Deutsches Institut für Bautechnik

Public-law institution jointly founded by the federal states and the Federation

European Technical Assessment Body for construction products

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European Technical Assessment ETA-24/1249 of 21 July 2025

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the European Technical Assessment:	Deutsches Institut für Bautechnik
Trade name of the construction product	Rebar connection with multi compound system MCS Protect Plus
Product family to which the construction product belongs	System for post-installed rebar connections with mortar
Manufacturer	Berner Omnichannel Trading Holding SE Bernerstraße 6 74653 Künzelsau GERMANY
Manufacturing plant	Berner manufacturing plant 6
This European Technical Assessment contains	25 pages including 3 annexes which form an integral part of this assessment
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of	EAD 330087-01-0601, Edition 06/2021

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Specific Part

1 Technical description of the product

The subject of this European Technical Assessment is the post-installed connection, by anchoring or overlap connection joint, of reinforcing bars (rebars) in existing structures made of normal weight concrete, using the Rebar connection with multi compound system MCS Protect Plus

in accordance with the regulations for reinforced concrete construction.

Reinforcing bars made of steel with a diameter ϕ from 8 to 25 mm or the BERNER rebar anchor BRA or BRA HCR of sizes M12, M16, M20 and M24 and injection mortar MCS Protect Plus are used for the rebar connection. The steel element is placed into a drilled hole filled with injection mortar and is anchored via the bond between embedded element, injection mortar and concrete.

The product description is given in Annex A.

2 Specification of the intended use in accordance with the applicable European assessment Document

The performances given in Section 3 are only valid if the anchor is used in compliance with the specifications and conditions given in Annex B.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the rebar connections of at least 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3 Performance of the product and references to the methods used for its assessment

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
Characteristic resistance under static and quasi-static loading	See Annex C1 and C2
Characteristic resistance under seismic loading	No performance assessed

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Class A1
Resistance to fire	See Annex C2 and C3

4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base

In accordance with European Assessment Document EAD No. 330087-01-0601, the applicable European legal act is: [96/582/EC].

The system to be applied is: 1

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable European Assessment Document

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

Issued in Berlin on 21 July 2025 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock
Head of Section

beglaubigt:
Baderschneider

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Installation conditions and application examples reinforcing bars, part 1

Figure A1.1:
Overlap joint with existing reinforcement for rebar connections of slabs and beams

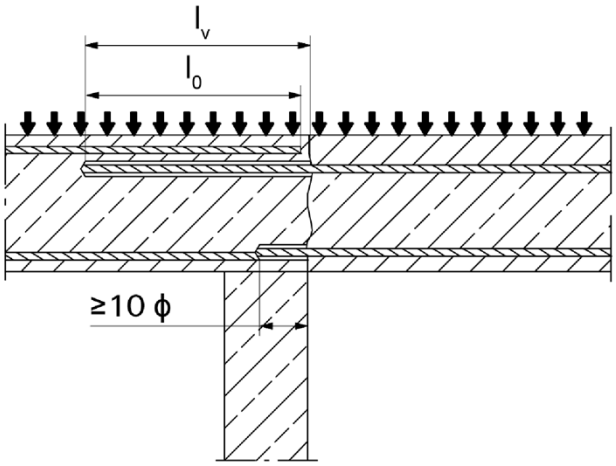


Figure A1.2:
Overlap joint with existing reinforcement at a foundation of a column or wall where the rebars are stressed

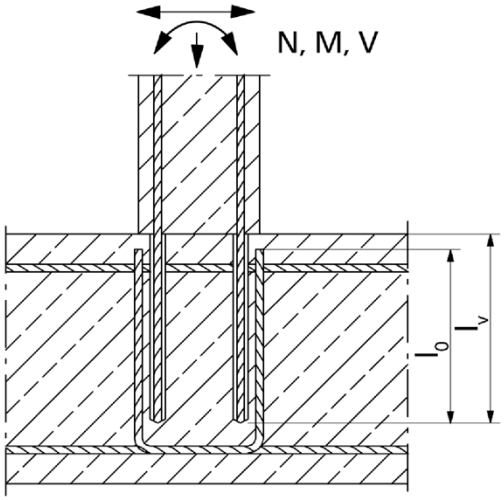
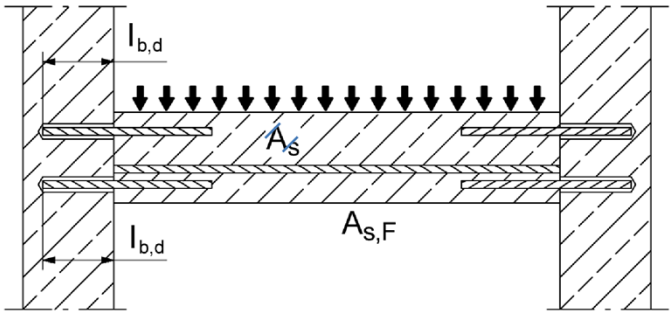


Figure A1.3:
End anchoring of slabs or beams (e.g. designed as simply supported)



Figures not to scale

Rebar connection with multi compound system MCS Protect Plus	**Annex A1**
Product description Installation conditions and application examples reinforcing bars, part 1	

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Installation conditions and application examples reinforcing bars, part 2

Figure A2.1:
Rebar connection for stressed primarily in compression

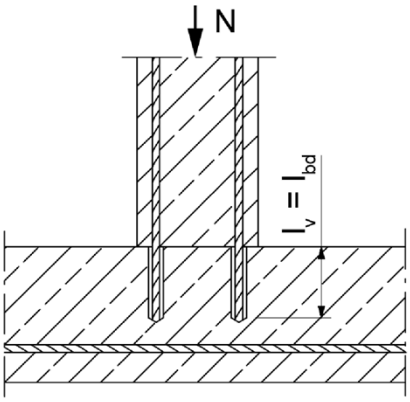
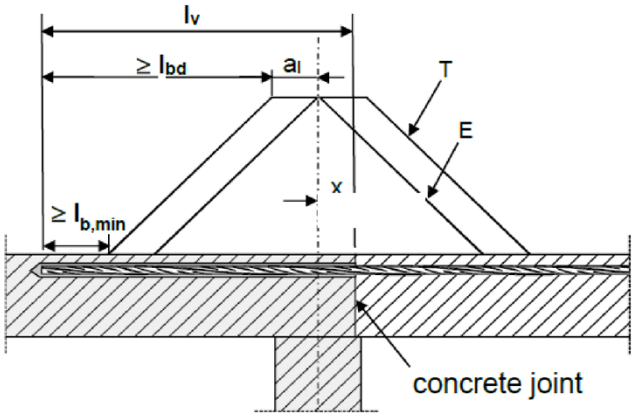


Figure A2.2:
Anchoring of reinforcement to cover the enveloped line of acting tensile force in the bending member



(only post-installed rebar is plotted)

Key to Figure

T Acting tensile force
E Envelope of M_{ed} / z + N_{ed} (see EN 1992-1-1:2011)
x Distance between the theoretical point of support and concrete joint

Note to **figure A1.1** to **A1.3** and **figure A2.1** to **A2.2**

In the figures no traverse reinforcement is plotted, the transverse reinforcement as required by EN 1992-1-1:2011 shall be present.

The shear transfer between old and new concrete shall be designed according to EN 1992-1-1:2011. Preparation of joints according to **Annex B3** of this document

Figures not to scale

Rebar connection with multi compound system MCS Protect Plus	**Annex A2**
Product description Installation conditions and application examples reinforcing bars, part 2	

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Installation conditions and application examples BERNER rebar anchor

Figure A3.1:
Lap to a foundation of a column under bending.

