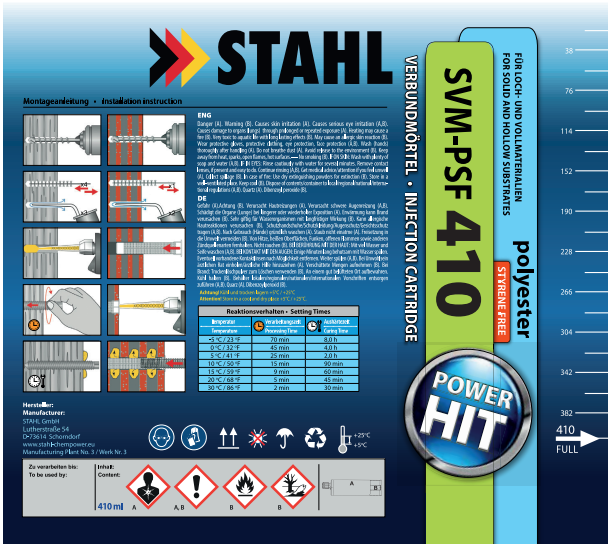
PSF-410 - Polyester resin for use in concrete

Bonded anchor with anchor rod made of galvanized steel or stainless steel of sizes M8 to M30 for use in non-cracked concrete



Basic product information

Features

- Styrene free resin (odorless)
- Several embedment depths
- ETAG 001-5 Option 7
- **PSF-410** - 410ml
- **STUD** – carbon steel, class 5.8 acc. EN ISO 898-1
- **STUD-88** – carbon steel , class 8.8 acc. EN ISO 898-1
  Coating thickness min. 5µm acc. EN ISO 4042
- **STUD-A4** – stainless steel, grade A4-70, A4-80 acc. EN ISO 3506
  Steel material 1.4401, 1.4404, 1.4571 acc. EN 10088

Substrate

- Non-cracked concrete C20/25 – C50/60
- Reinforced and unreinforced concrete
- Dry or wet concrete (Category 1)
- Flooded holes, except sea water (Category 2)

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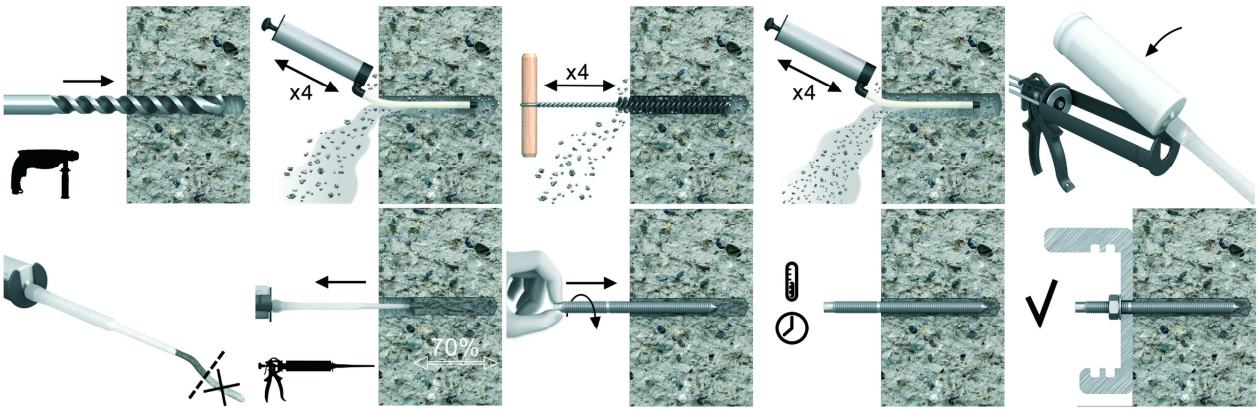
Installation guide



1. Drill hole to the correct diameter and depth for stud size being used.
2. Clean the hole with brush and hand pump at least four times each.
3. Insert cartridge into gun and attach nozzle.
4. Dispense to waste until an even color is obtained. Insert the mixing nozzle to the far end of the hole and inject the resin, slowly withdrawing the nozzle as the hole is filled to 70% of its depth.
5. Immediately insert the rod, slowly and with a slight twisting motion. Remove any excess resin around the hole before it sets and leave it undisturbed until the curing time elapses.
6. Attach fixture and tighten the nut to the required torque.

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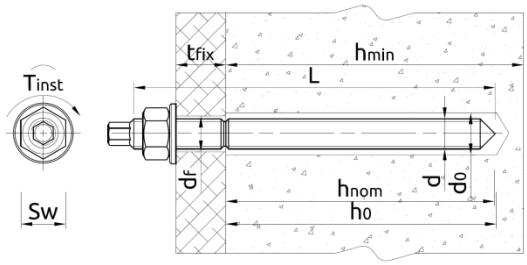
Installation data



Size				M8	M10	M12	M16	M20	M24	M30
Thread diameter		d	[mm]	8	10	12	16	20	24	30
Hole diameter in substrate		d_0	[mm]	10	12	14	18	24	28	35
Installation torque		T_{inst}	[Nm]	10	20	40	80	120	180	300
Wrench size		s_w	[mm]	13	17	19	24	30	36	46
Min. hole depth in substrate		h_0	[mm]	$h_{ef} + 5$						
Installation depth	Min.	h_{nom}	[mm]	60	70	80	100	120	140	165
	Std.	h_{nom}	[mm]	80	90	110	125	170	210	240
	Max.	h_{nom}	[mm]	100	120	145	190	240	290	360
Min. substrate thickness		h_{min}	[mm]	$h_{ef} + 30 \geq 100$				$h_{ef} + 2 \cdot d_0$		
Min. spacing		s_{min}	[mm]	$0.5 \cdot h_{ef} \geq 40$						
Min. edge distance		c_{min}	[mm]	$0.5 \cdot h_{ef} \geq 40$						

