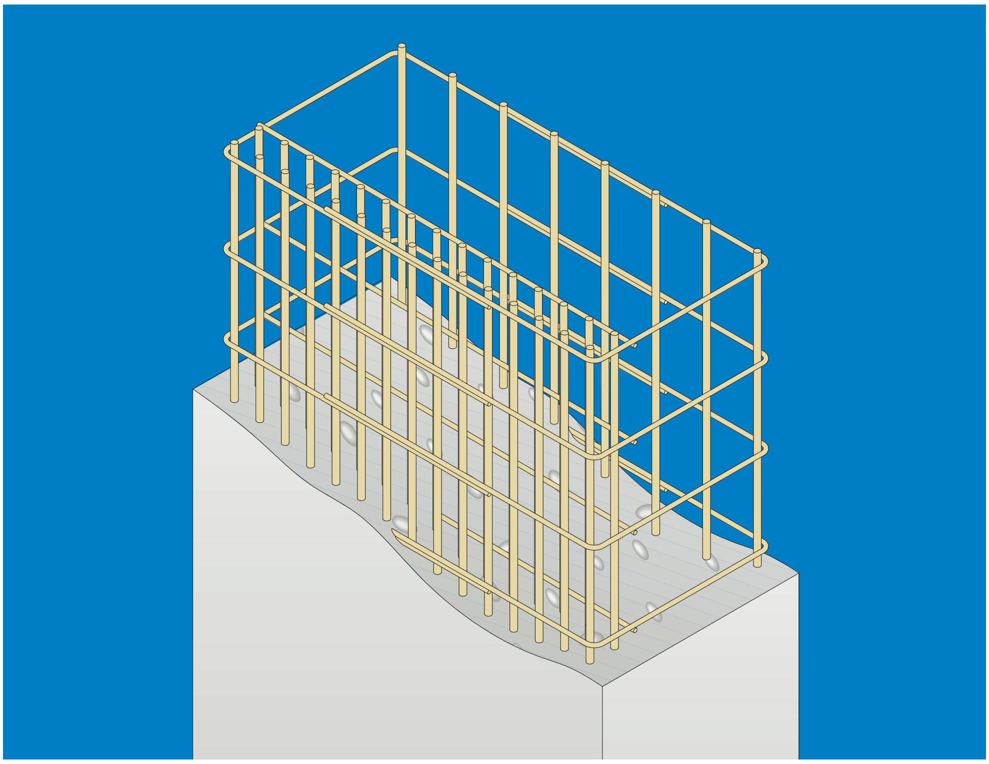
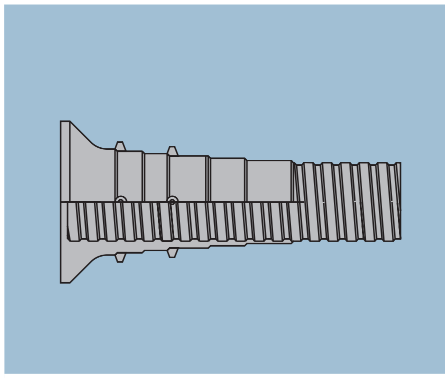
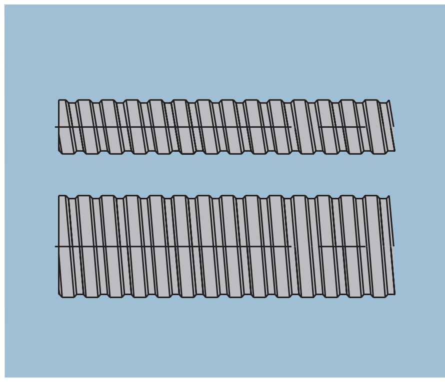
TECHNICAL INFORMATION SCHÖCK COMBAR®







ISSUED MARCH 2006

REINFORCEMENT MADE OF GLASS
FIBRE REINFORCED POLYMER

Schöck
build simply better

SCHÖCK COMBAR®

Design and consulting service

The engineers at Schöck will gladly assist you on questions regarding structural design and building physics. We will provide you with specific solutions including detail drawings.

Please contact us for assistance on national and international projects:

Schöck Bauteile GmbH
International Major Projects
Vimbucher Straße 2
76534 Baden-Baden
Germany

▶ **Technical Service**
telephone-hotline and technical project service

Telefon: +49(0)7223/967-449
Telefax: +49(0)7223/967-490
E-Mail: igp@schoeck.de

▶ **request and download of design guidelines**

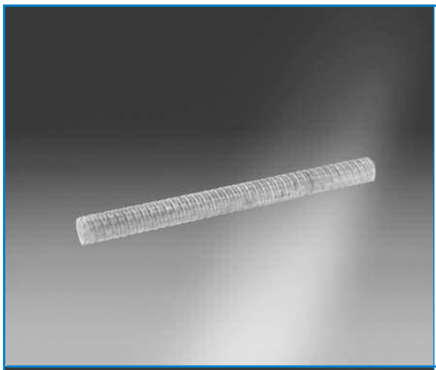
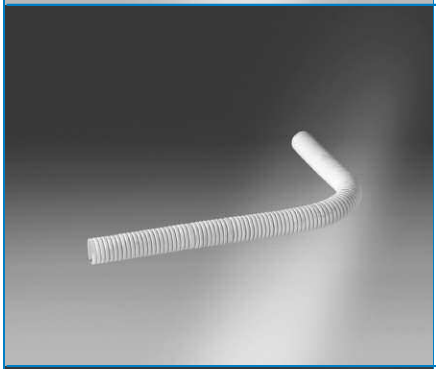
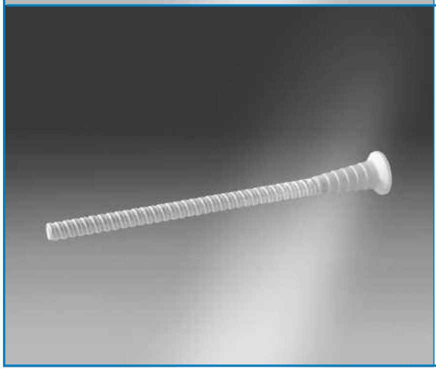
Telefon: +49(0)7223/967-435
Telefax: +49(0)7223/967-454
E-Mail: schoeck@schoeck.de
Internet: www.schoeck.com

The design values and recommendations provided in this technical information represent the best of our knowledge at the time of publication. They are based on the results of extensive research and testing and are intended to provide the planner and the designing engineer with a better understanding of Schöck ComBAR®. Until Schöck ComBAR® is fully accredited, they shall serve as a design guideline. The information provided in this technical information in no way releases the designing engineer of his duties and responsibilities. It can not replace commonly accepted engineering rules and regulations.

