WIT-PE 510 WITH REBAR

440 ml 585 ml

Ø8 - Ø32

Rebar not supplied by Würth

Approved for:
Concrete C20/25 to C50/60, non-cracked & cracked

Suitable for:
Concrete C12/15, Natural stone with dense structure

Cartridge sizes		Art. no.
440 ml	side-by-side	**5918 615 440**
585 ml	side-by-side	**5918 615 585**

Installation condition		
Dry concrete	Wet concrete	Flooded drill hole
✓	✓	✓

Drilling method		
Hammer drill	Diamond drill	Hollow drill
✓	✓	✓

Applications




Approvals and certificates

Description	Authority/laboratory	Guideline for assessment	No./date of issue
European Technical Assessment	DIBt, Berlin	EAD 330499-01-0601	ETA-20/1038, 02.04.2021
European Technical Assessment	DIBt, Berlin	EAD 330087-00-0601	ETA-20/1037, 04.03.2021

Basic load data (for a single anchor)

All data in this section applies when:

- Installation is correct (see installation instructions)
- No edge distance and spacing influence
- Base material thickness and embedment depth are according to anchor characteristics
- Rebar material is according to specifications, steel grade B500B
- Concrete C 20/25, f_{ck} = 20 N/mm²
- Concrete C 50/60, f_{ck} = 60 N/mm²
- Temperature range I (min. base material temperature -40°C, max long term/short term base material temperature: +24°C/40°C).
- Dry or wet conditions of drill hole, hammer drilling

Characteristic resistance

Rebar size				**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 24**	**Ø 25**	**Ø 28**	**Ø 32**
Effective anchorage depth		h_{ef}	[mm]	80	90	110	125	125	170	210	210	270	300
Non-cracked concrete													
Tension	C20/25	N_{Rk}	[kN]	27.5	39.6	56.8	66.0	68.8	109.0	149.7	149.7	218.2	255.6
	C50/60			27.5	43.5	62.2	72.6	82.9	141.0	209.0	199.6	287.4	364.9
Shear	≥ C20/25	V_{Rk}	[kN]	13.8	21.7	31.1	42.4	55.3	86.4	124.3	135.0	169.4	221.1
Cracked concrete													
Tension	C20/25	N_{Rk}	[kN]	12.1	19.8	29.0	35.7	40.8	64.1	95.0	99.0	130.6	165.9
	C50/60			13.3	21.8	31.9	39.3	44.9	70.5	104.5	108.9	143.7	182.5
Shear	≥ C20/25	V_{Rk}	[kN]	13.8	21.7	31.1	42.4	55.3	86.4	124.3	135.0	169.4	221.1

Design resistance

Rebar size				**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 24**	**Ø 25**	**Ø 28**	**Ø 32**
Effective anchorage depth		h_{ef}	[mm]	80	90	110	125	125	170	210	210	270	300
Non-cracked concrete													
Tension	C20/25	N_{Rd}	[kN]	13.4	18.8	27.0	31.4	32.7	51.9	71.3	71.3	103.9	121.7
	C50/60			14.7	20.7	30.4	34.6	39.5	67.1	99.5	95.0	136.8	173.8
Shear	≥ C20/25	V_{Rd}	[kN]	9.2	14.5	20.7	28.2	36.9	57.6	82.9	90.0	112.9	147.4
Cracked concrete													
Tension	C20/25	N_{Rd}	[kN]	5.7	9.4	13.8	17.0	19.4	30.5	45.2	47.1	62.2	79.0
	C50/60			6.3	10.4	15.2	18.7	21.4	33.6	49.8	51.8	68.4	86.9
Shear	≥ C20/25	V_{Rd}	[kN]	9.2	14.5	20.7	28.2	36.9	57.6	82.9	90.0	112.9	147.4

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Recommended/allowable loads [1)]

Rebar size				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Effective anchorage depth		h_{ef}	[mm]	80	90	110	125	125	170	210	210	270	300
Non-cracked concrete													
Tension	C20/25	N_{rec}	[kN]	9.6	13.5	19.3	22.4	23.4	37.1	50.9	50.9	74.2	86.9
	C50/60			10.5	14.8	21.7	24.7	28.2	48.0	71.1	67.9	97.7	124.1
Shear	≥ C20/25	V_{rec}	[kN]	6.5	10.3	14.8	20.2	26.3	41.1	59.2	64.3	80.7	105.3
Cracked concrete													
Tension	C20/25	N_{rec}	[kN]	4.1	6.7	9.9	12.2	13.9	21.8	32.3	33.7	44.4	56.4
	C50/60			4.5	7.4	10.9	13.4	15.3	24.0	35.5	37.0	48.9	62.1
Shear	≥ C20/25	V_{rec}	[kN]	6.5	10.3	14.8	20.2	26.3	41.1	59.2	64.3	80.7	105.3

[1)] Material safety factor γ_M and safety factor for action γ_L = 1.4 are included. The material safety factor depends on the failure mode.

Design method (simplified)

Simplified version of the design method according to Eurocode 2 - Design of concrete structures - Part 4: Design of fastenings for use in concrete (EN 1992-4):

- Influence factors related to concrete strength, edge distance, spacing and others must be considered when applicable
- Valid for a group of anchors. The influencing factors must then be considered for each edge distance and spacing. The calculated design resistances are on the safe side. They will be lower than the exact values according to EN 1992-4. For an economical optimization, we recommend using the anchor design module of the Würth Technical Software II
- The design method is based on the simplification that no different loads are acting on individual anchors (no eccentricity)
- Temperature range 1 (min. base material temperature -40°C, max. long term/short term base material temperature: +24°C/40°C)
- Dry or wet conditions of drill hole, hammer drilling (Installation factors might apply for other drilling methods)
- Rebar material according to specifications, steel grade B500B

I. Tension loading

The decisive design resistance in tension is the lowest value of the following failure modes:

