Einfach. Sicher. Upat

LEISTUNGSERKLÄRUNG

DoP: 0060

für Upat Injektionsmörtel UPM 55 (Mörtel für Bewehrungsanschlüsse) **– DE**

1. Eindeutiger Kenncode des Produkttyps: **DoP: 0060**

2. Verwendungszweck(e): **Nachträglicher Anschluss von Betonstahl durch Verankerung oder Übergreifungsstoß in Normalbeton, EN 1992-1-1, siehe Anhang, insbesondere Anhänge B 1 bis B 10**

3. Hersteller: **Upat Vertriebs GmbH, Bebelstraße 11, 79108 Freiburg im Breisgau, Deutschland**

4. Bevollmächtigter: **--**

5. System(e) zur Bewertung und Überprüfung der Leistungsbeständigkeit: 1

6. Europäisches Bewertungsdokument: **EAD 330087-00-0601**

   Europäische Technische Bewertung: **ETA-11/0417; 2018-06-27**

   Technische Bewertungsstelle: **DIBt**

   Notifizierte Stelle(n): **1343 – MPA Darmstadt**

7. Erklärte Leistung(en):

Mechanische Festigkeit und Standsicherheit (BWR 1)

- **Charakteristischer Widerstand unter statischer und quasi-statischer Belastung: Siehe Anhang, insbesondere Anhang C 1**

Brandschutz (BWR 2)

- **Brandverhalten: Der Dübel erfüllt die Anforderungen der Klasse A 1**
- **Feuerwiderstand: KLF**

8. Angemessene Technische Dokumentation und/oder Spezifische Technische Dokumentation: ---

Die Leistung des vorstehenden Produkts entspricht der erklärten Leistung/den erklärten Leistungen. Für die Erstellung der Leistungserklärung im Einklang mit der Verordnung (EU) Nr. 305/2011 ist allein der obengenannte Hersteller verantwortlich.

Unterzeichnet für den Hersteller und im Namen des Herstellers von:

Andreas Bucher, Dipl.-Ing. — Wolfgang Hengesbach, Dipl.-Ing., Dipl.-Wirtsch.-Ing.

i. V. A. Bucher — i. V. W. Hengesbach

Tumlingen, 2018-07-04

- Diese Leistungserklärung wurde in verschiedenen Sprachversionen erstellt. Für den Fall unterschiedlicher Auslegung hat immer die englische Version Vorrang.
- Der Anhang enthält freiwillige und ergänzende Informationen in englischer Sprache. Diese gehen über die (sprachneutral angegebenen) gesetzlichen Anforderungen hinaus.

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 Upat Injection mortar UPM 55" in accordance with the regulations for reinforced concrete construction.

Reinforcing bars made of steel with a diameter ϕ from 8 to 40 mm or the rebar anchor FRA from sizes 12, 16 and 20 according to Annex A and injection mortar UPM 55 are used for rebar connections. The rebar is placed into a drilled hole filled with injection mortar and is anchored via the bond between rebar, 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 connection 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 C 1

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Class A1
Resistance to fire	No performance assessed

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. 330087-00-0601, the applicable European legal act is: [96/582/EC].

The system to be applied is: 1

Installation anchor

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

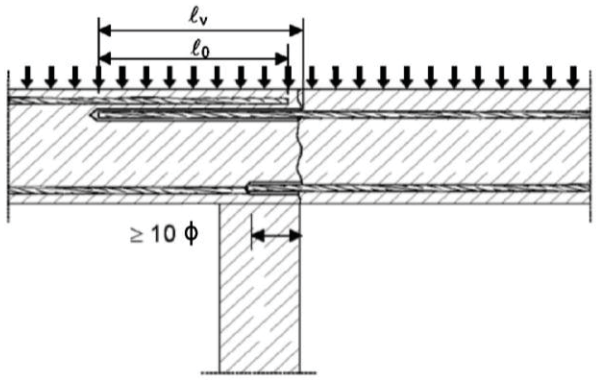


Figure A2:
Overlap joint with existing reinforcement at a foundation of a column or wall where the rebars are stressed

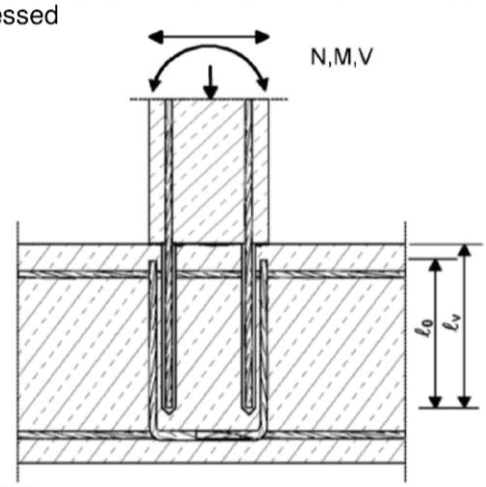


Figure A3:
End anchoring of slabs of beams (e.g. designed as simply supported)