Table of contents

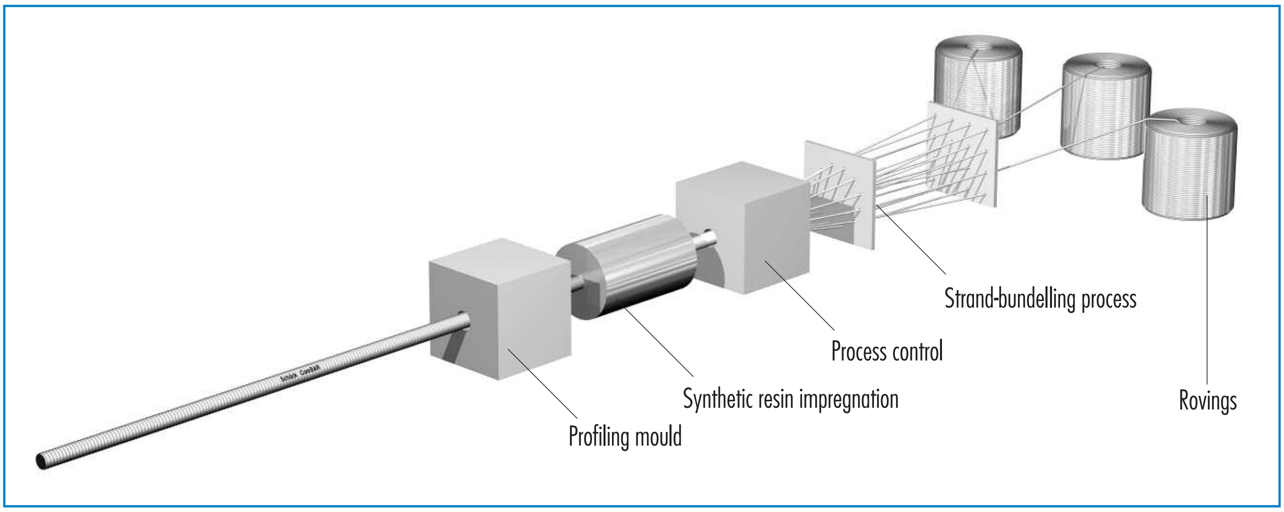
SCHÖCK COMBAR®

All types at a glance

	**Schöck ComBAR®** straight bars ⌀ 8 mm ⌀ 12 mm ⌀ 16 mm ⌀ 32 mm other diameters on request	▶ As load bearing reinforcement for tensile forces in concrete.
	**Schöck ComBAR®** bent bars ⌀ 12 mm ⌀ 20 mm	▶ For assembly of and to provide stability to the reinforcement cage.
	**Schöck ComBAR®** bars with anchorage head ⌀ 16 mm ⌀ 32 mm other diameters on request	▶ As shear reinforcement in slabs and beams.

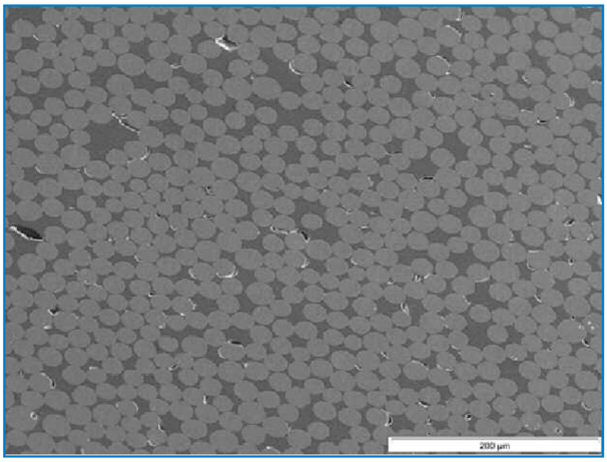
Schöck ComBAR® (composite rebar) belongs to the class of so called fibre composite materials. In fibre composites fibres are combined with other materials to achieve improved properties and synergy effects. The properties of the resulting material can be customized by choosing specific fibres, by adjusting the fibre orientation and by varying the additive and binder contents.

One of the best known composites is glass fibre reinforced polymer (GFRP). It is being used in many fields, such as electronics and ship building, to produce light weight, high strength and extremely durable components.

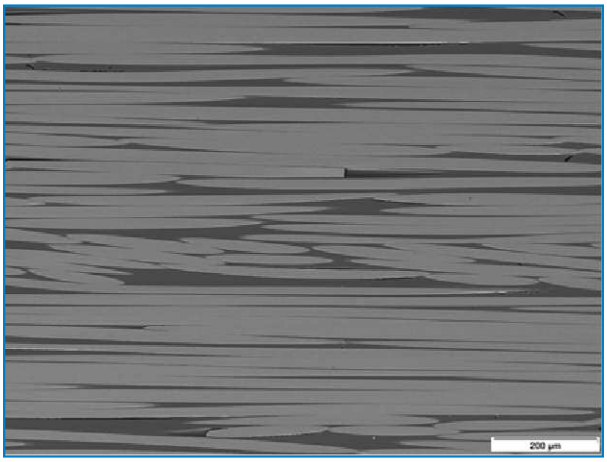


schematic of the "Pultrusion" process

The composite Schöck ComBAR® now offers an entirely new range of applications in civil engineering and high rise construction. The reinforcing bar consists of a multitude of continuous fibres, oriented in the direction of the load, each with a diameter of approx. 20 µm. They are bonded in a resin matrix.



cross-section of a Schöck ComBAR® bar



longitudinal section of a Schöck ComBAR® bar

The fibres provide the longitudinal strength and stiffness of the material. The resin matrix holds the fibres in place, distributes the load and protects the fibres against damaging influences.

The characteristic material properties of Schöck ComBAR® result from the uni-directional orientation of the fibres: high axial tensile strength, relatively low tensile and compressive strength perpendicular to the fibres. Loads acting perpendicular to the axis of the fibres pass through the resin first and then through the fibres. As a result the material strength is limited by the weaker resin. The analogy to the natural construction material timber best describes the non-isotropic material properties. The strength of timber parallel to the orientation of the fibres is greater than the perpendicular strength.

SCHÖCK COMBAR®

Product description

The standard Schöck ComBAR® bar is a glass fibre reinforced round bar with surface ribbing. The product was conceptualized as plain reinforcement for concrete components. Its physical as well as its bond properties are comparable to those of reinforcing steel. They are achieved by high quality components, the specialized production process and the unique, patented geometry of the ribs.

