FIXANCHOR W-FA/A4

W-FA/A4

A4 (AISI 316): M6 - M20

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

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

W-FA/HCR

A4 (AISI 316): M8 - M20 (on demand)

Type of installation		
Pre-positioned	In-place	Stand-off
-	✓	-

Applications

Approvals and certificates

ETA CE 🔥

Description	Authority/laboratory	Guideline for assessment	No./date of issue
European Technical Assessment	DiBt, Berlin	EAD 330232-01-0601	ETA-02/0001 /2017-08-10
European Technical Assessment	DiBt, Berlin	ETAG 001 Part 6	ETA-06/0162 /2018-05-17
Report fire resistance	Ing. Büro Thiele, Pirmasens	EN 1363-1:2012-10 / TR 020	21730_2/2017-06-21

Basic loading 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 is according to anchor characteristics
- Anchor material is as specified in anchor material specification table
- Concrete C 20/25, f_{ck} = 20 N/mm²
- Concrete C 50/60, f_{ck} = 60 N/mm²

Mean ultimate resistance

Thread size: M6 – M10

Thread size				M6			M8			M10		
Effective anchorage depth		h_{ef}	[mm]	30[1]	40	60	35[1]	44	70	42	48	80
Non-cracked concrete												
Tension	C20/25	$N_{Ru,m}$	[kN]	10.2	9.5	9.5	12.4	17.5	17.5	17.5	21.4	21.4
Shear	C20/25	$V_{Ru,m}$	[kN]	9.1	9.1	9.1	16.7	16.7	16.7	26.4	26.4	26.4

Thread size: M12 – M20

Thread size				M12			M16			M20		
Effective anchorage depth		h_{ef}	[mm]	50	65	100	64	82	120	78	100	115
Non-cracked concrete												
Tension	C20/25	$N_{Ru,m}$	[kN]	22.6	27.3	27.3	34.6	48.9	48.9	46.5	67.5	67.5
Shear	C20/25	$V_{Ru,m}$	[kN]	38.4	38.4	38.4	65.8	65.8	65.8	102.8	102.8	102.8

[1] Use restricted to anchoring of structural components that are statically indeterminate

Characteristic resistance

Thread size: M6 – M10

Thread size				M6			M8			M10		
Effective anchorage depth		h_{ef}	[mm]	30[1]	40	60	35[1]	44	70	42	48	80
Non-cracked concrete												
Tension	C20/25	N_{Rk}	[kN]	6.5	8.0	8.0	9.0	14.4	15.0	12.0	16.4	16.4
	C50/60			10.0	10.0	10.0	14.2	18.0	18.0	19.0	25.9	25.9
Shear	≥ C20/25	V_{Rk}	[kN]	7.0	7.0	7.0	12.0	12.0	12.0	19.0	19.0	19.0

Thread size: M12 – M20

Thread size				M12			M16			M20		
Effective anchorage depth		h_{ef}	[mm]	50	65	100	64	82	120	78	100	115
Non-cracked concrete												
Tension	C20/25	N_{Rk}	[kN]	17.4	25.0	25.0	25.2	35.2	42.0	33.9	49.2	60.0
	C50/60			27.5	39.5	39.5	39.8	55.7	66.4	53.6	77.8	94.9
Shear	≥ C20/25	V_{Rk}	[kN]	27.0	27.0	27.0	50.0	50.0	50.0	86.0	86.0	86.0

[1] Use restricted to anchoring of structural components that are statically indeterminate

FIXANCHOR W-FA/A4

Design resistance

Thread size: M6 – M10

Thread size				**M6**			**M8**			**M10**		
Effective anchorage depth		h_{ef}	[mm]	30[1]	40	60	35[1]	44	70	42	48	80
Non-cracked concrete												
Tension	C20/25	N_{Rd}	[kN]	4.3	5.3	5.3	6.0	9.6	10.0	8.0	10.9	10.9
	C50/60			6.7	6.7	6.7	9.5	12.0	12.0	12.6	17.2	17.3
Shear	≥ C20/25	V_{Rd}	[kN]	5.4	5.6	5.6	9.6	9.6	9.6	15.2	15.2	15.2

