Product Data Sheet
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Sika® CarboDur® Plates

Construction

Sika® CarboDur® Plates

Pultruded carbon fibre plates for structural strengthening

System Description

Sika® CarboDur® plates are pultruded carbon fibre reinforced polymer (CFRP) laminates designed for strengthening concrete, timber and masonry structures.

Sika® CarboDur® plates are bonded onto the structure as external reinforcement using Sikadur®-30 structural adhesive (for details on the adhesive see the relevant Product Data Sheet).

Uses

To strengthen structures for:

Load increase

- Increasing the capacity of floor slabs and beams
- Increasing the capacity of bridges to accommodate increase axle loads
- Installation of heavier machinery
- Stabilising vibrating structures
- Changes of building use

Damage to structural elements

- Deterioration of original construction materials
- Steel reinforcement corrosion
- Vehicle impact
- Fire
- Earthquakes

Service improvements

- Reduced deflection
- Stress reduction in steel reinforcement
- Crack width reduction
- Reduced fatigue

Change in structural system

- Removal of walls or columns
- Removal of slab sections for openings

Change of specification

- Earthquakes
- Changed design philosophy

Design or construction defects

- Insufficient / inadequate reinforcement
- Insufficient / inadequate structural depth

Characteristics / Advantages	■ Non corrosive ■ Very high strength ■ Excellent durability ■ Lightweight ■ Unlimited lengths, no joints required ■ Low overall thickness, can be coated ■ Easy transportation (rolls) ■ Simple plate intersections or crossings ■ Very easy to install, especially overhead ■ Outstanding fatigue resistance ■ Minimal preparation of plate ■ Combinations of high strength and modulus of elasticity available ■ High alkali resistance ■ Clean edges without exposed fibres thanks to the pultrusion process ■ Approvals from many countries worldwide

Tests

Approval / Standards	Deutsches Institut für Bautechnik Z-36.12-29, 2002: General Construction Authorisation for Sika® CarboDur. SOCOTEC Rapport No. HX0823, 2000: Rapport d'enquete technique / cahier des charges - Sika® CarboDur® / SikaWrap® (French). NBI Teknisk Godkjenning, NBI Technical Approval, No. 2178, 2001, (Norwegian). ZAG, Technical Approval No. S418/99-620-2, za uporabo nacina ojacitev armirano betonskih in prednapetih elementov konstrukcij z dolepljenjem lamel iz karbonskih vlaken "Sika® CarboDur®" v Republiki Sloneniji (Slovenian). TSUS, Building Testing and research institutes, Technical approval No. 5502A/02/0633/0/004, 2003: Systém dodatocného zosilnovania zelezobetonovych a drevenych konstrukcil Sika CarboDur® (Slovak). Instytut badawczy drog i mostow, technical approval No. AT/2003-04-0336, System materialow Sika® CarboDur® do wzmacniania konstrukcji obiektow mostowych (Polish). Fib, Technical Report, bulletin 14: Externally bonded FRP reinforcement for RC structures, July 2001 (International). ACI 440.2R-02, Guide for the Design and construction of Externally Bonded FRP Systems for strengthening concrete structures, October 2002, (USA). Concrete Society Technical Report No. 55, Design guidance for strengthening concrete structures using fibre composite material, 2000 (UK). SIA 166, Klebebewehrungen, 2003 /2004 (CH).

Product Data — Sika® CarboDur® CFRP plates

Form

Appearance / Colour	Carbon fibre reinforced polymer with an epoxy matrix, black.
Packaging	Cut to size according parts list in reusable packaging. Supplied in rolls of 250 m in reusable packing boxes.

Types

Sika® CarboDur® S — Tensile E-Modulus 165'000 N/mm²

Type	Width	Thickness	Cross sectional area
Sika® CarboDur® S512*	50 mm	1.2 mm	60 mm²
Sika® CarboDur® S612	60 mm	1.2 mm	72 mm²
Sika® CarboDur® S812*	80 mm	1.2 mm	96 mm²
Sika® CarboDur® S1012*	100 mm	1.2 mm	120 mm²
Sika® CarboDur® S1512*	150 mm	1.2 mm	180 mm²
Sika® CarboDur® S914	90 mm	1.4 mm	126 mm²
Sika® CarboDur® S1014	100 mm	1.4 mm	140 mm²
Sika® CarboDur® S1214	120 mm	1.4 mm	168 mm²

Sika® CarboDur® M (steel equivalent) — Tensile E-Modulus 210'000 N/mm²

Type	Width	Thickness	Cross sectional area
Sika® CarboDur® M614	60 mm	1.4 mm	84 mm²
Sika® CarboDur® M914*	90 mm	1.4 mm	126 mm²
Sika® CarboDur® M1214*	120 mm	1.4 mm	168 mm²

* Stock grades. Others to special order

Storage

Storage Conditions / Shelf Life — Unlimited (no exposure to direct sunlight, dry).