Material characteristics	**Fields of application**
▶ high corrosion resistance	=> roadways/waterworks
▶ high resistance to chemicals	=> industrial structures
▶ ease of machining	=> launching and reception shafts in tunnel construction, building back
▶ very low thermal conductivity	=> energy conservation in housing construction
▶ non-magnetic	=> sensitive electronic equipment and structural biology
▶ electrically non-conductive	=> high field-strengths, structural biology, railways

material properties of straight bars (acc. DIN 1045-1)	reinforcing steel DIN EN ISO 15630 DIN 488	stainless steel EN 10088	Schöck ComBAR®
tensile strength f_{tk} (N/mm²)	550	550	1000 char.
characteristic yield strength f_{yk} (N/mm²)	500	500	1000
design value of yield strength f_{yd} (N/mm²)	435	435	435*
strain at ultimate limit state ε_{ULS}	2.18 ‰	2.72 ‰	7.25 ‰
tension modulus of elasticity (N/mm²)	200,000	160,000	60,000
design value bond stress f_{bd} C20/25 (N/mm²)	2.3	2.3	2.3
design value bond stress f_{bd} C30/37 (N/mm²)	3.0	3.0	3.0
design value bond stress f_{bd} C40/50 (N/mm²)	3.7	3.7	3.7
concrete cover	nach DIN 1045-1	d_s + 10 mm	d_s + 10 mm
density γ (g/cm³)	7.85	7.85	2.2
thermal conductivity λ (W/mK)	60	15	< 0.5
coefficient of thermal expansion α (1/K)	$0.8 - 1.2 \times 10^{-5}$	$1.2 - 1.6 \times 10^{-5}$	0.6×10^{-5} (axial)/2.2×10^{-5} (radial)
magnetism	yes	very low	no

**design value of tensile strength (no yielding)*

The material properties were determined in various test series on the tensile strength and bond behavior.

Schöck
build simply better
SCHÖCK COMBAR®

Properties of straight bars

properties	terms	values	comments
dimensions	A_{GFK}	0.50 cm² 1.13 cm² 2.01 cm² 8.04 cm²	⌀ 8 mm ⌀ 12 mm ⌀ 16 mm ⌀ 32 mm
nominal weigth	g_{GFK}	0.14 kg/m 0.30 kg/m 0.52 kg/m 1.95 kg/m	⌀ 8 mm ⌀ 12 mm ⌀ 16 mm ⌀ 32 mm
characteristic tensil strength	f_{tk}	1000 N/mm²	
design tensile strength	f_{GFKd}	435 N/mm²	
strain at ultimate limit state (ULS)	ε_{GFK}	7.3 ‰	
modulus of elasticity	E_{GFK}	60,000 N/mm²	
compressive strength	σ_{GFK2}	500 N/mm²	stress at 3.5 ‰ strain = 210 N/mm²
shear strength (characteristic)	–	200 N/mm² 150 N/mm²	⌀ 16 mm ⌀ 32 mm
design bond strength	f_{bd}	2.3 N/mm² 3.0 N/mm² 3.7 N/mm²	C 20/25 C 30/37 C 40/50
concrete cover	c_v	d_s + 10 mm	all exposition classes precast: d_s + 5 mm
density	γ	2.2 g/cm³	
thermal conductivity	λ	< 0.5 W/mK	
coefficient of thermal expansion	α	0.6 x 10^{-5} 1/K (axial) 2.2 x 10^{-5} 1/K (radial)	concrete: 0.5 - 1.5 x 10^{-5} 1/K
critical core temperature	–	400° C	refer to page 13
specific resistance	–	> 10^{12} μΩcm	
chemical resistance	–	very good	
electro-magnetic conductivity	–	none	

The values listed in this table are determined at room temperature.

ComBAR® (straight bars ⌀ 16 and ⌀ 32 mm) is tested and certified according to the American guideline ACI 440.3R-04 „Guide Test Methods for Fiber-Reinforced Polymers (FRPs) for Reinforcing or Strengthening Concrete Structures".

SCHÖCK COMBAR®

Design recommendations

On the basis of our investigation and the information summarised in the product data sheet, structures can be designed with Schöck ComBAR® reinforcement according to accepted regulations and codes, such as DIN 1045-1, if the following issues are taken into consideration.

1. Schöck ComBAR® is conceptualised as plain reinforcement for concrete construction. We recommend that, for long-term application, the maximum allowable stress at the ultimate limit state (ULS) be set at 435 N/mm². The associated strain of ε_{GFK} = 0.72 %, should not be exceeded.

2. Schöck ComBAR® is not corrosive. As a result a concrete cover of d_s + 10 mm in accordance with DIN 1045-1, is recommended for all exposition classes. The reduced value of d_s + 5 mm can be applied for precast elements.

3. The long-term deflection and bond creep of Schöck ComBAR® are comparable to those of steel rebar.

4. Due to the comparatively low modulus of elasticity of Schöck ComBAR®, special attention needs to be paid to the control of the deflection and the crack width.

5. Ideally double headed bolts are used as shear reinforcement in slabs and beams. They are designed to transfer loads at minimal slip. Stirrups or bent bars are also possible.

6. Schöck ComBAR® bars failed in lab tests at a compressive stress of 500 N/mm². We discourage the use of ComBAR® bars as compression reinforcement.

7. Structural elements reinforced with Schöck ComBAR® behave in a ductile fashion. As is the case with steel reinforced elements, failure is indicated well in advance by wide cracks and large deflections.

8. The coefficient of thermal expansion is compatible with that of concrete. Neither cracks nor other signs of damage due to temperature-induced volume changes have been observed in structural elements reinforced with Schöck ComBAR®.

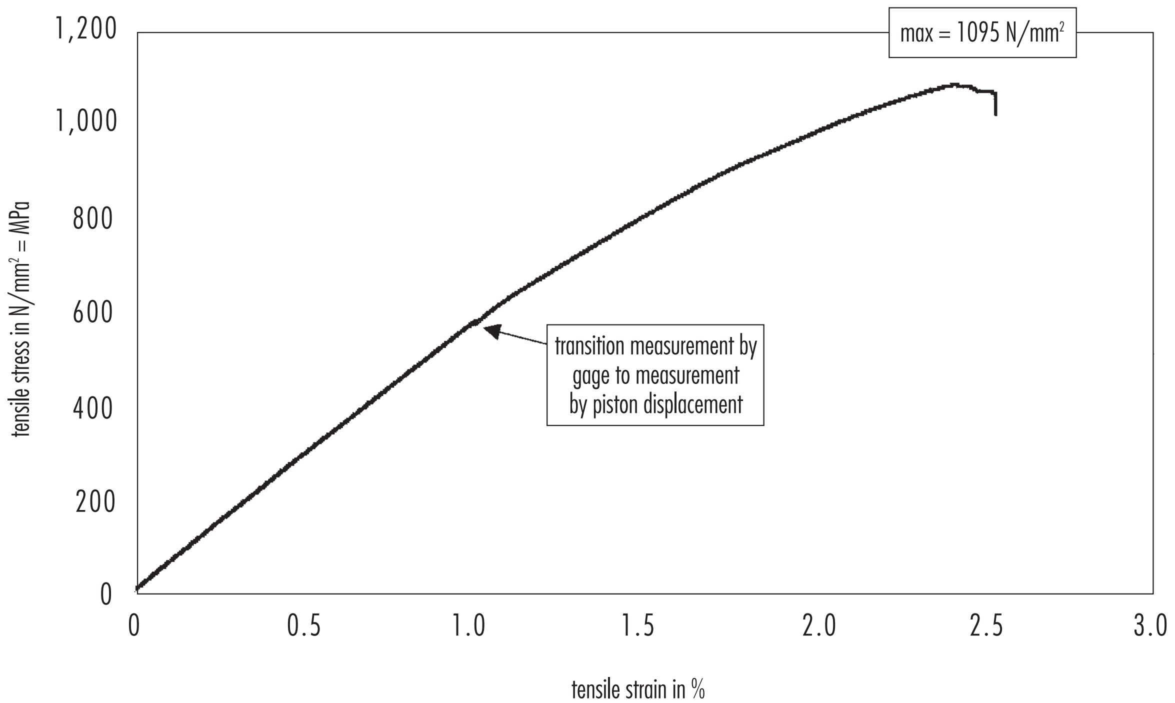
9. The long-term ambient temperature of elements reinforced with Schöck ComBAR® should not exceed 60° C. The elevated temperatures during curing of massive concrete elements do not cause any harm to the material. A reduction of the strength of the material was not observed.