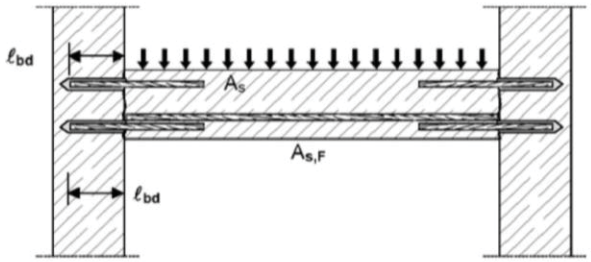


Figure A4:
Rebar connection for stressed primarily in compression

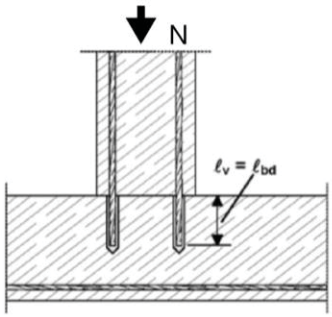
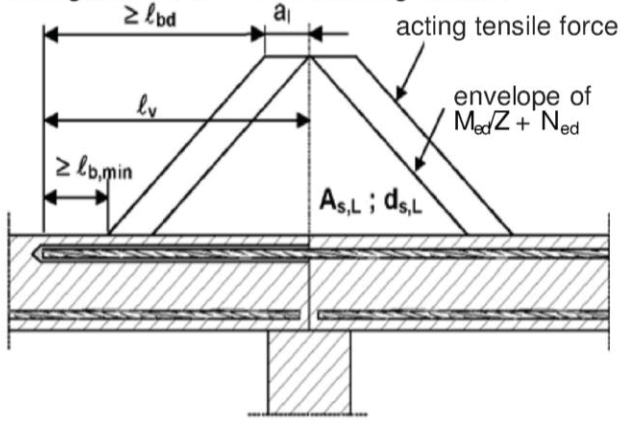


Figure A5:
Anchoring of reinforcement to cover the enveloped line of acting tensile force in the bending member



Note to **Figure A1** to **A5**:

In the Figures no traverse reinforcement is plotted, the transverse reinforcement shall comply with EN 1992-1-1: 2004+AC:2010.

Preparing of joints according to **Annex B 2**

Rebar connection with Upat injection mortar UPM 55	**Annex A 1**
Product description Installed condition and examples of use for rebars	

Installation anchor

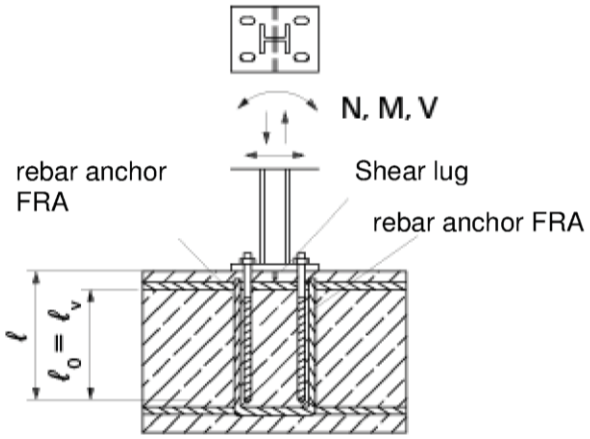


Figure A6: Lap to a foundation of a column under bending.

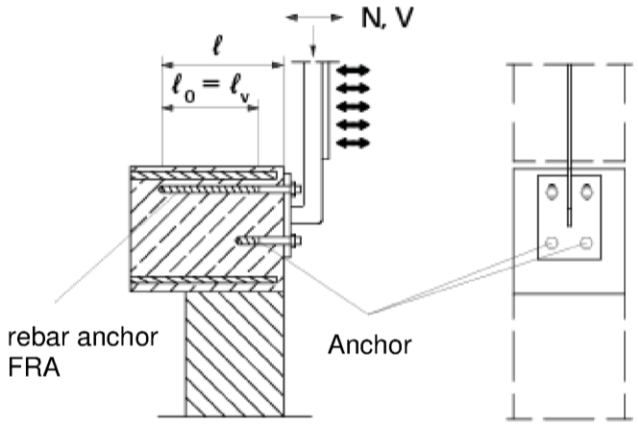


Figure A7: Lap of the anchoring of guardrail posts.
In the anchor plate, the drill holes for the rebar anchors FRA have to be designed as elongated holes with axial direction to the shear force.

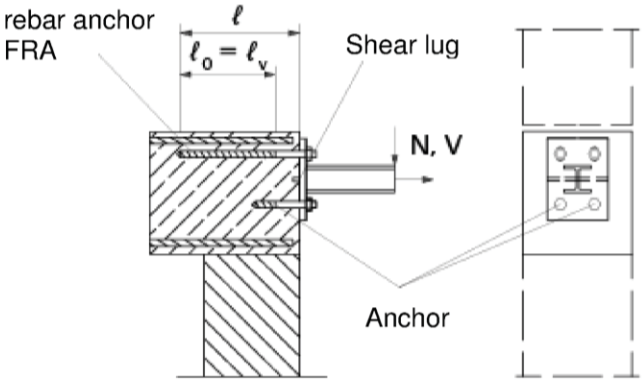
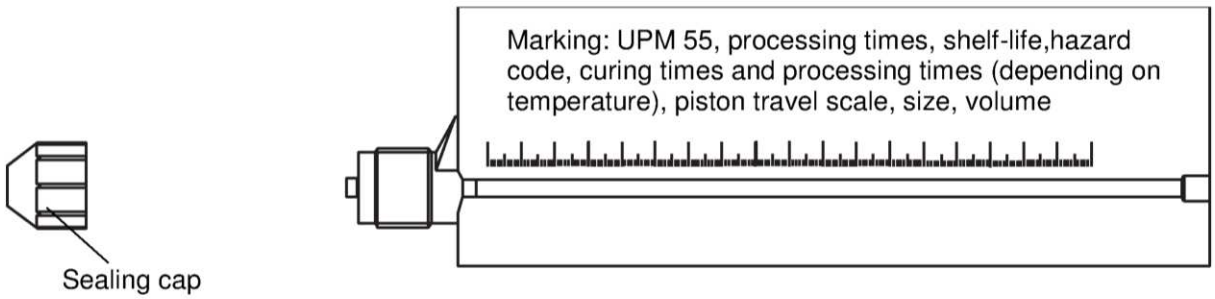