1. Steel failure $N_{Rd,s}$
2. Pull-out failure $N_{Rd,p} = N^0_{Rd,p} \cdot f_{b,N} \cdot f_{hef} \cdot f_{sx,p} \cdot f_{sy,p} \cdot f_{cx,1,p} \cdot f_{cx,2,p} \cdot f_{cy,p} \cdot f_{sus}$
3. Concrete cone failure $N_{Rd,c} = N^0_{Rd,c} \cdot f_{b,N} \cdot f_{hef} \cdot f_{sx} \cdot f_{sy} \cdot f_{cx,1} \cdot f_{cx,} \cdot f_{cy}$
4. Concrete splitting failure $N_{Rd,sp} = N^0_{Rd,sp} \cdot f_{b;N} \cdot f_{hef} \cdot f_{sx,sp} \cdot f_{sy,sp} \cdot f_{cx,1,sp} \cdot f_{cx,2,sp} \cdot f_{cy,sp} \cdot f_h$

1. Design steel tensile resistance

Table 1: Design value of steel resistance under tension load $N_{Rd,s}$ of a single anchor

Rebar size			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Effective anchorage depth	h_{ef}	[mm]	80	90	110	125	125	170	210	210	270	300
Design steel resistance	$N_{Rd,s}$	[kN]	19.6	31.0	44.4	60.5	79.0	123.4	177.6	192.9	242.0	315.9

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2. Design combined pull-out and concrete cone resistance

$$N_{Rd,p} = N^0_{Rd,p} \cdot f_{b,N} \cdot f_{hef} \cdot f_{sx,p} \cdot f_{sy,p} \cdot f_{cx,1,p} \cdot f_{cx,2,p} \cdot f_{cy,p} \cdot f_{sus}$$

Table 2: Basic design resistance $N^0_{Rd,p}$ in case of combined pull-out and concrete cone failure of a single anchor

Rebar size			**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 24**	**Ø 25**	**Ø 28**	**Ø 32**
Effective anchorage depth	h_{ef}	[mm]	80	90	110	125	125	170	210	210	270	300
Non-cracked concrete												
Combined pull-out and concrete cone resistance	$N^0_{Rd,p}$	[kN]	13.4	18.8	27.6	31.4	35.9	61.0	90.5	86.4	124.4	158.0
Cracked concrete												
Combined pull-out concrete cone resistance	$N^0_{Rd,p}$	[kN]	5.7	9.4	13.8	17.0	19.4	30.5	45.2	47.1	62.2	79.0

- $s_{cr,p} = 7.3\, d\, (f_{sus} \cdot \tau_{Rk})^{0.5} \leq 3h_{ef}$
- $c_{cr,p} = s_{cr,p}/2$

Where τ_{Rk} is the value $\tau_{Rk,ucr}$ for non-cracked concrete C20/25

Table 3: Characteristic edge distance $c_{cr,p}$ and spacing $s_{cr,p}$ (f_{sus} = 1)

Rebar size			**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 24**	**Ø 25**	**Ø 28**	**Ø 32**
Effective anchorage depth	h_{ef}	[mm]	80	90	110	125	125	170	210	210	270	300
Spacing	$s_{cr,p}$	[mm]	219	270	328	354	375	506	607	605	678	775
Edge distance	$c_{cr,p}$	[mm]	109	135	164	177	188	253	303	303	339	387

a. Influence of concrete strength

Table 4: Influence of concrete strength on combined pull-out and concrete cone resistance

Concrete strength classes (EN 206:2000)			**C12/15**	**C16/20**	**C20/25**	**C25/30**	**C30/37**	**C35/45**	**C40/50**	**C45/55**	**C50/60**
Characteristic compressive strength of concrete determined by testing cylinders[1]	f_{ck}	[N/mm²]	12	16	20	25	30	35	40	45	50
Characteristic compressive strength of concrete determined by testing cube[2]	$f_{ck,cube}$	[N/mm²]	15	20	25	30	37	45	50	55	60
Influencing factor	$f_{b,N}$	[-]	0.77	0.89	1.00	1.02	1.04	1.07	1.08	1.09	1.10

[1] strength at 28 days of 150 mm diameter by 300 mm cylinders

[2] strength at 28 days of 150 mm cubes

b. Influence of embedment depth

$$f_{hef} = \frac{h_{ef}}{h_{ef,typ}}$$

Consider the approved range of embedment $h_{ef,min} \leq h_{ef} \leq h_{ef,max}$ according to the table „installation parameters".

c. Influence of spacing

$$f_{sx,p} = f_{sy,p} = \left(1 + \left(n_{x(y)} - 1\right)\frac{s_{x(y)}}{s_{cr,p}}\right) \cdot \frac{1}{n_{x(y)}} \leq 1$$

Table 5: Influence of spacing on combined pull-out and concrete cone resistance

Number of fixing per direction	$s/s_{cr,p}$ [1)]	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.70	0.75	0.90	0.95	≥ 1.0
2	$f_{sx,p}$, $f_{sy,p}$	0.55	0.58	0.60	0.63	0.65	0.68	0.70	0.73	0.75	0.78	0.80	0.83	0.85	0.88	0.85	0.88	0.95	0.98	1.00
3	$f_{sx,p}$, $f_{sy,p}$	0.40	0.43	0.47	0.50	0.53	0.57	0.60	0.63	0.67	0.70	0.73	0.77	0.80	0.83	0.80	0.83	0.93	0.97	1.00
4	$f_{sx,p}$, $f_{sy,p}$	0.33	0.36	0.40	0.44	0.48	0.51	0.55	0.59	0.63	0.66	0.70	0.74	0.78	0.81	0.78	0.81	0.93	0.96	1.00
5	$f_{sx,p}$, $f_{sy,p}$	0.28	0.32	0.36	0.40	0.44	0.48	0.52	0.56	0.60	0.64	0.68	0.72	0.76	0.80	0.76	0.80	0.92	0.96	1.00

[1)] Choose always the lowest value of the spacing s, when there are different spacings in one row

d. Influence of edge distance

$$f_{cx,1,p} = 0.7 + 0.3\frac{c_x}{c_{cr,p}} \leq 1 \qquad f_{cx,2,p} = f_{cy,p} = \left(1 + \frac{c_{x(y)}}{c_{cr,p}}\right) \cdot \frac{1}{2} \leq 1$$

Table 6: Influence of edge distance on combined pull-out and concrete cone resistance