Minimum curing and working time

Resin temperature	Concrete temperature	Curing time*			Working time		
		Summer version	Standard version	Winter version	Summer version	Standard version	Winter version
[°C]	[°C]	[min]			[min]		
5	-20	-	-	1440	-	-	45
5	-15	-	-	1080	-	-	30
5	-10	-	-	480	-	-	20
5	-5	1440	480	300	180	70	11
5	0	1080	240	120	120	45	7
5	5	720	120	60	60	25	5
10	10	480	90	45	45	15	2
15	15	360	60	30	25	9	1.5
20	20	240	45	15	15	5	1
25	30	90	30	-	7	2	-
25	40	45	-	-	5	-	-

* For wet concrete the curing time must be doubled.

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Mechanical properties

Size			M8	M10	M12	M16	M20	M24	M30
STUDS Metric Threaded Rods - Steel Class 5.8									
Nominal ultimate tensile strength - tension	f_{uk}	[N/mm²]	500	500	500	500	500	500	500
Nominal yield strength - tension	f_{yk}	[N/mm²]	400	400	400	400	400	400	400
Cross sectional area - tension	A_s	[mm²]	36.6	58	84.3	157	245	352.8	559.8
Elastic section modulus	W_{el}	[mm³]	31.2	62.3	109.2	277.5	541	935	1868
Characteristic bending resistance	$M^0_{Rk,s}$	[Nm]	19	37	65	166	324	561	1124
Design bending resistance	M	[Nm]	15	30	52	133	259	449	899
Allowable bending resistance	M_{rec}	[Nm]	11	21	37	95	185	321	642
STUDS Metric Threaded Rods - Steel Class 8.8									
Nominal ultimate tensile strength - tension	f_{uk}	[N/mm²]	800	800	800	800	800	800	800
Nominal yield strength - tension	f_{yk}	[N/mm²]	640	640	640	640	640	640	640
Cross sectional area - tension	A_s	[mm²]	36.6	58	84.3	157	245	352.8	559.8
Elastic section modulus	W_{el}	[mm³]	31.2	62.3	109.2	277.5	541	935	1868
Characteristic bending resistance	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519	898	1799
Design bending resistance	M	[Nm]	24	48	84	213	416	718	1439
Allowable bending resistance	M_{rec}	[Nm]	17	34	60	152	297	513	1028
STUDS Metric Threaded Rods - A4									
Nominal ultimate tensile strength - tension	f_{uk}	[N/mm²]	700	700	700	700	700	700	700
Nominal yield strength - tension	f_{yk}	[N/mm²]	450	450	450	450	450	450	450
Cross sectional area - tension	A_s	[mm²]	36.6	58	84.3	157	245	352.8	559.8
Elastic section modulus	W_{el}	[mm³]	31.2	62.3	109.2	277.5	541	935	1868
Characteristic bending resistance	$M^0_{Rk,s}$	[Nm]	26	52	92	233	454	786	1574
Design bending resistance	M	[Nm]	17	34	59	149	291	504	1009
Allowable bending resistance	M_{rec}	[Nm]	12	24	42	107	208	360	721

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Product information

Size	Product Code			Anchor		Fixture			
				Thread diameter	Length	Max. thickness			Hole diameter
	Steel class 5.8	Steel class 8.8	Steel grade A4			Min.	Stand.	Max.	
				d	L	$t_{fix,min}$	$t_{fix,stnd}$	$t_{fix,max}$	d_f
				[mm]	[mm]		[mm]		[mm]
M8	STUDS-08110	STUDS-08110-88	STUDS-08110-A4	8	110	40	20	-	9
	STUDS-08160	-	STUDS-08160-A4	8	160	90	70	50	9
M10	STUDS-10130	STUDS-10130-88	STUDS-10130-A4	10	130	48	28	-	12
	STUDS-10170	-	STUDS-10170-A4	10	170	88	68	38	12
	STUDS-10190	-	STUDS-10190-A4	10	190	108	88	58	12
M12	STUDS-12160	STUDS-12160-88	STUDS-12160-A4	12	160	65	35	-	14
	STUDS-12190	-	STUDS-12190-A4	12	190	95	65	30	14
	STUDS-12220	-	STUDS-12220-A4	12	220	125	95	60	14
	STUDS-12260	-	STUDS-12260-A4	12	260	165	135	100	14
	STUDS-12300	-	STUDS-12300-A4	12	300	205	175	140	14
M16	STUDS-16190	STUDS-16190-88	STUDS-16190-A4	16	190	71	46	-	18
	STUDS-16220	-	STUDS-16220-A4	16	220	101	76	11	18
	STUDS-16260	-	STUDS-16260-A4	16	260	141	116	51	18
	STUDS-16300	-	STUDS-16300-A4	16	300	181	156	91	18
	STUDS-16380	-	STUDS-16380-A4	16	380	261	236	171	18
M20	STUDS-20260	STUDS-20260-88	STUDS-20260-A4	20	260	117	67	-	22
	STUDS-20300	-	STUDS-20300-A4	20	300	157	107	37	22
	STUDS-20350	-	STUDS-20350-A4	20	350	207	157	87	22
M24	STUDS-24300	STUDS-24300-88	STUDS-24300-A4	24	300	132	62	-	26
M30	STUDS-30380	STUDS-30380-88	STUDS-30380-A4	30	380	181	70	-	32

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Basic performance data for single anchor

Performance data for single anchor without influence of edge distance and spacing