1. Shear lug (or fastener loaded in shear)
2. BERNER rebar tension anchor (tension only)
3. Existing stirrup / reinforcement for overlap (lap splice)
4. Slotted hole

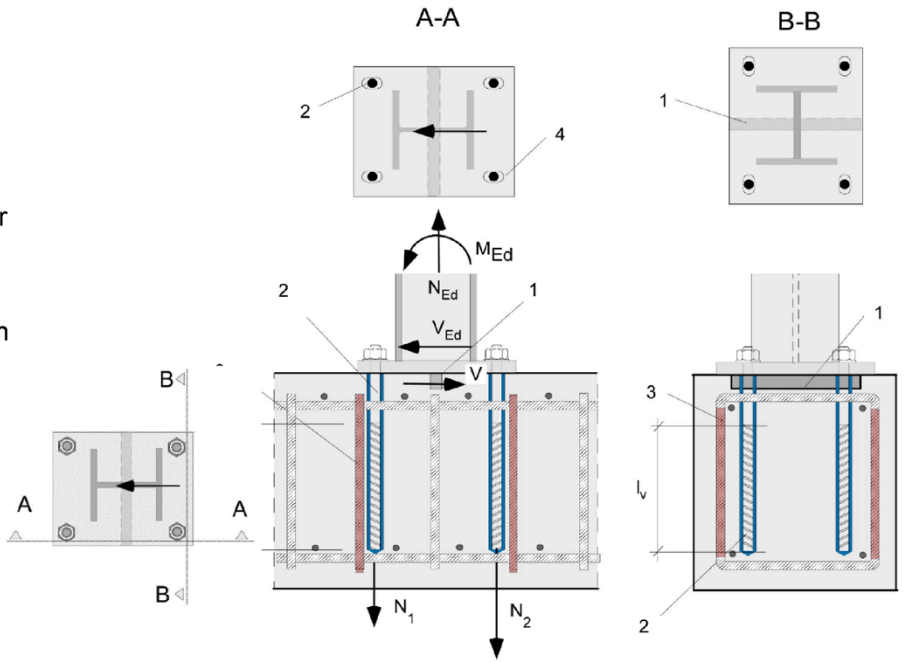
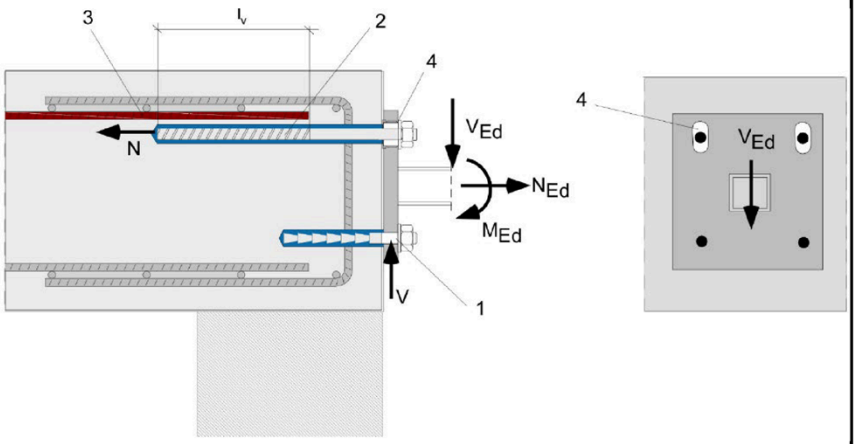


Figure A3.2:
Lap of the anchoring of guardrail posts or anchoring of cantilevered building components.
In the anchor plate, the drill holes for the BERNER rebar anchors have to be designed as slotted holes with axial direction to the shear force.

1. Fastener for shear load transfer
2. BERNER rebar tension anchor (tension only)
3. Existing stirrup / reinforcement for overlap (lap splice)
4. Slotted hole



The required transverse reinforcement acc. to EN 1992-1-1:2011 is not shown in the figures. **The BERNER rebar anchor BRA may be only used for axial tensile force.** The tensile force must transferred by lap to the existing reinforcement of the building. The transfer of the shear force has to be ensured by suitable measures, e.g. by means of shear force or anchors with European Technical Assessment (ETA).

Figures not to scale

Rebar connection with multi compound system MCS Protect Plus	**Annex A3**
Product description Installation conditions and application examples BERNER rebar anchors	

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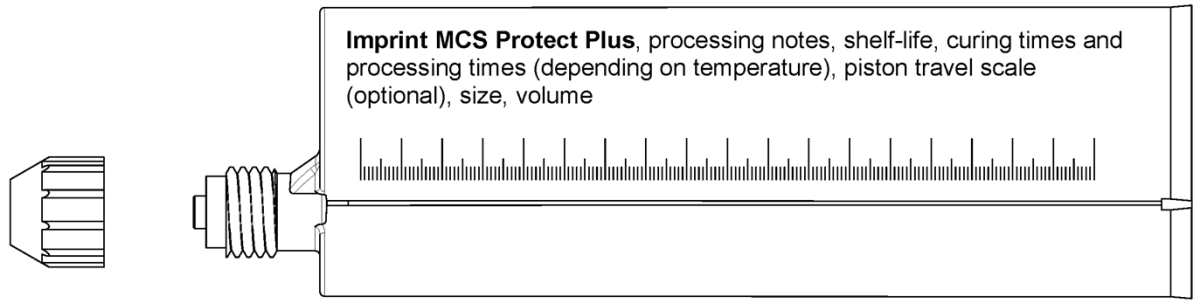
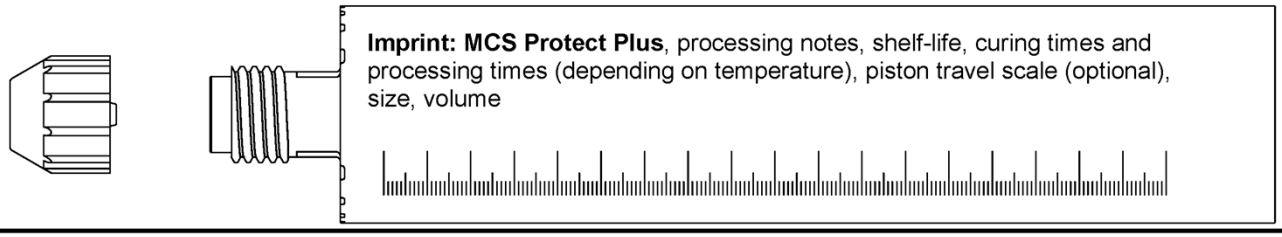
Overview system components

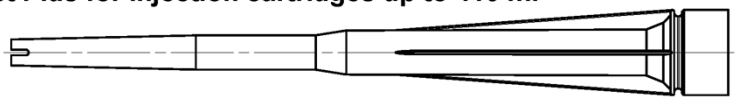
Injection cartridge (shuttle cartridge) MCS Protect Plus with sealing cap; Sizes: 360 ml, 825 ml



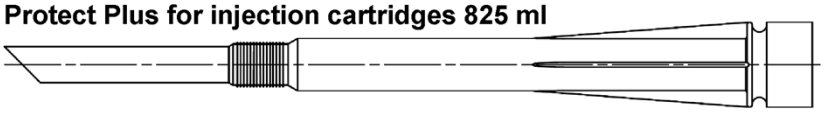
Injection cartridge (coaxial cartridge) MCS Protect Plus with sealing cap; Sizes: 300 ml ,380 ml, 400 ml, 410 ml



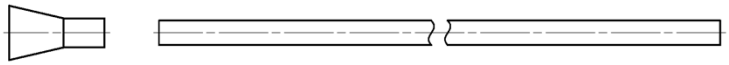
Static mixer MCS Protect Plus for injection cartridges up to 410 ml



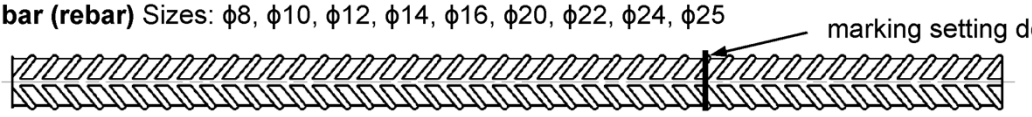
Static mixer MCS Protect Plus for injection cartridges 825 ml