$c/c_{cr,P}$	0,10	0,15	0,20	0,25	0,30	0,35	0,40	0,45	0,50	0,55	0,60	0,65	0,70	0,75	0,70	0,75	0,90	0,95	≥ 1
$f_{cx,1}$	0.73	0.75	0.76	0.78	0.79	0.81	0.82	0.84	0.85	0.87	0.88	0.90	0.91	0.93	0.91	0.93	0.97	0.99	1.00
$f_{cx,2}$ f_{cy}	0.55	0.58	0.60	0.63	0.65	0.68	0.70	0.73	0.75	0.78	0.80	0.83	0.85	0.88	0.85	0.88	0.95	0.98	1.00

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e. Influence of sustained loads

$$a_{sus} = \frac{N_{sus,d}}{N_{Ed}}$$

$N_{sus,d}$ = design value of sustained actions (permanent actions & permanent component of variable actions)

N_{Ed} = Value of total actions in tension loading at ultimate limit state

Table 7: Influence of sustained loads on combined pull-out and concrete cone resistance

a_{sus}	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
f_{sus}	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60

3. Design concrete cone resistance

$$N_{Rd,c} = N^0_{Rd,c} \cdot f_{b,N} \cdot f_{sx} \cdot f_{sy} \cdot f_{cx,1} \cdot f_{cx,2} \cdot f_{cy}$$

No verification of splitting is required if at least one of the conditions is fulfilled:

a) The edge distance in all directions is $c \geq c_{cr,sp}$ for single fasteners and $c \geq 1.2\ c_{cr,sp}$ for fastener groups and the member depth is $h \geq h_{min}$ in both cases.

b) The characteristic resistance for concrete cone failure and pull-out failure is calculated for cracked concrete and reinforcement resists the splitting forces and limits the crack width to $w_k \leq 0.3$ mm

Table 8: Basic design resistance $N^0_{Rd,c}$ in case of concrete cone failure of a single anchor

Rebar size			**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 24**	**Ø 25**	**Ø 28**	**Ø 32**
Effective anchorage depth	h_{ef}	[mm]	80	90	110	125	125	170	210	210	270	300
Non-cracked concrete												
Concrete cone resistance	$N^0_{Rd,c}$	[kN]	16.8	20.0	27.0	32.7	32.7	51.9	71.3	71.3	103.9	121.7
Cracked concrete												
Concrete cone resistance	$N^0_{Rd,c}$	[kN]	11.7	14.0	18.9	22.9	22.9	36.3	49.9	49.9	72.7	85.2

Table 9: Characteristic edge distance $c_{cr,N}$ and spacing $s_{cr,N}$

Rebar size			**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 24**	**Ø 25**	**Ø 28**	**Ø 32**
Effective anchorage depth	h_{ef}	[mm]	80	90	110	125	125	170	210	210	270	300
Spacing	$s_{cr,N}$	[mm]	240	270	330	375	375	510	630	630	810	900
Edge distance	$c_{cr,N}$	[mm]	120	135	165	188	188	255	315	315	405	450

Above characteristic spacing and edge distances are given for the typical effective anchorage depths. Calculating for smaller depths leads to conservative load capacities. For calculation with bigger depths, use the following:

$$s_{cr,N} = 3\ h_{ef} \text{ and } c_{cr,N} = 1.5\ h_{ef}$$

a. Influence of concrete strength

Table 10: Influence of concrete strength on concrete cone resistance

Concrete strength classes (EN 206:2000)			C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
Characteristic compressive strength of concrete determined by testing cylinders[1]	f_{ck}	[N/mm²]	12	16	20	25	30	35	40	45	50
Characteristic compressive strength of concrete determined by testing cube[2]	$f_{ck,cube}$	[N/mm²]	15	20	25	30	37	45	50	55	60
Influencing factor	$f_{b,N}$	[-]	0.77	0.89	1.00	1.12	1.22	1.32	1.41	1.50	1.58

[1] strength at 28 days of 150 mm diameter by 300 mm cylinders

[2] strength at 28 days of 150 mm cubes

b. Influence of embedment depth

$$f_{hef} = \left(\frac{h_{ef}}{h_{ef,typ}}\right)^{1.5}$$

Consider the approved range of embedment $h_{ef,min} \leq h_{ef} \leq h_{ef,max}$ according to the table „anchor characteristics".

c. Influence of spacing

$$f_{sx} = f_{sy} = \left(1 + \left(n_{x(y)} - 1\right)\frac{s_{x(y)}}{s_{cr,N}}\right) \cdot \frac{1}{n_{x(y)}} \leq 1$$

Table 11: Influence of spacing on concrete cone resistance

Number of fixing per direction	$s/s_{cr,p}$ [1]	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.70	0.75	0.90	0.95	≥ 1
2	f_{sx}, f_{sy}	0.55	0.58	0.60	0.63	0.65	0.68	0.70	0.73	0.75	0.78	0.80	0.83	0.85	0.88	0.85	0.88	0.95	0.98	1.00
3	f_{sx}, f_{sy}	0.40	0.43	0.47	0.50	0.53	0.57	0.60	0.63	0.67	0.70	0.73	0.77	0.80	0.83	0.80	0.83	0.93	0.97	1.00
4	f_{sx}, f_{sy}	0.33	0.36	0.40	0.44	0.48	0.51	0.55	0.59	0.63	0.66	0.70	0.74	0.78	0.81	0.78	0.81	0.93	0.96	1.00
5	f_{sx}, f_{sy}	0.28	0.32	0.36	0.40	0.44	0.48	0.52	0.56	0.60	0.64	0.68	0.72	0.76	0.80	0.76	0.80	0.92	0.96	1.00

[1] Choose always the lowest value of the spacing s, when there are different spacings in one row

d. Influence of edge distance

$$f_{cx,1} = 0.7 + 0.3\frac{c_x}{c_{cr,N}} \leq 1 \qquad f_{cx,2} = f_{cy} = \left(1 + \frac{c_{x(y)}}{c_{cr,N}}\right) \cdot \frac{1}{2} \leq 1$$

