



TECHNICAL INFORMATION MANUAL

SikaWrap® FX Fibre Connector

APRIL 2016

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1 INTRODUCTION

This Technical information manual is written as a guideline for the use of SikaWrap® glass and carbon fibre connectors. This document must be used and referred to, in combination with all of the relevant Product Data Sheets (PDS), Material Safety Data Sheets (MSDS), and Technical information manuals (MS) for SikaWrap® as well as the specific Project Specifications.

Structural strengthening must only be carried out by trained and experienced specialists. If additional clarification or advice is needed, please do not hesitate to contact your local Sika Technical Service Department who will be pleased to assist you.

This document only describes the application process for the SikaWrap® FX Fibre Connectors. For more detailed information on the application of the SikaWrap® Structural Strengthening System, please refer to the relevant Technical Information Manuals.

APPLICATION YOUTUBE VIDEO <https://www.youtube.com/watch?v=v2Q5nna4VHs>

2 SYSTEM DESCRIPTION

SikaWrap® FX is used in combination with the SikaWrap® Structural Strengthening System. The individual products combine to form a high performance strengthening system consisting of FRP fabrics, carbon fibre or glass strings and impregnating epoxy resins. The system is applied and built-up on site where it is formed into a fibre composite. The SikaWrap® FX is installed to secure SikaWrap® fabric and improve the end anchorage of non-overlapping fabric strips.

The SikaWrap® FX can be installed in three different configurations:

Single Connector: Into a prepared hole in the substrate perpendicular to the SikaWrap® fabric, with the outer half of the connector fibres placed into star-shaped slits

Double Connectors: Into a prepared hole or channel through the substrate perpendicular to the SikaWrap® fabric, with the fibres placed into star-shaped slits on both sides of the channel.

Parallel Connector: Into a prepared hole in the substrate parallel or slightly angled to the SikaWrap® fabric, with the outer half of the connector fibres placed into V-shaped slits.

2.1 REFERENCES

Please check and confirm your local patent situation prior to application of this system.

This document was written according to the recommendations in the **fib bulletin 14**.

2.2 LIMITATIONS

- The SikaWrap® FX must only be used for their intended applications. The system configurations as described in the Product Data Sheets must be fully complied with and may not be changed.
- SikaWrap® systems must only be used by trained and experienced specialists. All works must be carried out as directed by the responsible Structural Engineer.
- For any other specific construction details or information, please refer to the relevant Architect, Engineer or Contractor's details, drawings, specifications and risk assessments etc.
- Differences in local products may result in performance variations. Always refer to the relevant and most recent local Product Data Sheets (PDS) and Material Safety Data Sheets (MSDS) which apply.
- Record the batch numbers for the SikaWrap® FX, SikaWrap® fabric and Sikadur® resin materials used each day.

- Larger mixing quantities and /or high temperatures will result in shortening of the pot life of the impregnating resins. In order to prolong the pot life, reduce the quantity of the components in each and/or the material's temperature.
- For application in hot or cold conditions, pre-condition the impregnating resin materials for 24 hours in temperature controlled storage facilities to improve mixing, application and pot life limits.
- Special attention should be paid to the environment and ambient conditions. Observe min. / max. temperature limitations for the substrate, atmosphere and materials as well as avoiding dew point conditions (Application temperature > dew point +3 °C)
- The substrate moisture content must be less than 4 %. All concrete surfaces must be dry and free of any surface moisture or ice / frost.
- **This Technical Information Manual is produced and intended as a guide and must be adapted to suit local Products, Standards, Legislation or any other specific requirements as necessary.**

3 PRODUCTS

3.1 SYSTEM COMPONENTS

SikaWrap® FX

SikaWrap® FX are used in combination with the other components of the SikaWrap® Structural Strengthening System.

Sika Brand	Description
SikaWrap® FX-50C	SikaWrap® FX-50C consists of a cord of unidirectional carbon fibres, held together by a plastic sleeve. It is cut to length and impregnated on site.

The Epoxy Resin Products

As described in section below, different epoxy resin products are used for the impregnation and adhesive bonding of the SikaWrap® FX-50C Fibre Connectors in the substrate.