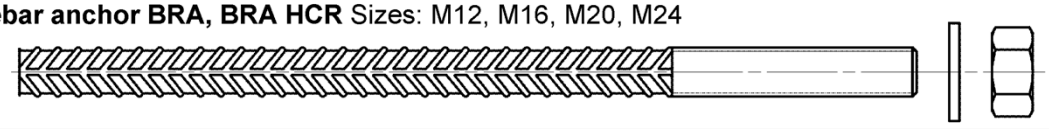
Injection adapter and extension tube Ø 9 for static mixer MCS Protect Plus up to 410 ml;
Injection adapter and extension tube Ø 9 or Ø 15 for static mixer MCS Protect Plus 825 ml



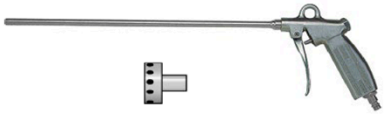
Reinforcing bar (rebar) Sizes: ϕ8, ϕ10, ϕ12, ϕ14, ϕ16, ϕ20, ϕ22, ϕ24, ϕ25



BERNER rebar anchor BRA, BRA HCR Sizes: M12, M16, M20, M24



Compressed-air cleaning tool with compressed-air nozzle



or AB G: Blow out pump

Figures not to scale

Rebar connection with multi compound system MCS Protect Plus	**Annex A4**
Product description Overview system components: injection mortar, static mixer, injection adapter, reinforcing bar, BERNER rebar anchor, blow out pump	

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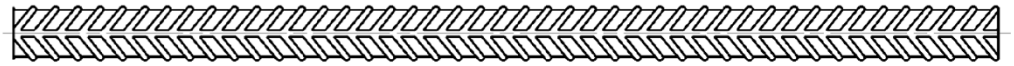
Properties of reinforcing bars (rebar)

Figure A5.1:



- The minimum value of related rip area $f_{R,min}$ according to EN 1992-1-1:2011
- The maximum outer rebar diameter over the rips shall be:
  - The nominal diameter of the bar with rip $\phi + 2 * h$ ($h \leq 0{,}07 * \phi$)
  - (ϕ: Nominal diameter of the bar; h: rip height of the bar)

Table A5.1: Installation conditions for rebars

Nominal diameter of the bar		**ϕ**	**8[1)]**		**10[1)]**		**12[1)]**		**14**	**16**	**20**	**22**	**24**	**25**
Nominal drill hole diameter	d_0	[mm]	10	12	12	14	14	16	18	20	25	28	30	30
Drill hole depth	h_0		$h_0 = l_v$											
Effective embedment depth	l_v		acc. to static calculation											
Minimum thickness of concrete member	h_{min}		$l_v + 30$ (≥ 100)						$l_v + 2d_0$					

[1)] Both drill hole diameters can be used.

Table A5.2: Materials of rebars

Designation	**Reinforcing bar (rebar)**
Reinforcing bar EN 1992-1-1:2011, Annex C	Bars and de-coiled rods class B or C with f_{yk} and k according to NDP or NCL of EN 1992-1-1/NA $f_{uk} = f_{tk} = k \cdot f_{yk}$

Figures not to scale

Rebar connection with multi compound system MCS Protect Plus	**Annex A5**
Product description Properties and materials of reinforcing bars (rebar)	

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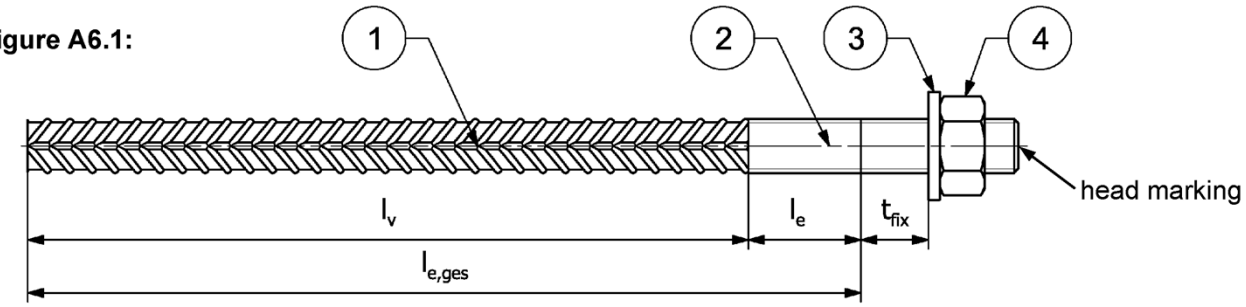
Properties of BERNER rebar anchors BRA

Figure A6.1:



Head marking e.g.: BRA (for stainless steel)

BRA HCR (for high corrosion-resistant steel)

Table A6.1: Installation conditions for BERNER rebar anchors BRA

Threaded diameter				**M12** [2]		**M16**	**M20**	**M24**
Nominal diameter		ϕ	[mm]	12		16	20	25
Nominal drill bit diameter		d_0	[mm]	14	16	20	25	30
Drill hole depth ($h_0 = l_{e,ges}$)		$l_{e,ges}$	[mm]	$l_v + l_e$				
Effective embedment depth		l_v	[mm]	acc. to static calculation				
Distance concrete surface to welded joint		l_e	[mm]	100				
Diameter of clearance hole in the fixture[1]	Pre-positioned	$\leq d_f$	[mm]	14		18	22	26
	Push through	$\leq d_f$	[mm]	16	18	22	26	32
Minimum thickness of concrete member		h_{min}	[mm]	h_0+30 ($\geq$ 100)		$h_0 + 2d_0$		
Maximum torque moment for attachment of the fixture		max T_{fix}	[Nm]	50		100	150	150

[1] For bigger clearance holes in the fixture see EN 1992-4:2018
[2] Both drill bit diameters can be used

Table A6.2: Materials of BERNER rebar anchors

Part	Description	Materials	
		BRA Corrosion resistance class CRC III acc. to EN 1993-1-4:2006+A1:2015	BRA HCR Corrosion resistance class CRC V acc. to EN 1993-1-4: 2006+A1:2015
1	Reinforcing bar	Bars and de-coiled rods class B or C with f_{yk} and k according to NDP or NCI of EN 1992-1-1:NA; $f_{uk} = f_{tk} = k \cdot f_{yk;}$ (f_{yk} = 500 N/mm^2)	
2	Round bar with partial or full thread	Stainless steel, strength class 80, according to EN 10088-1:2023	High corrosion-resistant steel, strength class 80, according to EN 10088-1: 2023
3	Washer ISO 7089:2000	Stainless steel, according to EN 10088-1: 2023	High corrosion-resistant steel, according to EN 10088-1: 2023
4	Hexagon nut	Stainless steel, strength class 80, acc. to EN ISO 3506-2:2020, according to EN 10088-1: 2023	High corrosion-resistant steel, strength class 80, acc. to EN ISO 3506-2:2020, according to EN 10088-1: 2023

Figures not to scale

Rebar connection with multi compound system MCS Protect Plus

Product description
Properties and materials of BERNER rebar anchors

Annex A6

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Specifications of intended use part 1

Table B1.1: Overview use and performance categories

Anchorages subject to	**MCS Protect Plus with …**			
	Reinforcing bar 		BERNER rebar anchor 	
Hammer drilling with standard drill bit or compressed air drilling	all sizes			
Hammer drilling with hollow drill bit (BERNER Cleandrill dustless, fischer “FHD”, Heller "Duster Expert"; Bosch „Speed Clean“; Hilti "TE-CD, TE-YD") 	Nominal drill bit diameter (d_0) 12 mm to 30 mm			
Static and quasi static load, in uncracked concrete	all sizes	Tables: C1.1 C1.2 C2.2	all sizes	Tables: C1.1 C1.2 C1.3 C2.1 C2.2
Installation temperature	$T_{i,min}$ = -10 °C to $T_{i,max}$ = +40 °C			
Resistance to fire	all sizes	Annex C3	all sizes	Table C2.3

Rebar connection with multi compound system MCS Protect Plus

Intended use
Specifications part 1

Annex B1

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Specifications of intended use part 2

Anchorages subject to:
- Static and quasi-static loads: reinforcing bar (rebar) size 8 mm to 25 mm; BRA M12 to M24.
- Resistance to fire: reinforcing bar (rebar) size 8 mm to 25 mm; BRA M12 to M24.