Technical Data

Density — 1.60 g/cm³

Temperature Resistance — > 150 °C

Fibre Volume Content — > 68% (type S)

Mechanical / Physical Properties

Plate Properties

		Sika CarboDur S	Sika CarboDur M
E-Modulus*	Mean Value	165'000 N/mm^2	210'000 N/mm^2
	Min. Value	> 160'000 N/mm^2	> 200'000 N/mm^2
	5% Fractile-Value	162'000 N/mm^2	210'000 N/mm^2
	95% Fractile-Value	180'000 N/mm^2	230'000 N/mm^2
Tensile Strength*	Mean Value	3'100 N/mm^2	3'200 N/mm^2
	Min. Value	> 2'800 N/mm^2	> 2'900 N/mm^2
	5% Fractile-Value	3'000 N/mm^2	3'000 N/mm^2
	95% Fractile-Value	3'600 N/mm^2	3'900 N/mm^2
Strain at break* (min. value)		> 1.70%	> 1.35%
Design strain**		0.85%	0.65%

* Mechanical values obtained from longitudinal direction of fibres.

**These values should be used for design as the maximum strains in the CFRP-plates and must be adapted to local design regulations as necessary. Dependent upon the structure and the load situation, they may also have to be decreased by the responsible Engineer according to requirements and standards.

System Information

Sika® CarboDur® + Sikadur®-30

Application Details

Consumption

Width of plate	Sikadur®-30
50 mm	0.35 kg/m'
60 mm	0.40 kg/m'
80 mm	0.55 kg/m'
90 mm	0.70 kg/m'
100 mm	0.80 kg/m'
120 mm	1.00 kg/m'
150 mm	1.20 kg/m'

Depending on the surface plane, profile and roughness of the substrate as well as any plate crossings and loss or wastage, the actual consumption of adhesive may be higher.

Substrate Quality

Evenness / plane or level: (according to FIB14)
The surface to be strengthened must be levelled, with variations and formwork marks not greater than 0.5 mm. Plane and level of the substrate to be checked with a metal batten. Tolerance for 2 m length max. 10 mm and for 0.3 m length 4 mm. These tolerances shall be adapted to conform to national standards.

Substrate strength (concrete, masonry, natural stone) must be verified in all cases): Mean adhesive tensile strength of the prepared concrete substrate should be 2.0 N/mm^2, min. 1.5 N/mm^2. If these values can not be reached, then see the SikaWrap® Fabric Product Data Sheets for alternative Sika® solutions.

Concrete must be older than 28 days (dependent on environment and strengths).

Substrate Preparation

Concrete and masonry:
Substrates must be sound, dry, clean and free from laitance, ice, standing water, grease, oils, old surface treatments or coatings and all loosely adhering particles.

Concrete must be cleaned and prepared to achieve a laitance and contaminant free, open textured surface.

Repairs and levelling must be undertaken with structural repair materials such as Sikadur®-41 repair mortar or Sikadur®-30 adhesive, filled max. 1 : 1 by weight with quartz sand (0.6 – 1.2 mm). If levelling has been conducted more than 2 days before applying the plates, the levelled surface has to be textured again to ensure a proper bond between Sikadur®-41 and Sikadur®-30 (see the relevant Product Data Sheets).

Timber surfaces:
Must be prepared by planing, grinding or sanding. Dust must be removed by vacuum.

Steel surfaces:
Must be prepared by blastcleaning to Sa 2.5 free from grease, oil, rust and any other contaminants which could reduce or prevent adhesion.
Use primer (see table).

Be careful to avoid water condensation (dew point).
Priming can be done with Sikagard®-63N as temporary corrosion protection; or Icosit-EG1 as permanent corrosion protection.

	+10 °C	+20 °C	+30 °C
1) Maximum waiting time between - Blastcleaning of steel and - Primer / or Sikadur®-30 (application without priming possible, if no corrosion protection is needed)	48 hours	48 hours	48 hours
2) Minimum waiting time between - Primer and - Sikadur®-30 application (**without** additional preparation of the Primer)	48 hours	24 hours	12 hours
3) Maximum waiting time between - Primer and - Sikadur®-30 application (**without** additional preparation of the Primer)	7 days	3 days	36 hours
4) Waiting time between - Primer and - Sikadur®-30 application (**with** additional preparation of the Primer)*	> 7 days	> 3 days	> 36 hours

*If additional preparation of the primer is necessary (4), it shall be done at the earliest, the day before application. After preparation of the Primer, the surface has to be cleaned/vacuumed free from dust.

