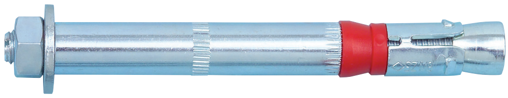
HIGH PERFORMANCE ANCHOR W-HAZ/S

W-HAZ-B/S

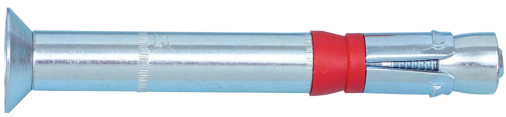


Galvanized (5 microns): M6 - M20

W-HAZ-S/S

Galvanized (5 microns): M6 - M20

W-HAZ-SK/S



Galvanized (5 microns): M6 – M12

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

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

Variable effective anchorage depths possible!

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-02/0031 / 2021-28-01
Shock test, Critical infra-structure protection	BABS, CH-Bern		BZS D 09-0605 /2010-04-28

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/mm^2
- Concrete C 50/60, f_{ck} = 60 N/mm^2

Mean ultimate resistance

Thread size					10/M6	12/M8	15/M10	18/M12	24/M16	24/16L	28/M20	32/M24
Effective anchorage depth			h_{ef}	[mm]	50	60	71	80	100	115	125	150
Non-cracked concrete												
Tension	S / SK / B	C20/25	$N_{Ru,m}$	[kN]	16.1	27.6	39.4	49.0	71.9	90.4	84.7	139.7
Shear	S / SK	C20/25	$V_{Ru,m}$	[kN]	19.0	33.4	58.6	83.7	143.7	143.7	198.5	213.9
	B	C20/25			18.0	28.3	42.0	71.3	106.0	106.0	151.4	213.9
Cracked concrete												
Tension	S / SK / B	C20/25	$N_{Ru,m}$	[kN]	16.1	19.3	29.9	38.8	55.5	72.8	73.0	122.7
Shear	S / SK	C20/25	$V_{Ru,m}$	[kN]	19.0	33.4	58.6	83.7	143.7	143.7	198.5	213.9
	B	C20/25			18.0	28.3	42.0	71.3	106.0	106.0	151.4	213.9

Characteristic resistance

Thread size					10/M6	12/M8	15/M10	18/M12	24/M16	24/16L	28/M20	32/M24
Effective anchorage depth			h_{ef}	[mm]	50	60	71	80	100	115	125	150
Non-cracked concrete												
Tension	S / SK / B	C20/25	N_{Rk}	[kN]	16.0	20.0	29.4	35.2	49.2	60.7	68.8	90.4
		C50/60			16.0	29.0	46.0	55.7	77.8	95.9	108.7	142.9
Shear	S / SK	C20/25	V_{Rk}	[kN]	18.0	30.0	48.0	70.4	98.4	121.3	137.5	180.7
		C50/60			18.0	30.0	48.0	73.0	126.0	126.0	150.0	200.0
	B	C20/25			16.0	25.0	36.0	63.0	91.0	91.0	122.0	180.7
		C50/60			16.0	25.0	36.0	63.0	91.0	91.0	122.0	200.0
Cracked concrete												
Tension	S / SK / B	C20/25	N_{Rk}	[kN]	5.0	12.0	16.0	24.6	34.4	42.5	48.1	63.3
		C50/60			7.9	19.0	25.3	39.0	54.4	67.1	76.1	100.0
Shear	S / SK	C20/25	V_{Rk}	[kN]	18.0	30.0	41.2	49.3	68.9	84.9	96.3	126.5
		C50/60			18.0	30.0	48.0	73.0	108.9	126.0	150.0	200.0
	B	C20/25			16.0	25.0	36.0	49.3	68.9	84.9	96.3	126.5
		C50/60			16.0	25.0	36.0	63.0	91.0	91.0	122.0	200.0