Thread size: M12 – M20

Thread size				**M12**			**M16**			**M20**		
Effective anchorage depth		h_{ef}	[mm]	50	65	100	64	82	120	78	100	115
Non-cracked concrete												
Tension	C20/25	N_{Rd}	[kN]	11.6	16.7	16.7	16.8	23.5	28.0	22.6	32.8	40.0
	C50/60			18.3	26.4	26.4	26.5	37.1	44.3	35.7	51.9	63.2
Shear	≥ C20/25	V_{Rd}	[kN]	21.6	21.6	21.6	40.0	40.0	40.0	61.4	61.4	61.4

[1] Use restricted to anchoring of structural components that are statically indeterminate

Recommended/allowable Loads [1]

Thread size: M6 – M10

Thread size				**M6**			**M8**			**M10**		
Effective anchorage depth		h_{ef}	[mm]	30[2]	40	60	35[2]	44	70	42	48	80
Non-cracked concrete												
Tension	C20/25	N_{rec}	[kN]	4.1	4.1	4.1	7.3	7.3	7.3	10.1	12.3	12.3
	C50/60			4.8	4.8	4.8	6.8	8.6	8.6	9.0	12.3	12.3
Shear	≥ C20/25	V_{rec}	[kN]	3.8	4.0	4.0	6.9	6.9	6.9	10.9	10.9	10.9

Thread size: M12 – M20

Thread size				**M12**			**M16**			**M20**		
Effective anchorage depth		h_{ef}	[mm]	50	65	100	64	82	120	78	100	115
Non-cracked concrete												
Tension	C20/25	N_{rec}	[kN]	10.8	16.0	16.1	16.2	23.5	25.8	25.5	37.0	41.4
	C50/60			13.1	18.8	18.8	19.0	26.5	31.6	25.5	37.0	45.2
Shear	≥ C20/25	V_{rec}	[kN]	15.4	15.4	15.4	28.6	28.6	28.6	43.9	43.9	43.9

[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.

[2] Use restricted to anchoring of structural components that are statically indeterminate

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)
- Concrete strength for design load values is C20/25 unless stated otherwise
- Dry or wet conditions of drill hole, hammer drilling
- Anchor material as specified in anchor material specification table
- Anchorage depths hef < 40 mm are restricted to use of structural components with which are statically intdeterminate and subject to internal exposure conditions only

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

1. Design steel tensile resistance

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

Thread size: M6 – M10

Thread size			**M6**			**M8**			**M10**		
Effective anchorage depth	h_{ef}	[mm]	30	40	60	35	44	70	42	48	80
Design steel resistance	$N_{Rd,s}$	[kN]	6.7	6.7	6.7	12.0	12.0	12.0	20.0	20.0	20.0

Thread size: M12 – M20

Thread size			**M12**			**M16**			**M20**		
Effective anchorage depth	h_{ef}	[mm]	50	65	100	64	82	120	78	100	115
Design steel resistance	$N_{Rd,s}$	[kN]	29.3	29.3	29.3	58.7	58.7	58.7	79.8	79.8	79.8

2. Design pullout resistance

$$N_{Rd,p} = N^0_{Rd,p} \cdot f_{b,N}$$

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

Thread size: M6 – M10

Thread size			**M6**			**M8**			**M10**		
Effective anchorage depth	h_{ef}	[mm]	30	40	60	35	44	70	42	48	80
Design pull-out resistance	$N^0_{Rd,p}$	[kN]	4.3	5.3	5.3	6.0	10.0	10.0	8.0	10.9	10.9

Thread size: M12 – M20

Thread size			**M12**			**M16**			**M20**		
Effective anchorage depth	h_{ef}	[mm]	50	65	100	64	82	120	78	100	115
Design pull-out resistance	$N^0_{Rd,p}$	[kN]	11.6	16.7	16.7	16.8	23.5	28.0	22.6	32.8	40.0

a. Influence of concrete strength

Table 3: Influence of concrete strength on pull-out 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	1.10	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

3. Design concrete cone resistance

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

Table 4: Basic design resistance $N^0_{Rd,c}$ in case of concrete cone failure of a single anchor