Size		M8	M10	M12	M16	M20	M24	M30
Substrate		**Non-cracked concrete**						
MEAN ULTIMATE LOAD								
TENSION LOAD $N_{Ru,m}$								
STUDS METRIC THREADED RODS - STEEL CLASS 5.8								
Minimum embedment depth	[kN]	18.9	30.5	40.7	63.4	88.7	111.8	143.1
Maximum embedment depth	[kN]	18.9	30.5	44.1	81.9	128.1	184.8	294.0
STUDS METRIC THREADED RODS - STEEL CLASS 8.8								
Minimum embedment depth	[kN]	21.1	30.8	40.7	65.4	88.7	111.8	143.1
Maximum embedment depth	[kN]	30.5	48.3	70.4	124.2	196.0	251.5	339.3
STUDS METRIC THREADED RODS - A4								
Minimum embedment depth	[kN]	21.1	30.8	40.7	65.4	88.7	111.8	143.1
Maximum embedment depth	[kN]	27.3	43.1	62.0	115.5	179.6	251.5	339.3
SHEAR LOAD $V_{Ru,m}$								
STUDS METRIC THREADED RODS - STEEL CLASS 5.8								
Minimum embedment depth	[kN]	11.3	18.3	26.5	49.1	76.9	110.9	176.4
Maximum embedment depth	[kN]	11.3	18.3	26.5	49.1	76.9	110.9	176.4
STUDS METRIC THREADED RODS - STEEL CLASS 8.8								
Minimum embedment depth	[kN]	18.3	29.0	42.2	79.4	123.5	177.7	282.9
Maximum embedment depth	[kN]	18.3	29.0	42.2	79.4	123.5	177.7	282.9
STUDS METRIC THREADED RODS - A4								
Minimum embedment depth	[kN]	16.4	25.8	37.2	69.3	107.7	155.6	247.6
Maximum embedment depth	[kN]	16.4	25.8	37.2	69.3	107.7	155.6	247.6
CHARACTERISTIC LOAD								
TENSION LOAD N_{Rk}								
STUDS METRIC THREADED RODS - STEEL CLASS 5.8								
Minimum embedment depth	[kN]	14.3	20.9	27.1	40.2	60.3	68.6	85.5
Maximum embedment depth	[kN]	18.0	29.0	42.0	76.4	120.6	142.1	186.6
STUDS METRIC THREADED RODS - STEEL CLASS 8.8								
Minimum embedment depth	[kN]	14.3	20.9	27.1	40.2	60.3	68.6	85.5
Maximum embedment depth	[kN]	23.9	35.8	49.2	76.4	120.6	142.1	186.6
STUDS METRIC THREADED RODS - A4								
Minimum embedment depth	[kN]	14.3	20.9	27.1	40.2	60.3	68.6	85.5
Maximum embedment depth	[kN]	23.9	35.8	49.2	76.4	120.6	142.1	186.6
SHEAR LOAD V_{Rk}								
STUDS METRIC THREADED RODS - STEEL CLASS 5.8								
Minimum embedment depth	[kN]	9.00	14.0	21.0	39.0	61.0	88.0	140.0
Maximum embedment depth	[kN]	9.00	14.0	21.0	39.0	61.0	88.0	140.0
STUDS METRIC THREADED RODS - STEEL CLASS 8.8								
Minimum embedment depth	[kN]	15.0	23.0	34.0	63.0	98.0	137.2	171.1
Maximum embedment depth	[kN]	15.0	23.0	34.0	63.0	98.0	141.0	224.0
STUDS METRIC THREADED RODS - A4								
Minimum embedment depth	[kN]	13.0	20.0	29.0	55.0	86.0	124.0	171.1
Maximum embedment depth	[kN]	13.0	20.0	29.0	55.0	86.0	124.0	196.0

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Size		M8	M10	M12	M16	M20	M24	M30
DESIGN LOAD								
TENSION LOAD N_{Rd}								
STUDS METRIC THREADED RODS - STEEL CLASS 5.8								
Minimum embedment depth	[kN]	6.82	11.6	15.1	22.3	33.5	38.1	47.5
Maximum embedment depth	[kN]	11.4	19.3	27.3	42.5	67.0	79.0	103.7
STUDS METRIC THREADED RODS - STEEL CLASS 8.8								
Minimum embedment depth	[kN]	6.82	11.6	15.1	22.3	33.5	38.1	47.5
Maximum embedment depth	[kN]	11.4	19.9	27.3	42.5	67.0	79.0	103.7
STUDS METRIC THREADED RODS - A4								
Minimum embedment depth	[kN]	6.82	11.6	15.1	22.3	33.5	38.1	47.5
Maximum embedment depth	[kN]	11.4	19.9	27.3	42.5	67.0	79.0	103.7
SHEAR LOAD V_{Rd}								
STUDS METRIC THREADED RODS - STEEL CLASS 5.8								
Minimum embedment depth	[kN]	7.20	11.2	16.8	31.2	48.8	70.4	112.0
Maximum embedment depth	[kN]	7.20	11.2	16.8	31.2	48.8	70.4	112.0
STUDS METRIC THREADED RODS - STEEL CLASS 8.8								
Minimum embedment depth	[kN]	12.0	18.4	27.2	50.4	78.4	91.5	114.0
Maximum embedment depth	[kN]	12.0	18.4	27.2	50.4	78.4	112.8	179.2
STUDS METRIC THREADED RODS - A4								
Minimum embedment depth	[kN]	8.33	12.8	18.6	35.3	55.1	79.5	114.0
Maximum embedment depth	[kN]	8.33	12.8	18.6	35.3	55.1	79.5	125.6
RECOMMENDED LOAD								
TENSION LOAD N_{rec}								
STUDS METRIC THREADED RODS - STEEL CLASS 5.8								
Minimum embedment depth	[kN]	4.87	8.29	10.8	16.0	23.9	27.2	33.9
Maximum embedment depth	[kN]	8.12	13.8	19.5	30.3	47.9	56.4	74.1
STUDS METRIC THREADED RODS - STEEL CLASS 8.8								
Minimum embedment depth	[kN]	4.87	8.29	10.8	16.0	23.9	27.2	33.9
Maximum embedment depth	[kN]	8.12	14.2	19.5	30.3	47.9	56.4	74.1
STUDS METRIC THREADED RODS - A4								
Minimum embedment depth	[kN]	4.87	8.29	10.8	16.0	23.9	27.2	33.9
Maximum embedment depth	[kN]	8.12	14.2	19.5	30.3	47.9	56.4	74.1
SHEAR LOAD V_{rec}								
STUDS METRIC THREADED RODS - STEEL CLASS 5.8								
Minimum embedment depth	[kN]	5.14	8.00	12.0	22.3	34.9	50.3	80.0
Maximum embedment depth	[kN]	5.14	8.00	12.0	22.3	34.9	50.3	80.0
STUDS METRIC THREADED RODS - STEEL CLASS 8.8								
Minimum embedment depth	[kN]	8.57	13.1	19.4	36.0	56.0	65.4	81.5
Maximum embedment depth	[kN]	8.57	13.1	19.4	36.0	56.0	80.6	128.0
STUDS METRIC THREADED RODS - A4								
Minimum embedment depth	[kN]	5.95	9.16	13.3	25.2	39.4	56.8	81.5
Maximum embedment depth	[kN]	5.95	9.16	13.3	25.2	39.4	56.8	89.7