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Design resistance

Thread size					10/M6	12/M8	15/M10	18/M12	24/M16	24/16L	28/M20	32/M24
Effective anchorage depth			h_{ef}	[mm]	50	60	71	80	100	115	125	150
Non-cracked concrete												
Tension	S / SK / B	C20/25	N_{Rd}	[kN]	10.7	13.3	19.6	23.5	32.8	40.4	45.8	60.2
		C50/60			10.7	19.3	30.7	37.1	51.9	63.9	72.5	95.3
Shear	S / SK	C20/25	V_{Rd}	[kN]	14.4	24.0	38.4	46.9	65.6	80.9	91.7	120.5
		C50/60			14.4	24.0	38.4	58.4	100.8	100.8	120.0	160.0
	B	C20/25			12.8	20.0	28.8	46.9	65.6	72.8	91.7	120.5
		C50/60			12.8	20.0	28.8	50.4	72.8	72.8	97.6	160.0
Cracked concrete												
Tension	S / SK / B	C20/25	N_{Rd}	[kN]	3.3	8.0	10.7	16.4	23.0	28.3	32.1	42.2
		C50/60			5.3	12.6	16.9	26.0	36.3	44.8	50.7	66.7
Shear	S / SK	C20/25	V_{Rd}	[kN]	14.4	21.3	27.5	32.9	45.9	56.6	64.2	84.3
		C50/60			14.4	24.0	38.4	51.9	72.6	89.5	101.5	133.4
	B	C20/25			12.8	20.0	27.5	32.9	45.9	56.6	64.2	84.3
		C50/60			12.8	20.0	28.8	50.4	72.6	72.8	97.6	133.4

Recommended/allowable Loads [1)]

Thread size					10/M6	12/M8	15/M10	18/M12	24/M16	24/16L	28/M20	32/M24
Effective anchorage depth			h_{ef}	[mm]	50	60	71	80	100	115	125	150
Non-cracked concrete												
Tension	S / SK / B	C20/25	N_{rec}	[kN]	7.6	9.5	14.0	16.8	23.4	28.9	32.7	43.0
		C50/60			7.6	13.8	21.9	26.5	37.0	45.7	51.8	68.0
Shear	S / SK	C20/25	V_{rec}	[kN]	10.3	17.1	27.4	33.5	46.9	57.8	65.5	86.1
		C50/60			10.3	17.1	27.4	41.7	72.0	72.0	85.7	114.3
	B	C20/25			9.1	14.3	20.6	33.5	46.9	52.0	65.5	86.1
		C50/60			9.1	14.3	20.6	36.0	52.0	52.0	69.7	114.3
Cracked concrete												
Tension	S / SK / B	C20/25	N_{rec}	[kN]	2.4	5.7	7.6	11.7	16.4	20.2	22.9	30.1
		C50/60			3.8	9.0	12.0	18.6	25.9	32.0	36.2	47.6
Shear	S / SK	C20/25	V_{rec}	[kN]	10.3	15.2	19.6	23.5	32.8	40.4	45.8	60.2
		C50/60			10.3	17.1	27.4	37.1	51.9	63.9	72.5	95.3
	B	C20/25			9.1	14.3	19.6	23.5	32.8	40.4	45.8	60.2
		C50/60			9.1	14.3	20.6	36.0	51.9	52.0	69.7	95.3

[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)
- 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
- Tables calculated for standard effective anchorage depths. Larger effective anchorage depths possible

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			10/M6	12/M8	15/ M10	18/ M12	24/ M16	24/16L	28/ M20	32/ M24
Effective anchorage depth	h_{ef}	[mm]	50	60	71	80	100	115	125	150
Design steel resistance	$N_{Rd,s}$	[kN]	10.7	19.3	30.7	44.7	84.0	84.0	130.7	188.0

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			10/M6	12/M8	15/M10	18/M12	24/M16	24/16L	28/M20	32/M24
Effective anchorage depth	h_{ef}	[mm]	50	60	71	80	100	115	125	150
Non-cracked concrete										
Design pull-out resistance	$N^0_{Rd,p}$	[kN]	11.3	13.3	20.0	24.0	33.3	40.4	46.7	60.2
Cracked concrete										
Design pull-out resistance	$N^0_{Rd,p}$	[kN]	3.3	8.0	10.7	16.7	24.0	29.3	33.3	43.3

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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			10/M6	12/M8	15/M10	18/M12	24/M16	24/16L	28/M20	32/M24
Effective anchorage depth	h_{ef}	[mm]	50	60	71	80	100	115	125	150
Non-cracked concrete										
Design concrete cone resistance	$N^0_{Rd,c}$	[kN]	11.6	15.2	19.6	23.5	32.8	40.4	45.8	60.2
Cracked concrete										
Design concrete cone resistance	$N^0_{Rd,c}$	[kN]	8.1	10.7	13.7	16.4	23.0	28.3	32.1	42.2