Thread size: M6 – M10

Thread size			**M6**			**M8**			**M10**		
Effective anchorage depth	h_{ef}	[mm]	30	40	60	35	44	70	42	48	80
Design concrete cone resistance	$N^0_{Rd,c}$	[kN]	5.4	8.3	15.2	6.8	9.6	19.2	8.9	10.9	23.5

Thread size: M12 – M20

Thread size			**M12**			**M16**			**M20**		
Effective anchorage depth	h_{ef}	[mm]	50	65	100	64	82	120	78	100	115
Design concrete cone resistance	$N^0_{Rd,c}$	[kN]	11.6	17.2	32.8	16.8	24.4	43.1	22.6	32.8	40.4

Table 5: Characteristic edge distance $c_{cr,N}$ and spacing $s_{cr,N}$

Thread size: M6 – M10

Thread size			**M6**			**M8**			**M10**		
Effective anchorage depth	h_{ef}	[mm]	30	40	60	35	44	70	42	48	80
Characteristic spacing	$s_{cr,N}$	[mm]	90	120	180	105	132	210	126	144	240
Characteristic edge distance	$c_{cr,N}$	[mm]	45	60	90	53	66	105	63	72	120

Thread size: M12 – M20

Thread size			**M12**			**M16**			**M20**		
Effective anchorage depth	h_{ef}	[mm]	50	65	100	64	82	120	78	100	115
Characteristic spacing	$s_{cr,N}$	[mm]	150	195	300	192	246	360	234	300	345
Characteristic edge distance	$c_{cr,N}$	[mm]	75	98	150	96	123	180	117	150	173

a. Influence of concrete strength

Table 6: 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	1.10	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 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 7: Influence of spacing on concrete cone resistance

Number of fixing per direction	$s/s_{cr,N}$ [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}, 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

c. 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 8: 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	≥ 1.0
$f_{cx,1}$	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
$f_{cx,2}$	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
f_{cy}																			

4. Design splitting resistance

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

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 9: Design resistance $N^0_{Rd,sp}$ in case of concrete splitting failure of a single anchor

Thread size: M6 – M10

Thread size			**M6**			**M8**			**M10**		
Effective anchorage depth	h_{ef}	[mm]	30	40	60	35	44	70	42	48	80
Design splitting resistance	$N^0_{Rd,sp}$	[mm]	4.3	5.3	5.3	6.0	9.6	10.0	8.0	10.9	10.9

Thread size: M12 – M20

Thread size			**M12**			**M16**			**M20**		
Effective anchorage depth	h_{ef}	[mm]	50	65	100	64	82	120	78	100	115
Design splitting resistance	$N^0_{Rd,sp}$	[mm]	11.6	16.7	16.7	16.8	23.5	28.0	22.6	32.8	40.0

Table 10: Characteristic edge distance $c_{cr,sp}$ and spacing $s_{cr,sp}$

Thread size: M6 – M10

Thread size			**M6**			**M8**			**M10**		
Effective anchorage depth	h_{ef}	[mm]	30	40	60	35	44	70	42	48	80
Characteristic spacing	$s_{cr, sp}$	[mm]	180	160	360	180	220	240	180	240	480
Characteristic edge distance	$c_{cr, sp}$	[mm]	90	80	180	90	110	210	90	120	240
Minimum member thickness	h_{min}	[mm]	80	100	120	80	100	126	100	100	132

Thread size: M6 – M10

Thread size			**M12**			**M16**			**M20**		
Effective anchorage depth	h_{ef}	[mm]	50	65	100	64	82	120	78	100	115
Characteristic spacing	$s_{cr, sp}$	[mm]	180	340	600	180	410	720	180	560	690
Characteristic edge distance	$c_{cr, sp}$	[mm]	90	170	300	90	205	360	90	280	345
Minimum member thickness	h_{min}	[mm]	100	130	165	130	170	208	160	200	215

a. Influence of concrete strength

Table 11: 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	1.10	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 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 12: 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	≥ 1.0
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

c. 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 13: 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	≥ 1.0
$f_{cx,1,sp}$	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

d. 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 14: Influence of concrete member thickness on splitting resistance

h/h_{min}	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.10	2.20	2.30	2.40	2.30	2.40	2.70	2.80	2.90
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