Table 12: Influence of edge distance on concrete cone resistance

$c/c_{cr,N}$	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.70	0.75	0.90	0.95	≥ 1
$f_{cx,1}$	0.73	0.75	0.76	0.78	0.79	0.81	0.82	0.84	0.85	0.87	0.88	0.90	0.91	0.93	0.91	0.93	0.97	0.99	1.00
$f_{cx,2}$ / f_{cy}	0.55	0.58	0.60	0.63	0.65	0.68	0.70	0.73	0.75	0.78	0.80	0.83	0.85	0.88	0.85	0.88	0.95	0.98	1.00

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4. Design splitting resistance

$$N_{Rd,sp} = N^0_{Rd,sp} \cdot f_{b,N} \cdot f_{hef} \cdot f_{sx,sp} \cdot f_{sy,sp} \cdot f_{cx,1,sp} \cdot f_{cx,2,sp} \cdot f_{cy,sp} \cdot f_h$$

Table 13: Design resistance $N_{Rd,sp}$ in case of concrete splitting failure of a single anchor

Rebar size			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Effective anchorage depth	h_{ef}	[mm]	80	90	110	125	125	170	210	210	270	300
Non-cracked concrete												
Splitting resistance	$N^0_{Rd,c}$	[kN]	13.4	18.8	27.0	31.4	32.7	51.9	71.3	71.3	103.9	121.7

Table 14: Characteristic edge distance $c_{cr,sp}$ and spacing $s_{cr,sp}$

Rebar size			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Effective anchorage depth	h_{ef}	[mm]	80	90	110	125	125	170	210	210	270	300
Characteristic spacing	$s_{cr,sp}$	[mm]	360	420	528	600	590	816	1004	1004	1296	1440
Characteristic edge distance	$c_{cr,sp}$	[mm]	180	210	264	300	295	408	502	502	648	720
Minimum member thickness	h_{min}	[mm]	110	120	142	161	165	218	274	274	340	380

Above characteristic spacing and edge distances are given for the typical effective anchorage depth. Calculating for smaller depths leads to conservative load capacities. For calculation with bigger depths, use the following:

$$s_{cr,sp} = 2 \cdot c_{cr,sp} \quad \text{and} \quad c_{cr,sp} = \left\{ h_{ef} \leq 2\, h_{ef} \cdot \left(2.5 - \left(\frac{h_{min}}{h_{ef}}\right)\right) \leq 2.4\, h_{ef} \right\}$$

and h_{min} according to the table „anchor characteristics".

a. Influence of concrete strength

Table 15: Influence of concrete strength on splitting resistance

Concrete strength classes (EN 206:2000)			C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
Characteristic compressive strength of concrete determined by testing cylinders [1)]	f_{ck}	[N/mm²]	12	16	20	25	30	35	40	45	50
Characteristic compressive strength of concrete determined by testing cube [2)]	$f_{ck,cube}$	[N/mm²]	15	20	25	30	37	45	50	55	60
Influencing factor	$f_{b,N}$	[-]	0.77	0.89	1.00	1.12	1.22	1.32	1.41	1.50	1.58

[1)] strength at 28 days of 150 mm diameter by 300 mm cylinders

[2)] strength at 28 days of 150 mm cubes

b. Influence of embedment depth

$$f_{hef} = \left(\frac{h_{ef}}{h_{ef,typ}}\right)^{1.5}$$

Consider the approved range of embedment $h_{ef,min} \leq h_{ef} \leq h_{ef,max}$ according to the table „anchor characteristics".

c. Influence of spacing

$$f_{sx,sp} = f_{sy,sp} = \left(1 + \left(n_{x(y)} - 1\right)\frac{s_{x(y)}}{s_{cr,sp}}\right) \cdot \frac{1}{n_{x(y)}} \leq 1$$

Table 16: Influence of spacing on splitting resistance

Number of fixing per direction	$s/s_{cr,sp}$ [1)]	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.70	0.75	0.90	0.95	≥ 1
2	$f_{sx,sp}$, $f_{sy,sp}$	0.55	0.58	0.60	0.63	0.65	0.68	0.70	0.73	0.75	0.78	0.80	0.83	0.85	0.88	0.85	0.88	0.95	0.98	1.00
3	$f_{sx,sp}$, $f_{sy,sp}$	0.40	0.43	0.47	0.50	0.53	0.57	0.60	0.63	0.67	0.70	0.73	0.77	0.80	0.83	0.80	0.83	0.93	0.97	1.00
4	$f_{sx,sp}$, $f_{sy,sp}$	0.33	0.36	0.40	0.44	0.48	0.51	0.55	0.59	0.63	0.66	0.70	0.74	0.78	0.81	0.78	0.81	0.93	0.96	1.00
5	$f_{sx,sp}$, $f_{sy,sp}$	0.28	0.32	0.36	0.40	0.44	0.48	0.52	0.56	0.60	0.64	0.68	0.72	0.76	0.80	0.76	0.80	0.92	0.96	1.00

[1)] Choose always the lowest value of the spacing s, when there are different spacings in one row

d. Influence of edge distance

$$f_{cx,1,sp} = 0.7 + 0.3\frac{c_x}{c_{cr,sp}} \leq 1 \qquad f_{cx,2,sp} = f_{cy,sp} = \left(1 + \frac{c_{x(y)}}{c_{cr,sp}}\right) \cdot \frac{1}{2} \leq 1$$

Table 17: Influence of edge distance on splitting resistance

$c/c_{cr,sp}$	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.70	0.75	0.90	0.95	≥ 1
$f_{cx,1,sp}$	0.73	0.75	0.76	0.78	0.79	0.81	0.82	0.84	0.85	0.87	0.88	0.90	0.91	0.93	0.91	0.93	0.97	0.99	1.00
$f_{cx,2,sp}$ $f_{cy,sp}$	0.55	0.58	0.60	0.63	0.65	0.68	0.70	0.73	0.75	0.78	0.80	0.83	0.85	0.88	0.85	0.88	0.95	0.98	1.00

e. Influence of concrete member thickness

$$f_h = \left(\frac{h}{h_{min}}\right)^{2/3} \leq max\left(1; \left(\frac{h_{ef} + 1.5c_1}{h_{min}}\right)^{2/3}\right)$$