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

Thread size			10/M6	12/M8	15/M10	18/M12	24/M16	24/16L	28/M20	32/M24
Effective anchorage depth	h_{ef}	[mm]	50	60	71	80	100	115	125	150
Characteristic spacing	$s_{cr,N}$	[mm]	150	180	213	240	300	345	375	450
Characteristic edge distance	$c_{cr,N}$	[mm]	75	90	107	120	150	173	188	225

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
$f_{cx,2}$ / 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

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

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			10/M6	12/M8	15/M10	18/M12	24/M16	24/16L	28/M20	32/M24
Effective anchorage depth	h_{ef}	[mm]	50	60	71	80	100	115	125	150
Non-cracked concrete										
Design splitting resistance	$N^0_{Rd,sp}$	[kN]	8.0	10.7	16.7	20.0	26.7	46.7	33.3	46.7

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

Thread size			10/M6	12/M8	15/M10	18/M12	24/M16	24/16L	28/M20	32/M24
Effective anchorage depth	h_{ef}	[mm]	50	60	71	80	100	115	125	150
Characteristic spacing	$s_{cr,sp}$	[mm]	150	180	213	240	300	345	375	450
Characteristic edge distance	$c_{cr,sp}$	[mm]	125	150	178	200	250	173	313	300
Minimum member thickness	h_{min}	[mm]	100	120	140	160	200	230	250	300

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

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

Screw size				**10/M6**	**12/M8**	**15/10**	**18/12**	**24/16**	**24/16L**	**28/20**	**32/24**
Effective anchorage depth		h_{ef}	[mm]	50	60	71	80	100	115	125	150
Design steel resistance	S and SK	$V_{Rd,s}$	[kN]	14.4	24.0	38.4	58.4	100.8	100.8	120.0	160.0
	B	$V_{Rd,s}$	[kN]	12.8	20.0	28.8	50.4	72.8	72.8	97.6	160.0

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

Screw size			**10/M6**	**12/M8**	**15/10**	**18/12**	**24/16**	**24/16L**	**28/20**	**32/24**
Effective anchorage depth	h_{ef}	[mm]	50	60	71	80	100	115	125	150
Concrete pry-out resistance factor	k_8	[-]	1.8	2.0	2.0	2.0	2.0	2.0	2.0	2.0

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 $c \geq \max\,(10\,h_{ef}\,;\,60\,d)$. 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 17: Design resistance $V^0_{Rd,c}$ in case of concrete edge failure