10. A fire-rating of Schöck ComBAR® is not yet available. In case fire resistance of ComBAR®-reinforced structural elements is an issue, nonstructural fire proofing measures, such as an encasement with fire board, should be considered. The same methods as those used on conventionally reinforced concrete structures can be considered (please refer to page 13).

Tensile strength and modulus of elasticity

In contrast to steel, Schöck ComBAR® behaves in a linear elastic manner up to failure. Yielding is not observed. The modulus of elasticity is 60,000 N/mm^2. The measured tensile strength for all bar diameters is greater than 1,000 N/mm^2.

To determine the tensile strength and the stress-strain relationship both ends of Schöck ComBAR® bars are glued into shafts. The load is applied at approximately 1 kN/sec. in a hydraulic press. Up to a load of sixty percent of the ultimate load, the modulus of elasticity is determined using highly sensitive strain gages. Afterwards the load is increased until failure occurs. The results of a test on a 32 mm bar, carried out by the MPA (material testing facility) in Munich, are shown in the diagram.



stress-strain diagram

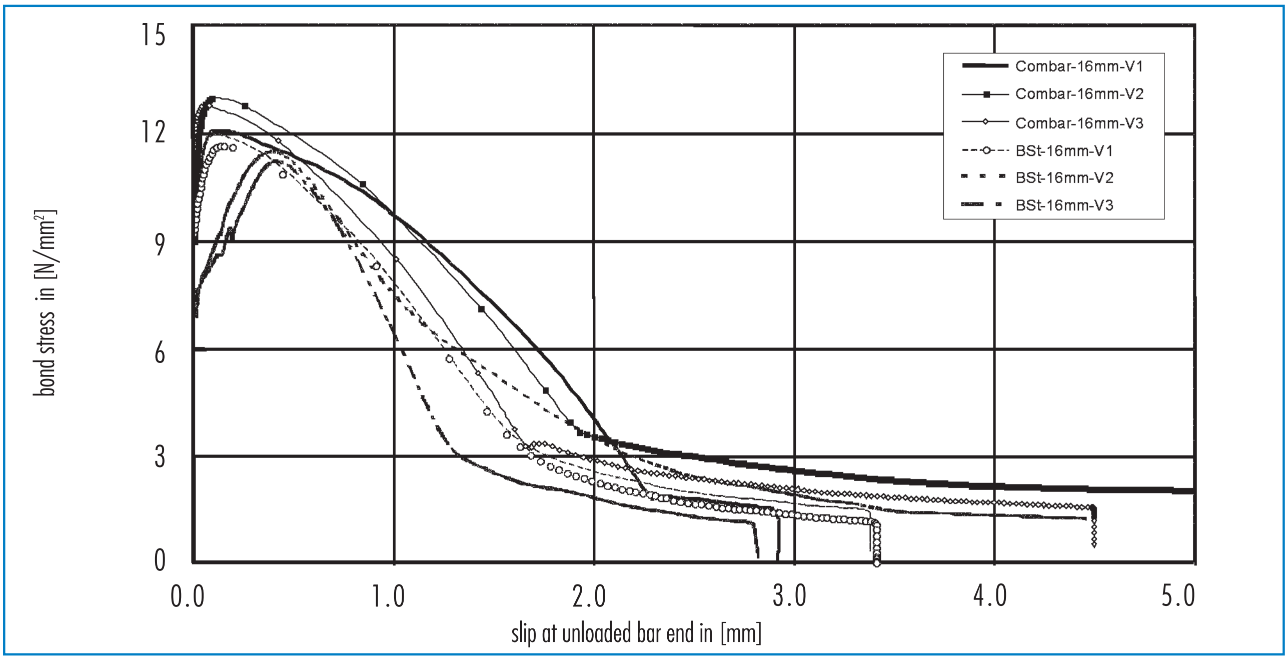
Failure is brittle. It occurs in the free span of the test specimen, when the tensile strength of the material is exceeded. The fibres burr in the fracture zone in a brush-like fashion. The outermost bar ends, where the specimen is fixed in the hydraulic press, including the ribs of the bars, are undamaged.

In contrast to the brittle failure of the test specimen, a ComBAR®-reinforced structural element behaves in a ductile manner. Distinct signs of the impending failure occur well in advance of the ultimate load.

SCHÖCK COMBAR®

Bond behavior and crack widths

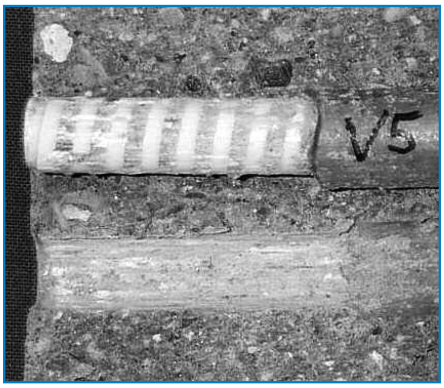
An excentric pull-out test was performed on a 150 mm concrete cube, according to the RILEM recommendations. The displacement at the unloaded end of the bar was plotted as a function of the load. The compressive strength of the concrete was > 30 N/mm².



excentric RILEM test with crack sheet, d_S = 16 mm, 5 d_S embedded length: comparison

The results of the test series are:

- The failure mode is, as with steel rebar, extraction of the concrete corbels from the concrete block. The ribs of the rebar are largely undamaged.
- As is the case for reinforcing steel, higher bond stresses are observed in higher grade concrete.
- No significant differences were observed regarding the slip of the unloaded bar end of Schöck ComBAR® and steel bars. The maximum bond stress was recorded at a slip between 0.4 mm and 0.6 mm.
- Even though the bond stress of ComBAR® bars is greater at the same amount of slip, the tensile splitting forces are lower than those of steel rebar.