Table 18: Influence of concrete member thickness on splitting resistance

h/h_{min}	1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2	2.1	2.2	2.3	2.4	2.3	2.4	2.7	2.8	2.9
f_h	1.00	1.07	1.13	1.19	1.25	1.31	1.37	1.42	1.48	1.53	1.59	1.64	1.69	1.74	1.79	1.74	1.79	1.94	1.99	2.00

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II. Shear loading

The decisive design resistance in shear is the lowest value of the following failure modes:

1. Steel failure V_{Rds}
2. Concrete pry-out failure $V_{Rd,c} = k \cdot min\ \{N_{Rd,p;}\ N_{Rd,c}\}$
3. Concrete edge failure $V_{Rd,c} = V^0_{Rd,c} \cdot f_{b,V} \cdot f_{hef,V} \cdot f_{s,V} \cdot f_{c1,V} \cdot f_{c2,V} \cdot f_a \cdot f_h$

1. Design steel shear resistance

Table 19: Design value of steel resistance $V_{Rd,s}$ of a single anchor

Rebar size			**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 24**	**Ø 25**	**Ø 28**	**Ø 32**
Effective anchorage depth	h_{ef}	[mm]	80	90	110	125	125	170	210	210	270	300
Design steel resistance	$V_{Rd,s}$	[kN]	9.2	14.5	20.7	28.2	36.9	57.6	82.9	90.0	112.9	147.4

2. Design concrete pry-out resistance

$$V_{Rd,c} = k_8 \cdot min\ \{N_{Rd,p};N_{Rd,c}\}$$

Table 20: factor k_8 for calculating design pry-out resistance

Rebar size			**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 24**	**Ø 25**	**Ø 28**	**Ø 32**
Effective anchorage depth	h_{ef}	[mm]	80	90	110	125	125	170	210	210	270	300
Concrete pry-out resistance factor	k_8	[-]	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

3. Design concrete edge resistance

$$V_{Rd,c} = V^0_{Rd,c} \cdot f_{b,V} \cdot f_{hef,V} \cdot f_{s,V} \cdot f_{c1,V} \cdot f_{c2,V} \cdot f_a \cdot f_h$$

Verification of concrete edge failure may be omitted for single fasteners and groups with an edge distance in all directions $c \geq max\ (10\ h_{ef}\ ;\ 60\ d)$. For anchorages with more than one edge, the resistance for all edges shall be calculated. The smallest value should be used in the verification.

Table 21: Design resistance $V^0_{Rd,c}$ in case of concrete edge failure

Rebar size			**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 24**	**Ø 25**	**Ø 28**	**Ø 32**
Effective anchorage depth	h_{ef}	[mm]	80	90	110	125	125	170	210	210	270	300
Non-cracked concrete												
Basic design edge resistance	$V^0_{Rd,c}$	[kN]	2.8	3.6	4.6	5.6	5.8	8.3	12.2	12.2	14.3	17.2
Cracked concrete												
Basic design edge resistance	$V^0_{Rd,c}$	[kN]	2.0	2.5	3.2	4.0	4.1	5.9	8.6	8.6	10.2	12.2

a. Influence of concrete strength

Table 22: Influence of concrete strength on concrete edge resistance

Concrete strength classes (EN 206:2000)			**C12/15**	**C16/20**	**C20/25**	**C25/30**	**C30/37**	**C35/45**	**C40/50**	**C45/55**	**C50/60**
Characteristic compressive strength of concrete determined by testing cylinders[1)]	f_{ck}	[N/mm²]	12	16	20	25	30	35	40	45	50
Characteristic compressive strength of concrete determined by testing cube[2)]	$f_{ck,cube}$	[N/mm²]	15	20	25	30	37	45	50	55	60
Influencing factor	$f_{b,N}$	[-]	0.77	0.89	1.00	1.12	1.22	1.32	1.41	1.50	1.58

[1)] strength at 28 days of 150 mm diameter by 300 mm cylinders

[2)] strength at 28 days of 150 mm cubes

b. Influence of embedment depth

Table 23: Influence of embedment depth on concrete edge resistance

h_{ef}/d	4	5	6	7	8	9	10	11	≥ 12
$f_{hef,V}$	0.87	0.91	0.94	0.97	1.00	1.02	1.05	1.07	1.08

c. Influence of spacing

In groups loaded perpendicular to the edge only two adjacent anchors closest and parallel to the edge carry the load. The smallest spacing should be used for the verification.

$$f_{s,V} = \frac{1}{3} \cdot \frac{s}{c_1} + 1 \leq 2$$

Table 24: Influence of spacing on concrete edge resistance

s/c_1[1)]	0.50	0.60	0.70	0.80	0.90	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	2.60	2.80
$f_{s,V}$	1.17	1.20	1.23	1.27	1.30	1.33	1.40	1.47	1.53	1.60	1.67	1.73	1.80	1.87	1.93	1.87	1.93

[1)] Always choose the lowest value of the spacing s, when there are different spacing in the row closest to the edge.

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d. Influence of edge distance c_1

Table 25: Influence of edge distance c_1 on concrete edge resistance

c_1/d	4	8	12	15	20	30	40	50	60	100	150	200
$f_{c1,V}$	0.47	1.19	2.05	2.76	4.05	6.95	10.22	13.76	17.54	34.66	59.52	87.35

e. Influence of edge distance c_2

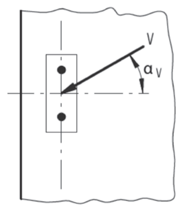
$$f_{c2,V} = \left(\frac{1}{2} + \frac{1}{3}\frac{c_2}{c_1}\right)\left(0.7 + 0.3\frac{c_2}{1.5c_1}\right) \leq 1$$

Table 26: Influence of edge distance c_2 on concrete edge resistance

$c_{2/c1}$ [1)]	1	1.1	1.2	1.3	1.4	1.5
$f_{c,V}$	0.75	0.80	0.85	0.90	0.95	1.00

[1)] Distance to the second edge: $c_1 \leq c_2$

f. Influence of load direction



$$f_\alpha = \sqrt{\frac{1}{cos^2\alpha_V + \left(\frac{sin\alpha_V}{2}\right)^2}} \leq 2$$