Thread size	10/M6		12/M8		15/M10		18M12		24/M16		24/M16L		28/M20		32/M24	
h_{ef} [mm]	50		60		71		80		100		115		125		150	
Edge distance c_1	$V^0_{Rd,c}$															
[mm]	[kN]															
	non-cracked	cracked	non-cracked	cracked	non-cracked	cracked	non-cracked	cracked	non-cracked	cracked	non-cracked	cracked	non-cracked	cracked	non-cracked	cracked
50	4.2	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55	4.8	3.4	-	3.6	-	-	-	-	-	-	-	-	-	-	-	-
60	5.4	3.8	5.7	4.1	6.2	4.4	-	-	-	-	-	-	-	-	-	-
65	6.0	4.3	6.4	4.5	6.8	4.8	-	-	-	-	-	-	-	-	-	-
70	6.6	4.7	7.0	5.0	7.5	5.3	8.0	5.6	-	-	-	-	-	-	-	-
75	7.3	5.2	7.7	5.5	8.2	5.8	8.7	6.2	-	-	-	-	-	-	-	-
80	8.0	5.6	8.4	6.0	9.0	6.3	9.5	6.7	-	-	-	-	-	-	-	-
85	8.6	6.1	9.1	6.5	9.7	6.9	10.2	7.2	-	-	-	-	-	-	-	-
90	9.3	6.6	9.8	7.0	10.5	7.4	11.0	7.8	-	-	-	-	-	-	-	-
95	10.0	7.1	10.6	7.5	11.2	8.0	11.8	8.4	-	-	-	-	-	-	-	-
100	10.8	7.6	11.3	8.0	12.0	8.5	12.6	9.0	13.9	9.8	14.4	10.2	-	-	-	-
110	12.3	8.7	12.9	9.1	13.7	9.7	14.3	10.2	15.7	11.1	16.2	11.5	-	-	-	-
120	13.8	9.8	14.5	10.3	15.3	10.9	16.1	11.4	17.6	12.4	18.1	12.8	-	-	-	-
130	15.5	11.0	16.2	11.5	17.1	12.1	17.9	12.7	19.5	13.8	20.1	14.2	-	-	-	-
140	17.1	12.1	17.9	12.7	18.9	13.4	19.7	14.0	21.4	15.2	22.1	15.6	-	-	-	-
150	18.9	13.4	19.7	13.9	20.7	14.7	21.6	15.3	23.4	16.6	24.1	17.1	-	-	26.9	19.0
160	20.6	14.6	21.5	15.2	22.6	16.0	23.6	16.7	25.5	18.1	26.2	18.6	-	-	29.1	20.6
170	22.4	15.9	23.4	16.6	24.6	17.4	25.6	18.1	27.6	19.6	28.4	20.1	-	-	31.4	22.3
180	24.3	17.2	25.3	17.9	26.5	18.8	27.6	19.6	29.8	21.1	30.6	21.7	31.8	22.5	33.8	23.9
190	26.2	18.6	27.3	19.3	28.6	20.2	29.7	21.0	32.0	22.7	32.8	23.3	34.1	24.2	36.2	25.7
200	28.2	19.9	29.3	20.7	30.7	21.7	31.9	22.6	34.2	24.3	35.1	24.9	36.5	25.8	38.7	27.4
250	38.5	27.3	39.9	28.3	41.7	29.5	43.2	30.6	46.1	32.7	47.2	33.4	48.9	34.6	51.6	36.5
300	49.8	35.3	51.5	36.5	53.6	38.0	55.4	39.2	59.0	41.8	60.3	42.7	62.3	44.1	65.4	46.4
350	61.9	43.9	64.0	45.3	66.4	47.0	68.5	48.5	72.7	51.5	74.2	52.6	76.5	54.2	80.2	56.8
400	74.9	53.0	77.2	54.7	80.0	56.7	82.5	58.4	87.2	61.8	88.9	63.0	91.6	64.9	95.8	67.8
450	88.5	62.7	91.2	64.6	94.4	66.9	97.1	68.8	102.5	72.6	104.4	74.0	107.4	76.1	112.1	79.4
500	102.9	72.9	105.9	75.0	109.5	77.5	112.5	79.7	118.5	83.9	120.7	85.5	124.0	87.8	129.2	91.5
550	117.9	83.5	121.2	85.9	125.2	88.7	128.6	91.1	135.2	95.8	137.5	97.4	141.2	100.0	146.9	104.0
600	133.5	94.6	137.2	97.2	141.5	100.2	145.2	102.9	152.5	108.0	155.1	109.8	159.0	112.7	165.3	117.1

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Thread size	10/M6		12/M8		15/M10		18M12		24/M16		24/M16L		28/M20		32/M24	
h_{ef} [mm]	50		60		71		80		100		115		125		150	
Edge distance c_1	$V^0_{Rd,c}$															
[mm]	[kN]															
	non-cracked	cracked	non-cracked	cracked	non-cracked	cracked	non-cracked	cracked	non-cracked	cracked	non-cracked	cracked	non-cracked	cracked	non-cracked	cracked
650	-	-	153.8	108.9	158.5	112.3	162.5	115.1	170.4	120.7	173.2	122.7	177.5	125.7	184.3	130.5
700	-	-	170.9	121.0	176.0	124.7	180.4	127.8	188.9	133.8	192.0	136.0	196.6	139.3	203.9	144.4
750	-	-	-	-	194.1	137.5	198.8	140.8	208.0	147.3	211.3	149.6	216.2	153.2	224.0	158.7
800	-	-	-	-	212.8	150.7	217.8	154.3	227.6	161.2	231.1	163.7	236.4	167.5	244.8	173.4
850	-	-	-	-	231.9	164.3	237.3	168.1	247.8	175.5	251.5	178.1	257.2	182.2	266.0	188.4
900	-	-	-	-	251.6	178.2	257.3	182.3	268.5	190.2	272.4	192.9	278.4	197.2	287.8	203.9
950	-	-	-	-	-	-	277.8	196.8	289.6	205.2	293.8	208.1	300.2	212.6	310.1	219.6
1000	-	-	-	-	-	-	298.8	211.6	311.3	220.5	315.6	223.6	322.4	228.4	332.9	235.8
1100	-	-	-	-	-	-	-	-	356.0	252.1	360.8	255.6	368.2	260.8	379.8	269.0
1200	-	-	-	-	-	-	-	-	402.4	285.1	407.7	288.8	415.9	294.6	428.6	303.6
1300	-	-	-	-	-	-	-	-	450.6	319.2	456.4	323.3	465.3	329.6	479.1	339.4
1400	-	-	-	-	-	-	-	-	500.5	354.5	506.7	358.9	516.4	365.8	531.3	376.3
1500	-	-	-	-	-	-	-	-	-	-	-	-	569.0	403.1	585.0	414.4
1600	-	-	-	-	-	-	-	-	-	-	-	-	623.2	441.4	640.3	453.6
1700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	697.2	493.8
1800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	755.4	535.1
1900	-	-	-	-	-	-	-	-	-	-	-	-	-	-	815.1	577.4