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Basic performance data for single anchor (cont.)

Edge distance and spacing

Edge distance (tensile)

Reduction factors for edge distance $<c_{cr,N}$ applicable to N_{Rd} or N_{rec} for non-cracked concrete

Table only valid for one edge $<c_{cr,N}$ and $s \geq s_{cr,N}$

c_N [mm]	M8		M10		M12		M16		M20	M24	M30
	$h \geq 1.20h_{min}$	h_{min}	$h \geq 1.40h_{min}$	h_{min}	$h \geq 1.45h_{min}$	h_{min}	$h \geq 1.54h_{min}$	h_{min}	h_{min}	h_{min}	h_{min}
40	0.60	0.53	0.56	0.50	0.53	0.50	-	-	-	-	-
50	0.65	0.58	0.62	0.54	0.58	0.54	0.53	0.50	-	-	-
60	0.71	0.63	0.68	0.59	0.64	0.58	0.57	0.53	0.53	-	-
70	0.77	0.68	0.75	0.63	0.69	0.63	0.62	0.57	0.57	0.53	-
85	0.87	0.77	0.85	0.70	0.78	0.70	0.68	0.62	0.62	0.58	0.54
90	0.90	0.80	0.89	0.72	0.81	0.72	0.70	0.64	0.64	0.59	0.55
105	0.96	0.85	1.00	0.80	0.90	0.80	0.77	0.69	0.69	0.64	0.59
120	1.00	0.90	-	0.84	1.00	0.88	0.85	0.75	0.75	0.68	0.63
150	-	1.00	-	0.93	-	0.97	1.00	0.88	0.87	0.78	0.71
165	-	-	-	0.97	-	1.00	-	0.91	0.93	0.84	0.75
180	-	-	-	1.00	-	-	-	0.95	1.00	0.89	0.79
210	-	-	-	-	-	-	-	1.00	-	1.00	0.88
250	-	-	-	-	-	-	-	-	-	-	1.00

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Basic performance data for single anchor (cont.)

Edge distance (shear)

Increasing factors for edge distance >c_{min} applicable to $V_{Rd,c}$ for non-cracked concrete

Tables only valid for one edge >c_{min} and s ≥ $3c_V$

C_V [mm]	M8		M10		M12		M16		M20		M24		M30	
	h≥ $1.5c_V$	h_{min}	h≥ $1.5c_V$	h_{min}	h≥ $1.5c_V$	h_{min}	h≥ $1.5c_V$	h_{min}	h≥ $1.5c_V$	h_{min}	h≥ $1.5c_V$	h_{min}	h≥ $1.5c_V$	h_{min}
40	1.00	1.00	1.00	1.00	1.00	1.00	-	-	-	-	-	-	-	-
50	1.40	1.40	1.40	1.40	1.40	1.40	1.00	1.00	-	-	-	-	-	-
60	1.84	1.84	1.84	1.84	1.84	1.84	1.31	1.31	1.00	1.00	-	-	-	-
70	2.32	2.26	2.32	2.26	2.32	2.32	1.66	1.66	1.26	1.26	1.00	1.00	-	-
83	2.99	2.68	2.99	2.68	2.99	2.81	2.14	2.14	1.63	1.63	1.29	1.29	1.00	1.00
90	3.38	2.90	3.38	2.90	3.38	3.05	2.41	2.37	1.84	1.84	1.46	1.46	1.13	1.13
100	3.95	3.23	3.95	3.23	3.95	3.39	2.83	2.63	2.15	2.15	1.71	1.71	1.32	1.32
120	-	3.87	5.20	3.87	5.20	4.06	3.72	3.16	2.83	2.73	2.24	2.24	1.74	1.74
150	-	-	-	4.84	7.26	5.08	5.20	3.95	3.95	3.42	3.14	2.93	2.43	2.43
165	-	-	-	5.33	8.38	5.59	5.99	4.34	4.56	3.76	3.62	3.22	2.80	2.73
180	-	-	-	5.81	-	6.09	6.83	4.74	5.20	4.10	4.12	3.51	3.19	2.98
210	-	-	-	-	-	7.11	8.61	5.53	6.55	4.78	5.20	4.10	4.02	3.48
250	-	-	-	-	-	8.46	11.18	6.58	8.51	5.69	6.75	4.88	5.23	4.14
300	-	-	-	-	-	-	-	7.90	-	6.83	8.87	5.86	6.87	4.97
350	-	-	-	-	-	-	-	9.22	-	9.97	-	6.83	8.66	5.79
400	-	-	-	-	-	-	-	10.53	-	-	-	7.81	10.58	6.62
450	-	-	-	-	-	-	-	-	-	-	-	8.78	-	7.45
500	-	-	-	-	-	-	-	-	-	-	-	-	-	8.28
550	-	-	-	-	-	-	-	-	-	-	-	-	-	9.10
600	-	-	-	-	-	-	-	-	-	-	-	-	-	9.93

