

Approval body for construction products  
and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and  
Laender Governments



## European Technical Assessment

**ETA-10/0170**  
**of 26 November 2018**

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

Upat Anchor Bolt MAX

Product family  
to which the construction product belongs

Mechanical anchor for use in concrete

Manufacturer

Upat Vertriebs GmbH  
Bebelstraße 11  
79108 Freiburg im Breisgau  
DEUTSCHLAND

Manufacturing plant

Upat

This European Technical Assessment  
contains

18 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 330232-00-0601

This version replaces

ETA-10/0170 issued on 7 May 2015

**European Technical Assessment**

**ETA-10/0170**

English translation prepared by DIBt

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## Specific Part

### 1 Technical description of the product

The Upat Anchor bolt MAX is an anchor made of galvanised steel (MAX) or made of stainless steel (MAX A4) or high corrosion resistant steel (MAX C) which is placed into a drilled hole and anchored by torque-controlled expansion.

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 anchor 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 to tension load (static and quasi-static loading)	See Annex C 1
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C 2
Displacements (static and quasi-static loading)	See Annex C 5
Characteristic resistance and displacements for seismic performance categories C1 and C2	See Annex C 4 and C 5

#### 3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Class A1
Resistance to fire	see Annex C 3

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

In accordance with the European Assessment Document EAD Nr. 330232-00-0601 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**

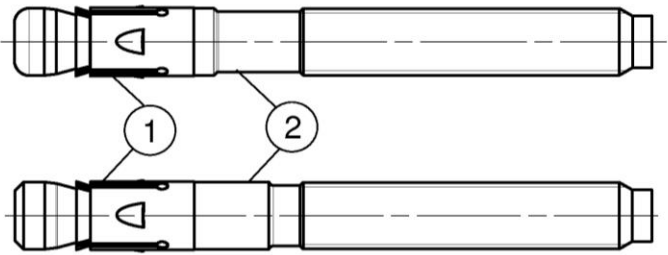
Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at Deutsches Institut für Bautechnik.

Issued in Berlin on 26 November 2018 by Deutsches Institut für Bautechnik

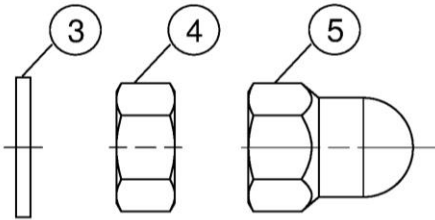
BD Dipl.-Ing. Andreas Kummerow  
Head of Department

*beglaubigt:*  
Baderschneider

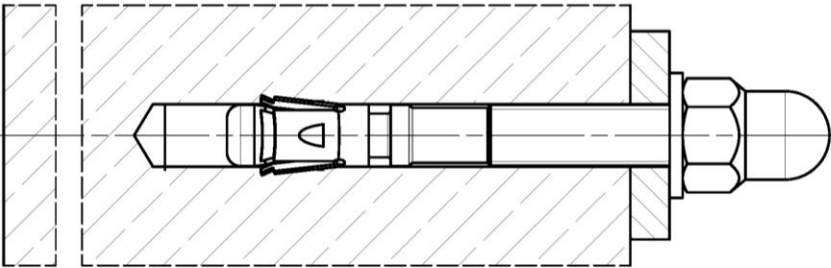
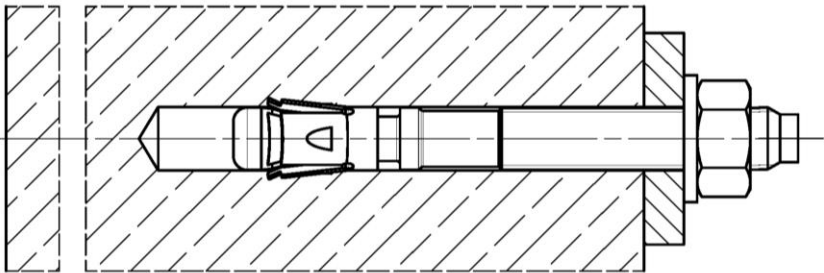
Cone bolt manufactured by cold - forming:



Cone bolt manufactured by turning:



- ① Expansion sleeve
- ② Cone bolt (cold – formed or turned)
- ③ Washer
- ④ Hexagon nut
- ⑤ Upat MAX dome nut



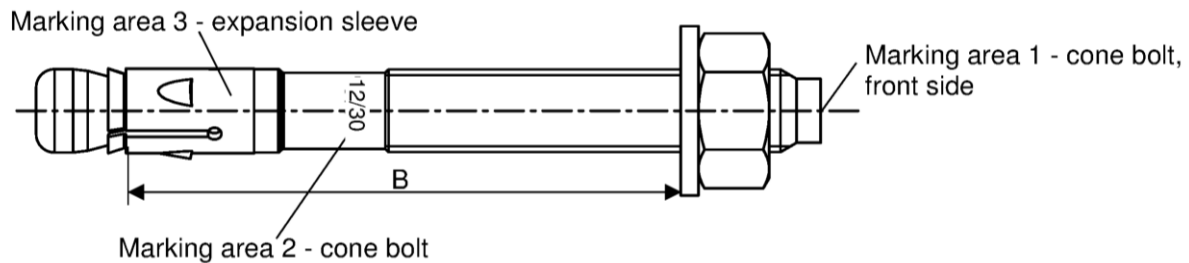
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Upat Anchor bolt MAX, MAX A4, MAX

**Product description**  
Installed condition

**Annex A 1**

## Product label and letter-code:



Product label, example:

MAX 12/30 A4

Brand | type of fastener  
placed at marking area 2 or marking area 3

Thread size / max. thickness of the fixture ( $t_{fix}$ )  
identification A4 or C placed at marking area 2

MAX: carbon steel, galvanized

MAX A4: stainless steel

MAX C: high corrosion resistant steel

**Table A2.1:** Letter - code at marking area 1:

Marking		(a)	(b)	(c)	(d)	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(K)
Max. t <sub>fix</sub>		5	10	15	20	5	10	15	20	25	30	35	40	45	50
B ≥ [mm]	M6	-				45	50	55	60	65	70	75	80	85	90
	M8	40	45	-		50	55	60	65	70	75	80	85	90	95
	M10	45	50	55	60	65	70	75	80	85	90	95	100	105	110
	M12	55	60	65	70	75	80	85	90	95	100	105	110	115	120
	M16	70	75	80	85	90	95	100	105	110	115	120	125	130	135
	M20	-				105	110	115	120	125	130	135	140	145	150
	M24	-				130	135	140	145	150	155	160	165	170	175
Marking		(L)	(M)	(N)	(O)	(P)	(R)	(S)	(T)	(U)	(V)	(W)	(X)	(Y)	(Z)
Max. t <sub>fix</sub>		60	70	80	90	100	120	140	160	180	200	250	300	350	400
B ≥ [mm]	M6	100	110	120	130	140	160	180	200	220	240	290	340	390	440
	M8	105	115	125	135	145	165	185	205	225	245	295	345	395	445
	M10	120	130	140	150	160	180	200	220	240	260	310	360	410	460
	M12	130	140	150	160	170	190	210	230	250	270	320	370	420	470
	M16	145	155	165	175	185	205	225	245	265	285	335	385	435	485
	M20	160	170	180	190	200	220	240	260	280	300	350	400	450	500
	M24	185	195	205	215	225	245	265	285	305	325	375	425	475	525

### Calculation existing $h_{ef}$ for installed fasteners:

$$\text{existing } h_{ef} = B_{(\text{according to table A2.1})} - \text{existing } t_{fix}$$

Thickness of the fixture  $t_{fix}$  including thickness of fastener plate  $t$  and e.g. thickness of grout layer  $t_{grout}$   
or other non-structural layers

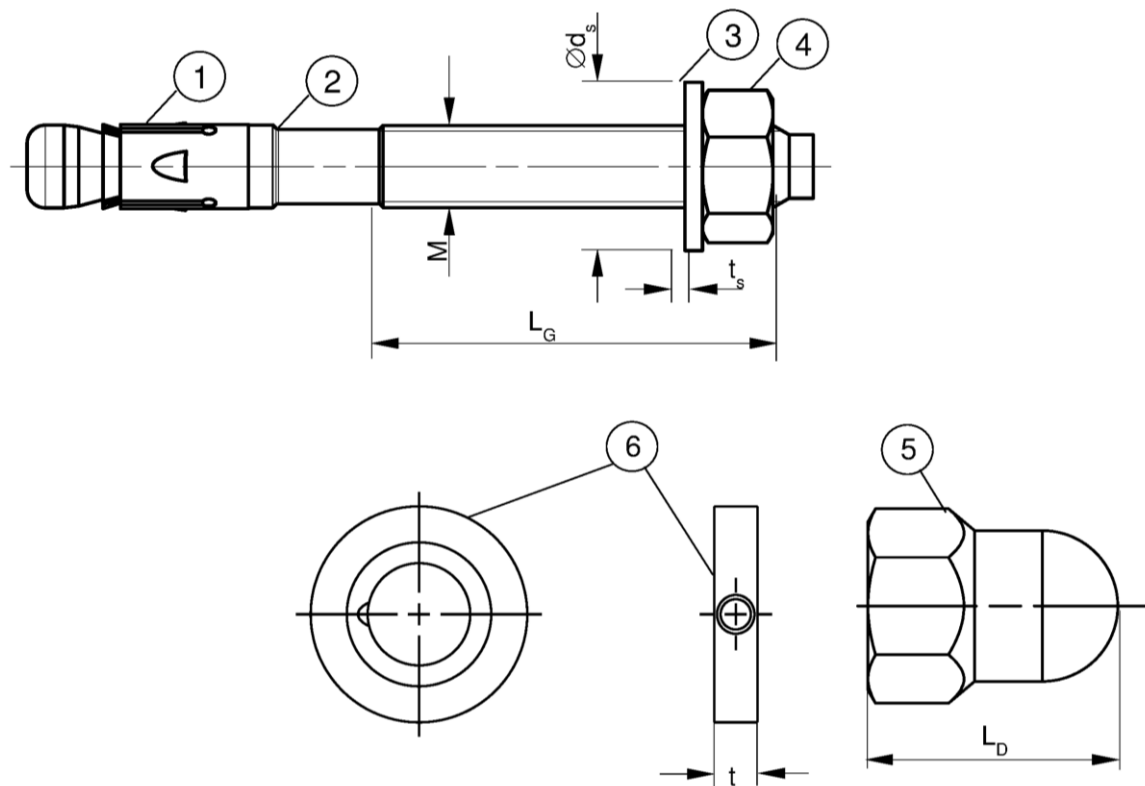
(Fig. not to scaled)