Base materials:
- Compacted reinforced or unreinforced normal weight concrete without fibres according to EN 206:2013+A1:2016.
- Strength classes C12/15 to C50/60 according to EN 206:2013+A1:2016
- Maximum chloride content of 0,40 % (CL 0.40) related to the cement content according to EN 206:2013+A1:2016
- Non-carbonated concrete
  Note: In case of a carbonated surface of the existing concrete structure, the carbonated layer shall be removed in the area of the post-installed rebar connection with a diameter of ϕ + 60 mm prior to the installation of the new rebar. The depth of concrete to be removed shall correspond to at least the minimum concrete cover in accordance with EN 1992-1-1 :2011. The foregoing may be neglected if building components are new and not carbonated and if building components are in dry conditions.

Application temperature Range:
- -40°C to +80°C (max. short term temperature +80°C and max long-term temperature +50°C).

Installation temperature:
- -10 °C to +40 °C

Use conditions (Environmental conditions) for BERNER rebar anchors:
- For all conditions according to EN 1993-1-4:2006+A1:2015 corresponding to corrosion resistance classes to Annex A6 Table A6.2

Design:
- The structural design according to EN 1992-1-1:2011, EN 1992-1-2:2011 and Annex B3 and B4 are conducted under responsibility of a designer expierenced in the field of anchorages and concrete works.
- Verifiable calculation notes and drawings are prepared taking account of the forces to be transmitted.
- The actual position of the reinforcement in the existing structure shall be determined on the basis of the construction documentation and taken into account when designing.

Installation:
- Dry or wet concrete.
- It must not be installed in water filled holes.
- Hole drilling by hammer drill, hollow drill or compressed air drill mode.
- Overhead installation allowed.
- The installation of post-installed rebar respectively BERNER rebar anchor BRA shall be done only by suitable trained installer and under supervision on site; the conditions under which an installer may be considered as suitable trained and the conditions for Supervision on site are up to the member states in which the installation is done.
- Check the position of the existing rebars (if the position of existing rebars is not known, it shall be determined using a rebar detector suitable for this purpose as well as on the basis of the construction documentation and then marked on the building component for the overlap joint).

Rebar connection with multi compound system MCS Protect Plus	**Annex B2**
Intended use Specifications part 2	

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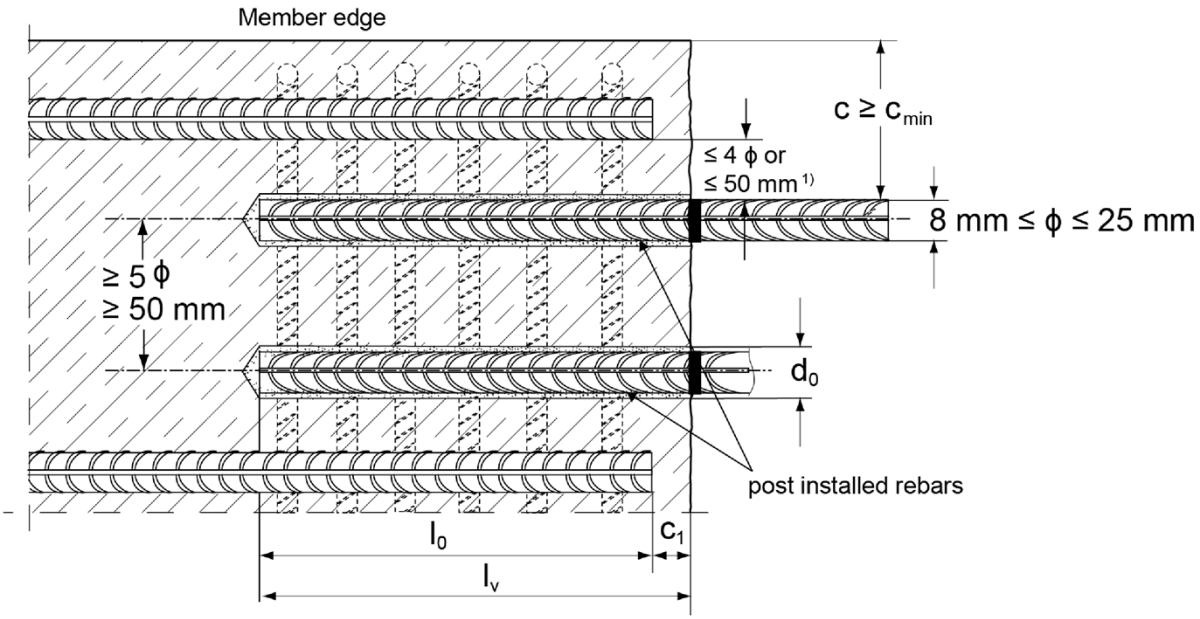
General construction rules for post-installed rebars

Figure B3.1:

- Only tension forces in the axis of the rebar may be transmitted.
- The transfer of shear forces between new concrete and existing structure shall be designed additionally according to EN 1992-1-1:2011.
- The joints for concreting must be roughened to at least such an extent that aggregate protrude.



[1] If the clear distance between lapped bars exceeds 4 ϕ or 50 mm then the lap length shall be increased by the difference between the clear bar distance and the smaller 4 ϕ or 50 mm.

c	concrete cover of post-installed rebar
c_1	concrete cover at end-face of existing rebar
c_{min}	minimum concrete cover according to **Table B5.1** and to EN 1992-1-1:2011, Section 4.4.1.2
ϕ	nominal diameter of reinforcing bar
l_0	lap length, according to EN 1992-1-1:2011 for static loading
l_v	effective embedment depth, ≥ l_0 + c_1
d_0	nominal drill bit diameter, see **Annex B6**

Figures not to scale

Rebar connection with multi compound system MCS Protect Plus	**Annex B3**
Intended use General construction rules for post-installed rebars	

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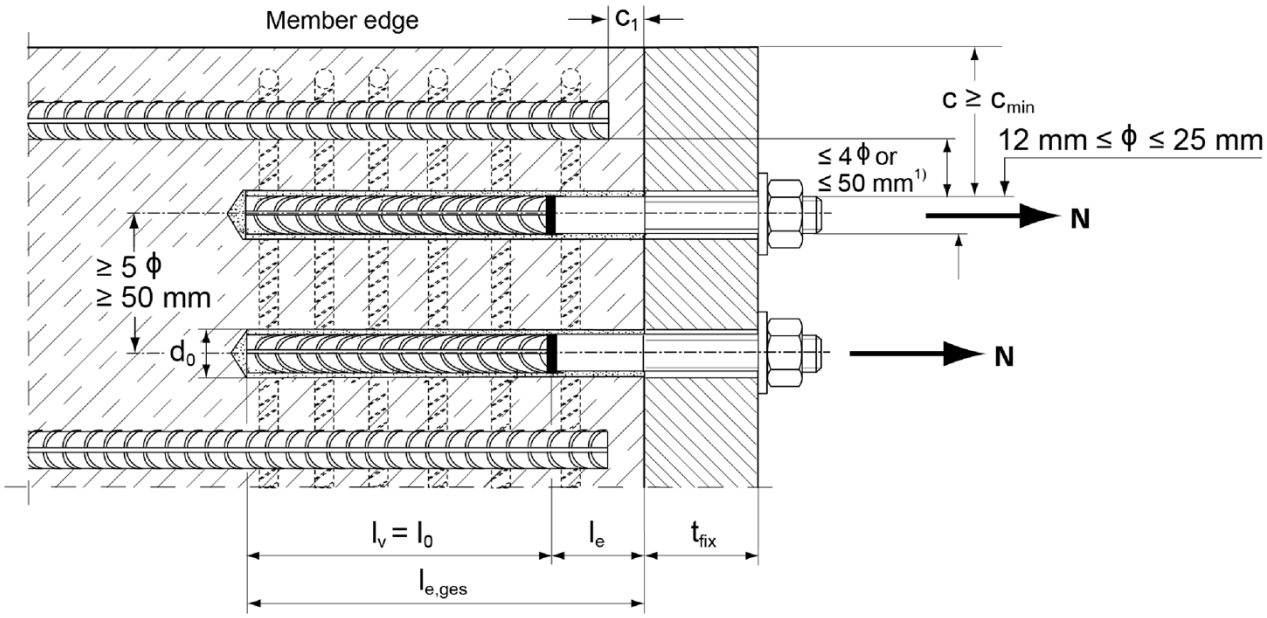
General construction rules for post-installed BERNER rebar anchors

Figure B4.1:

- Only tension forces in the axis of the BERNER rebar anchor BRA may be transmitted.
- The tension force must be transferred via an overlap joint to the reinforcement in the building part.
- The transmission of the shear load shall be ensured by appropriate additional measures, e.g. by shear lugs or by anchors with a European Technical Assessment (ETA).
- In the anchor plate, the holes for the BERNER rebar anchors BRA shall be executed as slotted holes with the axis in the direction of the shear force.
- The length of the bonded-in thread may not be accounted as anchorage.