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 $V_{Rd,c} = k \cdot N_{Rd,c}$
3. Concrete edge failure $V_{Rd,c} = V^0_{Rd,c} \cdot f_{b,V} \cdot f_{s,V} \cdot f_{c2,V} \cdot f_a \cdot f_h$

1. Design steel shear resistance

Table 15: Design value of steel resistance $V_{Rd,s}$ of a single anchor

Thread size: M6 – M10

Screw size			**M6**			**M8**			**M10**		
Effective anchorage depth	h_{ef}	[mm]	30	40	60	35	44	70	42	48	80
Design steel resistance	$V_{Rd,s}$	[kN]	5.6	5.6	5.6	9.6	9.6	9.6	15.2	15.2	15.2

Thread size: M12 – M20

Screw size			**M12**			**M16**			**M20**		
Effective anchorage depth	h_{ef}	[mm]	50	65	100	64	82	120	78	100	115
Design steel resistance	$V_{Rd,s}$	[kN]	21.6	21.6	21.6	40.0	40.0	40.0	61.4	61.4	61.4

2. Concrete pry-out resistance

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

Table 16: factor k_8 for calculating design pry-out resistance

Thread size: M6 – M10

Screw size			**M6**			**M8**			**M10**		
Effective anchorage depth	h_{ef}	[mm]	30	40	60	35	44	70	42	48	80
Concrete pry-out resistance factor	k_8	[-]	1.0	1.0	1.0	2.3	2.3	2.3	2.8	2.8	2.8

Thread size: M12 – M20

Screw size			**M12**			**M16**			**M20**		
Effective anchorage depth	h_{ef}	[mm]	50	65	100	64	82	120	78	100	115
Concrete pry-out resistance factor	k_8	[-]	2.8	2.8	2.8	3.0	3.0	3.0	3.3	3.3	3.3

FIXANCHOR W-FA/A4

3. Concrete edge resistance

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

Verification of concrete edge failure may be omitted for single fasteners and groups with an edge distance in all directions c ≥ 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 17: Design resistance $V^0_{Rd,c}$ in case of concrete edge failure