Sika Brand	Description
Sikadur® -330	Sikadur® -330 is a two part, thixotropic, epoxy resin based, impregnating resin / adhesive.
Sikadur® -300	Sikadur® -300 is a two part, epoxy resin based, impregnating resin. It is a clear light yellow liquid when mixed.
Sikadur® -52 N	Sikadur® -52 N is a two part, solvent-free, low viscosity injection-liquids, based on high strength epoxy resin.
Sikadur® -33	Sikadur® -33 is a solvent-free, thixotropic, two part, epoxy resin-based, high performance anchoring adhesive.

SikaWrap Fabric Strengthening System

SikaWrap® FX Fibre Connectors are normally installed in combination with SikaWrap® fabrics. However the product can also be used in other situations such as structural stitching of masonry or concrete.

3.2 MATERIALS STORAGE



Materials must be stored properly in undamaged, original sealed packaging, in dry and cool conditions. Also refer to the specific information contained in the respective Product Data Sheets regarding the minimum and maximum storage temperatures and times. The SikaWrap® System component products can be stored for 24 months from their date of production in undamaged, original sealed packaging in dry conditions at temperatures between +5°C and +25°C (SikaDur® and Sika Anchorfix® Resins), or between +5°C and +35°C (SikaWrap® Fabrics and SikaWrap® FX Fibre Connectors). Protect all of the products in storage from exposure to direct sunlight.

4 EQUIPMENT

4.1 TOOLS



Concrete Grinder



Concrete drill



Drill attachment



Vacuum Cleaner



Brush



Mixing Container



Mixing spindle



Paint Brush



Cable ties



Wooden Needles



Round Brush



Blow-out Tool



Plastic Roller

4.2 CLEANING

Clean all tools and application equipment with *Sika® Thinner C* (or an *Isopropanol based cleaner*) immediately after use. Any uncured epoxy resin material should be wiped up with a rag wetted with solvent. Hardened material can only be removed mechanically.

5 HEALTH AND SAFETY

5.1 RISK ASSESSMENT



The risks to health and safety from everything including any defects in the structure, working procedures and all of the chemicals used during the materials installation must be properly assessed and safely accommodated.

Any working areas on platforms and temporary structures must also provide a stable and safe area to work. All work and working procedures must be carried out fully in accordance with the relevant local health and safety legislation.

5.2 PERSONAL PROTECTION

Work Safely!

- Safety shoes, gloves and other appropriate skin protection should be worn at all times. The use of disposable or new / clean protective clothing during the materials preparation and application is strongly recommended.
- Always wear Nitrile based protective gloves when handling epoxy adhesives / impregnating resins as they can cause skin irritation. Apply barrier cream to hands and any unprotected skin before starting work.
- Appropriate eye protection should be worn at all times whilst handling, mixing and installing the products. Carrying an eye wash with you at all times is recommended.
- Always wash hands with suitable soap and clean water after handling the products and before food consumption, smoking, visiting the toilet and after finishing work.
- The work area needs to be well ventilated and operatives should take frequent breaks in fresh air to avoid any other health issues.
- Silica dust produced by the drilling, grinding or blast cleaning of concrete can be hazardous. Protect yourself and others by using a vacuum grinder or vacuum blast cleaning equipment with dust extraction and abrasive recycling attachments respectively. Always wear a dust mask/respirator when grinding concrete. Do not inhale the concrete drilling dust.



For more detailed health and safety information, please refer to the relevant Material Safety Data Sheet (MSDS)

5.3 FIRST AID



If the epoxy resin based adhesive products come into contact with eyes or mucous membranes, remove any glasses or contact lenses and rinse with clean warm water for 10 to 15 minutes then seek medical attention.

Any chemical spillages on skin must be cleaned immediately and rinsed thoroughly with clean warm water.

For more detailed health and safety information, please refer to the relevant Material Safety Data Sheet (MSDS).

5.4 WASTE DISPOSAL



Do not empty any surplus material into drainage or water systems; dispose of all waste materials and packaging responsibly through licensed waste disposal facilities or contractors, fully in accordance with local legislation and the relevant authorities requirements. Also avoid any chemical materials run-off into soil or into waterways, drains or sewers.

Any uncured adhesive waste or spillages must be disposed of as hazardous waste. Waste and / or leftover Sika® Thinner C must be disposed of according to local regulations. Cured adhesive waste can be disposed of safely as normal building materials waste according to the relevant local regulations.

For more detailed health and safety information, please refer to the relevant Material Safety Data Sheet (MSDS)

6 PREPARATION

6.1 PRE-PROJECT

Review the project specifications in detail. Inspect the site conditions and the concrete surfaces to receive the treatment and report immediately in writing to the responsible Engineer if anything is unsuitable for proper execution of the works.