1) If the clear distance between lapped bars exceeds 4 ϕ or 50 mm then the lap length shall be increased by the difference between the clear bar distance and the smaller 4 ϕ or 50 mm.

c	concrete cover of post-installed BERNER rebar anchor
c_1	concrete cover at end-face of existing rebar
c_{min}	minimum concrete cover according to Table B5.1 and to EN 1992-1-1:2011, Section 4.4.1.2
ϕ	nominal diameter of reinforcing bar
l_0	lap length, according to EN 1992-1-1:2011, Section 8.7.3
$l_{e,ges}$	overall embedment depth, ≥ l_0 + l_e
d_0	nominal drill bit diameter, see **Annex B6**
l_e	length of the bonded in threaded part
t_{fix}	thickness of the fixture
l_v	effective embedment depth

Figures not to scale

Rebar connection with multi compound system MCS Protect Plus	**Annex B4**
Intended use General construction rules for post-installed BERNER rebar anchors	

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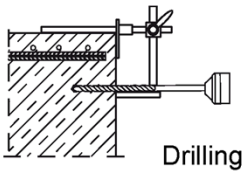
Table B5.1: Minimum concrete cover c_{min} [1)] depending on the drilling method and the drilling tolerance

Drilling method	nominal diameter of reinforcing bar ϕ [mm]	Minimum concrete cover c_{min} Without drilling aid [mm]	Minimum concrete cover c_{min} With drilling aid [mm]	
Hammer drilling with standard drill bit or Hammer drilling with hollow drill bit (detailed list see **Annex B1; Table B1.1)**	< 25	30 mm + 0,06 l_v ≥ 2 ϕ	30 mm + 0,02 l_v ≥ 2 ϕ	 Drilling aid
	= 25	40 mm + 0,06 l_v ≥ 2 ϕ	40 mm + 0,02 l_v ≥ 2 ϕ	
Compressed air drilling	< 25	50 mm + 0,08 l_v	50 mm + 0,02 l_v	
	= 25	60 mm + 0,08 l_v ≥ 2 ϕ	60 mm + 0,02 l_v ≥ 2 ϕ	

[1)] See Annex B 3, figure B3.1 and Annex B 4, figure B4.1
Note: The minimum concrete cover as specified in EN 1992-1-1:2011 must be observed.

Table B5.2: Dispensers and cartridge sizes corresponding to maximum embedment depth $l_{v,max}$ resp. $l_{e,ges,max}$

reinforcing bars (rebar)	BERNER rebar anchor	Manual dispenser	Pneumatic or cordless dispenser (small)	Pneumatic or cordless dispenser (large)
		Cartridge size ≤ 500 ml (e.g. 300 ml, 360 ml, 380 ml, 400 ml, 410 ml)		Cartridge size >500 ml (e.g. 825 ml)
ϕ [mm]	[-]	$l_{v,max}$ / $l_{e,ges,max}$ [mm]		$l_{v,max}$ / $l_{e,ges,max}$ [mm]
8	---	700	1000	1500
10	---			
12	BRA M12 BRA HCR M12			
14	---			
16	BRA M16 BRA HCR M16			
20	BRA M20 BRA HCR M20			
22	---			
24	---			
25	BRA M24 BRA HCR M24			

Table B5.3: Conditions for use static mixer without an extension tube

Nominal drill hole diameter		d_0	[mm]	10	12	14	16	18	20	22	24	25	28	30
Drill hole depth h_0 by using	MCS Protect Plus up to 410 ml		[mm]	-		≤120	≤140	≤150	≤160	≤170	≤190	≤210		
	MCS Protect Plus 825 ml			-	-	-	≤160	≤180	≤190	≤210	≤220		≤250	

Rebar connection with multi compound system MCS Protect Plus

Intended use
Minimum concrete cover;
dispenser and cartridge sizes corresponding to maximum embedment depth

Annex B5

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Table B6.1: Working times t_{work} and curing times t_{cure}

Temperature at anchoring base [°C] [3]	Maximum processing time[1] t_{work}	Minimum curing time [2] t_{cure}
	MCS Protect Plus	**MCS Protect Plus**
-10 to -5	6 h	72 h
> -5 to 0	2 h	24 h
> 0 to 5	45 min	12 h
> 5 to 10	20 min	6 h
> 10 to 15	8 min	3 h
> 15 to 20	5 min	2 h
> 20 to 25	3 min	1 h
> 25 to 30	2 min	45 min
> 30 to 40	1 min	30 min

[1] Maximum time from the beginning of the injection to rebar / BERNER rebar anchor setting and positioning
[2] For wet concrete the curing time must be doubled
[3] If the temperature in the concrete falls below 10°C the cartridge has to be warmed up to +20°C. If the temperature in the concrete exceeds 30°C the cartridge has to be cooled down to +20°C

Table B6.2: Installation tools for drilling and cleaning the bore hole and injection of the mortar

reinforcing bars (rebar)	BERNER rebar anchor	Drilling and cleaning				Injection	
		Nominal drill bit diameter	Diameter of cutting edge	Steel brush diameter	Diameter of cleaning nozzle	extension tube 9mm	extension tube 15mm
						Injection adapter	Injection adapter
ϕ [mm]	[-]	d_0 [mm]	d_{cut} [mm]	d_b [mm]	[mm]	[colour]	[colour]
8[1]	---	10 [2]	≤ 10,50	11	---		---
		12	≤ 12,50	14	11	nature	---
10[1]	---	12	≤ 12,50	14			
		14	≤ 14,50	16		blue	---
12[1]	BRA M12[1] BRA HCR M12[1]	14	≤ 14,50	16	15		
		16	≤ 16,50	20		red	---
14	---	18	≤ 18,50	20		yellow	---
16	BRA M16 BRA HCR M16	20	≤ 20,55	25	19	green	green
20	BRA M20 BRA HCR M20	25	≤ 25,55	27		black	black
22	---	28	≤ 28,55	30	28	blue	blue
24	---	30	≤ 30,55	40		grey	grey
25	BRA M24[1] BRA HCR M24[1]	30	≤ 30,55	40			

[1] Both drill bit diameters can be used
[2] Only hammer drilling with standard drill bit

Rebar connection with multi compound system MCS Protect Plus

Intended use
Working times and curing times;
Installation tools for drilling and cleaning the bore hole and injection of the mortar

Annex B6

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Safety regulations

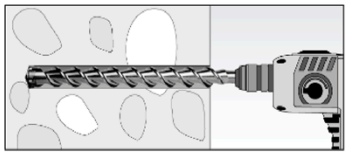
Review the Safety Data Sheet (SDS) before use for proper and safe handling!
Wear well-fitting protective goggles and protective gloves when working with mortar MCS Protect Plus.
Important: Observe the instructions for use provided with each cartridge.

Installation instruction part 1; Installation with MCS Protect Plus

Hole drilling

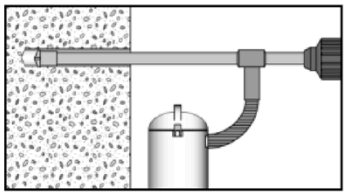
Note: Before drilling, remove carbonated concrete; clean contact areas (see **Annex B2**)
In case of aborted drill holes the drill hole shall be filled with mortar.

