclusively for all of this repair and refurbishment work. This project won the International Concrete Repair Institute (ICRI) 'Award of Merit' in 2009.

Few years after the initial concrete repair works were completed shear cracks were noticed in the beams and the requirement for structural strengthening was decided by the Engineers. After sealing and filling the cracks with Sikadur® injection resin, the substrate was prepared and a lightweight SikaWrap® fabric strengthening system was applied in two directions and finally the areas were covered with a SikaTop® coating.

This full-scale refurbishment and upgrading with Sika products and systems has given this engineering icon a new future. The Pumarejo Bridge will now be able to handle the anticipated rising traffic volumes, increased loads and environmental exposure for years to come, requiring only routine maintenance in the coming years.

International Concrete Repair Institute (ICRI):
Sika won the ICRI Award of Merit in the Strengthening Category in 2009.
Click on the QR Code to learn more about Sika's ICRI Award-Winning Projects.

Substrate preparation

Repair

Strengthening with SikaWrap®

BRIDGE STRUCTURES

Penang Bridge, Penang Island, Malaysia

THERE ARE TWO BRIDGES connecting the Malaysian mainland with the Penang peninsula.

The original Penang Bridge is a dual carriageway toll bridge that spans 13.5 km and was completed and first opened to traffic in 1985, and by 2010 was used by over 80'000 vehicles a day. Following an accidental fire in 2010, a complete inspection and structural assessment of the bridge was undertaken. In addition to the concrete repairs that were necessary after the fire and 25 years exposure in the aggressive marine environment, the structure was also found to be in need of structural strengthening to replace the damaged steel tendons.

The damaged concrete was removed and the reinforced concrete beams were repaired with a SikaTop® concrete repair System and SikaGrout® poured concrete. The beams were then strengthened to the performance levels required by the Engineers, using a layered build-up of the Sika CarboDur® CFRP System. Finally, all of the exposed concrete and CarboDur® plate surfaces were given a protective Sikagard® coating to protect them against UV light and future attack from the aggressive marine environment respectively.

The Second Penang Bridge was completed in 2014 and at 24 km, is the longest bridge in South-East Asia and designed to last for 120 years with minimal maintenance. Sika's involvement started at the very beginning with systems for the concreting and construction work, from curing compounds to Sikadur® structural resins and concrete protection with Sikagard® hydrophobic impregnation, all contributing significantly to the required durability of the structure.

Installation CarboDur®

Coating of CarboDur® plates with Sikadur®

BUILDINGS

Käfergrund Apartment Building, Aarau, Switzerland

A ROUTINE INSPECTION OF THIS FOUR-STORY APARTMENT BUILDING in Aarau, Switzerland showed that the structure only had 25% of the seismic resistance required to meet the current local building standards.

To be fully compliant with all current standards and regulations, the building therefore needed to be strengthened to meet the required seismic resistance to be able to withstand the potential level of earthquakes in the area.
The Sika CarboStress® system was selected to achieve the necessary seismic resistance on the structure. This consisted of post-tensioned Sika CarboDur® CFRP plates anchored into the substrate. In the three stairwells of the building, a total of 12 Sika CarboStress® tendons were installed. Since these Sika CarboStress® tendons were relatively small, flexible and could be assembled on site, the installation of the system was straightforward, even in the limited space constraints of the stairwells. There was also minimal breakout of sound material on site, as for all of the tendons, the dead end was simply anchored into the cellar wall, with the live end assembled in such a way that it transferred the post-tensioning force through a steel element into the floor and subsequently into the wall of the building. With this setup, the walls were quickly strengthened to the necessary standards and without damaging the masonry or adding unsightly bulk and unnecessary weight to the structure.

Anchorage of Sika CarboStress System

Pressure cylinder

BUILDINGS

Puri Adhimelati Office Building, Jakarta, Indonesia

THE PURI ADHIMELATI OFFICE BUILDING is a 20 years old structure in the heart of the business district in Jakarta.

The city is located in an earthquake zone and the building was built in accordance with the seismic design requirements of that time. However, a Structural Assessment concluded that many of the supporting beams and columns required strengthening to bring the building into compliance with current building codes.
The Engineers selected a Sika structural strengthening solution with carbon fiber-reinforced polymer (CFRP) materials, because of its effective performance despite its lightweight characteristics. Furthermore, the Sika systems allowed flexibility on site to overcome any issues and were easy to apply.
The columns in the basement and ground floor were strengthened to provide increased confinement with the SikaWrap® fabric strengthening system. The cross beams were then either strengthened in flexure and against shear, or against shear only, by using a combination of Sika CarboDur® CFRP plates and SikaWrap® fabrics, with up to three layers of the fabrics being applied. During the installation works on site unforeseen conditions, including walls that could not be removed and voids in the existing concrete, were found. Another advantage of these Sika strengthening solutions was then that their design can be adjusted accordingly, so the works could still be completed successfully and with minimal break-out or removal of sound materials on site.