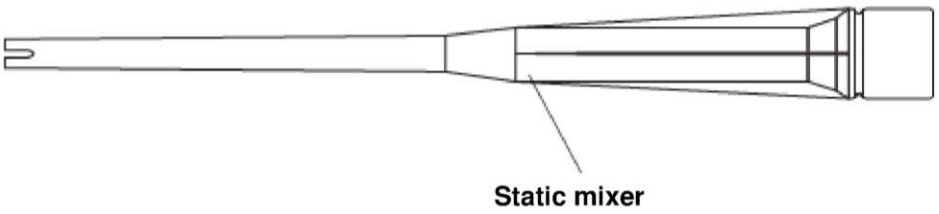
Figure A8: Lap of the anchoring of cantilevered building components.
In the anchor plate, the drill holes for the rebar anchors FRA have to be designed as elongated holes with axial direction to the shear load.

The required transverse reinforcement acc. to EN 1992-1-1:2004+AC:2010 is not shown in the figures. **The rebar anchor FRA 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 measure, e.g. by means of shear force or anchors with European Technical Approval/Assessment (ETA)

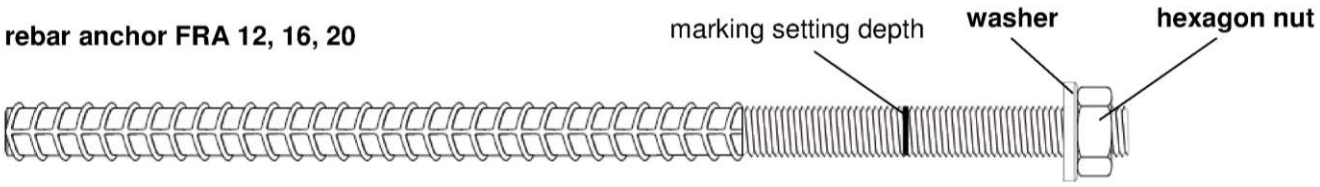
Rebar connection with Upat injection mortar UPM 55	**Annex A 2**
Product description Installed condition and examples of use for rebar anchor FRA	

Injection cartridge
Sizes: 390 ml, 585 ml, 1500 ml

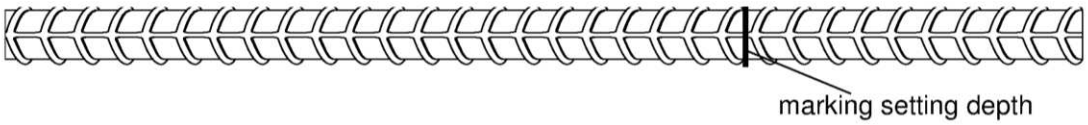




rebar anchor FRA 12, 16, 20



Reinforcing bar (rebar)
ϕ8, ϕ10, ϕ12, ϕ14, ϕ16, ϕ20, ϕ22, ϕ24, ϕ25, ϕ26, ϕ28, ϕ30, ϕ32, ϕ34, ϕ36, ϕ40



Rebar connection with Upat injection mortar UPM 55	**Annex A 3**
Product description Injection mortar; reinforcing bar, rebar anchor FRA	

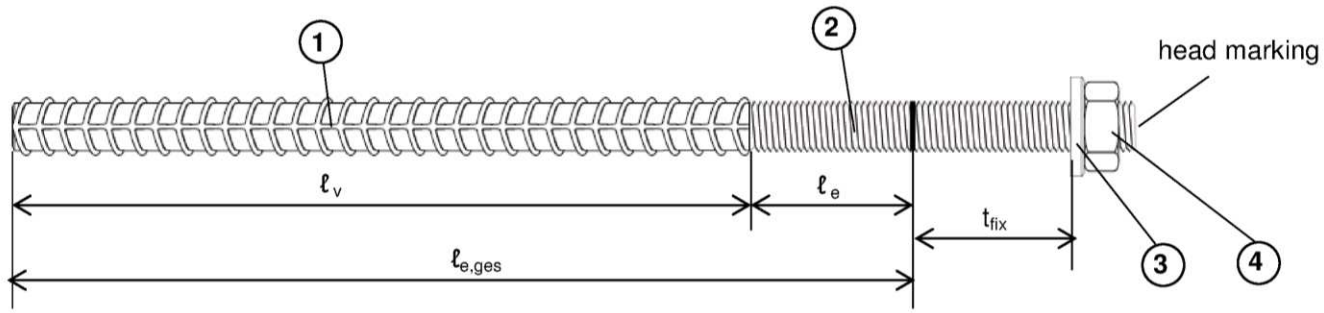
Figure A9: Properties of reinforcing bars (rebar)

- The minimum value of related rip area $f_{R,min}$ according to EN 1992-1-1:2004+AC:2010
- The maximum outer rebar diameter over the rips shall be:
    - The nominal diameter of the rip $\phi + 2 * h$ ($h \leq 0{,}07 * \phi$)
    - (ϕ: Nominal diameter of the bar; h: rip height of the bar)