1 **Hammer drilling or compressed air drilling**



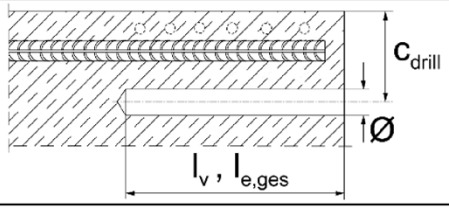
Drill the hole to the required embedment depth using a hammer drill with carbide drill bit set in rotation hammer mode or a pneumatic drill.
Drill bit sizes see **Table B6.2**.

1b **Hammer drilling with hollow drill bit**

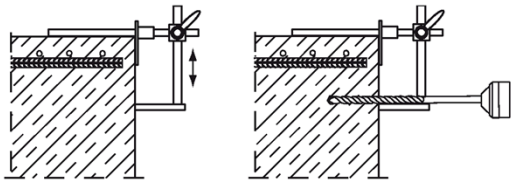


Drill the hole to the required embedment depth using a hammer drill with hollow drill bit in rotation hammer mode.
Dust extraction conditions see drill hole cleaning **Annex B9**.
Drill bit sizes see **Table B6.2.**

2



Measure and control concrete cover c
(c_{drill} = c + Ø / 2)
Drill parallel to surface edge and to existing rebar.
Where applicable use drilling aid.



For holes l_v > 20 cm use drilling aid.
Three different options can be considered:

A) Drilling aid
B) Slat or spirit level
C) Visual check

Minimum concrete cover c_{min} see **Table B5.1**

Go to step 3 or 4

Rebar connection with multi compound system MCS Protect Plus	**Annex B7**
Intended use Safety regulations; Installation instruction part 1, hole drilling	

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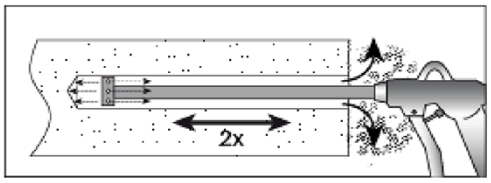
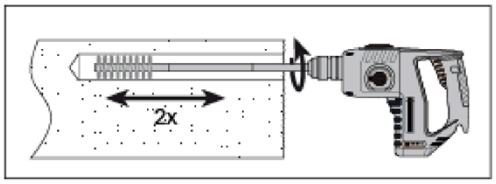
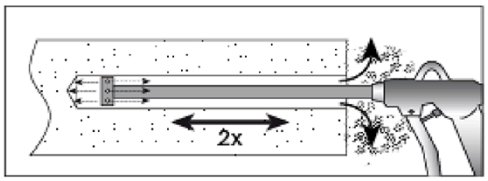
Installation instruction part 2

Drill hole cleaning with oil-free compressed air

3	**Hammer or compressed air drilling** 	
		**Blowing** twice from the back of the hole with the appropriate nozzle (oil-free compressed air ≥ 6 bar) until return air stream is free of noticeable dust. Personal protective equipment must be used. (see safety regulations **Annex B7**).
		**Brushing (with power drill)** Check steel brush with brush control template. The brush must produce a noticeable resistance when it is inserted into the drill hole. Fix an adequate steel brush with an extension into a drilling machine and brush the bore hole twice.
		**Blowing** twice from the back of the hole with the appropriate nozzle (oil-free compressed air ≥ 6 bar) until return air stream is free of noticeable dust. Personal protective equipment must be used. (see safety regulations **Annex B7**).

Go to step 7

Rebar connection with multi compound system MCS Protect Plus	**Annex B8**
Intended use Installation instruction part 2, drill hole cleaning	

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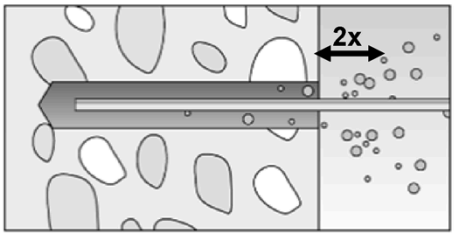
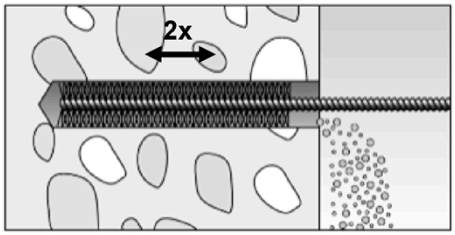
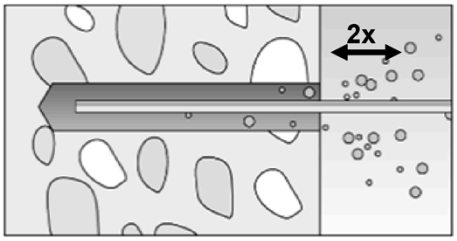
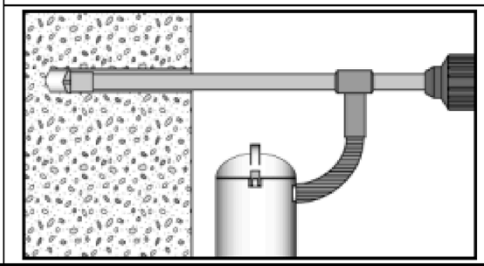
Installation instruction part 3

Drill hole cleaning: manual cleaning is permitted for hammer drilled boreholes up to hole diameters $d_0 < 18$ mm and depths l_v resp. $l_{e,ges} \leq 12 \times \phi$

4		**Blowing** blow out the hole twice by hand from the back of the hole. Use only the BERNER blow out pump. Personal protective equipment must be used (see safety regulations **Annex B7**).
5		**Brushing** Twice with the specified brush size by inserting the round steel brush to the back of the hole and twisting motion. The brush must produce a noticeable resistance when it is inserted into the drill hole. Corresponding brushes see **Table B6.2**.
6		**Blowing** blow out the hole twice by hand from the back of the hole. Use only the BERNER blow out pump. Personal protective equipment must be used. (see safety regulations **Annex B7**).
6b	**Hammer drilling with hollow drill bit** 	
		Use a suitable dust extraction system, e. g. BERNER BWDVC PERM M-1 or a comparable dust extraction system with equivalent performance data. Drill the hole with hollow drill bit. The dust extraction system has to extract the drill dust nonstop during the drilling process and must be adjusted to maximum power. No further drill hole cleaning necessary.

Go to step 7

Rebar connection with multi compound system MCS Protect Plus	**Annex B9**
Intended use Installation instruction part 3, drill hole cleaning	

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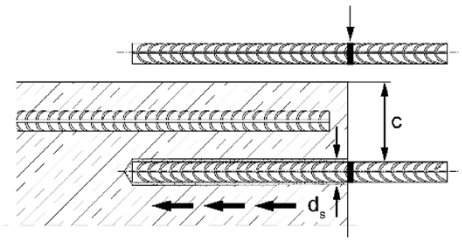
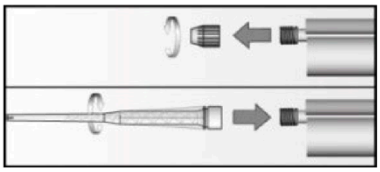
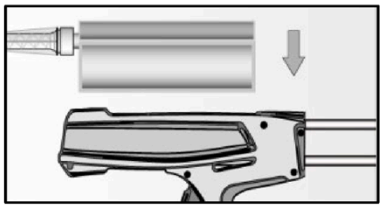
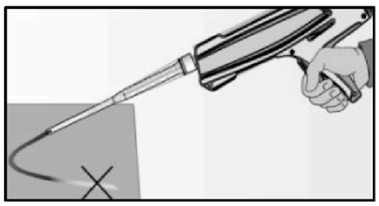
Installation instruction part 4

reinforcing bars (rebar) / BERNER rebar anchor and cartridge preparation

7		Before use, make asure that the rebar or the BERNER rebar anchor is dry and free of oil or other residue. Mark the embedment depth l_v resp. $l_{e,ges}$ (e.g. with tape) Insert rebar in borehole, to verify drill hole depth and setting depth l_v resp. $l_{e,ges}$
8		Twist off the sealing cap Twist on the static mixer (the spiral in the static mixer must be clearly visible).
9		Place the cartridge into a suitable dispenser.
10		Press out approximately 10 cm of mortar until the resin is permanently grey in colour. Mortar which is not grey in colour will not cure and must be disposed.