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.

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

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: $c_1 \leq c_2$

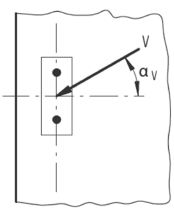
d. Influence of load direction

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

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 α ≥ 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

Mechanical characteristics

Thread size			10/M6	12/M8	15/M10	18/M12	24/M16	24/M16L	28/M20	32/M24
Effective anchorage depth	h_{ef}	[mm]	50	60	71	80	100	115	125	150
Governing cross section (bolt and screw)										
Stressed cross section	A_s	[mm²]	20.1	36.6	58	84.3	157	157	244.8	352.5
Section modulus	W	[mm³]	12.7	31.2	62.3	109	277	277	541	935
Yield strength	f_y	[N/mm²]	640	640	640	640	640	640	640	640
Tensile strength	f_u	[N/mm²]	800	800	800	800	800	800	800	800
Design bending moment	$M^0_{Rd,s}$	[Nm]	9.6	24	48	84	212.8	212.8	415.2	718.4

*For larger effective anchorage depths, design bending moments are higher

Material specifications

Product description	Steel, zinc plated
	galvanized ≥ 5 µm
Threaded bolt	Steel, Strength class 8.8, EN ISO 898-1:2013
Washer	Steel, EN 10139:2016
Washer	Steel, galvanized
Hexagon nut	Steel, galvanized, coated
Distance sleeve	Steel tube EN 10305-2:2016
Ring	Polyethylene
Expansion sleeve	Steel, EN 10139:2016
Threaded cone	Steel EN 10083-2:2006
Hexagon nut	Steel, Strength class 8, EN ISO 898-2:2012
Hexagon head screw	Steel, Strength class 8.8, EN ISO 898-2:2013
Countersunk screw	Steel, Strength class 8.8, EN ISO 898-1:2013
Countersunk washer	Steel, EN 10083-2:2006