Obtain all of the necessary tools and equipment, plus materials required (for a checklist example, see Section 9.1), together with any special project requirements. It is recommended that SikaWrap® FX Fibre Connectors are cut to their specified lengths with sharp scissors before beginning to mix the Sikadur® epoxy resin products.

When planning the anchoring works always consider the likely ambient temperatures, as these also affect the epoxy resins pot-life and with that the possibility of using wet-on-wet application techniques, i.e. for SikaWrap® Fabric to the SikaWrap® FX Fibre Connectors.

Protect any adjacent surfaces, vehicles etc., surrounding the work area from any dust or damage due to the preparation and execution of the strengthening works.

6.2 SUBSTRATE

SikaWrap® FX Fibre Connectors can be installed in concrete, stone and masonry substrates. Where none of these are specifically mentioned, the following statements refer to installation in concrete substrates.

Before preparing the substrate for the application, it must be thoroughly inspected and any unsound material (such as any areas of damaged concrete, pieces of formwork or tie-wires etc.) must be removed.

Where concrete repairs are necessary on a structure prior to the application of a SikaWrap® FX Fibre Connector and fabric strengthening system, it is important that the repair materials are designed and installed to be fully compatible with the Sikadur® adhesive and suitable for use in a structural situation (i.e. they must have low shrinkage, compatible modulus of elasticity, good interface bond, adequate strength and an appropriate finished surface).

Repairs to concrete surface irregularities such as blowholes or voids must be made with a suitable repair mortar such as Sikadur®-41. Sikadur®-30 adhesive must also be used as a bonding bridge layer for both of these surface repair options, to ensure a good bond with the substrate and no voids in the repairs. Any non-moving structural cracks must be filled by injection with Sikadur®-52 or other suitable Sikadur® injection resin with the Structural Engineer's agreement.

Further advice on all aspects of concrete repairs can be obtained from your local Sika® Technical Service Department.

The actual strength of the concrete substrate must be verified on all projects. If the concrete has to be repaired, then another test must be performed after the repairs are completed and adequately cured. Please refer to section 8 of this Technical information manual for more details of testing procedures and the necessary concrete strengths.

Concrete must normally be older than 28 days (dependent on the environmental situation, the mix design and effective strength requirements).



The concrete, stone and masonry substrates must be prepared mechanically using abrasive blast cleaning, or grinding equipment. During this preparation work, an integrated vacuum system (see picture on the right) should be used, in order to reduce the risk of contamination, plus a dust mask should be worn to prevent the inhalation of concrete dust.

The mechanical preparation is carried out to remove cement laitance, any loose and friable materials and achieve a profiled, open textured surface. Any surface defects such as honeycombing, blowholes and voids must be fully exposed.



All prepared surfaces must be brushed, air blasted and vacuumed to achieve a dust free condition. No loose particles should be left on any of the substrate surfaces.

External corners and arrises where fabrics will be applied must generally be rounded to a minimum radius of 20 mm, or as required by the Engineer's specification. This can be achieved either by grinding, or by building up with Sikadur® mortars. Internal corners must be made smooth by trowel application of Sikadur® epoxy mortar into the prepared corners.



The surfaces to be strengthened must be made level to ensure that the specified tolerances are achieved and maintained as detailed in the table below. The plane and level of the substrate is to be checked with a suitable straight edge. The tolerance required depends on the specified standards to be achieved. The recommended Sika values are given in the right hand column of the table below; however these tolerances, their method of measurement and testing can be varied on different projects and structures according to any local guidelines and requirements. Any testing must only be carried out in relation to one standard or the other.

Standard	Fib bulletin 14	Sika® recommendation
Tolerance for 2 m length	10 mm	-
Tolerance for 0.3 m length	4 mm	2 mm
Max. formwork marks	-	0.5 mm



The final surface must be smooth, dry and free of damaged concrete and any other contaminants as dust, foreign particles, cement laitance, oil, grease, surface coatings, curing compounds, waxes and impregnations etc., which could adversely affect or inhibit the bond of the strengthening system to the concrete.

The substrate moisture content must be less than 4% pbw.

For the installation of the SikaWrap® Fibre Connector, a hole needs to be drilled with a diameter of 20 mm and a depth of 100 mm, or according to the engineer's specifications. Depending of the type of installation, the hole can also be drilled through the substrate. The edges of the hole must be rounded to a radius of 2 cm to avoid any fibre damage to the FX during installation. If it is installed through the substrate as opposed to inserted from one side the hole has to be drilled from both sides, with special care being taken that the hole is straight (see also section 7.2).