Table A1: Materials of rebars

Designation	Reinforcing bar (rebar)
Reinforcing bar EN 1992-1-1:2004+AC:2010, 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 $f_{uk} = f_{tk} = k \cdot f_{yk}$

Figure A10: Properties of rebar anchors FRA



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

FRA C (for high corrosion-resistant steel)

Table A2: Installation parameters for rebar anchors FRA

Threaded diameter				**M12**		**M16**	**M20**
Nominal bar size		ϕ	[mm]	12		16	20
Width across flat		SW	[mm]	19		24	30
Nominal drill bit diameter		d_0	[mm]	14[1)]	16	20	25
Depth of drill hole ($h_0 = l_{ges}$)		$\ell_{e,ges}$	[mm]	$\ell_v + \ell_e$			
Effective anchorage depth		ℓ_v	[mm]	acc. to static calculation			
Distance concrete surface to welded join		ℓ_e	[mm]	100			
Diameter of clearance hole in the fixture	Pre-positioned ≤ d		[mm]	14		18	22
	Push through ≤ d_f		[mm]	18		22	26
Minimum thickness of concrete member		h_{min}	[mm]	h_0+30 ≥ 100		$h_0 + 2d_0$	
Maximum torque moment		$T_{inst,max}$	[Nm]	50		100	150

[2)] Both drill bit diameters can be used

Table A3: Materials of rebar anchors FRA

Part	Description	Materials	
		FRA	FRA C
1	Reinforcing bar	Class B according to NDP or NCL acc. to EN 1992-1-1/NA; $f_{uk} = f_{tk} = k \cdot f_{yk}$	
2	Round bar with partial or full thread	Stainless steel acc. to EN 10088-1:2014	High corrosion-resistant steel acc. to EN 10088-1:2014
3	Washer	Stainless steel acc. to EN 10088-1:2014	High corrosion-resistant steel acc. to EN 10088-1:2014
4	Hexagon nut	Stainless steel acc. to EN 10088-1:2014 Strength class 80; acc. to EN ISO 3506:2009	High corrosion-resistant steel acc. to EN 10088-1:2014 Strength class 80; acc. to EN ISO 3506:2009

Rebar connection with Upat injection mortar UPM 55

Product description
Properties and materials of rebar anchors FRA

Annex A 5

Specifications of intended use

Anchorages subject to:

- Static and quasi-static loads

Base materials:

- Reinforced or unreinforced normal weight concrete according to EN 206-1:2000
- Strength classes C12/15 to C50/60 according to EN 206-1:2000
- Maximum chloride concrete of 0,40% (CL 0.40) related to the cement content according toEN 206-1:2000
- 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 1992-1-1:2004+AC:2010. The foregoing may be neglected if building components are new and not carbonated and if building components are in dry conditions

Temperature Range:

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

Use conditions (Environmental conditions) for rebar anchors FRA:

- Structures subject to dry internal conditions (rebar anchors FRA and FRA C)
- Structures subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal condition, if no particular aggressive conditions exist (rebar anchors FRA and FRA C)
- Structures subject to external atmospheric exposure and to permanently damp internal condition, if other particular aggressive conditions exist (rebar anchors FRA C)

  Note: Particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used)

Design:

- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work
- Verifiable calculation notes and drawings are prepared taking account of the forces to be transmitted
- Design according to EN 1992-1-1:2004+AC:2010 and Annex B 2 and B 3
- 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

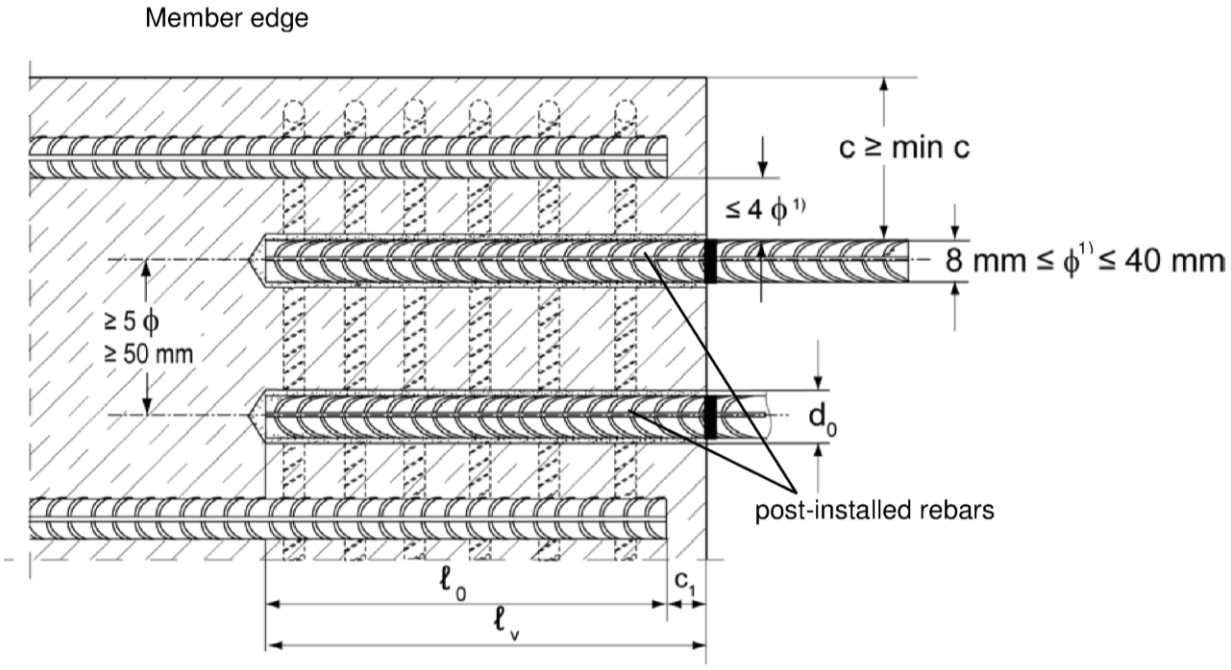
Installation:

- Dry or wet concrete
- It must not be installed in flooded holes
- Overhead installation allowed
- Hole drilling by hammer drill, compressed air drill or diamond drill mode
- The installation of post-installed rebar respectively rebar anchor FRA 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 Upat injection mortar UPM 55	**Annex B 1**
Intended use Specifications	

Figure B1: General construction rules for post-installed rebars

- 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 1992-1-1:2004+AC:2010
- The joints for concreting must be roughened to at least such an extent that aggregate protrude



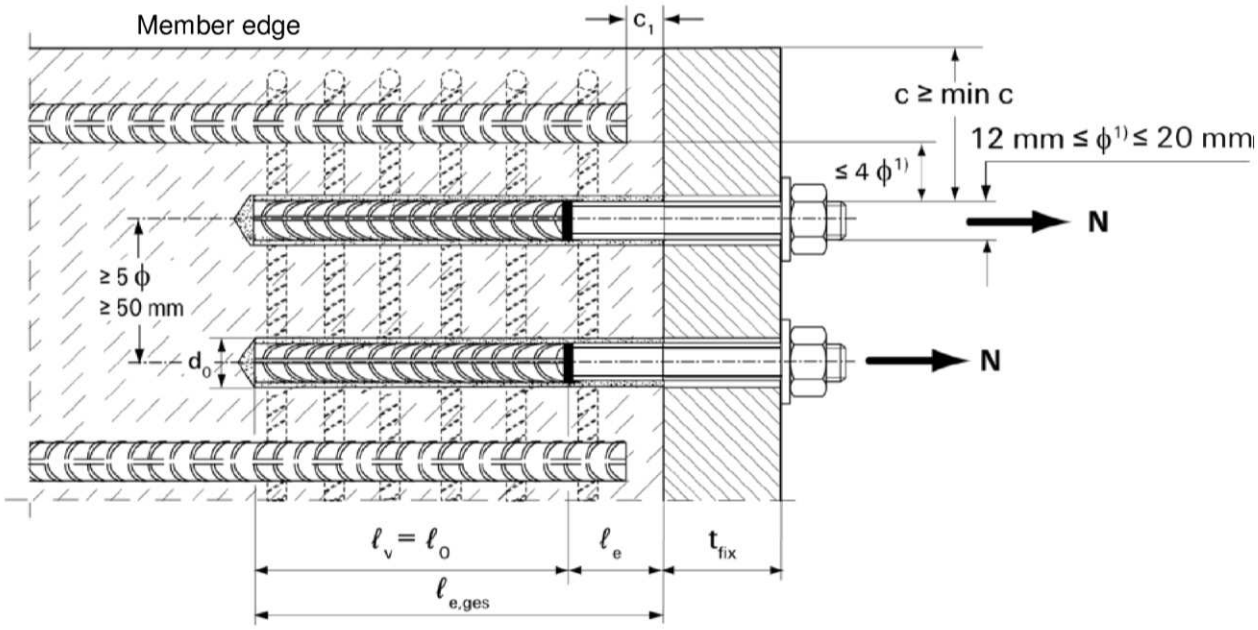
[1] If the clear distance between lapped bars exceeds 4 ϕ then the lap length shall be increased by the difference between the clear bar distance and 4 ϕ

c	concrete cover of post-installed rebar
c_1	concrete cover at end-face of existing rebar
min c	minimum concrete cover according to Table B1 and to EN 1992-1-1:2004+AC:2010, Section 4.4.1.2
ϕ	diameter of post-installed rebar
ℓ_0	lap length, according to EN 1992-1-1:2004+AC:2010, Section 8.7.3
ℓ_v	effective embedment depth, ≥: $\ell_0 + c_1$
d_0	nominal drill bit diameter, see Annex B 5

Rebar connection with Upat injection mortar UPM 55	**Annex B 2**
Intended use General construction rules for post-installed rebars	

Figure B2: General construction rules for post-installed rebar anchors FRA

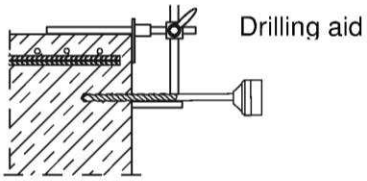
- Only tension forces in the axis of the FRA may be transmitted
- The tension force must be transferred via an overlap joint to the reinforcement in the building part.
- The transmission of the shear load shall be ensured by appropriate additional measures, e.g. by shear lugs or by anchors with an European Technical Assessment (ETA).
- In the anchor plate, the holes for the tension anchor shall be executed as elongated holes with the axis in the direction of the shear force.