Go to step 11

Rebar connection with multi compound system MCS Protect Plus	**Annex B10**
Intended use Installation instruction part 4, reinforcing bars (rebar) / BERNER rebar anchor and cartridge preparation	

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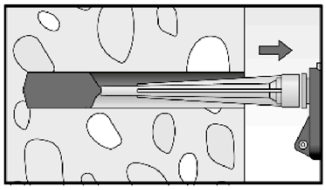
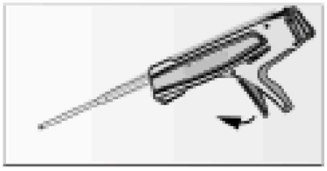
Installation instruction part 5; Installation with MCS Protect Plus

Injection of the mortar without extension tube

11a



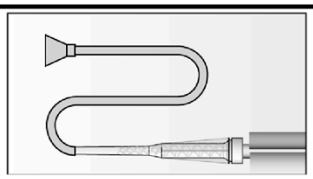
Inject the mortar from the back of the hole towards the front and slowly withdraw the mixing nozzle step by step with each trigger pull.
Avoid bubbles.
Fill holes approximately 2/3 full, to ensure that the annular gap between the rebar and the concrete will be completely filled with adhesive over the entire embedment length.
The conditions for mortar injection without extension tube can be found in **Table B5.3**



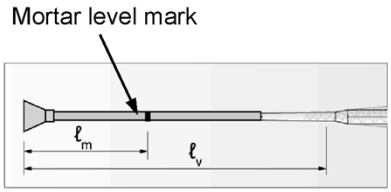
After injecting, release the dispenser. This will prevent further mortar discharge from the mixing nozzle.

Injection of the mortar with extension tube

11b



Assemble mixing nozzle MCS Protect Plus up to 410 ml or MCS Protect Plus 825 ml, extension tube and appropriate injection adapter (see **Table B6.2**)



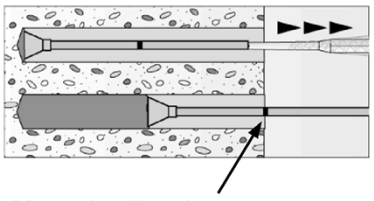
Mark the required mortar level l_m and embedment depth l_v resp. $l_{e,ges}$ with tape or marker on the injection extension tube.

a) Estimation:

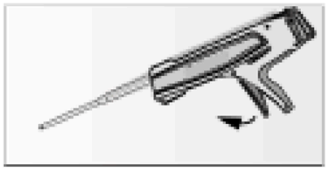
$$l_m = \frac{1}{3} * l_v \; resp. \; l_m = \frac{1}{3} * l_{e,ges}$$

b) Precise equation for optimum mortar volume:

$$l_m = l_v \; resp. \; l_{e,ges} \left((1{,}2 * \frac{d_s^2}{d_0^2} - 0{,}2) \right) \text{[mm]}$$



Insert injection adapter to back of the hole. Begin injection allowing the pressure of the injected adhesive mortar to push the injection adapter towards the front of the hole. Do not actively pull out!
Fill holes approximately 2/3 full, to ensure that the annular gap between the rebar and the concrete will be completely filled with adhesive over the embedment length.
When using an injection adapter continue injection until the mortar level mark l_m becomes visible.
Maximum embedment depth see **Table B5.2**



After injecting, release the dispenser. This will prevent further mortar discharge from the mixing nozzle.

Go to step 12

Rebar connection with multi compound system MCS Protect Plus

Intended use
Installation instruction part 5, mortar injection

Annex B11

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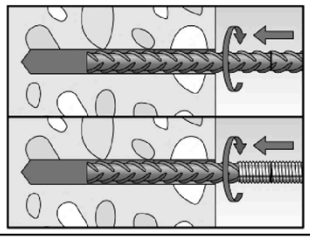
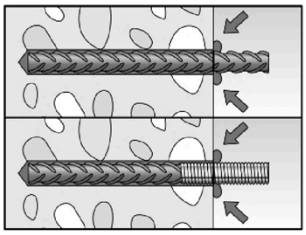
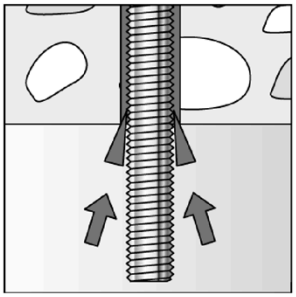
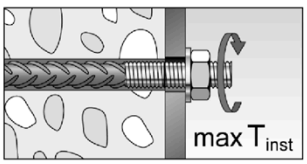
Installation instruction part 6; Installation with MCS Protect Plus

Insert rebar / BERNER rebar anchor

12		Insert the rebar / BERNER rebar anchor slowly twisted into the borehole until the embedment mark is reached. Recommendation: Rotation back and forth of the reinforcement bar or the BERNER rebar anchor makes pushing easy
13		After installing the rebar or BERNER rebar anchor the annular gap must be completely filled with mortar. Proper installation • Desired embedment depth is reached l_v resp. $l_{e,ges}$: embedment mark at concrete surface • Excess mortar flows out of the borehole after the rebar or BERNER rebar anchor have been fully inserted up to the embedment mark.
14		For overhead installation, support the rebar / BERNER rebar anchor and secure it from falling till mortar started to harden, e.g. using wedges.
15		Observe the working time "t_{work}" (see **Table B6.1**), which varies according to temperature of base material. Minor adjustments to the rebar / BERNER rebar anchor position may be performed during the working time Full load may be applied only after the curing time "t_{cure}" has elapsed (see **Table B6.1**).
16		Mounting the fixture, max T_{fix} see **Table A6.1**.

Rebar connection with multi compound system MCS Protect Plus

Intended use
Installation instruction part 6, insert rebar / BERNER rebar anchor

Annex B12

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Minimum anchorage length and minimum lap length

The minimum anchorage length $l_{b,min}$ and the minimum lap length $l_{o,min}$ according to EN 1992-1-1:2011 shall be multiplied by the relevant amplification factor α_{lb} according to **Table C1.1**.

Table C1.1: Amplification factor α_{lb} related to concrete strength class and drilling method

Hammer drilling, hollow drilling and compressed air drilling

Rebar / BERNER rebar anchor ϕ [mm]	**Amplification factor α_{lb}**								
	Concrete strength class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
8 to 25	1,5								

Table C1.2: Bond efficiency factor k_b for hammer drilling, hollow drilling and compressed air drilling

Hammer drilling, hollow drilling and compressed air drilling

Rebar / BERNER rebar anchor ϕ [mm]	**Bond efficiency factor k_b**								
	Concrete strength class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
8	1,0	1,0	1,0	0,86	0,76	0,69	0,73	0,67	0,63
10	1,0	1,0	1,0	0,86	0,76	0,69	0,63	0,67	0,63
12	1,0	1,0	1,0	0,86	0,76	0,69	0,63	0,58	0,54
14	1,0	1,0	0,86	0,74	0,76	0,69	0,63	0,58	0,54
16	1,0	1,0	0,86	0,74	0,66	0,59	0,63	0,58	0,54
20	1,0	0,83	0,71	0,74	0,66	0,59	0,54	0,50	0,47
22	1,0	0,83	0,71	0,61	0,54	0,59	0,54	0,50	0,47
24	1,0	0,83	0,71	0,61	0,54	0,49	0,45	0,50	0,47
25	1,0	0,83	0,71	0,61	0,54	0,49	0,45	0,41	0,47

Table C1.3: Characteristic resistance to **steel failure** under tension load of **BERNER rebar anchors**

BERNER rebar anchor BRA / BRA HCR			**M12**	**M16**	**M20**	**M24**
Bearing capacity under tension load, steel failure						
Characteristic resistance	$N_{Rk,s}$	[kN]	62,0	111,0	173,0	236,5
Partial factor						
Partial factor	$\gamma_{Ms,N}$	[-]	1,4			

