Construction

Sika® CarboDur® Plates

Pultruded carbon fiber plates for structural strengthening

System Description

Sika® CarboDur® plates are pultruded carbon fiber 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 for normal - or Sikadur®-30 LP epoxy resin for elevated application temperatures (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, applicable in several layers ■ Combinations of high strength and modulus of elasticity available ■ Clean edges without exposed fibers thanks to the pultrusion process ■ Approvals from many countries worldwide

Tests

Approval / Standards	Germany: Deutsches Institut für Bautechnik Z-36.12-29, 2006: General Construction Authorisation for Sika® CarboDur®. France: CSTB - Avis Technique 3/07-502, SIKA CARBODUR SIKA WRAP Norway: NBI Teknisk Godkjenning, NBI Technical Approval, No. 2178, 2001, (Norwegian). Slovenia: 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). Slovakia: 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). Poland: 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). USA: ACI 440.2R-02, Guide for the Design and construction of Externally Bonded FRP Systems for strengthening concrete structures, October 2002, (USA). UK: Concrete Society Technical Report No. 55, Design guidance for strengthening concrete structures using fiber composite material, 2000 (UK). Switzerland: SIA 166, Klebebewehrungen, 2003 /2004 (CH). Italy: CNR-DT 200/2004 - Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Existing Structures

Product Data — Sika® CarboDur® CFRP plates

Form

Appearance / Colour

Carbon fiber reinforced polymer with an epoxy matrix, black.

Packaging

Cut to size according parts list in nonreturnable cardboard packaging.
Supplied in rolls of 250 m in nonreturnable cardboard boxes.

Types

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

Type	Width	Thickness	Cross sectional area
Sika® CarboDur® S1.525/60	15 mm	2.5 mm	37.5 mm²
Sika® CarboDur® S2.025/80	20 mm	2.5 mm	50 mm²
Sika® CarboDur® S512/80	50 mm	1.2 mm	60 mm²
Sika® CarboDur® XS514/80	50 mm	1.4 mm	70 mm²
Sika® CarboDur® S613/100	60 mm	1.3 mm	78 mm²
Sika® CarboDur® S812/120	80 mm	1.2 mm	96 mm²
Sika® CarboDur® S912/140	90 mm	1.2 mm	108 mm²
Sika® CarboDur® S1012/160	100 mm	1.2 mm	120 mm²
Sika® CarboDur® S1014/180	100 mm	1.4 mm	140 mm²
Sika® CarboDur® S1213/200	120 mm	1.3 mm	156 mm²
Sika® CarboDur® S1214/220	120 mm	1.4 mm	168 mm²
Sika® CarboDur® S1512/240	150 mm	1.2 mm	180 mm²

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

Type	Width	Thickness	Cross sectional area
Sika® CarboDur® M614/110	60 mm	1.4 mm	84 mm²
Sika® CarboDur® M914/170	90 mm	1.4 mm	126 mm²
Sika® CarboDur® M1014/190	100 mm	1.4 mm	140 mm²
Sika® CarboDur® M1214/230	120 mm	1.4 mm	168 mm²

Sika® CarboDur® H — Tensile E-Modulus 300'000 N/mm²

Type	Width	Thickness	Cross sectional area
Sika® CarboDur® H514/50	50 mm	1.4 mm	70 mm²

Storage

Storage Conditions / Shelf Life

Unlimited provided if there is no exposure to direct sunlight, dry conditions at temperatures of max. 50°C

Transportation: only in original packaging or protected against any mechanical damaging

Technical Data

Density

1.60 g/cm³

Temperature Resistance

> 150°C

Fiber Volume Content

> 68% (type S)

Mechanical / Physical Properties

Plate Properties

		Sika CarboDur			
(numbers in N/mm^2 or MPa)		XS	S	M	H
E-Modulus*	Mean Value	165'000	165'000	210'000	300'000
	Min. Value	> 160'000	> 160'000	> 200'000	> 290'000
	5% Fractile-Value	-	162'000	210'000	-
	95% Fractile-Value	-	180'000	230'000	-
Tensile Strength*	Mean Value	2'400	3'100	3'200	1'500
	Min. Value	> 2'200	> 2'800	> 2'900	> 1'350
	5% Fractile-Value	-	3'000	3'000	-
	95% Fractile-Value	-	3'600	3'900	-
Strain at break* (min. value)		> 1.20%	> 1.70%	> 1.35%	> 0.45%
Design strain**		< 0.7%	< 0.85%	< 0.65%	< 0.25%

* Mechanical values obtained from longitudinal direction of fibers.

**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 or Sikadur®-30 LP

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'

Dependent 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 local guidelines.

Substrate strength (concrete, masonry, natural stone) must be verified in all cases: Mean adhesive tensile strength of the prepared concrete substrate shall 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 any loosely adhering particles.

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

Repairs and levelling: If carbonised or weak concrete cover has to be removed or levelling of uneven surfaces is needed, the following systems may be applied:
(Details on application and limitation see the relevant Product Data Sheets)

- Protection of corroded rebars: SikaTop® Armatec® 110 EpoCem®
- Structural repair materials: Sikadur®-41 epoxy repair mortar, Sikadur®-30 adhesive or cementitious Sika® MonoTop®-412 (horizontal, vertical, overhead) or Sika® MonoTop®-438 (horizontal, top-side) range.

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 the correct primer (see table).

Be careful to avoid water condensation on the surfaces (dew point conditions).
Priming can be done with Icosit-277 or with Sikagard®-63 N 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 earliest the day before application. After preparation of the Primer, the surface has to be cleaned / vacuumed free from dust.

Plate preparation:
Prior to the application of Sikadur®-30, solvent wipe the bonding surface with Sika® Colma Cleaner to remove contaminants. Wait until the surface is dry before applying the adhesive (> 10 minutes).

Application Conditions / Limitations

Substrate Temperature	See the Product Data Sheets of Sikadur®-30 and Sikadur®-30 LP.
Ambient Temperature	See the Product Data Sheets of Sikadur®-30 and Sikadur®-30 LP.
Substrate Moisture Content	See the Product Data Sheets of Sikadur®-30 and Sikadur®-30 LP.
Dew Point	See the Product Data Sheets of Sikadur®-30 and Sikadur®-30 LP.

Application Instructions

Mixing	See the Product Data Sheets of Sikadur®-30 and Sikadur®-30 LP.
Mixing Time	See the Product Data Sheets of Sikadur®-30 and Sikadur®-30 LP.
Application Method / Tools	See the Method Statement of Sika CarboDur®.
Cleaning of Tools	Clean all tools and application equipment with Sika® Colma Cleaner immediately after use. Cured material can only be removed mechanically.
Potlife	See the Product Data Sheets of Sikadur®-30 and Sikadur®-30 LP.
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 labour.** Only apply plates within the open time of Sikadur®-30. Site quality control shall 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, to water and/or moisture and from direct contact to wet concrete. Coating: The exposed plate-surface can be painted with a coating material such as Sikagard®-550 W Elastic or Sikagard®-ElastoColor W for UV and water and/or moisture protection. Maximum permissible service temperature is approx. +50°C. Note: When using the Sika® CarboHeater together with Sikadur®-30 LP this can be increased to max. +80°C (see the Sika® CarboHeater Product Data Sheet). 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.

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 shall 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.

It may be necessary to adapt the above disclaimer to specific local laws and regulations. Any changes to this disclaimer may only be implemented with permission of Sika® Corporate Legal in Baar.

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