Table 27: Influence of load direction on concrete edge resistance

α[1)]	0	10	20	30	40	50	60	70	80	90
$f_{\alpha,V}$	1.00	1.01	1.05	1.11	1.20	1.34	1.51	1.72	1.92	2.00

[1)] For a ≥ 90° the component of the shear load acting away from the edge may be neglected and the verification may be done with component acting parallel to the edge only.

g. Influence of concrete member thickness

$$f_{h,V} = \left(\frac{h}{1.5c_1}\right)^{1/2}$$

Table 28: Influence of concrete member thickness on edge resistance

h/c_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	≥ 1.50
$f_{h,V}$	0.26	0.37	0.45	0.52	0.58	0.63	0.68	0.73	0.77	0.82	0.86	0.89	0.93	0.97	1.00

Structural verification

N_{Ed} = Design value of tension load acting on a fastener
V_{Ed} = Design value of a shear load acting on a fastener

	Failure mode	Verification
1	Steel failure of fastener [1)]	$\left(\frac{N_{Ed}}{N_{Rd}}\right)^2 + \left(\frac{V_{Ed}}{V_{Rd}}\right)^2 \leq 1$ If N_{Ed} and V_{Ed} are different for the individual fasteners of the group, the interaction shall be verified for all fasteners.
2	Failure modes other than steel failure	$\left(\frac{N_{Ed}}{N_{Rd,i}}\right)^{1.5} + \left(\frac{V_{Ed}}{V_{Rd,i}}\right)^{1.5} \leq 1$ or $\left(\frac{N_{Ed}}{N_{Rd,i}}\right) + \left(\frac{V_{Ed}}{V_{Rd,i}}\right) \leq 1.2$ With $N_{Ed} / N_{Rd,i} \leq 1$ and $V_{Ed} / V_{Rd,i} \leq 1$ The largest value of $N_{Ed} / N_{Rd,i}$ and $V_{Ed} / V_{Rd,i}$ for the different failure modes shall be taken.

[1)] This verification is not required in case of shear load with lever arm

WIT-PE 510 WITH REBAR

Design bond strength

Service temperature for working life of 50 years

	Base material temperature	Maximum long-term base material temperature	Maximum short-term base material temperature
Temperature range I	- 40°C to +40°C	+24°C	+40°C
Temperature range II	- 40°C to +60°C	+35°C	+60°C
Temperature range III	- 40°C to +70°C	+43°C	+70°C

Working life of 50 years

1- Non-cracked concrete

Thread size				**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø24**	**Ø25**	**Ø28**	**Ø32**
Design bond resistance in non-cracked concrete C20/25 in hammer drilled holes (HD), with hollow drill bit (HDB), and compressed air drilled holes (CD)													
Temperature range I	Dry, wet concrete and flooded bore holee	$\tau_{Rd,ucr}$	[N/mm²]	6.7	6.7	6.7	5.7	5.7	5.7	5.7	5.2	5.2	5.2
Temperature range II				4.5	4.5	4.5	4.0	4.0	4.0	3.6	3.6	3.6	3.6
Temperature range III				2.9	2.9	2.9	2.9	2.9	2.6	2.6	2.6	2.4	2.4

2- Cracked concrete

Thread size				**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø24**	**Ø25**	**Ø28**	**Ø32**
Design bond resistance in cracked concrete C20/25 in hammer drilled holes (HD), with hollow drill bit (HDB), and compressed air drilled holes (CD)													
Temperature range I	Dry, wet concrete and flooded bore holee	$\tau_{Rd,ucr}$	[N/mm²]	2.9	3.3	3.3	3.1	3.1	2.9	2.9	2.9	2.6	2.6
Temperature range II				1.9	2.1	2.1	2.1	1.9	1.9	1.9	1.9	1.7	1.7
Temperature range III				1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2

Reduction factors

Working life of 50 years

1- Non-cracked concrete

Rebar size				Ø8	Ø10	Ø12	Ø14	Ø16	Ø20	Ø24	Ø25	Ø28	Ø32
Reduction factors in non-cracked concrete C20/25 in hammer drilled holes (HD), with hollow drill bit (HDB), and compressed air drilled holes (CD)													
Temperature range I	Dry, wet concrete and flooded bore hole	$\tau_{Rd,ucr}$	[N/mm²]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Temperature range II				0.68	0.68	0.68	0.71	0.71	0.71	0.63	0.68	0.68	0.68
Temperature range III				0.43	0.43	0.43	0.50	0.50	0.46	0.46	0.50	0.45	0.45

2- Cracked concrete

Rebar size				Ø8	Ø10	Ø12	Ø14	Ø16	Ø20	Ø24	Ø25	Ø28	Ø32
Reduction factors in cracked concrete C20/25 in hammer drilled holes (HD), with hollow drill bit (HDB), and compressed air drilled holes (CD)													
Temperature range I	Dry, wet concrete and flooded bore hole	$\tau_{Rd,cr}$	[N/mm²]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Temperature range II				0.67	0.64	0.64	0.69	0.62	0.67	0.67	0.67	0.64	0.64
Temperature range III				0.42	0.36	0.36	0.38	0.38	0.42	0.42	0.42	0.45	0.45

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Mechanical characteristics

Steel grade	Rebar size			Ø8	Ø10	Ø12	Ø14	Ø16	Ø20	Ø24	Ø25	Ø28	Ø32
	Stressed cross section	A_s	[mm²]	50	79	113	154	201	314	452	491	616	804
	Section modulus	W	[mm³]	50	98	170	269	402	785	1357	1534	2155	3217
460A	Yield strength	f_y	[N/mm²]	460	460	460	460	460	460	460	460	460	460
	Tensile strength	f_u	[N/mm²]	483	483	483	483	483	483	483	483	483	483
	Design bending moment	$M^0_{Rd,s}$	[Nm]	19	38	66	104	155	303	524	593	833	1243
460B	Yield strength	fy	[N/mm²]	460	460	460	460	460	460	460	460	460	460
	Tensile strength	fu	[N/mm²]	497	497	497	497	497	497	497	497	497	497
	Design bending moment	$M^0_{Rd,s}$	[Nm]	20	39	68	107	160	312	540	610	857	1279
B500B	Yield strength	f_y	[N/mm²]	500	500	500	500	500	500	500	500	500	500
	Tensile strength	f_u	[N/mm²]	550	550	550	550	550	550	550	550	550	550
	Design bending moment	$M^0_{Rd,s}$	[Nm]	22	43	75	118	177	345	597	675	948	1415