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Basic performance data for single anchor (cont.)

Spacing

Reduction factors for spacing $<s_{cr,N}$ applicable to N_{Rd} / V_{Rd} or N_{rec} / V_{rec} for non-cracked concrete

Table only valid for one spacing $<s_{cr,N}$ and $c \geq c_{cr,N}$

s [mm]	M8		M10		M12		M16		M20	M24	M30
	$h \geq 1.20h_{min}$	h_{min}	$h \geq 1.40h_{min}$	h_{min}	$h \geq 1.45h_{min}$	h_{min}	$h \geq 1.54h_{min}$	h_{min}	h_{min}	h_{min}	h_{min}
40	0.61	0.57	0.60	0.56	0.58	0.56	-	-	-	-	-
50	0.64	0.58	0.62	0.57	0.60	0.58	0.58	0.56	-	-	-
60	0.67	0.60	0.64	0.59	0.63	0.59	0.60	0.58	0.58	-	-
70	0.69	0.62	0.67	0.60	0.65	0.61	0.62	0.59	0.60	0.58	-
85	0.72	0.64	0.70	0.62	0.68	0.63	0.64	0.61	0.62	0.60	0.59
100	0.75	0.67	0.74	0.64	0.71	0.66	0.67	0.63	0.64	0.62	0.60
125	0.80	0.71	0.80	0.68	0.76	0.70	0.71	0.66	0.67	0.65	0.63
150	0.85	0.75	0.86	0.71	0.81	0.73	0.75	0.69	0.71	0.68	0.65
180	0.90	0.80	0.93	0.76	0.88	0.78	0.80	0.73	0.75	0.71	0.68
200	0.94	0.83	0.98	0.79	0.92	0.81	0.83	0.75	0.78	0.74	0.70
225	0.99	0.88	1.00	0.82	0.97	0.85	0.88	0.78	0.81	0.77	0.73
250	1.00	0.92	-	0.86	1.00	0.89	0.92	0.81	0.85	0.80	0.75
275	-	0.96	-	0.89	-	0.93	0.96	0.84	0.88	0.83	0.78
300	-	1.00	-	0.93	-	0.97	1.00	0.88	0.92	0.86	0.80
325	-	-	-	0.96	-	1.00	-	0.91	0.95	0.89	0.83
360	-	-	-	1.00	-	-	-	0.95	1.00	0.93	0.86
400	-	-	-	-	-	-	-	1.00	-	0.98	0.90
440	-	-	-	-	-	-	-	-	-	1.00	0.94
500	-	-	-	-	-	-	-	-	-	-	1.00

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Basic performance data for single anchor (cont.)

Performance data for single anchor without influence of edge distance and spacing.

STANDARD EMBEDMENT DEPTH – NON CRACKED CONCRETE

Size			M8	M10	M12	M16	M20	M24	M30
Embedment depth			**80**	**90**	**110**	**125**	**170**	**210**	**240**
MEAN ULTIMATE LOAD									
STUDS (5.8)	TENSION $N_{RU,m}$	[kN]	20.4	32.2	42.6	68.6	102.6	115.4	150.8
	SHEAR $V_{RU,m}$	[kN]	18.3	29.0	42.2	78.5	122.5	176.5	280.5
STUDS-88 (8.8)	TENSION $N_{RU,m}$	[kN]	20.4	32.2	42.6	68.6	102.6	115.4	150.8
	SHEAR $V_{RU,m}$	[kN]	29.3	46.4	67.4	125.6	196.0	282.4	448.4
STUDS-A4 (A4-70)	TENSION $N_{RU,m}$	[kN]	20.4	32.2	42.6	68.6	102.6	115.4	150.8
	SHEAR $V_{RU,m}$	[kN]	25.6	40.6	59.0	109.9	171.5	247.1	392.7
CHARACTERISTIC LOAD									
STUDS (5.8)	TENSION N_{Rk}	[kN]	18.0	26.9	37.3	50.3	85.5	102.9	124.4
	SHEAR V_{Rk}	[kN]	9.0	14.0	21.0	39.0	61.0	88.0	140.0
STUDS-88 (8.8)	TENSION N_{Rk}	[kN]	19.1	26.9	37.3	50.3	85.5	102.9	124.4
	SHEAR V_{Rk}	[kN]	15.0	23.0	34.0	63.0	98.0	141.0	224.0
STUDS-A4 (A4-70)	TENSION N_{Rk}	[kN]	19.1	26.9	37.3	50.3	85.5	102.9	124.4
	SHEAR V_{Rk}	[kN]	13.0	20.0	29.0	55.0	86.0	124.0	196.0
DESIGN LOAD									
STUDS (5.8)	TENSION N_{Rd}	[kN]	9.1	14.9	20.7	27.9	47.5	57.2	69.1
	SHEAR V_{Rd}	[kN]	7.2	11.2	16.8	31.2	48.8	70.4	112.0
STUDS-88 (8.8)	TENSION N_{Rd}	[kN]	9.1	14.9	20.7	27.9	47.5	57.2	69.1
	SHEAR V_{Rd}	[kN]	12.0	18.4	17.2	50.4	78.4	112.8	179.2
STUDS-A4 (A4-70)	TENSION N_{Rd}	[kN]	9.1	14.9	20.7	27.9	47.5	57.2	69.1
	SHEAR V_{Rd}	[kN]	8.3	12.8	18.6	35.3	55.1	79.5	125.6
RECOMMENDED LOAD*									
STUDS (5.8)	TENSION N_{Rec}	[kN]	6.5	10.7	14.8	20.0	33.9	40.9	49.4
	SHEAR V_{Rec}	[kN]	5.1	8.0	12.0	22.3	34.9	50.3	80.0
STUDS-88 (8.8)	TENSION N_{Rec}	[kN]	6.5	10.7	14.8	20.0	33.9	40.9	49.4
	SHEAR V_{Rec}	[kN]	8.6	13.1	19.4	36.0	56.0	80.6	128.0
STUDS-A4 (A4-70)	TENSION N_{Rec}	[kN]	6.5	10.7	14.8	20.0	33.9	40.9	49.4
	SHEAR V_{Rec}	[kN]	5.9	9.1	13.3	25.2	39.4	56.8	89.7
				Steel failure					