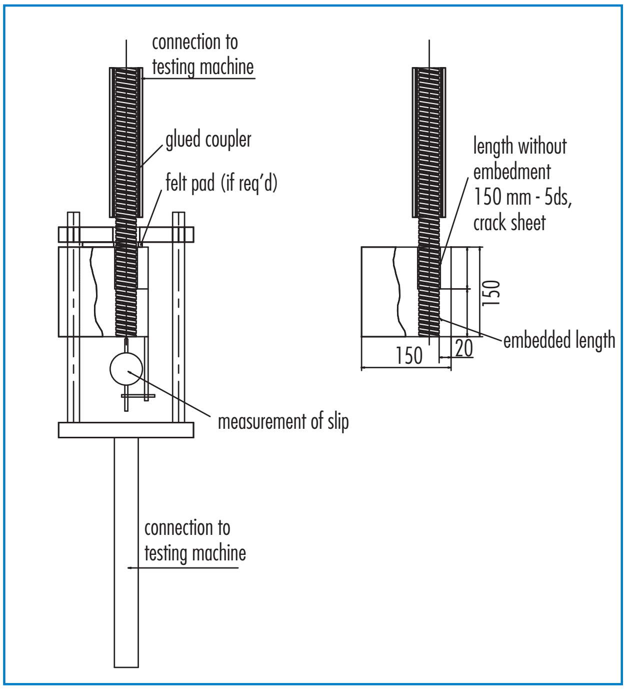


The special surface profile of Schöck ComBAR® bars ensures optimal bond between concrete and the rebar.

To determine the crack widths, tensile tests were carried out on cylindrical strain elements (Schöck ComBAR® Ø = 16 mm; c_v = 30 mm).

- Cracks appear in the specimen at intervals of 60 to 120 mm, when the concrete tensile strength is reached. As the load is raised, the crack widths increase.
- Tensile splitting of the un-reinforced test specimen occurs at a stress of 800 N/mm².
- Entirely intact concrete corbels are seen in the middle sections of the fragments of the test specimen. In the vicinity of the cracks the concrete corbels have been sheared off (compare picture).
- The bar, as well as its ribs, remain undamaged.

fragment of test specimen showing intact and sheared-off ribs



RILEM test setup (excentric)

Reasons for the ductile failure of Schöck ComBAR® reinforced elements are the comparatively low modulus of elasticity and the ductile bond behaviour.

SCHÖCK COMBAR®

Coefficient of thermal expansion and bending forms

Coefficient of thermal expansion

The axial and radial coefficient of thermal expansion were determined on test specimen at temperatures ranging from 0° C to 70° C.

Coefficient of thermal expansion α	Schöck ComBAR®
axial [1/K]	0.6 x 10^{-5}
radial [1/K]	2.2 x 10^{-5}

For comparison: the coefficient of thermal expansion of concrete is between 0.5 and 1.2 x 10^{-5} 1/K, that of reinforcing steel is 1.0 x 10^{-5} 1/K, that of stainless steel 1.5 x 10^{-5} 1/K.

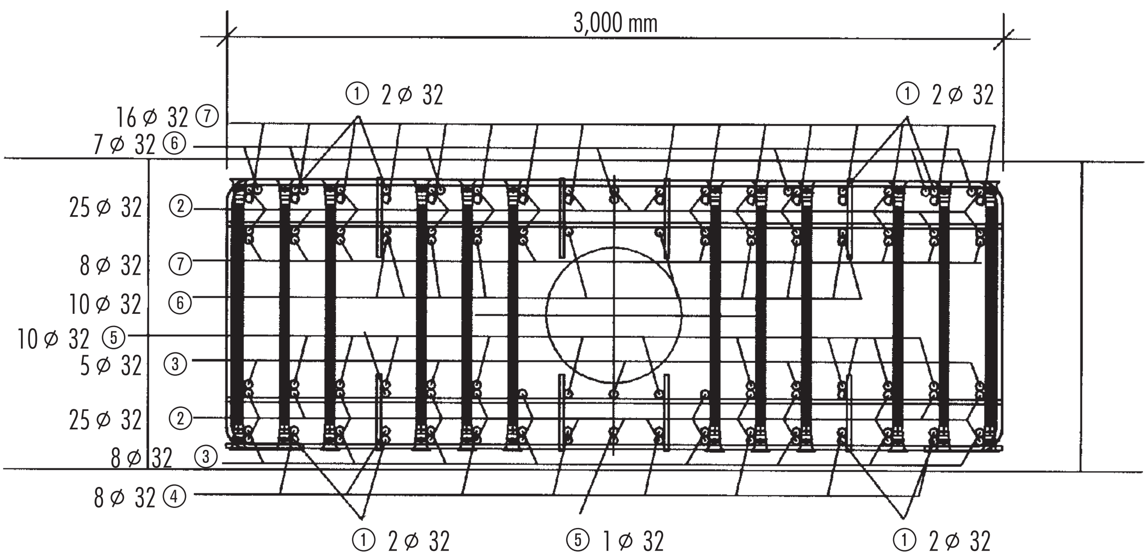
Structural elements reinforced with Schöck ComBAR® are not affected by temperature changes. Expansive cracking did not occur in lab experiments, even when ComBAR® reinforcing bars were placed close to the surface of the specimen and the moisture content was varied over time.

Bending forms

As Schöck ComBAR® can not be bent, the required bending forms must be shaped at the factory. Generally the same bending forms can be produced with Schöck ComBAR® as with reinforcing steel. The minimum bend diameter d_{BR} = 5 d_S. Bent bars are produced in a special process. As a result they are momentarily available only with a diameter of 12 and 20 mm.

Shear forces are best transferred by double headed bolts. The load transfer from the concrete to the headed bolt occurs with little slip. Double headed bolts are available with a diameter of 16 and 32 mm, in lengths of up to 2 m. The allowable strain is limited to a similar value as that of steel reinforcement (0.2175 %). Given the modulus of elasticity of Schöck ComBAR® of 60,000 N/mm², the resulting design stress in the double headed bolt is 130 N/mm².