Thread size	M6			M8			M10			M12			M16			M20		
h_{ef} [mm]	30	40	60	35	44	70	42	48	80	50	65	100	64	82	120	78	100	115
Edge distance c_1	$V^0_{Rd,c}$																	
[mm]	[kN]																	
	non-cracked concrete																	
40	2.7	2.8	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	3.1	3.3	3.5	-	3.5	3.8	-	-	-	-	-	-	-	-	-	-	-	-
50	3.6	3.8	4.0	-	4.0	4.3	-	-	-	-	-	-	-	-	-	-	-	-
55	4.1	4.3	4.6	-	4.5	4.9	-	4.8	5.3	-	-	-	-	-	-	-	-	-
60	4.7	4.9	5.2	4.9	5.1	5.5	-	5.4	5.9	-	-	-	-	-	-	-	-	-
65	5.2	5.4	5.7	5.5	5.7	6.2	5.8	6.0	6.5	-	-	-	-	-	-	-	-	-
70	5.8	6.0	6.4	6.1	6.3	6.8	6.5	6.6	7.2	-	7.1	7.8	-	-	-	-	-	-
75	6.4	6.6	7.0	6.7	6.9	7.5	7.1	7.2	7.9	-	7.8	8.5	-	-	-	-	-	-
80	7.0	7.2	7.6	7.4	7.6	8.1	7.7	7.9	8.6	-	8.5	9.3	-	9.3	10.2	-	-	-
85	7.6	7.9	8.3	8.0	8.2	8.8	8.4	8.6	9.3	-	9.2	10.0	-	10.1	11.0	-	-	-
90	8.3	8.5	9.0	8.7	8.9	9.5	9.1	9.3	10.1	-	10.0	10.8	-	10.9	11.8	-	-	-
95	8.9	9.2	9.7	9.3	9.6	10.3	9.8	10.0	10.8	-	10.7	11.6	-	11.7	12.7	-	-	-
100	9.6	9.9	10.4	10.0	10.3	11.0	10.5	10.7	11.6	11.0	11.5	12.4	-	12.5	13.5	-	13.5	13.9
110	11.0	11.3	11.8	11.5	11.8	12.5	12.0	12.2	13.2	12.5	13.1	14.1	13.5	14.2	15.3	-	15.2	15.7
120	12.4	12.8	13.4	12.9	13.3	14.1	13.5	13.8	14.8	14.1	14.7	15.8	15.2	15.9	17.1	-	17.1	17.6
130	13.9	14.3	14.9	14.5	14.9	15.8	15.1	15.4	16.5	15.8	16.4	17.6	16.9	17.7	19.0	-	18.9	19.5
140	15.4	15.9	16.6	16.1	16.5	17.4	16.8	17.0	18.3	17.5	18.1	19.4	18.7	19.5	20.9	19.9	20.9	21.4
150	17.0	17.5	18.3	17.7	18.2	19.2	18.5	18.8	20.1	19.2	19.9	21.3	20.6	21.4	22.9	21.8	22.8	23.5
160	18.7	19.2	20.0	19.4	19.9	21.0	20.2	20.5	21.9	21.0	21.8	23.2	22.4	23.3	24.9	23.8	24.9	25.5
170	20.4	20.9	21.8	21.1	21.6	22.8	22.0	22.3	23.8	22.8	23.6	25.2	24.4	25.3	27.0	25.8	26.9	27.6
180	22.1	22.7	23.6	22.9	23.5	24.7	23.8	24.2	25.8	24.7	25.6	27.2	26.3	27.3	29.1	27.9	29.1	29.8
190	23.9	24.5	25.4	24.7	25.3	26.6	25.7	26.1	27.8	26.7	27.6	29.3	28.4	29.4	31.3	30.0	31.2	32.0
200	25.7	26.3	27.4	26.6	27.2	28.6	27.6	28.0	29.8	28.6	29.6	31.4	30.4	31.5	33.5	32.1	33.4	34.3
250	35.4	36.2	37.5	36.6	37.3	39.1	37.8	38.3	40.6	39.1	40.3	42.5	41.4	42.8	45.2	43.5	45.1	46.1
300	46.0	47.0	48.6	47.4	48.4	50.5	49.0	49.6	52.3	50.5	52.0	54.7	53.3	54.9	57.8	55.8	57.8	59.0
350	57.4	58.6	60.5	59.1	60.2	62.8	61.0	61.7	64.9	62.8	64.5	67.7	66.0	68.0	71.4	69.0	71.3	72.7
400	-	71.0	73.2	71.6	72.9	75.8	73.7	74.6	78.2	75.9	77.8	81.4	79.6	81.8	85.7	83.0	85.6	87.2
450	-	-	86.7	84.8	86.3	89.6	87.3	88.2	92.4	89.7	91.9	96.0	93.9	96.4	100.8	97.8	100.7	102.5
500	-	-	100.8	-	-	104.1	101.5	102.6	107.2	104.2	106.7	111.2	108.9	111.7	116.6	113.2	116.5	118.5
550	-	-	115.6	-	-	119.3	116.3	117.5	122.7	119.3	122.1	127.1	124.5	127.6	133.0	129.3	133.0	135.2
600	-	-	131.0	-	-	135.1	131.8	133.1	138.8	135.1	138.1	143.7	140.8	144.2	150.1	146.1	150.1	152.5
650	-	-	-	-	-	151.4	-	-	155.5	151.5	154.8	160.8	157.7	161.4	167.8	163.5	167.8	170.4
700	-	-	-	-	-	168.4	-	-	172.8	168.4	172.0	178.5	175.2	179.2	186.1	181.4	186.1	188.9
750	-	-	-	-	-	-	-	-	190.6	-	-	196.8	193.2	197.6	205.0	199.9	204.9	208.0
800	-	-	-	-	-	-	-	-	209.0	-	-	215.7	211.8	216.4	224.4	219.0	224.3	227.6