*Partial safety factor 1.4

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Performance data for dry or wet concrete (Category 1) and flooded holes, except sea water (Category 2)
In the area of reinforcement with (Ø≤10mm with spacing <100mm or Ø>10mm with spacing <150mm) use partial safety factor
$\psi_{re} = 0.5 + h_{ef} / 200 \leq 1$

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Basic performance data for single anchor (cont.)

Edge distance and spacing

Edge distance (tensile)

Reduction factors for edge distance $<c_{cr,N}$ applicable to N_{Rd} or N_{rec} for non-cracked concrete

Table only valid for one edge $<c_{cr,N}$ and $s \geq s_{cr,N}$

C_N [mm]	M8		M10		M12		M16		M20		M24		M30	
	h≥ 1.45 h_{min}	h_{min}	h≥ 1.50 h_{min}	h_{min}	h≥ 1.57 h_{min}	h_{min}	h≥ 1.61 h_{min}	h_{min}	h≥ 1.56 h_{min}	h_{min}	h≥ 1.58 h_{min}	h_{min}	h≥ 1.55 h_{min}	h_{min}
40	0.60	0.50	-	-	-	-	-	-	-	-	-	-	-	-
45	0.64	0.52	0.57	0.49	-	-	-	-	-	-	-	-	-	-
55	0.71	0.56	0.53	0.53	0.59	0.52	-	-	-	-	-	-	-	-
63	0.77	0.60	0.68	0.56	0.62	0.54	0.56	0.51	-	-	-	-	-	-
85	0.90	0.70	0.81	0.64	0.74	0.62	0.65	0.57	0.58	0.55	-	-	-	-
105	0.98	0.76	0.94	0.72	0.85	0.69	0.73	0.63	0.64	0.60	0.62	0.56	-	-
120	1.00	0.80	1.00	0.77	0.93	0.75	0.79	0.68	0.69	0.64	0.66	0.59	0.62	0.56
140	-	0.85	-	0.81	1.00	0.82	0.88	0.74	0.76	0.70	0.72	0.64	0.67	0.60
165	-	0.91	-	0.87	-	0.88	1.00	0.83	0.85	0.77	0.80	0.70	0.73	0.65
180	-	0.95	-	0.90	-	0.91	-	0.86	0.90	0.82	0.85	0.74	0.77	0.68
200	-	1.00	-	0.94	-	0.95	-	0.90	0.97	0.88	0.92	0.79	0.83	0.73
225	-	-	-	1.00	-	1.00	-	0.95	1.00	0.94	1.00	0.86	0.90	0.78
265	-	-	-	-	-	-	-	1.00	-	1.00	-	0.92	1.00	0.87
300	-	-	-	-	-	-	-	-	-	-	-	0.98	-	0.92
320	-	-	-	-	-	-	-	-	-	-	-	1.00	-	0.94
360	-	-	-	-	-	-	-	-	-	-	-	-	-	1.00

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Basic performance data for single anchor (cont.)

Edge distance (shear)

Increasing factors for edge distance >c_{min} applicable to $V_{Rd,c}$ for non-cracked concrete