Material specifications

Product form		**Bars and de-coiled rods**		
Class		**A**	**B**	**V**
Characteristic yield strength f_{yk} or $f_{0,2k}$ (MPa)		400 to 600		
Minimum value of $k = (f_t/f_y)_k$		≥ 1,05	≥ 1,08	≥ 1,15 < 1,35
Characteristic strain at maximum force, ε_{uk} (%)		≥ 2,5	≥ 5,0	≥ 7,5
Bendability		Bend/Rebend test		
Maximum deviation from nominal mass (individual bar or wire) (%)	Nominal bar size (mm) ≤ 8 > 8	+/- 6,0 +/- 4,5		

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Working and curing times

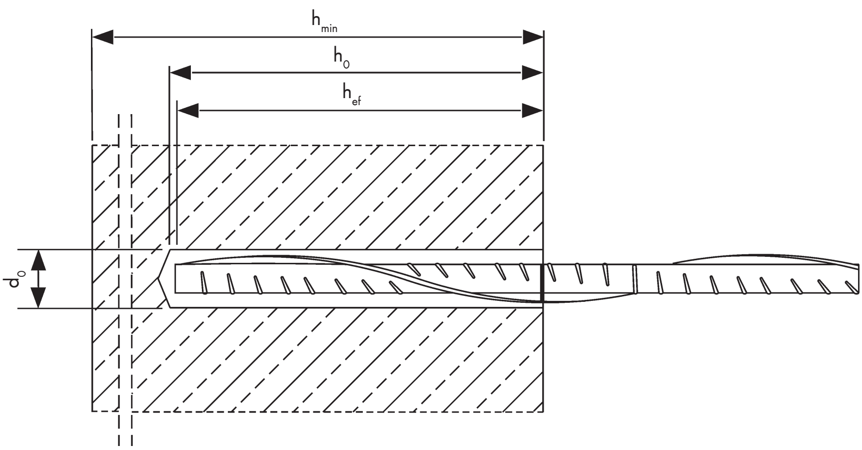
Temperature of base material	Gelling – working time	Min. curing time – dry conditions[1]
5°C to 9°C	80 min	60 h
10°C to 14°C	60 min	48 h
15°C to 19°C	40 min	24 h
20°C to 24°C	30 min	12 h
25°C to 34°C	12 min	10 h
35°C to 39°C	8 min	7 h
+40°C	8 min	4 h

[1] for wet base material the curing time must be doubled

Installation parameters

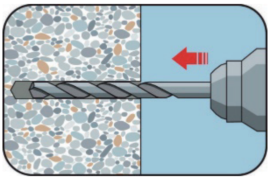
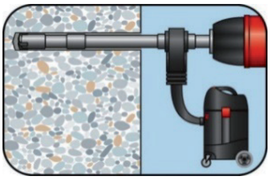
<table>
<tr><td>Rebar size</td><td></td><td></td><td colspan="2">Ø 8[1]</td><td colspan="2">Ø 10[1]</td><td colspan="2">Ø 12[1]</td><td>Ø 14</td><td>Ø 16</td><td>Ø 20</td><td colspan="2">Ø 24[1]</td><td colspan="2">Ø 25[1]</td><td>Ø 28</td><td>Ø 32</td></tr>
<tr><td>Diameter of element</td><td>$d = d_{nom}$</td><td>[mm]</td><td colspan="2">8</td><td colspan="2">10</td><td colspan="2">12</td><td>14</td><td>16</td><td>20</td><td colspan="2">24</td><td colspan="2">25</td><td>28</td><td>32</td></tr>
<tr><td>Nominal drill hole diameter</td><td>d_0</td><td>[mm]</td><td>10</td><td>12</td><td>12</td><td>14</td><td>14</td><td>16</td><td>18</td><td>20</td><td>25</td><td>30</td><td>32</td><td>30</td><td>32</td><td>35</td><td>40</td></tr>
<tr><td rowspan="2">Effective anchorage depth</td><td>$h_{ef,min}$</td><td>[mm]</td><td colspan="2">60</td><td colspan="2">60</td><td colspan="2">70</td><td>75</td><td>80</td><td>90</td><td colspan="2">96</td><td colspan="2">100</td><td>112</td><td>128</td></tr>
<tr><td>$h_{ef,max}$</td><td>[mm]</td><td colspan="2">160</td><td colspan="2">200</td><td colspan="2">240</td><td>280</td><td>320</td><td>400</td><td colspan="2">480</td><td colspan="2">500</td><td>560</td><td>640</td></tr>
<tr><td>Minimum thickness of member</td><td>h_{min}</td><td>[mm]</td><td colspan="5">h_{ef} + 30 mm ≥ 100 mm</td><td colspan="10">$h_{ef} + 2d_0$</td></tr>
<tr><td>Minimum spacing</td><td>s_{min}</td><td>[mm]</td><td colspan="2">40</td><td colspan="2">50</td><td colspan="2">60</td><td>70</td><td>75</td><td>85</td><td colspan="2">120</td><td colspan="2">120</td><td>130</td><td>150</td></tr>
<tr><td>Minimum edge distance</td><td>c_{min}</td><td>[mm]</td><td colspan="2">35</td><td colspan="2">40</td><td colspan="2">45</td><td>50</td><td>50</td><td>60</td><td colspan="2">70</td><td colspan="2">70</td><td>75</td><td>85</td></tr>
</table>

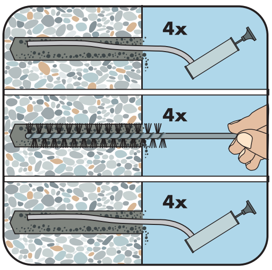
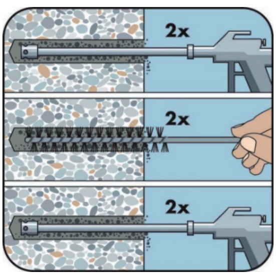
[1] both nominal drill hole diameter can be used