Thread size	M6			M8			M10			M12			M16			M20		
h_{ef} [mm]	30	40	60	35	44	70	42	48	80	50	65	100	64	82	120	78	100	115
Edge distance c_1	$V^0_{Rd,c}$																	
[mm]	[kN]																	
	non-cracked concrete																	
850	-	-	-	-	-	-	-	-	-	-	-	235.0	230.9	235.8	244.3	238.5	244.3	247.7
900	-	-	-	-	-	-	-	-	-	-	-	254.9	250.5	255.8	264.7	258.6	264.7	268.4
950	-	-	-	-	-	-	-	-	-	-	-	275.2	270.6	276.2	285.7	279.2	285.7	289.5
1000	-	-	-	-	-	-	-	-	-	-	-	296.0	-	-	307.1	300.3	307.1	311.2
1100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	351.3	343.8	351.3	355.8
1200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	397.3	389.0	397.3	402.3

a. Influence of concrete strength

Table 18: 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	1.10	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 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 19: 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.

c. Influence of edge distance

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.

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

Table 20: Influence of edge distance on concrete edge resistance

c_2/c_1 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: $c_1 \le c_2$

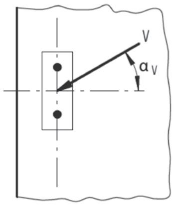
d. Influence of load direction

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

Table 21: 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.



e. Influence of concrete member thickness

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

Table 22: Influence of concrete member thickness on concrete edge resistance

h/c_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	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

FIXANCHOR W-FA/A4

Mechanical characteristics

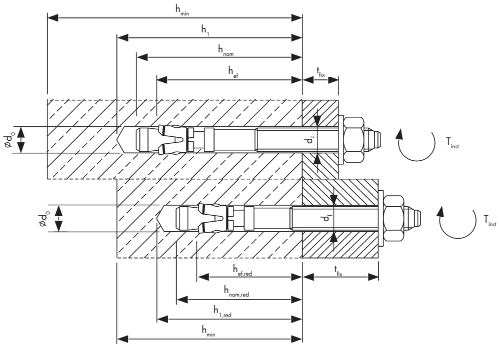
Thread size			M6	M6	M8	M8	M10	M10	M12	M12	M16	M16	M20	M20
Effective anchorage depth	h_{ef}	[mm]	30	40	35	44	42	48	50	65	64	82	78	100
Governing cross section														
Stressed cross section	A_s	[mm^2]	14.5	14.5	25.5	25.5	43.0	43.0	58.1	58.1	116.9	116.9	191.1	191.1
Section modulus	W	[mm^3]	7.8	7.8	18.2	18.2	39.8	39.8	62.4	62.4	178.3	178.3	372.7	372.7
Yield strength	f_y	[N/mm^2]	560	560	560	560	5600	560	600	600	600	600	560	560
Tensile strength	f_u	[N/mm^2]	700	700	700	700	700	700	750	750	750	750	700	700
Non-cracked concrete														
Stressed cross section	A_s	[mm^2]	20.1	20.1	36.6	36.6	58.0	58.0	84.3	84.3	156.7	156.7	244.8	244.8
Section modulus	W	[mm^3]	12.7	12.7	31.23	31.23	62.3	62.3	109.17	109.17	276.67	276.67	540.23	540.23
Yield strength	f_y	[N/mm^2]	480	480	480	480	480	480	480	480	420	420	420	420
Tensile strength	f_u	[N/mm^2]	600	600	600	600	600	600	600	600	560	560	560	560
Design bending moment	$M^0_{Rd,s}$	[Nm]	18.4	37.6	65.6	167.2	272.9	718.4	1065	1065	62.4	148.8	148.8	272.9

Material specifications

Part	**W-FA/A4; W-FA/HCR**	
	Stainless steel A4	**High corrosion resistant steel HCR**
Conical bolt	Stainless steel 1.4401, 1.4404, 1.4571, 1.4578, 1.4362, EN 10088:2005, coated	High corrosion resistant steel 1.4529, 1.4565, EN 10088:2005, coated
Expansion sleeve	Stainless steel 1.4401, 1.4571, 1.4362, EN 10088:2005	
Washer	Stainless steel 1.4401, 1.4571, 1.4362, EN 10088:2005	High corrosion resistant steel 1.4529, 1.4565, EN 10088:2005, coated
Hexagon nut	ISO 3506:2009, A4-70, stainless steel 1.4401, 1.4571, 1.4362, EN 10088:2005, coated	ISO 3506:2009, strength class 70, high corrosion resistant steel 1.4529, 1.4565, EN 10088:2005, coated