The allowable shear force transferred by each double headed bolt is 26 kN for the 16 mm diameter and 104 kN for the 32 mm diameter bolt.



example of reinforcement cage for installation in a diaphragm wall (North-South Line, Amsterdam)

Ambient temperatures

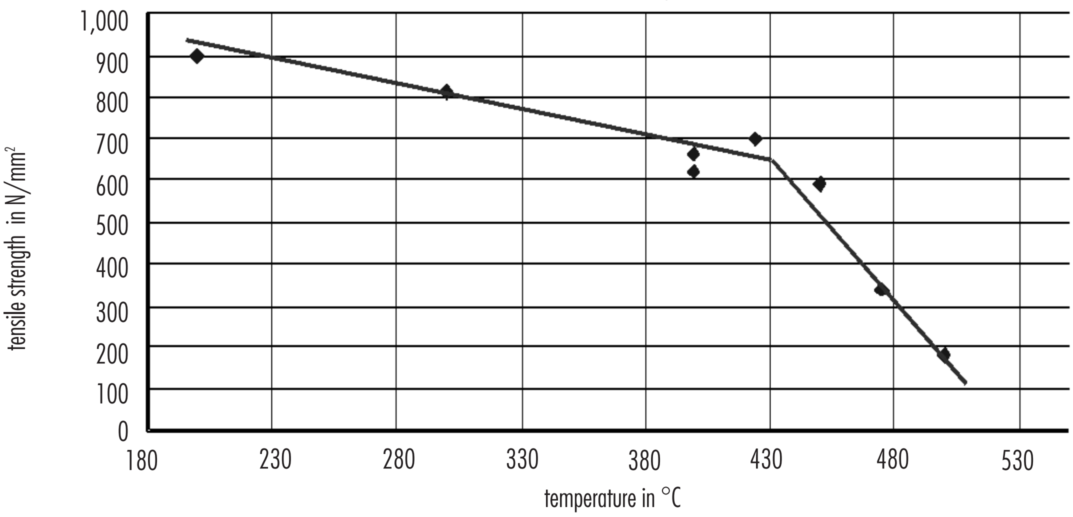
The ambient temperature of a structural element reinforced with Schöck ComBAR® should not exceed 60° C. Unless noted otherwise, all technical values specified in the product data sheet were determined at room temperature. Please contact the technical service at Schöck in case Schöck ComBAR® is to be installed in structural elements that will be exposed to increased temperatures over longer time spans.

Fire resistance

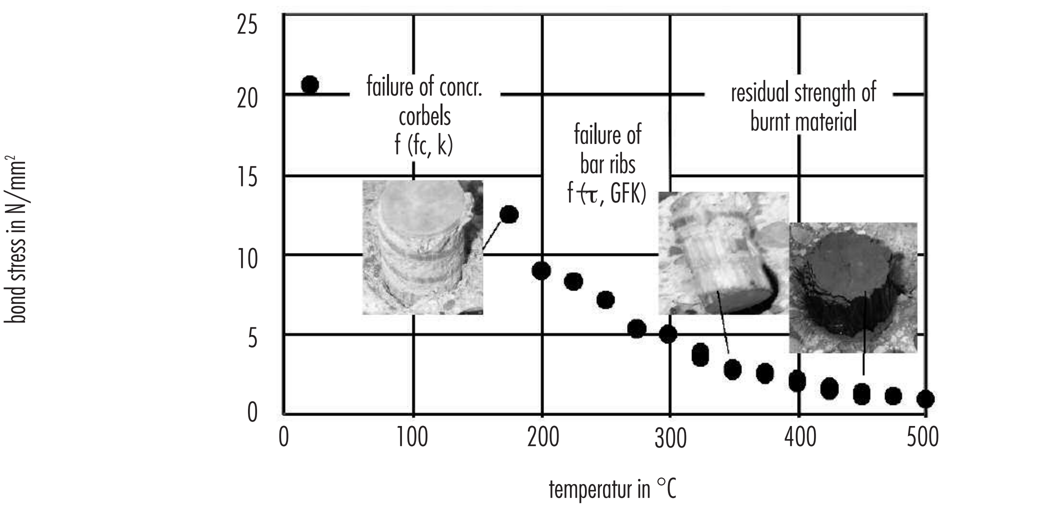
The resins used in the production of Schöck ComBAR® withstand temperatures up to about 200° C over short time spans. The glass fibres soften/melt at about 600° C. Schöck ComBAR® can catch on fire when exposed to an open flame. After a few seconds the bars stop burning, when no more flammable material remains on the surface of the bars. Schöck ComBAR® bars do not contain fire-resisting additives.

In case an increased fire resistance of Schöck ComBAR®-reinforced structural elements is required, non-structural measures, such as an increase of the concrete cover or an encasement with fire-resistant material, are recommended. Most fire protection methods custom-ary to conventionally reinforced concrete construction can be applied.

temperature dependence of tensile strength of Schöck ComBAR®



bond strength of heated specimen, $2d_s$ cylinder, axial compression, concrete C25/30, ComBAR® d_s = 16 mm



SCHÖCK COMBAR®

Storage, transport and machining

Storage and transport

In general, high intensity long-term exposure to UV-rays can lead to the discoloration of polymers. After long exposure the material becomes brittle. Unless special protective measures are undertaken, this results in the lasting deterioration of the polymers.

As a result, Schöck ComBAR® should be covered and stored in a dry environment, especially when stored for longer time periods.

Tests on bars, that were stored outdoors for up to eight weeks without being protected, showed that climatic exposure in central Europe does not lead to a discoloration or a reduction of the bond or the tensile strength.

To avoid damage to the ribs, the material should not be dragged on the ground. It should not be subjected to abrasive forces.

When hoisted by crane, the deflection of ComBAR® bars is similar to that of steel bars of equal diameter. It is important that the appropriate cross beam/lifting equipment is used at all times.

Cutting

Cutting Schöck ComBAR® is significantly easier than cutting steel rebar. Either a hacksaw, band saw, or a grinder, using a diamond or a tough metal disc, is recommended. Both are fine enough to achieve a clean cut. ComBAR® bars should not be trimmed with bolt cutters or shears, as the glass fibres fray when the material is sheared off.

If desired, grates at the bar ends can be removed with a file or a rasp.

Because of the relatively low strength perpendicular to the glass fibres, ComBAR® bars should not be subjected to impact forces.

Connection technology

Reinforcement cages made of Schöck ComBAR® bars are best assembled with ordinary tying wire. Damage to the bars caused by properly installed tying wire is insignificant.

In cases where reinforcement cages are to be entirely free of steel, plastic wire ties, such as those used by electricians, can be used. A tightening wrench facilitates pulling and trimming of the ties.

Wire rope grips can be used to connect Schöck ComBAR® bars to steel reinforcing bars. The ComBAR® bar should be placed in the curved form piece of the grip. Two short pieces of smaller diameter steel rebar should be placed in the grip, between the Schöck ComBAR® and the steel bar, to minimize the damage to the ComBAR® bar caused by the clamping force. When diameter 32 mm bars are connected, the torque applied to the nuts should not exceed 80 Nm.