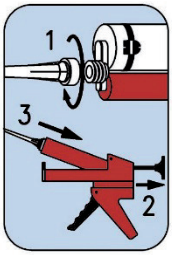
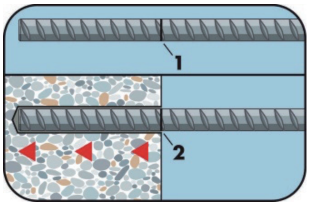
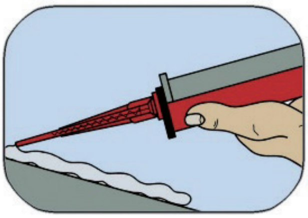
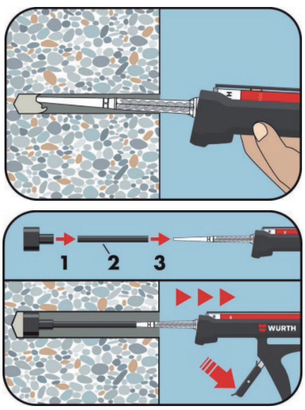


WIT-PE 510 WITH REBAR

Installation instructions

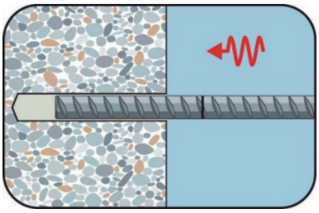
A) Bore hole drilling		
	**1a.**	**Hammer (HD) or compressed air drilling (CD)** Drill a hole into the base material to the size and embedment depth required by the selected reinforcing bar. Proceed with Step B1.
	**1b.**	**Hollow drill bit system (HDB)** Drill a hole into the base material to the size and embedment depth required by the selected reinforcing bar. This drilling system removes the dust and cleans the bore hole during drilling. Proceed with Step C.

B) Bore hole cleaning		
MAC: Cleaning for dry and wet bore holes with diameter d0 ≤ 20 mm and bore hole depth h ≤ 10 d_{nom} (non-cracked concrete only!)		
	**2a.**	Starting from the bottom or back of the bore hole, blow the hole clean with a hand pump a minimum of <u>four</u> times until return air stream is free of noticeable dust.
	2b.	Check brush diameter. Brush the hole with an appropriate sized wire brush > <u>db,min</u> a minimum of <u>four</u> times in a twisting motion. If the bore hole ground is not reached with the brush, a brush extension shall be used.
	2c.	Finally blow the hole clean again with a hand pump a minimum of <u>four</u> times until return air stream is free of noticeable dust.
CAC: Cleaning for dry, wet and water-filled bore holes for all diameters in non-cracked and cracked concrete		
	**2a.**	Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) a minimum of <u>two</u> times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used.
	2b.	Check brush diameter. Brush the hole with an appropriate sized wire brush > $d_{b,min}$ a minimum of <u>two</u> times. If the bore hole ground is not reached with the brush, a brush extension shall be used.
	2c.	Finally blow the hole clean again with compressed air (min. 6 bar) a minimum of <u>two</u> times until return air stream is free of noticeable dust. If the bore hole ground is not reached, an extension shall be used.

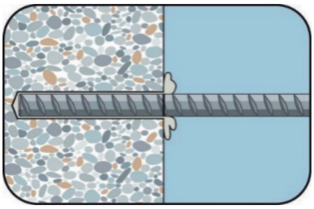
C) Preparation of bar and cartridge		
	**3a.**	Attach the supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool. For every working interruption longer than the recommended working time as well as for every new cartridge, a new static-mixer shall be used.
	**3b.**	Prior to inserting the reinforcing bar into the filled bore hole, the position of the embedment depth shall be marked (e.g. with tape) on the reinforcing bar. After that, insert the bar in the empty hole to verify hole and depth lv. The anchor should be free of dirt, grease, oil and other foreign material.
	**3c.**	Prior to dispensing into the bore hole, squeeze out separately the mortar until it shows a consistent grey or red color (minimum of three full strokes) and discard non-uniformly mixed adhesive components.
D) Filling the bore hole		
	**4.**	Starting from the bottom or back of the cleaned bore hole, fill the hole up to approximately two-thirds with adhesive. Slowly withdraw the static mixing nozzle as the hole fills to avoid creating air pockets. If the bottom or back of the anchor hole is not reached, an appropriate extension nozzle must be used. Observe the gel-/working times. Piston plugs and mixer nozzle extensions shall be used for the following applications: • Horizontal assembly (horizontal direction) and ground erection (vertical downwards direction): Drill bit-Ø d_0 ≥ 18 mm and embedment depth hef > 250 mm • Overhead assembly (vertical upwards direction): Drill bit-Ø d_0 ≥ 18 mm

WIT-PE 510 WITH REBAR

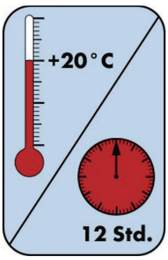
E) Setting the rebar



5a. Push the reinforcing bar into the bore hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached. The bar should be free of dirt, grease, oil or other foreign material.



5b. Be sure that the bar is inserted in the bore hole until the embedment mark is at the concrete surface and that excess mortar is visible at the top of the hole. If these requirements are not maintained, the application has to be renewed. For horizontal and overhead installation, fix embedded part (e.g. with wedges).



5c. Observe gelling time t_{gel}. Attend that the gelling time can vary according to the base material temperature. Do not move or load the bar until full curing time t_{cure} has elapsed.

Filling quantity

Anchor type: M8 - M30

Rebar size			**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 24**	**Ø 25**	**Ø 28**	**Ø 32**
Nominal drill hole diameter	d_0	[mm]	12	14	16	18	20	25	32	32	35	40
Drill depth	h_0 / h_1	[mm]	= l_v									
Filling volume per 10mm embedment depth		[ml]	0.81	1.01	1.21	1.43	1.66	2.59	4.85	4.47	5.07	6.62

Assumed waste of 15 % included.