These works finished as the largest CFRP strengthening project ever undertaken in Indonesia at that time.

1 Beam strengthened without removing wall
2 CFRP installed around existing obstacles
3 Columns strengthened with SikaWrap® fabric
4 Reinforcement of beam with CFRP

BUILDINGS

Maypo Office and Laboratory Buildung in Mexico City, Mexico

THE FOUR-STORY OFFICE AND LABORATORY BUILDING was originally built in the early 1980s.

Since then, more extensive research on soil characteristics and the seismic activity in the region have led to new design standards and construction methods that have greatly improved the seismic resistance of new buildings. However, existing buildings built to the earlier, less stringent standards present a challenge. Worried about the safety of their building, Maypo initiated a detailed structural assessment and seismic upgrade for the property.

Because the original building design details and calculations no longer existed, a series of diagnostic studies were performed, including research on soil mechanics in the area, steel reinforcement location and assessment, concrete condition survey, and an overall visual inspection; followed by 3-dimensional computer modeling with the results for dynamic structural analysis. These revealed that in the event of a seismic event the concrete floor slabs exhibited deflection and excessive vibration resulting in cracking, the supporting beams exhibited shear cracking at their ends and the non-structural masonry walls interfered with the free deformation of the main structure. Furthermore, the computer modelling also revealed that the main support columns were overloaded.

A number of steps were then taken to refurbish and upgrade the whole building, including additional steel bracing and casting additional concrete, sealing existing cracks by injection and then overall structural strengthening. The beams were strengthened in flexure and shear using the SikaWrap® fabric strengthening system, the columns had continuous Sika CarboDur® CFRP plates installed along their axis over several storeys, then the columns were also wrapped with SikaWrap® fabric to increase their strength and ductility. The complete refurbishment project was easily completed on time due to the lightweight nature and rapid installation procedure for these Sika systems. The weight of the structure was only slightly increased, and no useable area was lost.

International Concrete Repair Institute (ICRI):
Sika won the ICRI Award of Merit in the Low-Rise Category in 2013.
Click on the QR Code to learn more about Sika's ICRI Award-Winning Projects

Beams and columns strenghtened with SikaWrap®

BUILDINGS

Audi Automotive Plant in Győr, Hungary

A FORMER LOGISTICS AREA NEEDED STRENGTHENING as it was to be converted into a Production Hall and had to accommodate much heavier loads.

In the course of internal re-organization, a hall which had been used as a logistics area was to be fitted with fabrication machinery. The existing reinforced concrete base plate which is divided by contraction joints into several sections was not compliant with the required layout. Displacement and consequential forces onto the base plate, caused by temperature change would exceed the production tolerances.
Several base sections were joined using the Sika CarboStress System. Three tendons, consisting of CarboDur® plates and special end anchorage heads were installed to produce a united base without joints. The CFRP plates were then encapsulated into the concrete base to protect the system and to make the area ready for use.

With 29 m this is the one of the longest post-tensioned CFRP plates ever installed in the world.

The longest post-tensioned CFRP-plates ever installed

Plate and end-anchorage

Base channel with post-tensioned CFRP plates

HISTORIC STRUCTURES

Wooden Bridge in Sins, Switzerland

THE FAMOUS WOODEN BRIDGE OVER THE RIVER REUSS IN SINS in Switzerland is more than 200 years old and was built in 1807 with an original design capacity of 12 tons.

Today, the bridge also serves as a back-up route for heavy vehicles, and the required loading is 20 tons. The residents opposed an option to replace the historic bridge with a new structure, so overall refurbishment and strengthening to upgrade the whole structure was carried out in 1991.
The structural strengthening of this timber bridge was also part of a long-term study and it was one of the first Sika CarboDur® strengthening projects on wooden structures. The system was selected for its excellent mechanical properties and minimal visual impact, as retaining the visual appearance of the bridge was also a key decision factor.

To refurbish the bridge the deck was removed and rebuilt, and Sika CarboDur® CFRP plates were bonded to the bottom of the crossbeams to reduce deflection. The installed plates were left exposed and uncoated to facilitate inspection and assessment, but to date the installation remains maintenance free.

CarboDur® strenghtened crossbeam

Bottom view of strenghtening system

HISTORIC STRUCTURES

St. Nicolas Church, Krakow, Poland

ST. NICHOLAS CHURCH IS ONE OF THE OLDEST BUILDINGS and a monument in Krakow, Poland. The church dates back to at least 1229 and it was designated as a parish church in 1327.