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

c	concrete cover of post-installed FRA
c_1	concrete cover at end-face of existing rebar
min c	minimum concrete cover according to Table B1 and to EN 1992-1-1:2004+AC:2010, Section 4.4.1.2
ϕ	nominal diameter of the bar
ℓ_0	lap length, according to EN 1992-1-1:2004+AC:2010, Section 8.7.3
$\ell_{e,ges}$	overall embedment depth, $\geq \ell_v + \ell_e$
d_0	nominal drill bit diameter, see Annex B 5
ℓ_e	length of the bonded in threaded part
t_{fix}	thickness of the fixture
ℓ_v	effective embedment depth

Table B1:
Minimum concrete cover c[1] depending of the drilling method and the drilling tolerance



Drilling method	Nominal diameter of the bar ϕ [mm]	Minimum concrete cover min c	
		Without drilling aid [mm]	With drilling aid [mm]
Hammer drilling	≤ 20	30 mm + 0,06 ℓ_v	30 mm + 0,02 $\ell_v \geq 2\ \phi$
	≥ 22	40 mm + 0,06 ℓ_v	40 mm + 0,02 $\ell_v \geq 2\ \phi$
Pneumatic drilling	≤ 20	50 mm + 0,08 ℓ_v	50 mm + 0,02 ℓ_v
	≥ 22	60 mm + 0,08 ℓ_v	60 mm + 0,02 ℓ_v
Diamond drilling	≤ 20	30 mm + 0,06 ℓ_v	30 mm + 0,02 $\ell_v \geq 2\ \phi$
	≥ 22	40 mm + 0,06 ℓ_v	40 mm + 0,02 $\ell_v \geq 2\ \phi$

[1] See Annex B2, Figure B1 and Annex B3, Figure B2
Note: The minimum concrete cover as specified in EN 1992-1-1:2004+AC:2010 must be observed

Table B2:
Dispensers and cartride sizes correspondending to maximum embedment depth $l_{v,max}$

Rebar / FRA	Manual dispenser	Accu and pneumatic dispenser (small)	Pneumatic dispenser (large)
	Cartridge size 390 ml, 585 ml	Cartridge size 390 ml, 585 ml	Cartridge size 1500 ml
ϕ [mm]	$\ell_{v,max}$ / $\ell_{e,ges,max}$ [mm]	$\ell_{v,max}$ / $\ell_{e,ges,max}$ [mm]	$\ell_{v,max}$ / $\ell_{e,ges,max}$ [mm]
8	1000	1000	1800
10			
12 / FRA 12		1200	
14			
16 / FRA 16		1500	
20 / FRA 20	700	1300	
22 / 24 / 25		1000	2000
26 / 28	500	700	
30 / 32 / 34	--------	500	
36			
40			

Table B3: Working times t_{work} and curing times t_{cure}

Temperature in the anchorage base [°C]	Max. working time[2] t_{work} [minutes]	Minimum curing time[3] t_{cure} [hours]
	UPM 55	**UPM 55**
+5 to +9[1]	120	40
>+10 to +19	30	18
>+20 to +29	14	10
>+30 to +40	7	5

[1] For installation temperature lower than 10°C the mortar UPM 55 must be tempered to 20°C

[2] Maximum time from the beginning of injection to rebar setting and positioning

[3] For wet concrete the curing time must be doubled

Rebar connection with Upat injection mortar UPM 55

Intended use
Minimum concrete cover/ Maximum embedment depth per dispenser and cartridge size/ Working times and curing times

Annex B 4

Table B4:
Installation tools for drilling and cleaning the bore hole and injection of the mortar

Rebar / FRA ϕ [mm]	Drilling and cleaning							Injection		
	Nominal drill bit diameter d_0 [mm]		Diameter of cutting edge d_{cut} [mm]		Steel brush diameter d_b [mm]		Cleaning nozzle [mm]	Extension tube [mm]	Injection adapter [colour]	
8	10[1)]	12[1)]	≤ 10,50	≤ 12,50	11,0	12,5	11	9	-	nature
10	12[1)]	14[1)]	≤ 12,50	≤ 14,50	12,5	15			nature	blue
12/ FRA 12	14[1)]	16[1)]	≤ 14,50	≤ 16,50	15	17	15		blue	red
14	18		≤ 18,50		19			9 or 15	yellow	
16/ FRA 16	20		≤ 20,55		21,5		19		green	
20/ FRA 20	25		≤ 25,55		26,5				black	
22, 24	30		≤ 30,55		32		28		grey	
25	30		≤ 30,55		32				grey	
26 / 28	35		≤ 35,70		37				brown	
30 / 32 / 34	40		≤ 40,70		42		38		red	
36	45		≤ 45,70		47				yellow	
40	55		≤ 55,70		58				nature	

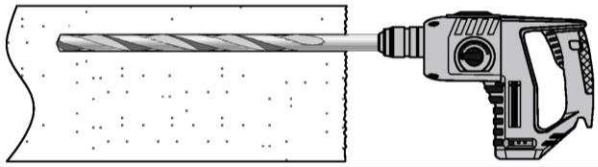
[1)] Both drill bit diameters can be used

Rebar connection with Upat injection mortar UPM 55	**Annex B 5**
Intended use Installation tools for drilling and cleaning the bore hole and injection installation of the mortar	

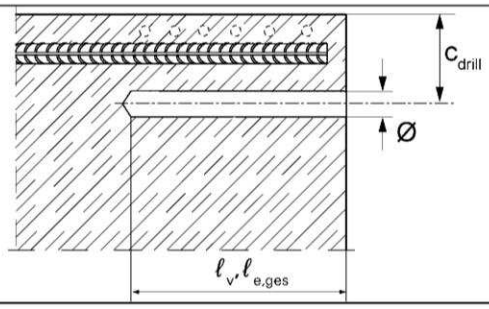
Safety regulations	Review the Material Safety Data Sheet (SDS) before use for proper and safe handling! Wear well-fitting protective goggles and protective gloves when working with mortar UPM 55 important: Observe the instructions for use provided with each cartridge.