Plate preparation:
Immediately prior to the application of Sikadur®-30, solvent wipe the bonding surface with Sika® Colma Cleaner/Thinner C to remove contaminants. Wait until the surface is dry before applying the adhesive.

Application Conditions / Limitations

Substrate Temperature	See the Product Data Sheet for Sikadur®-30
Ambient Temperature	See the Product Data Sheet for Sikadur®-30
Substrate Humidity	See the Product Data Sheet for Sikadur®-30.
Dew Point	See the Product Data Sheet for Sikadur®-30

Application Instructions

Mixing	See the Product Data Sheet for Sikadur®-30
Mixing Time	See the Product Data Sheet for Sikadur®-30
Application Method / Tools	Place the Sika® CarboDur® plate on a table and clean the unlabelled side with Colma Cleaner using a white rag. Apply the well-mixed Sikadur®-30 adhesive with a special “dome” shaped spatula onto the cleaned CarboDur® laminate. Apply the Sikadur®-30 adhesive carefully to the properly cleaned and prepared substrate, with a spatula to form a thin layer. Within the open time of the adhesive, place the Sikadur®-30 coated Sika® CarboDur® plate onto the Sikadur® coated concrete surface. Using a rubber roller, press the plate into the adhesive until the material is forced out on both sides of the laminate. Remove surplus adhesive. Intersections / multiple layers: Where there are to be plate intersections or crossovers, the first Sika® CarboDur® plate should be degreased with Sika® Colma Cleaner/Thinner C before overlaying with adhesive and then the second plate applied. If more than one plate is to be bonded together, they all have to be cleaned on both sides with Sika® Colma Cleaner/Thinner C. Use Sikadur®-330 or Sikadur®-30 adhesive in these instances (for details see the Product Data Sheets for Sikadur®-330 and Sikadur®-30). Quality assurance: Samples must be made up on site for quality control of curing rate and strength. Average standard values after curing 7 days at +23°C are: - Compressive strength > 75 N/mm^2 - Flexural tensile strength > 35 N/mm^2 These values can differ by up to 20% dependent on the circumstances. The following are the most important factors which can have a negative influence on the mechanical properties: - Air entrapment in the sample (from mixing or filling into the mould!) - Curing temperature / time - Contamination of the adhesive! Therefore care should be taken to avoid these situations. Application Tools: Sika® Colma Cleaner/Thinner C: For cleaning of Sika® CarboDur® plate before bonding, cleaning of application tools. Rubber Roller: For pressing the Sika® CarboDur® plate onto the surface. Sika® Mixing Spindle: For minimizing air entrapment.
Cleaning of Tools	Clean all tools and application equipment with Sika® Colma Cleaner/Thinner C immediately after use. Cured material can only be mechanically removed.
Potlife	See the Product Data Sheet for Sikadur®-30.

Construction

Notes on Application / Limitations	A suitably qualified Engineer must be responsible for the design of the strengthening works. **This application is structural and great care must be taken in selecting suitably experienced and trained specialist labourers.** Only apply plates within the open time of Sikadur®-30. Site quality control should be supported/monitored by an independent testing authority. Care must be taken when cutting plates. Use suitable protective clothing, gloves, eye protection and respirator. The Sika® CarboDur® system must be protected from permanent exposure to direct sunlight. Maximum permissible service temperature is approx. +50°C. The instructions in the Technical Data Sheet must be followed when applying Sikadur®-30 adhesive. Note: Detailed advice on the above must always be obtained from Sika® Services AG.
Fire Protection	If required Sika® CarboDur® plates may be protected with fire resistant material. When the Sikadur®-30 has cured, test for voids by tapping the surface of the plate with metallic object or impulse-thermography. Coating: The exposed plate-surface can be painted with a coating material such as Sikagard®-550W Elastic or Sikagard®-ElastoColor W.
Value Base	All technical data stated in this Product Data Sheet are based on laboratory tests. Actual measured data may vary due to circumstances beyond our control.
Local Restrictions	Please note that as a result of specific local regulations the performance of this product may vary from country to country. Please consult the local Product Data Sheet for the exact description of the application fields.
Health and Safety Information	For information and advice on the safe handling, storage and disposal of chemical products, users should refer to the most recent Material Safety Data Sheet containing physical, ecological, toxicological and other safety-related data.
Legal Notes	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 product's 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.

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