Rebar connection with multi compound system MCS Protect Plus

Performance
Amplification factor α_{lb}, bond efficiency factor k_b,
Characteristic resistance for steel failure under tension load of BERNER rebar anchors

Annex C1

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Table C2.1: Characteristic **tensile yield strength** for rebar part of **BERNER rebar anchors BRA**

BERNER rebar anchor BRA / BRA HCR			**M12**	**M16**	**M20**	**M24**
Characteristic tensile yield strength for rebar part						
Rebar diameter	ϕ	[mm]	12	16	20	25
Characteristic tensile yield strength for rebar	f_{yk}	[N/mm²]	520	520	520	520
Partial factor for rebar part	$\gamma_{Ms,N}$ [1)]	[-]	1,4			

[1)] In absence of national regulations

Table C2.2: Design values of the bond strength $f_{bd,PIR}$ in N/mm² for hammer drilling, hollow drilling, compressed air drilling

$$f_{bd,PIR} = k_b \bullet f_{bd}$$

f_{bd}: Design value of the bond strength in N/mm² considering the concrete strength classes and the rebar diameter for good bond condition (for all other bond conditions multiply the values by $\eta_1 = 0,7$) and recommended partial factor $\gamma_c = 1,5$ according to EN 1992-1-1:2011.

k_b: Bond efficiency factor according to **Table C1.2**.

Hammer drilling, hollow drilling and compressed air drilling

Rebar / BERNER rebar anchor ϕ [mm]	**bond strength $f_{bd,PIR}$ [N/mm²]** Concrete strength class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
8	1,6	2,0	2,3	2,3	2,3	2,3	2,7	2,7	2,7
10	1,6	2,0	2,3	2,3	2,3	2,3	2,3	2,7	2,7
12	1,6	2,0	2,3	2,3	2,3	2,3	2,3	2,3	2,3
14	1,6	2,0	2,0	2,0	2,3	2,3	2,3	2,3	2,3
16	1,6	2,0	2,0	2,0	2,0	2,0	2,3	2,3	2,3
20	1,6	1,6	1,6	2,0	2,0	2,0	2,0	2,0	2,0
22	1,6	1,6	1,6	1,6	1,6	2,0	2,0	2,0	2,0
24	1,6	1,6	1,6	1,6	1,6	1,6	1,6	2,0	2,0
25	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6	2,0

Table C2.3: Essential characteristics to **steel failure** for **BERNER rebar anchors** under fire exposure R30 to R120

For concrete strength classes C12/C15 to C50/60

BERNER rebar anchor BRA / BRA HCR				**M12**	**M16**	**M20**	**M24**
Characteristic tensile resistance	R30	$N_{Rk,s,fi}$	[kN]	1,7	3,1	4,9	7,1
	R60			1,3	2,4	3,7	5,3
	R90			1,1	2,0	3,2	4,6
	R120			0,8	1,6	2,5	3,5

Rebar connection with multi compound system MCS Protect Plus

Performance
Design values of the bond strength $f_{bd,PIR}$; Essential characteristics to steel failure for BERNER rebar anchor $N_{Rk,s,fi}$ under fire exposure

Annex C2

Deutsches Institut für Bautechnik DIBt

The bond strength $f_{bk,fi}$ at increased temperature for concrete strength classes C12/15 to C50/60 (all drilling methods)

The bond strength $f_{bk,fi}$ at increased temperature has to be calculated by the following equation:

$$f_{bk,fi} = k_{fi}(\theta) \cdot f_{bd,PIR} \cdot \frac{\gamma_c}{\gamma_{m,fi}}$$

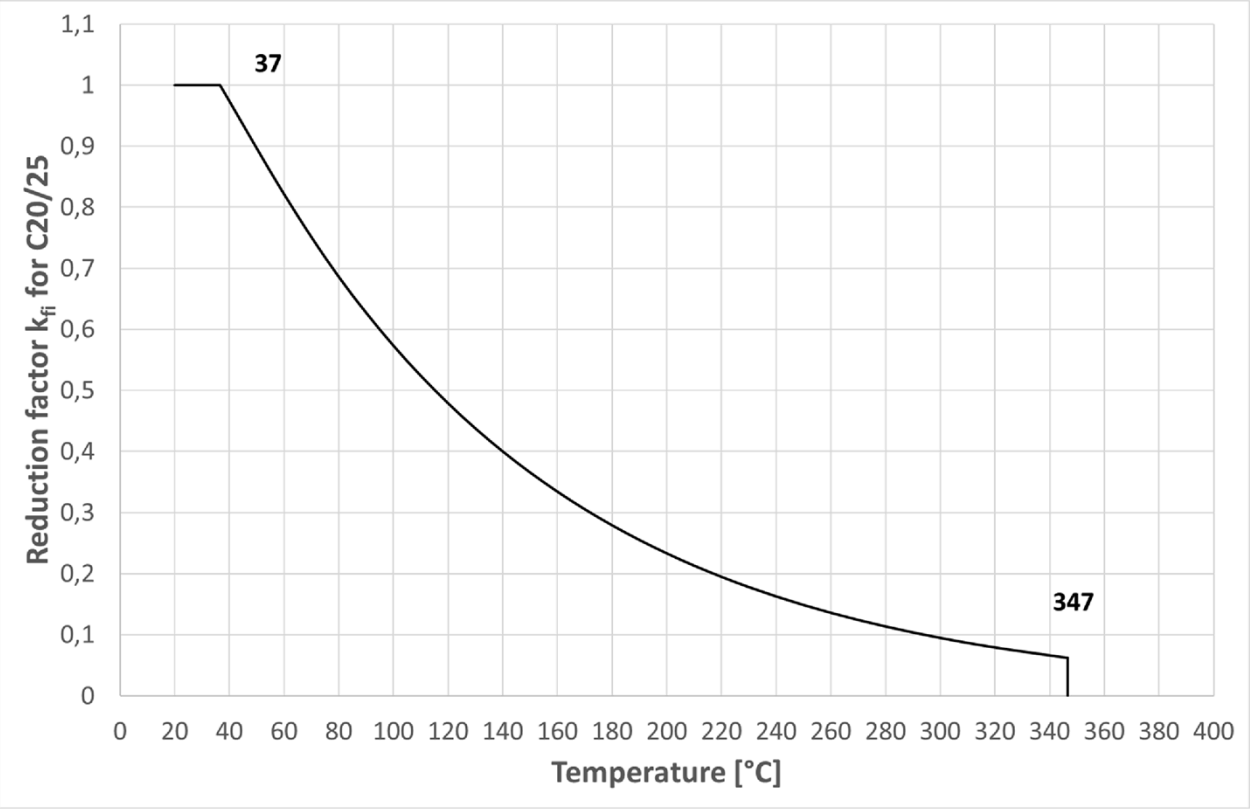
If: $\theta > 37$ °C $\quad k_{fi}(\theta) = \frac{13{,}898 \cdot e^{-0{,}009 \cdot \theta}}{f_{bd,PIR} \cdot 4{,}3} \leq 1.0$

If: $\theta > \theta_{max}$ (347 °C) $\quad k_{fi}(\theta) = 0$

$f_{bk,fi}$	=	The bond strength at increased temperature in N/mm²
(θ)	=	Temperature in °C in the mortar layer
$k_{fi}(\theta)$	=	Reduction factor at increased temperature
$f_{bd,PIR}$	=	Design value of the bond strength in N/mm² in cold condition according to table C2.1 considering the concrete classes, the rebar diameter, the drilling method and the bond conditions according to EN 1992-1-1:2011
γ_C	=	1,5 recommended partial factor according to EN 1992-1-1:2011
$\gamma_{m,fi}$	=	1,0 recommended partial factor according to EN 1992-1-2:2011

For evidence at increased temperature the anchorage length shall be calculated according to EN 1992-1-1:2011 Equation 8.3 using the temperature-dependent ultimate bond strength $f_{bk,fi}$.

Figure C3.1: Example graph of reduction factor $k_{fi}(\theta)$ for concrete class C20/25 for good bond conditions



Rebar connection with multi compound system MCS Protect Plus	**Annex C3**
Performance Design values of bond strength $f_{bk,fi}$ at increased temperature	