HIGH PERFORMANCE ANCHOR W-HAZ/S

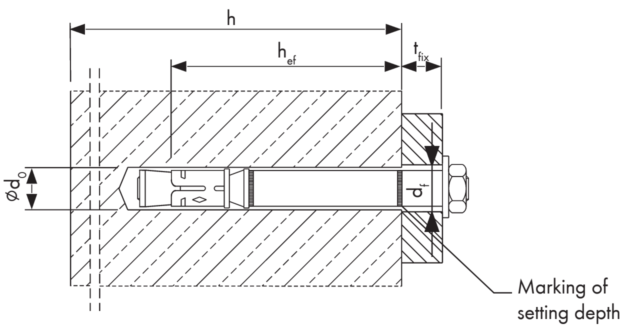
Installation parameters

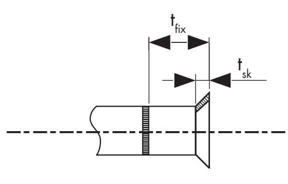
Thread size			10/M6	12/M8	15/10	18/12	24/16	24/16 L	28/20	32/24
Minimum effective anchorage depth	$h_{ef,min}$	[mm]	50	60	71	80	100	115	125	150
	$h_{ef,max}$	[mm]	76	100	110	130	114	150	185	210
Nominal drill hole diameter	d_0	[mm]	10	12	15	18	24	24	28	32
Cutting diameter of drill bit	$d_{cut} \leq$	[mm]	10.45	12.5	15.5	18.5	24.55	24.55	28.55	32.7
Depth of drill hole	$h_1 \geq$	[mm]	h_{ef} + 15	h_{ef} + 20	h_{ef} + 24	h_{ef} + 25	h_{ef} + 30	h_{ef} + 30	h_{ef} + 35	h_{ef} + 30
Diameter of clearance in hole in the fixture	$d_f \leq$	[mm]	12	14	17	20	26	26	31	35
Thickness of countersunk washer W-HAZ-SK	t_{sk}	[mm]	4	5	6	7	-	-	-	-
Minimum thickness of fixture W-HAZ-SK	$t_{fix,min}$ 2)	[mm]	8	10	14	18	-	-	-	-
Installation torque T_{inst} (W-HAZ-B, W-HAZ-S)	T_{inst} =	[Nm]	15	30	50	80	160	160	280	280
Installation torque T_{inst} (W-HAZ-SK)	T_{inst} =	[Nm]	10	25	55	70	-	-	-	-
Minimum thickness of member	h_{min}	[mm]	h_{ef} + 50	h_{ef} + 60	h_{ef} + 69	h_{ef} + 80	h_{ef} + 100	h_{ef} + 115	h_{ef} + 125	h_{ef} + 150
Uncracked concrete										
Minimum spacing 1) 3)	s_{min}	[mm]	50	60	60	70	100	100	125	150
	for c ≥	[mm]	80	100	120	140	180	180	300	300
Minimum edge distance 1) 3)	c_{min}	[mm]	50	60	60	70	100	100	180	150
	for s ≥	[mm]	100	120	120	160	220	220	540	300
Cracked concrete										
Minimum spacing 1) 3)	s_{min}	[mm]	50	50	60	70	100	100	125	150
	for c ≥	[mm]	50	80	120	140	180	180	300	300
Minimum edge distance 1) 3)	c_{min}	[mm]	50	55	60	70	100	100	180	150
	for s ≥	[mm]	50	100	120	160	220	220	540	300

1) Intermediate values by linear interpolation

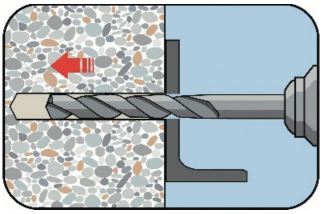
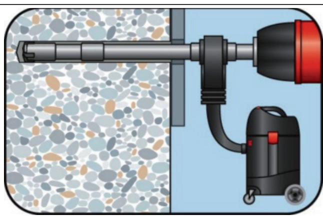
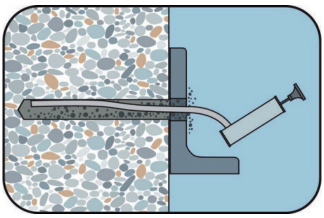
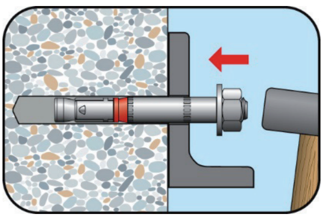
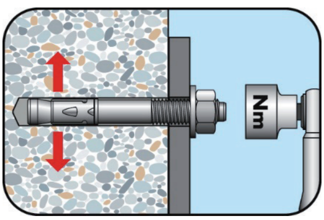
2) Depending on the existing shear load, the thickness of the fixture may be reduced to the thickness of the countersunk washer tsk. It must be verified that the present shear load can be transferred completely into the distance sleeve (bearing of hole).

3) For fire exposure from more than one side c ≥ 300 mm or c_{min} ≥ 300 mm applies.





Installation instructions

A) Bore hole drilling		
	**1a.**	**Hammer drilling (HD)** Drill a hole into the base material to the size and embedment depth required by the selected reinforcing bar. In case of aborted drill hole, the drill hole shall be filled with mortar.
	**1b.**	**Hollow drill bit system (HDB)** Drill a hole into the base material to the size and embedment depth required by the selected anchor. This drilling system removes the dust and cleans the bore hole during drilling (all conditions). Proceed with Step 3.
B) Bore hole cleaning		
	**2.**	Clean the bore hole from the bottom until the return air stream is without dust.
C) Setting the fastener		
	**3a.**	Drive the anchor with hammer impact into the drill hole and check the specified embedment depth.
	**3b.**	Application of the required torque moment using a calibrated torque wrench.