Upat Anchor bolt MAX, MAX A4, MAX

**Product description**  
Product label and letter code

**Annex A 2**

## Product dimensions



**Table A3.1:** Dimensions [mm]

Part	Designation		MAX, MAX A4, MAX C						
			M6	M8	M10	M12	M16	M20	M24
1	Expansion sleeve	Sheet thickness	0,8	1,3	1,4	1,6	2,4		3,0
2	Cone bolt	Thread size M	6	8	10	12	16	20	24
		L <sub>G</sub>	10	19	26	31	40	50	57
3	Washer	t <sub>s</sub>	1,4		1,8	2,3	2,7		3,7
		Ø d <sub>s</sub>	11	15	19	23	29	36	43
4 & 5	Hexagon nut / Upat MAX dome nut	Wrench size	10	13	17	19	24	30	36
5		L <sub>D</sub>	-		22	27	33	-	
6	Upat filling disc FFD	t	6				7	8	10

(Fig. not to scaled)

Upat Anchor bolt MAX, MAX A4, MAX

**Product description**  
Dimensions

**Annex A 3**

## Specifications of intended use

### Anchorage subject to:

Size	MAX, MAX A4, MAX C						
	M6	M8	M10	M12	M16	M20	M24
Static and quasi-static loads	✓						
Cracked and uncracked concrete							
Fire exposure							
Seismic performance category	C1	-	✓				
	C2 <sup>1)</sup>	-	✓				

<sup>1)</sup> MAX C: Only valid for cold-formed version (according to Annex A1)

### Base materials:

- Compacted reinforced and unreinforced normal weight concrete without fibres (cracked and uncracked) according to EN 206: 2013
- Strength classes C20/25 to C50/60 according to EN 206: 2013

### Use conditions (Environmental conditions):

- Structures subject to dry internal conditions (MAX, MAX A4, MAX C)
- Structures subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal condition, if no particular aggressive conditions exist (MAX A4, MAX C)
- Structures subject to external atmospheric exposure and permanently damp internal condition, if other particular aggressive conditions exist (MAX 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 deicing materials are used)

### Design:

- Anchorages are to be designed under the responsibility of an engineer experienced in anchorages and concrete work
- Verifiable calculation notes and drawings are to be prepared taking account of the loads to be anchored. The position of the anchor is indicated on the design drawings (e.g. position of the anchor relative to reinforcement or to supports, etc.)
- Design of fastenings according to EN 1992-4: 2018 and Technical Report TR 055
- For effective embedment depth  $h_{ef} < 40$  mm and  $h_{min} \geq 80$  mm and  $< 100$  mm only statically indeterminate fixings (e.g. light-weight suspended ceilings with internal exposure) are covered by the ETA