Tables only valid for one edge >c_{min} and s ≥ $3c_V$

C_V [mm]	M8		M10		M12		M16		M20		M24		M30	
	h≥ $1.5c_V$	h_{min}	h≥ $1.5c_V$	h_{min}	h≥ $1.5c_V$	h_{min}	h≥ $1.5c_V$	h_{min}	h≥ $1.5c_V$	h_{min}	h≥ $1.5c_V$	h_{min}	h≥ $1.5c_V$	h_{min}
40	1.00	1.00	-	-	-	-	-	-	-	-	-	-	-	-
45	1.19	1.19	1.00	1.00	-	-	-	-	-	-	-	-	-	-
55	1.61	1.61	1.35	1.35	1.00	1.00	-	-	-	-	-	-	-	-
63	1.98	1.98	1.66	1.66	1.23	1.23	1.00	1.00	-	-	-	-	-	-
85	3.10	2.88	2.60	2.52	1.92	1.92	1.57	1.57	1.00	1.00	-	-	-	-
105	4.25	3.55	3.56	3.11	2.64	2.49	2.15	2.13	1.37	1.37	1.00	1.00	-	-
120	-	4.06	4.35	3.56	3.22	2.84	2.63	2.44	1.68	1.68	1.22	1.22	1.00	1.00
150	-	-	-	4.44	4.50	3.55	3.67	3.05	2.34	2.31	1.71	1.71	1.40	1.40
180	-	-	-	-	5.92	4.26	4.83	3.66	3.08	2.77	2.24	2.23	1.84	1.84
225	-	-	-	-	-	5.33	6.75	4.57	4.31	3.46	3.14	2.78	2.57	2.46
250	-	-	-	-	-	-	7.90	5.08	5.04	3.85	3.67	3.09	3.01	2.73
300	-	-	-	-	-	-	-	6.10	-	4.62	4.83	3.71	3.95	3.28
350	-	-	-	-	-	-	-	7.12	-	-	-	4.33	4.98	3.83
400	-	-	-	-	-	-	-	-	-	-	-	4.95	6.09	4.37
450	-	-	-	-	-	-	-	-	-	-	-	-	7.26	4.92
500	-	-	-	-	-	-	-	-	-	-	-	-	8.51	5.47
550	-	-	-	-	-	-	-	-	-	-	-	-	-	6.01

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Basic performance data for single anchor (cont.)

Spacing

Reduction factors for spacing $<s_{cr,N}$ applicable to N_{Rd} / V_{Rd} or N_{rec} / V_{rec} for non-cracked concrete

Table only valid for one spacing $<s_{cr,N}$ and $c \geq c_{cr,N}$

S [mm]	M8		M10		M12		M16		M20		M24		M30	
	h≥ 1.45 h_{min}	h_{min}	h≥ 1.50 h_{min}	h_{min}	h≥ 1.57 h_{min}	h_{min}	h≥ 1.61 h_{min}	h_{min}	h≥ 1.56 h_{min}	h_{min}	h≥ 1.58 h_{min}	h_{min}	h≥ 1.55 h_{min}	h_{min}
40	0.61	0.55	-	-	-	-	-	-	-	-	-	-	-	-
45	0.62	0.56	0.60	0.55	-	-	-	-	-	-	-	-	-	-
55	0.65	0.57	0.62	0.56	0.60	0.56	-	-	-	-	-	-	-	-
63	0.67	0.58	0.64	0.57	0.62	0.57	0.60	0.56	-	-	-	-	-	-
85	0.74	0.61	0.69	0.59	0.66	0.60	0.63	0.59	0.60	0.58	-	-	-	-
105	0.79	0.63	0.73	0.62	0.70	0.62	0.66	0.61	0.63	0.60	0.62	-	-	-
120	0.83	0.65	0.77	0.63	0.73	0.64	0.68	0.62	0.65	0.62	0.63	0.60	0.62	0.58
150	0.88	0.69	0.83	0.67	0.79	0.67	0.73	0.65	0.68	0.65	0.67	0.62	0.65	0.60
180	0.93	0.73	0.90	0.70	0.84	0.70	0.77	0.68	0.72	0.68	0.70	0.64	0.68	0.63
200	0.96	0.75	0.94	0.72	0.88	0.73	0.80	0.70	0.74	0.70	0.72	0.66	0.69	0.64
225	1.00	0.78	0.98	0.75	0.93	0.76	0.84	0.73	0.77	0.72	0.75	0.68	0.72	0.66
280	-	0.85	1.00	0.81	1.00	0.82	0.92	0.78	0.84	0.77	0.81	0.72	0.77	0.69
320	-	0.90	-	0.86	-	0.86	0.98	0.82	0.89	0.81	0.86	0.75	0.81	0.72
400	-	1.00	-	0.94	-	0.95	1.00	0.90	0.98	0.89	0.95	0.82	0.89	0.78
450	-	-	-	1.00	-	1.00	-	0.95	1.00	0.94	1.00	0.86	0.94	0.81
500	-	-	-	-	-	-	-	1.00	-	0.99	-	0.90	0.99	0.85
550	-	-	-	-	-	-	-	-	-	1.00	-	0.94	1.00	0.88
630	-	-	-	-	-	-	-	-	-	-	-	1.00	-	0.94
760	-	-	-	-	-	-	-	-	-	-	-	-	-	1.00

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Basic performance data for single anchor (cont.)

Edge distance and spacing

Edge distance (tensile)

Reduction factors for edge distance $<c_{cr.N}$ applicable to N_{Rd} or N_{rec} for non-cracked concrete