The drilled hole has to be thoroughly cleaned so that it is free from dust and any loose particles. Clean the hole with the blow-out tool and the round brush, alternating the two tools at least three times.



On the substrate surface, **eight star-shaped slits** are cut into the substrate as illustrated in the picture above. The slits must have a minimum width and depth of 8-10 mm and 5-10 mm respectively. After cutting, the slits must be cleaned from dust and other residue by pressurized air or vacuum cleaner.

6.3 RESINS

As outlined in the table below, different Sika resins are used for the different steps in the installation of SikaWrap® FX Fibre Connectors.

Resin Type	Application Step
Sikadur®-300	Impregnation of the SikaWrap® FX Fibre Connector
Sikadur®-52 N	Priming of slits, installation of upper part of the connector
Sikadur®-330	Filling of the drilled hole
Sikadur® - 33	Filling of the drilled hole (alternative adhesive material)

The epoxy resin adhesives Sikadur®-330 Sikadur®-300 and Sikadur®-52 N can be supplied and mixed in their pre-batched units, or supplied and mixed from bulk packaging, according to the required volume and the practical situation on site

Sika Sikadur® - 33 is always supplied in pre-packaged cartridges and does not need to be mixed or filled into a different cartridge for application. For more details on the respective and comparative performance of the different adhesives, their pot life and other characteristics, please refer to the relevant Product Data Sheets.

Pre-batched packs:

Add component B to component A and stir with a mixing spindle fitted to an electric low speed drill (max. 500 rpm) to avoid entrapping air. Mix thoroughly for about 3 minutes to a homogeneous mix with a uniform grey colour and appearance. Then, pour the whole mix into a clean container and stir again for approx. one more minute, again at low speed to keep air entrapment at a minimum.

The adhesive pot life begins when the resin and hardener are first mixed. It is shorter at high temperatures and longer at low temperatures. Additionally the greater the quantity or volume of material mixed together at one time is, the shorter is the pot life. To obtain longer workability at high temperatures, the mixed adhesive may subsequently be divided into portions; alternatively another method is to chill the components A and B before mixing them.

If Sikadur®-330 is used to fill the holes, the mixed resin is either filled into a cartridge or rolled into a plastic sheet to facilitate the resin application (see pictures in the section below and in section 9.3).

Resin Consumption

	Sikadur-300	SikaDur-330	Anchorfix 3+
Impregnation (length 20 cm)	50 g – 60 g *	-	-
Filling of hole (10 cm deep)	-	80 g – 100 g *	80 g – 100 g *
Fabric layer	Depends on fabric weight, see relevant PDS		

*Values include waste. If a large series of connectors is installed, total consumption decreases due to less waste.

7 INSTALLATION

The SikaWrap® FX is inserted into the prepared hole and slits and installed under the SikaWrap® fabric according to the steps listed below.

7.1 INSTALLATION UNDERNEATH FABRIC LAYER

After the substrate has been prepared, and both the substrate surface with the slits and the hole for the connector are free from dust and loose particles, the connector is prepared and installed according to the steps outlined below.



Cut the SikaWrap® FX to size and prepare all tools necessary.
Mix the impregnation resin according to the relevant PDS.



Impregnate one half of the connector with resin until completely saturated, and squeeze out any air and excess resin



Tie all fibres on the impregnated end of the connector together with a cable tie and cut off the free end of the tie.

If the connector is still held together by the plastic sleeve, remove it.



Insert a knitting needle through the length of the connector with the tip wedged in the cable tie



Apply adhesive to the prepared slits with a brush.

Fill the hole drilled in the substrate with adhesive from the bottom up, either using an adhesive gun (pictured left) or a rolled plastic sheet funnel

If the hole goes through the substrate, fill the hole from both sides if necessary.
Avoid any air pockets.



Insert the connector into the hole with the use of the knitting needle.

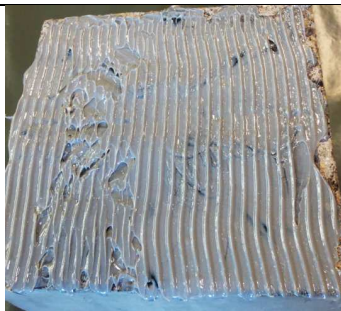


Split the dry upper half of the connector in 8 parts of equal size and place the fibre bundles into the slits. Impregnate the fibres with a brush while pushing them into the slits.