Upat Anchor bolt MAX, MAX A4, MAX

Intended Use  
Specifications

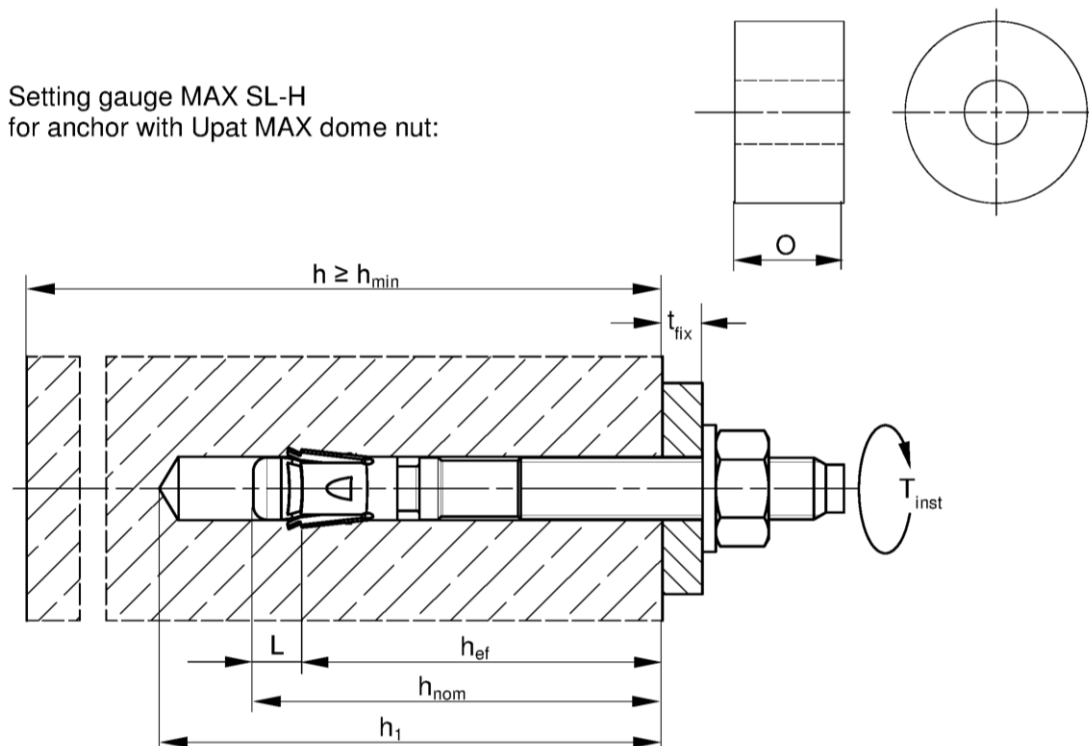
Annex B 1



**Table B2.1:** Installation parameters

Size	MAX, MAX A4, MAX C						
	M6	M8	M10	M12	M16	M20	M24
Nominal drill hole diameter $d_0 =$	6	8	10	12	16	20	24
Maximum bit diameter with hammer or hollow drilling $d_{cut,max}$ [mm]	6,40	8,45	10,45	12,5	16,5	20,55	24,55
Maximum bit diameter with diamond drilling	-	8,15		12,25	16,45	20,50	24,40
Overall fastener embedment depth in the concrete $h_{nom} \geq (L)$ [mm]	46,5 (6,5)	44,5 (9,5)	52,0 (12)	63,5 (13,5)	82,5 (17,5)	120 (20)	148,5 (23,5)
Depth of drill hole to deepest point $h_1 \geq$	Existing $h_{ef} + L = h_{nom}$ $h_{nom} + 5$					$h_{nom} + 10$	
Diameter of clearance hole in the fixture $d_f \leq$ [mm]	7	9	12	14	18	22	26
Required setting torque $T_{inst} =$ [Nm]	8	20	45	60	110	200	270
Excess length after hammering-in the cone bolt (for Upat dome nut applications according to Annex B6) $O =$ [mm]	-		12	16	20	-	

Setting gauge MAX SL-H  
for anchor with Upat MAX dome nut:



- $h_{ef}$  = Effective embedment depth  
 $t_{fix}$  = Thickness of the fixture  
 $h_1$  = Depth of drill hole to deepest point  
 $h$  = Thickness of the concrete member  
 $h_{min}$  = Minimum thickness of concrete member  
 $h_{nom}$  = Overall fastener embedment depth in the concrete  
 $T_{inst}$  = Required setting torque

(Fig. not to scaled)

Upat Anchor bolt MAX, MAX A4, MAX

**Intended Use**  
Installation parameters

**Annex B 2**

**Table B3.1:** Minimum thickness of concrete members, minimum spacing and minimum edge distance

Size		MAX, MAX A4, MAX C						
		M6	M8	M10	M12	M16	M20	M24
Minimum edge distance								
Uncracked concrete	c <sub>min</sub>	45	40	45	55	65	95	135
Cracked concrete							85	100
Minimum spacing	s <sub>min</sub>	[mm] according to Annex B4						
Minimum thickness of concrete member	h <sub>min</sub>	80		100	140	160	200	
Thickness of concrete member	h ≥	max. {h <sub>min</sub> ; h <sub>1</sub> <sup>1)</sup> + 30}				max. {h <sub>min</sub> ; h <sub>1</sub> <sup>1)</sup> + 2 · d <sub>o</sub> }		
Minimum spacing								
Uncracked concrete	s <sub>min</sub>	35	40	40	50	65	95	100
Cracked concrete			35					
Minimum edge distance	c <sub>min</sub>	[mm] according to Annex B4						
Minimum thickness of concrete member	h <sub>min</sub>	80		100	140	160	200	
Thickness of concrete member	h ≥	max. {h <sub>min</sub> ; h <sub>1</sub> <sup>1)</sup> + 30}				max. {h <sub>min</sub> ; h <sub>1</sub> <sup>1)</sup> + 2 · d <sub>o</sub> }		
Minimal splitting area								
Uncracked concrete	A <sub>sp,req</sub>	5,1	18	37	54	67	100	117,5
Cracked concrete								

<sup>1)</sup>  $h_1$  according to Annex B2

**Splitting failure** applied for minimum edge distance and spacing in dependence of the  $h_{ef}$

For the calculation of minimum spacing and minimum edge distance of anchors in combination with different embedment depths and thicknesses of concrete members the following equation shall be fulfilled:

$$A_{sp,req} < A_{sp,ef}$$

$A_{sp,req}$  = required splitting area

$A_{sp,ef}$  = effective splitting area (according to Annex B4)