1. Drill hole

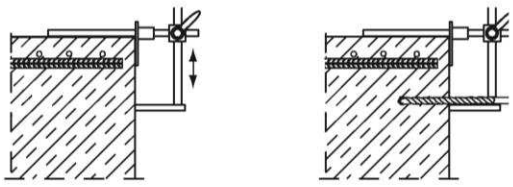
Note: Before drilling, remove carbonized concrete; clean contact areas (see Annex B 1)
In case of aborted drill hole the drill hole shall be filled with mortar.



Drill hole to the required embedment depth using a hammer-drill with carbide drill bit set in rotation hammer mode, a pneumatic drill or a diamond drill in drilling mode.
Drill bit sizes see Table B4.



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

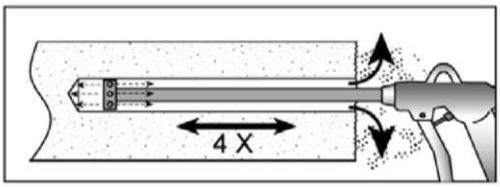
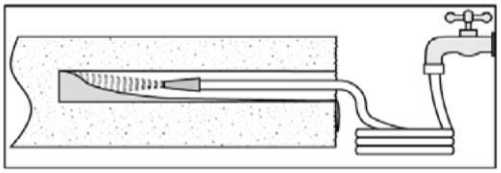
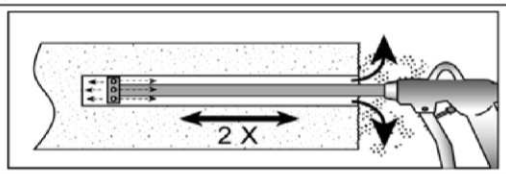
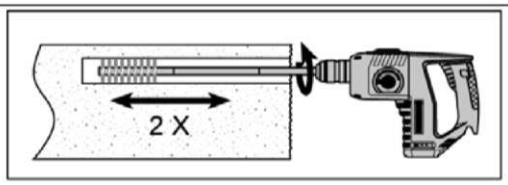
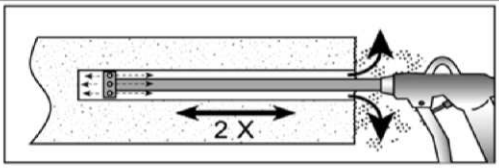


For holes ℓ_v > 20 cm use drilling aid.
Three different options can be considered:

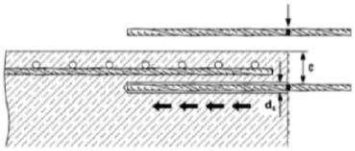
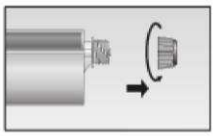
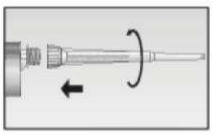
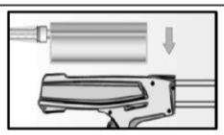
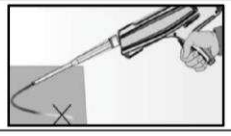
A) drilling aid
B) Slat or spirit level
C) Visual check

Rebar connection with Upat injection mortar UPM 55	
Intended use Installation instruction part 1	**Annex B 6**

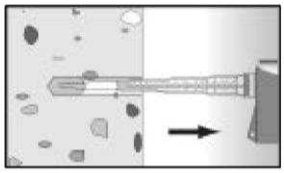
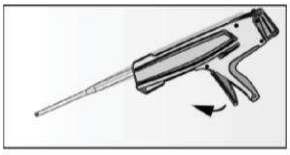
2. Cleaning the bore hole

Hammer- and pneumatic drilling	
	Blowing four times from the back of the hole with oil-free compressed air (min. 6 bar) until return air stream is free of noticeable dust.
Diamond drilling	
	Break away the drill core and remove it
	Flush the bore hole until the water comes clear
	Blowing two times from the back of the hole with oil-free compressed air (min. 6 bar) until return air stream is free of noticeable dust.
	Fix an adequate steel brush with an extension into a drilling machine and brush the bore hole two times
	Blowing two times from the back of the hole with oil-free compressed air (min. 6 bar) until return air stream is free of noticeable dust.

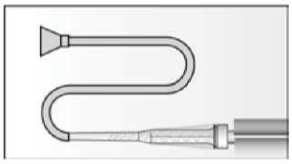
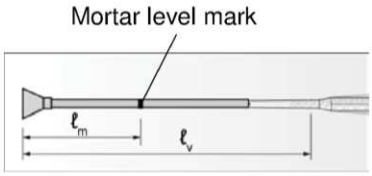
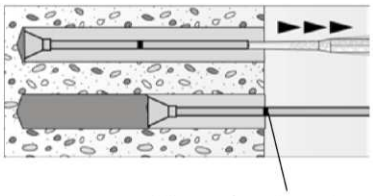
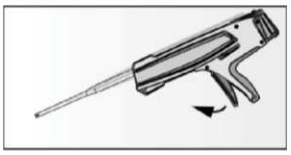
3. Rebar preparation and cartridge preparation

	Before use, make asure the rebar or the rebar anchor FRA is dry and free of oil or other residue. Mark the embedment depth ℓ_v on the rebar (e.g. with tape) Insert rebar in borehole, to verify hole and setting depth ℓ_v resp. $\ell_{e,ges}$
	Injection system preparation
	No. 1: Twist off the sealing cap
	No. 2:Twist on the static mixer (the spiral in the static mixer must be clearly visible).
	No. 3:Place the cartridge into a suitable dispenser.
	No. 4:Press approximate 10 cm of material out until the resin is evenly grey in colour. Don`t use mortar that is not uniformly grey.