Special grips with wire rope clamp straps have been developed by Schöck for the connection of bars with a diameter greater than 32 mm.

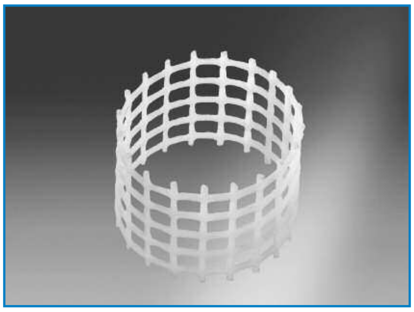
Bar couplers, that are glued onto the Schöck ComBAR® bars in the factory, are an alternative means of connecting ComBAR® and steel bars. When the ComBAR® bars are screwed onto the steel bars, it is important that they are handled and turned at the connector, not at the bar. The glued couplers should not be exposed to temperatures above 100° C. Special care needs to be taken when welding in the vicinity of the couplers.

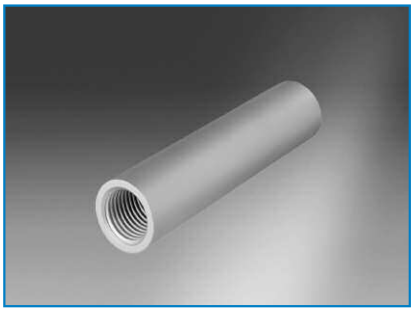
Schöck ComBAR® bars can not be bent on site.

Accessories

For applications where the reinforcement is to contain no metal elements, Schöck carries plastic spacers in various heights and sizes, as well as plastic cable ties.

For the connection with steel reinforcement cages we offer bar couplers and wire rope grips. Special grips with wire rope clamp straps have been developed by Schöck for the connection of bars with a diameter greater than 32 mm.


spacer


glued coupler


wire rope grip

Delivery times

Schöck ComBAR®	bar diameter	standard lengths	delivery time*
straight bars	8 mm, 12 mm	14 m	2 weeks
straight bars	16 mm, 32 mm	14 m	2 weeks
headed ends double headed bolts	16 mm, 32 mm	$0.3\ m < L_{DHB} < 2\ m$	approx. 3 weeks
bent bars	12 mm, 20 mm	–	approx. 3 weeks

*For orders of more than 1 ton or for orders of bent bars and double headed bolts delivery times on request.

Invitation to tender form Schöck ComBAR®

POSITION	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	TOTAL PRICE
1.			**Reinforced concrete works - reinforcement and accessories**		
1.1.			**Schöck ComBAR® straight reinforcing bars**		
			Schöck ComBAR® straight reinforcing bar Straight bar made of corrosion resistant glass fibre reinforced polymer: tensile strength f_{tk}: > 1.000 N/mm², design tensile strength f_{GFKd}: 435 N/mm², modulus of elasticity 60,000 N/mm². Bond properties equivalent to those of reinforcing steel. Standard bar length up to 14.0 m		
1.1.1.		pcs.	bar diameter 8 mm bar length:________ m		
1.1.2.		pcs.	bar diameter 12 mm bar length:________ m		
1.1.3.		pcs.	bar diameter 16 mm bar length:________ m		
1.1.4.		pcs.	bar diameter 32 mm bar length:________ m		
1.2.			**Schöck ComBAR® double headed bolts for shear**		
			Schöck ComBAR® double headed bolt Bar made of corrosion resistant glass fibre reinforced polymer with anchorage heads at both ends, for the transfer of shear forces. Modulus of elasticity 60,000 N/mm². Design tensile strength at the same strain (0.218 %) as that of steel reinforcement 130 N/mm². End heads are applied at the factory. Standard bar length up to 2.0 m.		
1.2.1.		pcs.	core diameter 16 mm length of double headed bolt: ________ m		
1.2.2.		pcs.	core diameter 32 mm length of double headed bolt: ________ m		
1.3.			**Schöck ComBAR® GFRP stirrups**		
			Schöck ComBAR® stirrup Bent bar made of corrosion resistant glass fibre reinforced polymer. Modulus of elasticity 32,000 N/mm². Non-structural, non-load bearing transverse reinforcement and stiffening element. Unwound length up to 5.6 m.		
1.3.1.		pcs.	bar diameter 12 mm, stirrup unwound length: ________ m		
1.3.2.		pcs.	bar diameter 20 mm, stirrup unwound length: ________ m		
1.4.			**Extras to straight ComBAR® bars for glued couplers**		
			Steel bar couplers, glued onto straight bars, for the connection with structural steel elements.		
1.4.1.		pcs.	Glued bar coupler for ComBAR® bars with 32 mm diameter, for the axial connection with steel rebar. Thread of the coupler M42. The attached steel rebar is not included in the unit price.		
1.4.2.		pcs.	Steel rebar, BSt 500 S, d = 28 mm, with attached Schöck MODIX® coupler, for the connection with a ComBAR® bar at one end and a lap slice with steel rebar at the other end. Including Schöck MODIX® coupler, which is pressed onto the bar in the shop.		
1.5.			**Wire rope grips for assembly connections**		
			Steel wire rope grips for the connection of Schöck ComBAR® GFRP rebar and steel rebar, for the assembly of the reinforcement cages.		
1.5.1.		pcs.	grips for bars with diameter 28 mm to 32 mm		

Vienna Valley Collector (Wientalsammler) WSK-E

Steel-free reinforcement of areas of the diaphragm wall in the launch and reception shaft that are penetrated by the tunnel boring machine. First self supporting reinforcement cage made of Schöck ComBAR®. Diameter of the tunnel boring machine 8.4 m.
Customer: City of Vienna
General contractor: ARGE A. Porr AG, Bilfinger Berger AG
Installation: 2003
Successful penetration of the diaphragm wall in the start shaft in the summer of 2004.