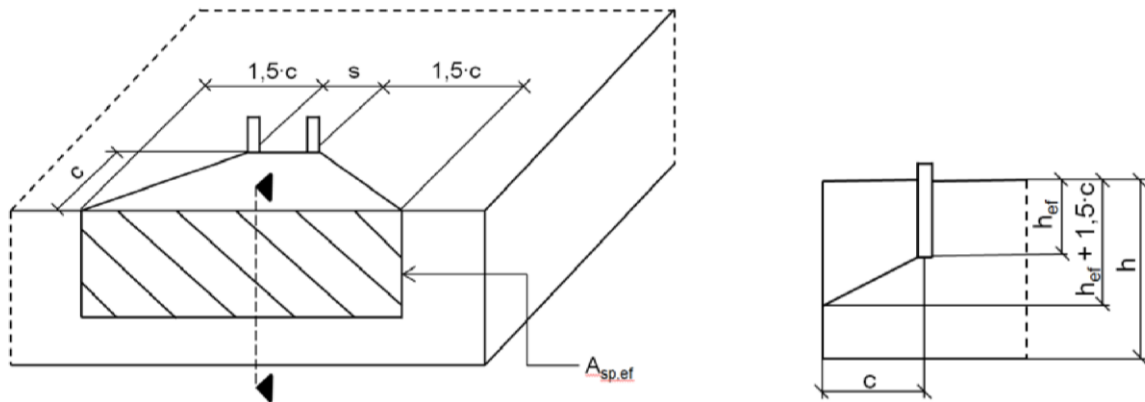
Upat Anchor bolt MAX, MAX A4, MAX

**Annex B 3**

**Intended Use**

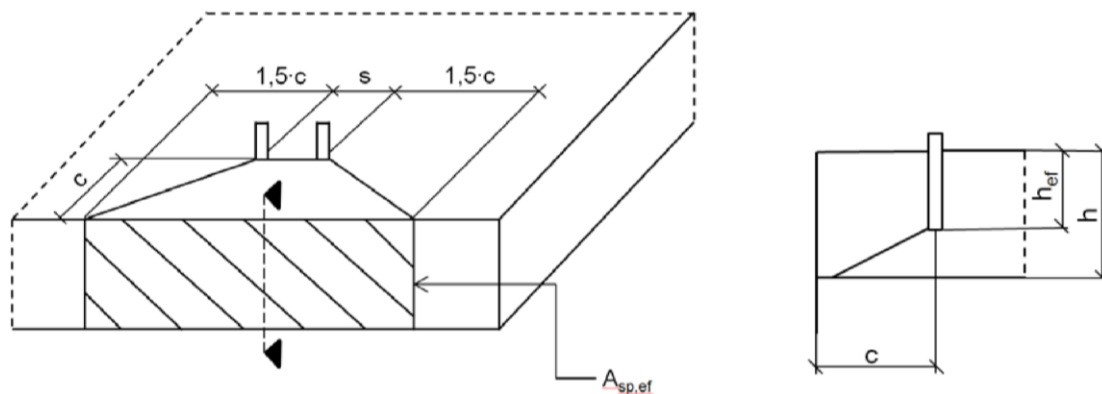
Minimum thickness of member, minimum spacing and edge distance

**Table B4.1:** Effective splitting area  $A_{sp,ef}$  with member thickness  $h > h_{ef} + 1,5 \cdot c$  and  $h \geq h_{min}$



Single anchor and group of anchors with $s > 3 \cdot c$	$A_{sp,ef} = (6 \cdot c) \cdot (h_{ef} + 1,5 \cdot c)$	[mm <sup>2</sup> ]	with $c \geq c_{min}$
Group of anchors with $s \leq 3 \cdot c$	$A_{sp,ef} = (3 \cdot c + s) \cdot (h_{ef} + 1,5 \cdot c)$	[mm <sup>2</sup> ]	with $c \geq c_{min}$ and $s \geq s_{min}$

**Table B4.2:** Effective splitting area  $A_{sp,ef}$  with member thickness  $h \leq h_{ef} + 1,5 \cdot c$  and  $h \geq h_{min}$



Single anchor and group of anchors with $s > 3 \cdot c$	$A_{sp,ef} = 6 \cdot c \cdot \text{existing } h$	[mm <sup>2</sup> ]	with $c \geq c_{min}$
Group of anchors with $s \leq 3 \cdot c$	$A_{sp,ef} = (3 \cdot c + s) \cdot \text{existing } h$	[mm <sup>2</sup> ]	with $c \geq c_{min}$ and $s \geq s_{min}$

Edge distance and axial spacing shall be rounded to at least 5 mm

(Fig. not to scaled)

Upat Anchor bolt MAX, MAX A4, MAX

**Intended Use**

Minimum thickness of member, minimum spacings and edge distances


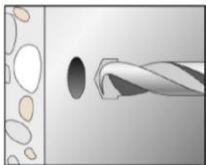
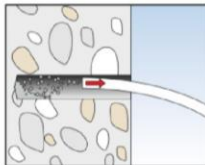

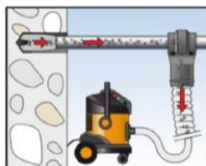

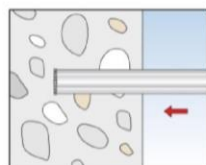
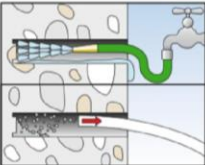
**Annex B 4**

## Installation instructions:

- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site
- Use of the anchor only as supplied by the manufacturer without exchanging the components of the anchor  
Exception: Upat MAX dome nut.
- Hammer, hollow or diamond drilling according to Annex B5
- Drill hole created perpendicular  $\pm 5^\circ$  to concrete surface, positioning without damaging the reinforcement
- In case of aborted hole: new drilling at a minimum distance twice the depth of the aborted drill hole or smaller distance if the aborted drill hole is filled with high strength mortar and if under shear or oblique tension load it is not in the direction of load application

## Installation instructions: Drilling and cleaning the hole

Types of drills and cleaning

Hammer drill			
		1: Drill the hole	2: Clean the hole
Hollow drill			-
		1: Drill the hole with automatic cleaning	
Diamond drill, for non seismic applications only and $\geq$ drill $\varnothing 8$			
		1: Drill the hole	2: Clean the hole

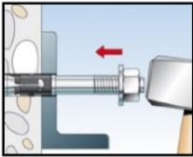
Upat Anchor bolt MAX, MAX A4, MAX

**Intended Use**  
Installation instructions

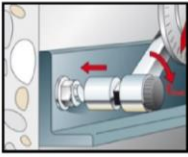
**Annex B 5**

Installation instructions: Installation of the anchor

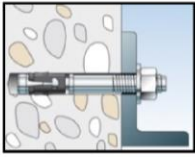
HEXAGON NUT:



3: Set the fastener



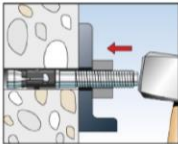
4: Apply  $T_{inst}$



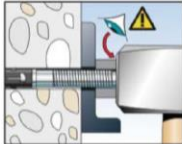
5: Installed fastener

Upat MAX DOME NUT:

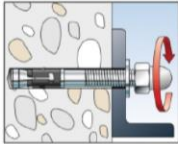
Option 1: Push through installation with setting gauge SL-H:



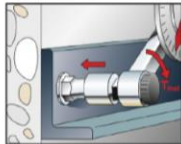
3: Set the fastener  
using setting  
gauge