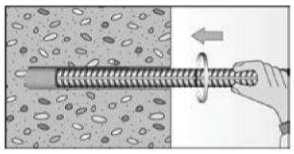
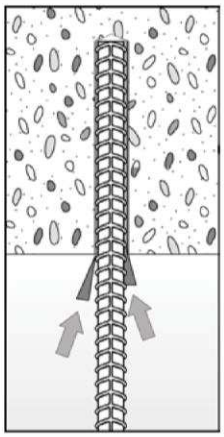
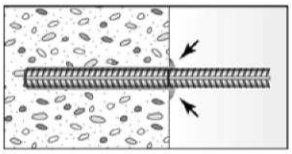
4. Inject mortar into borehole
4.1 borehole depth ≤ 250 mm:

	Inject the mortar from the back of the hole towards the front and slowly withdraw the mixing nozzle step by step after each trigger pull. Fill holes approximately 2/3 full, or as required to ensure that the annular gap between the rebar and the concrete is completely filled with adhesive over the embedment length.
	After injecting, depressurize the dispenser by pressing the release trigger. This will prevent further mortar discharge from the mixing nozzle.

4.2 borehole depth > 250 mm:

	Assemble mixing nozzle, extension tube and injection adapter (see Table B 4)
	Mark the required mortar level ℓ_m and embedment depth ℓ_v resp. $\ell_{e,ges}$ 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 formula for optimum mortar volume: $l_m = l_v \; resp. \; l_{e,ges} \left((1{,}2 * \frac{d_s^2}{d_0^2} - 0{,}2) \right)$ [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. Fill holes approximately 2/3 full, or as required to ensure that the annular gap between the rebar and the concrete is 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 B 2
	After injecting, depressurize the dispenser by pressing the release trigger. This will prevent further mortar discharge from the mixing nozzle.

4.3 Insert rebar

	For each installation insert the rebar / rebar anchor FRA slowly twisted into the borehole until the embedment mark is at the concrete surface level.
	For overhead installation support the rebar / rebar anchor FRA and secure it from falling till mortar started to harden, e.g. using wedges.
	After installing the rebar or FRA the annular gap must be completely filled with mortar. Proper installation • Desired anchoring embedment is reached ℓ_v: embedment mark at concrete surface. • Excess mortar flows out of the borehole after the rebar has been fully inserted until the embedment mark.
	Observe the working time "t_{work}" (see Table B3), which varies according to temperature of base material. Minor adjustments to the rebar / rebar anchor FRA position may be performed during the working time
	Full load may be applied only after the curing time "t_{cure}" has elapsed (see Table B 3)

Rebar connection with Upat injection mortar UPM 55	
Intended use Installation instruction part 5	**Annex B 10**

Minimum anchorage length and minimum lap length

The minimum anchorage length $\ell_{b,min}$ and the minimum lap length $\ell_{o,min}$ according to EN 1992-1-1:2004+AC:2010 ($\ell_{b,min}$ acc. to Eq. 8.6 and Eq. 8.7 and $\ell_{o,min}$ acc. to Eq. 8.11) shall be multiply by a amplification factor α_{lb} according to Table C1.

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

Concrete class	Drilling method	Amplification factor α_{lb}
C12/15 to C50/60	Hammer drilling and pneumatic drilling	1,0
C12/15 to C50/60	Diamond drilling	1,3

Table C2: Reduction factor k_b for all drilling methods

Hammer drill or pneumatic drill									
Rebar / FRA	**Reduction factor k_b**								
	Concrete classe								
ϕ [mm]	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
8 bis 25	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
26 bis 40	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	0,93
Diamond drill									
Rebar / FRA	**Reduction factor k_b**								
	Concrete class								
ϕ [mm]	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
8 bis 12	1,00	1,00	1,00	1,00	1,00	1,00	1,00	0,93	1,00
14 bis 25	1,00	1,00	1,00	1,00	1,00	1,00	1,00	0,86	0,86
26 bis 40	1,00	1,00	1,00	1,00	1,00	0,71	0,71	0,71	0,71

Table C3: Design values of the ultimate bond resistance $f_{bd,PIR}$ in N/mm² for all drilling methods and for good bond conditions

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

f_{bd}: Design value of the ultimate bond stress in N/mm² considering the concrete classes and the rebar diameter according to EN 1992-1-1: 2004+AC:2010
(for all other bond conditions multiply the values by 0,7)
k_b: Reduction factor according to Table C2

Hammer drill or pneumatic drill									
Rebar / FRA	**Bond resistance $f_{bd,PIR}$ [N/mm²]**								
	Concrete class								
ϕ [mm]	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
8 to 25	1,6	2,0	2,3	2,7	3,0	3,4	3,7	4,0	4,3
26 to 40									4,0
Diamond drill									
Rebar / FRA	**Bond resistance $f_{bd,PIR}$ [N/mm²]**								
	Concrete class								
ϕ [mm]	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
8 to 12	1,6	2,0	2,3	2,7	3,0	3,4	3,7	4,0	4,3
14 to 25								3,7	
26 to 40						3,0			

Rebar connection with Upat injection mortar UPM 55

Performances
Amplification factor α_{lb}, Reduction factor k_b
Design values of ultimate bond resistance $f_{bd,PIR}$

Annex C 1