North-South Line, Cologne

Steel-free reinforcement of the diaphragm wall for the Waidmarkt, Heumarkt, Kurt-Hackenberg-Platz stations.
Single Application permit (ZIE) by the Düsseldorf Regional Authority.
Customer: KVB AG
General contractor: ARGE Hochtief Construction AG, Brückner Grundbau GmbH, Bauer Spezialtiefbau GmbH; ARGE Wayss & Freytag Ingenieurbau AG, Ed. Züblin AG, Bilfinger Berger AG
Installation: spring 2004 - May 2005

North-south underground railway line in Amsterdam

Steel-free reinforcement of areas of the diaphragm wall which are to be penetrated by the tunnel boring machine.
Structural design based on the expert opinion of Prof. Walraven, TU Delft, using the VBC standard and dimensioning guideline ACI 440. 12 soft eyes in 6 diaphragm walls; diameter of the tunnel boring machine 8.4 m; reinforcement cages up to 21.0 m long. Connection of the load-bearing shell to the diaphragm wall with MODIX® couplers from Schöck.
Customer: Stadt Amsterdam
General contractor: Max Bögl GmbH & Co. KG
Installation: spring 2004 - summer 2006

U55 - Brandenburger Tor underground station, Berlin

Reinforcement of a diaphragm wall for penetration with a microtunnelling machine. 30 microtunnel holes with 2.0 m steel-free diameter in 8 diaphragm wall panels. Structural design by GuD Consult, Berlin, based on the expert opinion of Dr. Winselmann from the engineering office Ingenieurbüro Professor Duddek & Partner GmbH, Braunschweig. Validation by Professor a. D. Dr. Specht from the engineering office Specht, Kalleja und Partner Ingenieure, Berlin.
Single application permit (ZIE) by the Senate Administration of the City of Berlin.
Customer: Berliner Verkehrsbetriebe BVG (AöR)
General contractor: ARGE Hochtief Construction AG, Max Bögl GmbH & Co. KG
Installation: spring 2005

SCHÖCK COMBAR®

Reference projects – application in rail projects and other applications

Magdeburg tram system, redesign of the Universitätsplatz

Schöck ComBAR® reinforcement of the non-ballasted rail track in areas near the induction coils for operating the switches on the Universitätsplatz.
Customer: Civil Engineering Department of the City of Magdeburg
Contractor: Eurovia VBU, Eurovia Beton, ITB Ingenieurtiefbau GmbH Schönebeck
Installation: August 2004

Tram line 19 Delft

Glass-fibre-reinforced-polymer reinforcement in the non-ballasted rail track in areas near the sensors for the traffic signals. Schöck ComBAR® as replacement for reinforcing steel, which leads to malfunctions in the sensor operation due to its electromagnetic conductivity.
Customer: Stadgewest Haaglanden
General contractor: Heijmans Beton & Waterbouw
Installation: beginning of 2005

Foundation for NMR device, Institute for Plant Genetics and Crop Plant Research, Gatersleben

Reinforcement of a foundation (1.80 x 1.80 x 1.02 m) with Schöck ComBAR® to avoid metallic building materials in the vicinity of the nuclear magnetic resonance device (NMR device). Steel reinforcement disturbs the magnetic field. This results in inaccuracies in the measurement results. Connection of the ComBAR® bars with plastic cable binders.
Customer: IPK Gatersleben
General contractor: Grimmer Bau GmbH
Installation: March 2005

Foundation for NMR device, Frauenhofer Gesellschaft, Hanover

Steel-free reinforcement of the foundation plate for an NMR device. NMR devices work with strong magnetic fields. Glass-fibre-reinforced-polymer reinforcement was used to avoid interactions with magnetisable reinforcing steel.
Customer: Fraunhofer Gesellschaft
Installation: spring 1997

Concrete columns in a NMR room, ETH, Zurich

Structural reinforcement of 6.6 m high concrete columns of 1.0 m diameter in a NMR room using Schöck ComBAR®.
Customer: Swiss Federal Institute of Technology (ETH), Zurich
Installation: 1998

Foundation slab of production building at Chemetall, Frankfurt a. M.

GFRP reinforcement of a 15 x 15 m foundation slab in the chlorine chemical area. Due to its susceptibility to corrosion, conventional reinforcing steel was replaced by Schöck ComBAR®. An additional sealing of the base plate was thus not required.
Customer: Chemetall GmbH
Installation: 1998

Partition wall in HV transformer station

Horizontal transverse reinforcement made of Schöck ComBAR® in partition walls between adjacent transformers. GFRP bars were used as horizontal reinforcement to avoid inductive coupling of the two transformers by way of the electromagnetically conductive reinforcing steel. The load-bearing vertical reinforcement was made of conventional steel rebar. As a result, an expensive electromagnetic separation of the steel reinforcement bars was not required.
Customer: Isar Amperwerke/ABB Adtranz
Installation: 1998

Masonry refurbishment, Münster Salem, Lake of Constance

Attachment of masonry with ComBAR® bars and mortar compound. Due to the low elastic modulus of Schöck ComBAR®, warming of the dark natural stone by the sun results in relatively low reaction and restoring forces.
Customer: Markgräflich Badische Verwaltung
Installation: 1997

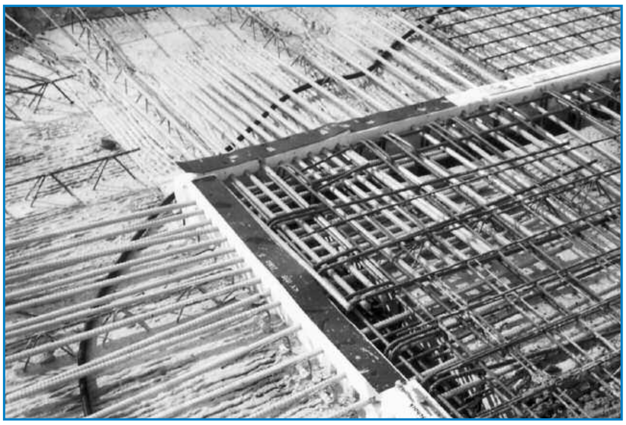
Single-family home in Bad Lippspringe

The owner of a new single-family home wanted a structure free of metallic, electrically conducting elements. The window and door lintels as well as the ring beams are in their entirety reinforced with the GFRP rebar Schöck ComBAR®.
Owner: private
Installation: 2005

Ceiling slab reinforcement at single family home, Riederau, Bavaria

Steel-free reinforcement of the ceiling slab above the ground floor for ecobiological reasons. Connection of the Schöck ComBAR® reinforcing bars with plastic cable binders. Spacers made of plastic. Single application permit (ZIE) by the Bavarian Ministry of the Interior.
Customer: private
Installation: May 2001

Schöck Isokorb® balcony connection in single family home, Lichtenau, Baden



Connection of a cantelevering balcony slab with Schöck Isokorb® elements. To reduce the thermally conducting steel cross section, ComBAR® bars were installed in the Isokorb® elements as tensile reinforcement.
Continuous technical surveillance of the balcony as a pilot project.
Customer: private
Installation: August 1997

Editor: Schöck Bauteile GmbH
Vimbucher Straße 2
76534 Baden-Baden
Germany
Tel.: +49(0)7223/967-0

Issue Date: March 2006

subject to technical alterations

issued March 2006

Schöck Bauteile GmbH
Industriegebiet Steinbach · Vimbucher Straße 2 · 76534 Baden-Baden · Germany
phone +49(0)7223/967-449 · fax +49(0)7223/967-490
Internet: www.schoeck.com
E-Mail: igp@schoeck.com

800056/03.2006/INT