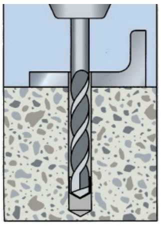
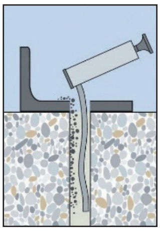
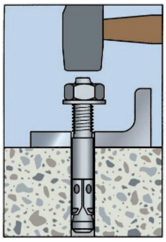
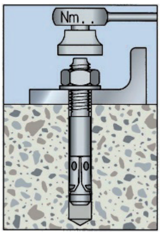
Installation parameters

Fastener size			M6	M8	M10	M12	M16	M20
Nominal drill hole diameter	d_0	[mm]	6	8	10	12	16	20
Cutting diameter of drill bit	$d_{cut} \leq$	[mm]	6,4	8,45	10,45	12,5	16,5	20,55
Diameter of clearance in hole in the fixture	$d_f \leq$	[mm]	7	9	12	14	18	22
Installation torque (Wedge Anchor B electroplated)	$T_{inst} =$	[Nm]	8	15	30	50	100	200
Installation torque (Wedge Anchor B hot-dip galvanised)	$T_{inst} =$	[Nm]	-	15	30	40	90	120
Embedment depth $h_{ef,1}$								
Effective anchorage depth	$h_{ef,1} \geq$	[mm]	30	35	42	50	64	78
Depth of drill hole	$h_{1,1} \geq$	[mm]	45	55	65	75	95	110
Embedment depth	$h_{nom,1} \geq$	[mm]	39	47	56	67	84	99
Minimum thickness of member	h_{min}	[mm]	80	80	100	100	130	160
Minimum spacing	s_{min}	[mm]	35	60	55	100	100	140
Minimum edge distance	c_{min}	[mm]	40	60	65	100	110	140
Embedment depth $h_{ef,2}$								
Effective anchorage depth	$h_{ef,2} \geq$	[mm]	40	44	48	65	80	100
Depth of drill hole	$h_{1,2} \geq$	[mm]	55	65	70	90	110	130
Embedment depth	$h_{nom,2} \geq$	[mm]	49	56	62	82	102	121
Minimum thickness of member	h_{min}	[mm]	100	100	100	130	160	200
Minimum spacing	s_{min}	[mm]	35	35	45	60	80	100
	for $c \geq$	[mm]	40	65	70	100	120	150
Minimum edge distance	c_{min}	[mm]	35	45	55	70	80	100
	for $s \geq$	[mm]	60	110	80	100	140	180
Embedment depth $h_{ef,3}$								
Effective anchorage depth	$h_{ef,3} \geq$	[mm]	60	70	80	100	120	115
Depth of drill hole	$h_{1,3} \geq$	[mm]	75	91	102	125	148	145
Embedment depth	$h_{nom,3} \geq$	[mm]	69	82	94	117	140	136
Minimum thickness of member	h_{min}	[mm]	120	126	132	165	200	215
Minimum spacing	s_{min}	[mm]	35	35	45	60	80	100
	for $c \geq$	[mm]	40	65	70	100	120	1050
Minimum edge distance	c_{min}	[mm]	35	45	55	70	80	100
	for $s \geq$	[mm]	60	110	80	100	140	180



FIXANCHOR W-FA/A4

Installation instructions

A) Bore hole drilling		
	**1a.**	**Hammer drilling (HD)** Drill the hole with a hammer drill. Drill bit diameter and its working length are determined by the diameter and depth of the drill hole of the selected anchor. (see table anchor characteristics). Positioning of drill holes without damaging the reinforcement.
B) Bore hole cleaning		
	**2.**	Clean the bore hole from the bottom until the return air stream is without dust.
C) Setting the screw		
	**3a.**	Drive the anchor with some hammer impacts or with the machine setting tool into the drill hole. Anchor installation ensuring the specified embedment depth.
	**3b.**	Application of the required torque moment using a calibrated torque wrench.