The building has seen much redesign and rebuilding over the centuries and the current structure was built on the foundations of earlier structures destroyed in the past. The church is now officially classified as a baroque and neo-baroque three-bay nave basilica.

Over the centuries, the foundations and the limestone rock on which they stand have been subjected to washout and the 'karst phenomenon' (wash-out accelerated by carbonic acid from atmospheric CO_2 in the rain), causing severe degradation. Vibrations caused by increasing traffic, especially from the rail tracks located just behind the church, also contributed to the deterioration. This all led to the front facade deviating from vertical and moving away from the structural supporting walls. On inspection, cracking was also observed throughout the structure, including within the main nave and the aisles.

The original timber frame was inadequate to stabilize the structure, so a new steel frame and braces was carefully retro-fitted internally and through the attic of the church, hidden to normal visitors. After confirming the substrate was otherwise sound, the cracks were injected with cementitious grout and then the walls, window frames and vaulted areas were strengthened with the Sika CarboDur® system. After completion of the refurbishment the building was reopened to the public in 2012.

International Concrete Repair Institute (ICRI):
Sika won the ICRI Award of Excellence in the Historic Category in 2013. Click on the QR Code to learn more about Sika's ICRI Award-Winning Projects.

COOLING TOWERS AND CHIMNEYS

Power Station Cooling Towers, Laziska, Poland

COLUMNS SUPPORTING THE CONCRETE SHELL OF THE COOLING TOWER at the Laziska Power Station were severely damaged after many years of use.

On 92 of the main supporting columns the concrete had spalled-off over corroding reinforcement in several areas, the steel was then exposed and continuing to corrode and lose significant cross section. The structure therefore now needed not only concrete repair and replacement on the damaged columns, but also a structural strengthening solution to reverse the loss of strength resulting from the corrosion and damage.

After removal of all damaged concrete and preparation of the surfaces, selected columns were repaired with sprayed concrete based on Sikacrete® admixture. The rest of all together 92 columns was then reprofiled with the Sika MonoTop® repair system and sealed with a Sikagard® impregnation. When the repairs were hardened the necessary confinement strengthening was carried out using SikaWrap® fabric in sections. Finally, all of the surfaces were overcoated with a Sikagard® protective coating for improved appearance and additional durability.

1 Damaged colums
2 Application of SikaWrap®
3 Installed strengthening system
4 Coated strengthening system


1


2


3


4

COOLING TOWERS AND CHIMNEYS

Heritage Masonry Chimney, Bogotá, Colombia

THE MASONRY CHIMNEY WAS BUILT BETWEEN 1925 AND 1929 and was part of a large abattoir complex supplying meat for the City of Bogotá.

After some years the complex declined and eventually was abandoned for several decades until the University Distrital bought the buildings in 2010 with the objective of developing and converting them into a cultural center. The masonry chimney was considered to be a heritage structure and had to be retained. Whilst built in good quality unreinforced masonry (URM) originally, it now needed upgrading and strengthening to be in-line with the current Colombian Seismic Construction Code. A structural strengthening system was therefore required, and one that would also preserve the aesthetics and appearance of the structure.

A complete Sika solution was selected. After cleaning the structure thoroughly, Sikadur® epoxy mortar was applied to level the surfaces and prepare them for application of the SikaWrap® fabric strengthening system. SikaWrap® fabric strips were then cut to size and applied symmetrically, both diagonally and vertically, to improve the strength of the whole chimney structure with a uniform appearance. Finally the whole masonry chimney surfaces were overcoated with an acrylic protective coating.

1

2

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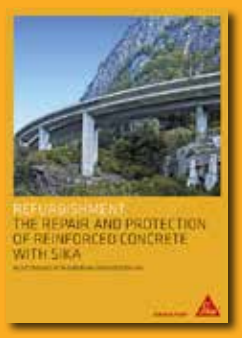
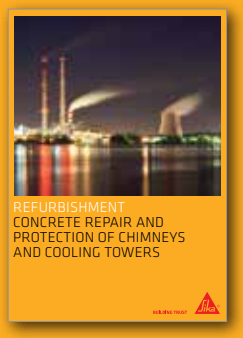
1 Substrate levelling
2 SikaWrap® roll
3 Installation of SikaWrap®
4 Coated strengthening system

ALSO AVAILABLE FROM SIKA





WHO WE ARE

Sika is a specialty chemicals company with a leading position in the development and production of systems and products for bonding, sealing, damping, reinforcing and protecting in the building sector and automotive industry. 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.

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