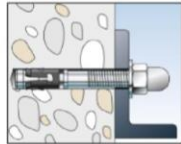
4: Check offset



5: Turn on the  
washer and  
Upat MAX  
dome nut

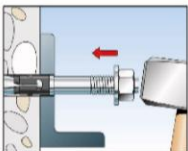


6: Apply  $T_{inst}$

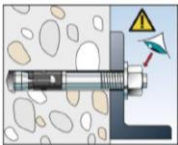


7: Installed fastener

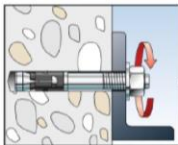
Option 2: Push through installation with hexagon nut:



3: Set the fastener

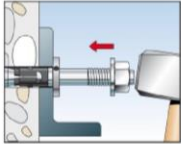
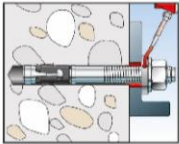


4: check setting  
position: Visible one  
turn of a thread



4.1: Remove nut

Upat FILLING DISC FFD optional for seismic C2 application or minimizing the annular gap:

Optional	The gap between bolt and fixture may be filled with mortar (compressive strength $\geq 50 \text{ N/mm}^2$ e.g. UPM 33) after step 7 (for eliminating the annular gap). The filling disc is additional to the standard washer. The thickness of the filling disc must be considered for definition of $t_{fix}$ . Countersunk of the filling disc in direction to the anchor plate.	 
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Upat Anchor bolt MAX, MAX A4, MAX

Intended Use  
Installation instructions

Annex B 6



**Table C1.1: Characteristic tension resistance under static and quasi-static action**

Size		MAX, MAX A4, MAX C								
		M6	M8		M10	M12	M16	M20	M24	
Steel failure										
Characteristic resistance	MAX	$N_{Rk,s}$ [kN]	7,6	16,6		28,3	43,2	67,0	123,3	176,7
	MAX A4/C		11,4	17,0		29,0	44,3	70,6	124,9	183,6
Partial factor for steel failure		$\gamma_{Ms}^{1)}$ [-]	1,5							
Pullout failure										
Effective embedment depth for calculation	$h_{ef}$ [mm]	40	35 - < 45	45	40 - 60	50 - 70	65 - 85	100	125	
Characteristic resistance in cracked concrete C20/25	$N_{Rk,p}$ [kN]	1,5	5,5	8	13	20	- <sup>2)</sup>			
Characteristic resistance in uncracked concrete C20/25		10,5	14		20	22				
Increasing factors for $N_{Rk,p}$ for cracked and uncracked concrete	$\psi_c$	C25/30	1,12							
		C30/37	1,22							
		C35/45	1,32							
		C40/50	1,41							
		C45/55	1,50							
		C50/60	1,58							
Installation factor		$\gamma_{inst}$ [-]	1,0							
Concrete cone and splitting failure										
Factor for uncracked concrete	$k_1 = k_{ucr,N}$	[-]	11,0							
Factor for cracked concrete	$k_1 = k_{cr,N}$		7,7							
Characteristic spacing	$s_{cr,N}$	[mm]	$3 \cdot h_{ef}$							
Characteristic edge distance	$c_{cr,N}$		$1,5 \cdot h_{ef}$							
Spacing	$s_{cr,sp}$	$c_{cr,sp}$ [mm]	$2 \cdot c_{cr,sp}$							
Edge distance for h = 80			40	$2,4 \cdot h_{ef}$	$2 \cdot h_{ef}$	-	-			
Edge distance for h = 100					$2,4 \cdot h_{ef}$	$2 \cdot h_{ef}$				
Edge distance for h = 120						$2,1 \cdot h_{ef}$				
Edge distance for h = 140					$1,9 \cdot h_{ef}$	$1,5 \cdot h_{ef}$				$2 \cdot h_{ef}$
Edge distance for h = 160										
Edge distance for h = 200							$2,4 \cdot h_{ef}$	$2,2 \cdot h_{ef}$		
<sup>1)</sup> In absence of other national regulations										
<sup>2)</sup> Pullout failure not relevant										
Upat Anchor bolt MAX, MAX A4, MAX							Annex C 1			
Performances Characteristic values of resistance under tension loads										

**Table C2.1:** Characteristic values of **shear** resistance under static and quasi-static action

Size		MAX, MAX A4, MAX C							
		M6	M8	M10	M12	M16	M20	M24	
Steel failure without lever arm									
Characteristic resistance	MAX	$V_{Rk,s}^0$ [kN]	5,9	13,6	21,4	30,6	55,0	81,4	110,1
	MAX A4/C		8,8	16,8	26,5	38,3	69,8	106,3	148,5
Partial factor for steel failure		$\gamma_{Ms}^{1)}$	1,25						
Ductility factor		$k_7$	1,0						
Steel failure with lever arm and Concrete pryout failure									
Effective embedment depth for calculation		$h_{ef}$ [mm]	40	45	60	70	85	100	125
Characteristic bending resistance	MAX	$M_{Rk,s}^0$ [Nm]	11,4	26	52	92	233	513	865
	MAX A4/C		10,7	29	59	100	256	519	898
Factor for pryout failure		$k_8$ [-]	2,6	2,8	3,2		3,0	2,6	2,4
Effective embedment depth for calculation		$h_{ef}$ [mm]	-	35 - < 45	40 - < 60	50 - < 70	65 - < 85	-	
Characteristic bending resistance	MAX	$M_{Rk,s}^0$ [Nm]		20	44	92	184		
	MAX A4/C			21	45	100	193		
Factor for pryout failure		$k_8$ [-]		2,5	2,6	3,1	3,2		
Partial factor for steel failure		$\gamma_{Ms}^{1)}$	1,25						
Ductility factor		$k_7$	1,0						
Concrete edge failure									
Effective anchor length		$l_f =$ [mm]	$h_{ef}$						
Outside diameter of a fastener		$d_{nom}$	6	8	10	12	16	20	24
1) In absence of other national regulations									
Upat Anchor bolt MAX, MAX A4, MAX							Annex C 2		
Performances Characteristic values of resistance under shear loads									