Remove the knitting needle carefully without pulling the connector back out.



Fill the slits with Sikadur-330 to level the surface

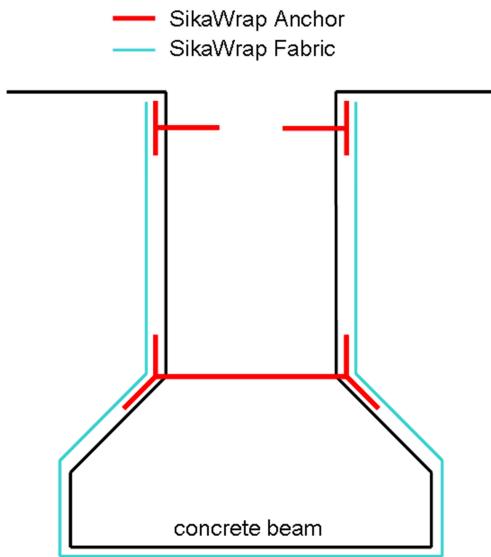


Apply additional resin for the installation of the SikaWrap® fabric



Install the SikaWrap® fabric on top of the connector as described in the relevant Product Data Sheet.

7.2 INSTALLATION THROUGH THE SUBSTRATE



SikaWrap® FX Fibre Connectors can be installed either into a hole drilled into the substrate, or into a channel which goes through the substrate (for example through a beam). The two possibilities are illustrated in the drawing on the right. The top connectors (red) are inserted into holes, but they could also be installed as one continuous piece like the connector (red) shown at the bottom if the column. Dependent on the project requirements, one or the other options may be more suitable.

When installing SikaWrap® Fibre Connectors into a channel, the following additional points have to be taken into consideration:

- The channel has to be drilled from both sides to prevent concrete spalling one side. Take care that the hole is straight; otherwise it will not be possible to insert the connector.
 - To avoid excessive waste of the resin adhesive, the hole can be only partially filled, leaving the “back end”, where the connector exits, empty, as resin will be pushed into this area when the connector is inserted from the other side, and the hole will still be filled completely. Air enclosures must be avoided.
- After inserting the connector, adjust it to ensure both sides have the same length of connector sticking out, then cut off the cable tie and apply the fibres into the slits as described above

All of the other steps, including the application of SikaWrap® fabrics, can then be performed as described in section 7.1.

8 INSPECTION AND TESTING

8.1 BEFORE APPLICATION

The substrate strength (concrete, masonry or natural stone) must always be checked and verified in all situations. This is done by means of a series of pull-off tests as outlined in EN 1542. The mean adhesive tensile strength of the prepared concrete substrate must be *minimum 1 N/mm² (Sika's minimum recommendation)* unless otherwise detailed by the responsible Structural Engineer.

If the strengthening work has to be performed according to fib bulletin 14, then the concrete must have a minimum tensile strength of 3 N/mm². Concrete substrates must generally be at least 28 days old.

If the substrate is damaged and needs to be repaired, a repetition of the substrate strength tests is necessary after the repair is completed and hardened.

8.2 SITE INSPECTION

On site, all aspects of the preparation, mixing, application and installation of the strengthening materials should be continuously observed and recorded, including at least the following:

- Surface preparation and testing
- Materials labels and batch numbers
- Mixing of the Sikadur resin materials
- Application of the resin to the substrate and the SikaWrap® Fibre Connectors
- Curing of the materials
- System testing
- Any other details required for the strengthening system and its specification

As SikaWrap® FX Fibre Connectors are part of a SikaWrap® Fabric Strengthening System installation, all of the same rules and conditions for SikaWrap® fabrics apply:

Upon completion of the resin curing periods the installed system should be checked again to confirm that there are no areas where the impregnation resin has not fully penetrated, or where the resin has not completely cured and hardened. Any such areas covering more than 25 x 25 mm on the surface must be repaired. Any repairs must be made subject to the same application, curing and quality control specifications as the original works.

Any small areas of delamination and / or bubbles can be repaired by injecting them with a compatible Sikadur resin to re-establish bond between the substrate and the strengthening system.

If any large defects are found, then removal and re-application, or the application of additional layers of SikaWrap® FRP Reinforcement may be necessary. The repair type, the preparatory works, the number of layers to be added and the overlapping lengths must always be approved by the responsible Structural Engineer.

9 APPENDIX

9.1 CONSTRUCTION RECORDS

Throughout the process of the project work, a written record should be maintained that details all aspects of the works involved in the preparation, mixing and application, including:

- Surface preparation
- Materials delivery / batch numbers
- Mixing and application of resin
- Ambient conditions (ambient temperature, substrate temperature, humidity, dew point)
- Any possible contamination
- Details of all test samples and results
- Any significant vibration of the structure
- Any other points of note or concern on site

9.2 ON-SITE EQUIPMENT CHECKLIST

- Mixing container
- Mixing spindle
- Mixing paddle
- Round hole brush
- Blow-out tool
- SikaWrap[®] FX Fibre Connectors
- SikaWrap[®] Fabric
- Sikadur[®] -330 resin
- Sikadur[®] -300 resin
- Sikadur[®] - 33
- Sika[®] Thinner C(or an Isopropanol based cleaner)
- Wire brush
- Soft brush
- Knitting needles
- Cable ties
- Plastic sheets (for resin funnels)
- Grinding / blast cleaning equipment (dependent on substrate)
- Concrete drill
- Special sharp scissors
- Safety goggles
- Safety hard hat
- Skin protection – barrier cream
- Protective gloves
- Nitrile gloves
- Clean water
- Eye wash kit
- Thermometer
- Moisture meter
- Concrete core drill
- Steel dollies
- Pull-off tester
- Adhesive for dollies

9.3 HOW-TO MAKE AND USE A PLASTIC SHEET FUNNEL

If the hole is filled with Sikadur®- 33 resin, then the material is supplied in cartridges and static mixing nozzles which are ready to use. If Sikadur-330 is used however, either empty cartridges or a plastic sheet funnel can be filled with the mixed resin and used to fill the hole. If no empty cartridges are available, or many holes need to be filled and the filling of the cartridges is considered too time consuming, then the use of a plastic sheet funnel is recommended, as described below.

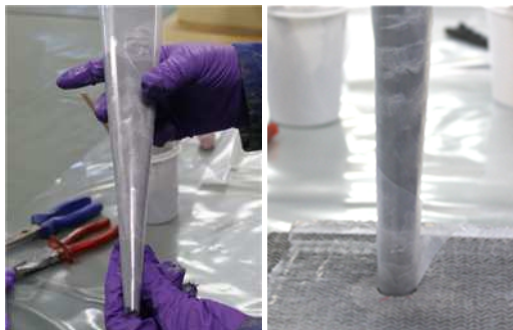


Mix the resin for filling the holes.

Cut a plastic sheet to size (minimum 20 cm longer than the hole depth, minimum 30 cm wide)



Apply the resin in a line towards one side of the sheet.



Roll the sheet tightly into a tube / funnel shape, with the resin on the inside. Ensure that the diameter of at least one end and to the depth of the holes, is smaller than the drilled hole diameter.

Insert the rolled sheet funnel into the hole until the plastic touches the bottom.



Squeeze the resin out while slowly pulling the plastic sheet funnel roll out of the hole. Avoid creating air voids by pulling out too fast.

10 LEGAL NOTE

The information, and, in particular, the recommendations relating to the application and end-use of Sika products, are given in good faith based on Sika's current knowledge and experience of the products when properly stored, handled and applied under normal conditions in accordance with Sika's recommendations. In practice, the differences in materials, substrates and actual site conditions are such that no warranty in respect of merchantability or of fitness for a particular purpose, nor any liability arising out of any legal relationship whatsoever, can be inferred either from this information, or from any written recommendations, or from any other advice offered. The user of the product must test the products suitability for the intended application and purpose. Sika reserves the right to change the properties of its products. The proprietary rights of third parties must be observed. All orders are accepted subject to our current terms of sale and delivery. Users must always refer to the most recent issue of the local Product Data Sheet for the product concerned, copies of which will be supplied on request.



SIKA LIMITED

Head Office · Watchmead · Welwyn Garden City ·
Hertfordshire · AL7 1BQ · United Kingdom
Phone: +44 1 707 394444 · Fax: +44 1 707 329129 · www.sika.co.uk

Sika Services AG
Refurbishment and
Strengthening
Speckstrasse 22
8330 Pfäffikon ZH
Switzerland
www.sika.com

Version given by
Mark Shaw

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Sika Ltd
Mark Shaw