**Table C3.1:** Characteristic values of **tension** resistance under **fire exposure**

Size		MAX, MAX A4, MAX C						
		M6	M8	M10	M12	M16	M20	M24
$h_{ef} \geq$ [mm]		40	35 / 45	40 / 60	50 / 70	65 / 85	100	125
Characteristic resistance <b>steel failure</b>	$N_{Rk,s,fi}$ R30	0,6 <sup>1)</sup> / 0,9 <sup>2)</sup>	1,4	2,8	5,0	9,4	14,7	21,1
	R60	0,4 <sup>1)</sup> / 0,9 <sup>2)</sup>	1,2	2,3	4,1	7,7	12,0	17,3
	R90	0,3 <sup>1)</sup> / 0,9 <sup>2)</sup>	0,9	1,9	3,2	6,0	9,4	13,5
	R120	0,2 <sup>1)</sup> / 0,7 <sup>2)</sup>	0,8	1,6	2,8	5,2	8,1	11,6
Characteristic resistance <b>Concrete cone failure</b>	$N_{Rk,c,fi}$ R30 - R90	$7,7 \cdot h_{ef}^{1,5} \cdot (20)^{0,5} \cdot h_{ef} / 200 / 1000$						
	R120	$7,7 \cdot h_{ef}^{1,5} \cdot (20)^{0,5} \cdot h_{ef} / 200 / 1000 \cdot 0,8$						
Characteristic resistance <b>pullout failure</b>	$N_{Rk,p,fi}$ R30	0,4	0,9 / 2,0	2,2 / 3,3	3,0 / 5,0	4,5 / 6,8	8,6	12,0
	R60		0,8 / 2,0					
	R90		0,5 / 2,0					
	R120	0,3	0,3 / 1,6	1,7 / 2,6	2,4 / 4,0	3,6 / 5,4	6,9	9,6

<sup>1)</sup> MAX gvz

<sup>2)</sup> MAX A4 / C

**Table C3.2:** Characteristic values of **shear** resistance under **fire exposure**

Size MAX, MAX A4, MAX C			R30		R60	
			V <sub>Rk,s,fi,30</sub> [kN]	M <sup>0</sup> <sub>Rk,s,fi,30</sub> [Nm]	V <sub>Rk,s,fi,60</sub> [kN]	M <sup>0</sup> <sub>Rk,s,fi,60</sub> [Nm]
M6	h <sub>ef</sub> ≥	40	0,6 <sup>1)</sup> / 0,9 <sup>2)</sup>	0,5 <sup>1)</sup> / 0,2 <sup>2)</sup>	0,4 <sup>1)</sup> / 0,9 <sup>2)</sup>	0,3 <sup>1)</sup> / 0,1 <sup>2)</sup>
M8		35	1,8	1,4	1,6	1,2
M10		40	3,6		2,9	3,0
M12		50	6,3	7,8	4,9	6,4
M16		65	11,7	19,9	9,1	16,3
M20		100	18,2	39,0	14,2	31,8
M24		125	26,3	67,3	20,5	55,0

Size MAX, MAX A4, MAX C			R90		R120	
			V <sub>Rk,s,fi,90</sub> [kN]	M <sup>0</sup> <sub>Rk,s,fi,90</sub> [Nm]	V <sub>Rk,s,fi,120</sub> [kN]	M <sup>0</sup> <sub>Rk,s,fi,120</sub> [Nm]
M6	h <sub>ef</sub> ≥	40	0,3 <sup>1)</sup> / 0,9 <sup>2)</sup>	0,2 <sup>1)</sup> / 0,1 <sup>2)</sup>	0,2 <sup>1)</sup> / 0,7 <sup>2)</sup>	0,2 <sup>1)</sup> / 0,1 <sup>2)</sup>
M8		35	1,3	1,0	1,2	0,8
M10		40	2,2	2,4	1,9	2,1
M12		50	3,5	5,0	2,8	4,3
M16		65	6,6	12,6	5,3	11,0
M20		100	10,3	24,6	8,3	21,4
M24		125	14,8	42,6	11,9	37,0

<sup>1)</sup> MAX gvz

<sup>2)</sup> MAX A4 / C

**Table C3.3:** Minimum spacings and minimum edge distances of anchors under **fire exposure** for **tension** and **shear** load

Size		MAX, MAX A4, MAX C						
		M6	M8	M10	M12	M16	M20	M24
Spacing	$s_{min}$	Annex B3 $c_{min} = 2 \cdot h_{ef}$ , for fire exposure from more than one side $c_{min} \geq 300$ mm						
Edge distance	$c_{min}$ [mm]							
Upat Anchor bolt MAX, MAX A4, MAX							Annex C 3	
<b>Performances</b> Characteristic values of resistance under fire exposure								



**Table C4.1: Characteristic values of tension and shear resistance under seismic action category C1**

Size	MAX, MAX A4, MAX C						
	M6	M8	M10	M12	M16	M20	M24
Length of anchor	-	167	186	221	285	394	477
Effective embedment depth		45	40 - 60	50 - 70	65 - 85	100	125
Steel failure							
Characteristic resistance tension load C1	-	16,0	27,0	41,0	66,0	111,0	150,0
Partial factor for steel failure		1,5					
Pullout failure							
Characteristic resistance tension load in cracked concrete C1	-	4,6	8,0	16,0	28,2	36,0	50,3
Installation factor		1,0					
Steel failure without lever arm							
Characteristic resistance shear load C1	-	11	17	27	47	56	69
Partial factor for steel failure		1,25					

<sup>1)</sup> In absence of other national regulations

**Table C4.2: Characteristic values of tension and shear resistance under seismic action category C2**

Size		MAX, MAX A4, MAX C <sup>1)</sup>						
		M6	M8	M10	M12	M16	M20	M24
Length of anchor L <sub>max</sub> [mm]		-		186	221	285	394	-
Steel failure								
Characteristic resistance tension load C2	N <sub>Rk,s,eq,C2</sub> [kN]	-		27	41	66	111	-
Partial factor for steel failure	γ <sub>Ms,C2</sub> <sup>2)</sup> [-]			1,5				
Pullout failure								
Characteristic resistance tension load in cracked concrete C2	h <sub>ef</sub> [mm]	-		60	70	85	100	-
	N <sub>Rk,p,eq,C2</sub> [kN]			5,1	7,4	21,5	30,7	
	h <sub>ef</sub> [mm]			40-59	50-69	65-84	-	
	N <sub>Rk,p,eq,C2</sub> [kN]			2,7	4,4	16,4		
Installation factor	γ <sub>inst</sub> [-]	1,0						
Steel failure without lever arm								
Characteristic resistance shear load C2	h <sub>ef</sub> [mm]	-		60	70	85	100	-
	V <sub>Rk,s,eq,C2</sub> [kN]			10,0	17,4	27,5	39,9	
	h <sub>ef</sub> [mm]			40-59	50-69	65-84	-	
	V <sub>Rk,s,eq,C2</sub> [kN]			7,0	12,7	22,0		
Partial factor for steel failure	γ <sub>Ms,C2</sub> <sup>2)</sup> [-]	1,25						
Factor for annular gap	α <sub>gap</sub> [-]	0,5 (1,0) <sup>3)</sup>						

<sup>1)</sup> MAX C: Only valid for cold-formed version (according to Annex A1)

<sup>2)</sup> In absence of other national regulations

<sup>3)</sup> Value in brackets valid for filled annular gap between anchor and clearance hole in the fixture. Use of special Upat filling Disc FFD is required.

Upat Anchor bolt MAX, MAX A4, MAX

**Performances**  
Characteristic values of resistance under tension and shear loads under seismic action

**Annex C 4**

**Table C5.1:** Displacements under **tension** loads

Size	MAX, MAX A4, MAX C						
	M6	M8	M10	M12	M16	M20	M24
<b>Displacement – factor for tensile load<sup>1)</sup></b>							
$\delta_{N0}$ - factor	0,13	0,22	0,12	0,09	0,08	0,07	0,05
	1,00	0,78	0,40	0,19	0,09	0,07	0,05
$\delta_{N\infty}$ - factor	0,16	0,07	0,05	0,06	0,05	0,04	0,04
	0,24	0,29	0,21	0,14	0,10	0,06	0,05

**Table C5.2:** Displacements under **shear** loads

Size	MAX						
	M6	M8	M10	M12	M16	M20	M24
<b>Displacement – factor for shear load<sup>2)</sup></b>							
$\delta_{V0}$ - factor	0,6	0,35	0,37	0,27	0,10	0,09	0,07
	0,9	0,52	0,55	0,40	0,14	0,15	0,11
$\delta_{V\infty}$ - factor	<b>MAX A4, MAX C</b>						
	0,6	0,23	0,19	0,18	0,10	0,11	0,07
	0,9	0,27	0,22	0,16	0,11	0,05	0,09

<sup>1)</sup> Calculation of effective displacement:

$$\delta_{N0} = \delta_{N0} - \text{factor} \cdot N_{ED}$$

$$\delta_{N\infty} = \delta_{N\infty} - \text{factor} \cdot N_{ED}$$

( $N_{ED}$ : Design value of the applied tension force)

<sup>2)</sup> Calculation of effective displacement:

$$\delta_{V0} = \delta_{V0} - \text{factor} \cdot V_{ED}$$

$$\delta_{V\infty} = \delta_{V\infty} - \text{factor} \cdot V_{ED}$$

( $V_{ED}$ : Design value of the applied shear force)

**Table C5.3:** Displacements under **tension** loads for **seismic category C2** for all embedment depths

Size	MAX, MAX A4, MAX C						
	M6	M8	M10	M12	M16	M20	M24
Displacement DLS $\delta_{N,eq(DLS)}$	-		2,7	4,4	5,6	-	
Displacement ULS $\delta_{N,eq(ULS)}$			11,5	13,0	12,3		

**Table C5.4:** Displacements under **shear** loads for **seismic category C2** for all embedment depths

Size	MAX, MAX A4, MAX C						
	M6	M8	M10	M12	M16	M20	M24
Displacement DLS $\delta_{V,eq(DLS)}$ [mm]	-		4,1	4,7	5,5	4,8	-
Displacement ULS $\delta_{V,eq(ULS)}$			6,2	7,8	10,1	11,2	

Upat Anchor bolt MAX, MAX A4, MAX

**Performances**  
Displacements under tension and shear loads

**Annex C 5**