Table only valid for one edge $<c_{cr.N}$ and $s \geq s_{cr.N}$

C_N [mm]	M8		M10		M12		M16		M20		M24		M30	
	$h \geq 1.54\ h_{min}$	h_{min}	$h \geq 1.60h_{min}$	h_{min}	$h \geq 1.66\ h_{min}$	h_{min}	$h \geq 1.73\ h_{min}$	h_{min}	$h \geq 1.67\ h_{min}$	h_{min}	$h \geq 1.68\ h_{min}$	h_{min}	$h \geq 1.67\ h_{min}$	h_{min}
50	0.67	0.52	-	-	-	-	-	-	-	-	-	-	-	-
60	0.64	0.56	0.66	0.52	-	-	-	-	-	-	-	-	-	-
73	0.81	0.61	0.74	0.56	0.67	0.54	-	-	-	-	-	-	-	-
95	0.92	0.69	0.86	0.63	0.79	0.61	0.69	0.55	-	-	-	-	-	-
100	0.93	0.70	0.88	0.64	0.82	0.62	0.71	0.56	-	-	-	-	-	-
120	0.99	0.75	0.96	0.70	0.93	0.69	0.79	0.60	0.69	0.58	-	-	-	-
140	1.00	0.78	1.00	0.73	1.00	0.74	0.88	0.65	0.76	0.63	-	-	-	-
145	-	0.79	-	0.74	-	0.75	0.90	0.67	0.77	0.64	0.80	0.60	-	-
165	-	0.83	-	0.78	-	0.78	1.00	0.72	0.85	0.69	0.85	0.64	-	-
180	-	0.86	-	0.80	-	0.81	-	0.74	0.90	0.72	0.92	0.67	0.77	0.61
200	-	0.90	-	0.83	-	0.84	-	0.76	0.97	0.77	1.00	0.71	0.83	0.64
225	-	0.95	-	0.88	-	0.89	-	0.80	1.00	0.81	-	0.76	0.90	0.68
265	-	1.00	-	0.94	-	0.96	-	0.85	-	0.87	-	0.80	1.00	0.75
300	-	-	-	1.00	-	1.00	-	0.89	-	0.92	-	0.84	-	0.78
360	-	-	-	-	-	-	-	0.97	-	1.00	-	0.91	-	0.83
400	-	-	-	-	-	-	-	1.00	-	-	-	0.96	-	0.87
450	-	-	-	-	-	-	-	-	-	-	-	1.00	-	0.92
550	-	-	-	-	-	-	-	-	-	-	-	-	-	1.00

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Basic performance data for single anchor (cont.)

Edge distance (shear)

Increasing factors for edge distance >c_{min} applicable to $V_{Rd.c}$ for non-cracked concrete

Tables only valid for one edge >c_{min} and s ≥ $3c_V$

C_V [mm]	M8		M10		M12		M16		M20		M24		M30	
	h≥ $1.5c_V$	h_{min}	h≥ $1.5c_V$	h_{min}	h≥ $1.5c_V$	h_{min}	h≥ $1.5c_V$	h_{min}	h≥ $1.5c_V$	h_{min}	h≥ $1.5c_V$	h_{min}	h≥ $1.5c_V$	h_{min}
50	1.00	1.00	-	-	-	-	-	-	-	-	-	-	-	-
60	1.31	1.31	1.00	1.00	-	-	-	-	-	-	-	-	-	-
73	1.76	1.76	1.34	1.34	1.00	1.00	-	-	-	-	-	-	-	-
95	2.62	2.50	1.99	1.99	1.48	1.48	1.00	1.00	-	-	-	-	-	-
100	2.83	2.63	2.15	2.15	1.60	1.60	1.08	1.08	-	-	-	-	-	-
105	-	2.76	2.32	2.26	1.73	1.73	1.16	1.16	-	-	-	-	-	-
120	-	-	2.83	2.58	2.11	2.08	1.42	1.42	1.00	1.00	-	-	-	-
145	-	-	3.76	3.12	2.80	2.51	1.89	1.89	1.33	1.33	1.00	1.00	-	-
180	-	-	-	3.87	3.87	3.12	2.61	2.35	1.84	1.84	1.38	1.38	1.00	1.00
200	-	-	-	-	-	3.46	3.05	2.62	2.15	2.11	1.62	1.62	1.17	1.17
230	-	-	-	-	-	-	3.77	3.01	2.65	2.42	2.00	2.00	1.44	1.44
250	-	-	-	-	-	-	-	3.27	-	2.64	2.26	2.17	1.64	1.64
300	-	-	-	-	-	-	-	3.92	-	-	2.98	2.61	2.15	2.10
350	-	-	-	-	-	-	-	-	-	-	-	3.04	2.71	2.45
400	-	-	-	-	-	-	-	-	-	-	-	-	3.31	2.80
450	-	-	-	-	-	-	-	-	-	-	-	-	-	3.15

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Basic performance data for single anchor (cont.)

Spacing

Reduction factors for spacing $<s_{cr.N}$ applicable to N_{Rd} / V_{Rd} or N_{rec} / V_{rec} for non-cracked concrete

Table only valid for one spacing $<s_{cr.N}$ and $c \geq c_{cr.N}$

S [mm]	M8		M10		M12		M16		M20		M24		M30	
	h≥ 1.54 h_{min}	h_{min}	h≥ 1.60 h_{min}	h_{min}	h≥ 1.66 h_{min}	h_{min}	h≥ 1.73 h_{min}	h_{min}	h≥ 1.67 h_{min}	h_{min}	h≥ 1.68 h_{min}	h_{min}	h≥ 1.67 h_{min}	h_{min}
50	0.64	0.55	-	-	-	-	-	-	-	-	-	-	-	-
60	0.67	0.56	0.63	0.55	-	-	-	-	-	-	-	-	-	-
73	0.70	0.57	0.66	0.56	0.64	0.56	-	-	-	-	-	-	-	-
95	0.76	0.60	0.71	0.58	0.68	0.58	0.64	0.56	-	-	-	-	-	-
100	0.78	0.60	0.72	0.58	0.69	0.59	0.65	0.57	-	-	-	-	-	-
120	0.83	0.62	0.77	0.60	0.73	0.60	0.68	0.58	0.65	0.58	-	-	-	-
145	0.86	0.65	0.82	0.62	0.78	0.63	0.72	0.60	0.68	0.60	0.66	0.58	-	-
180	0.91	0.68	0.89	0.65	0.84	0.66	0.77	0.62	0.72	0.63	0.70	0.60	0.68	0.58
200	0.93	0.70	0.91	0.67	0.88	0.67	0.80	0.63	0.74	0.64	0.72	0.61	0.69	0.59
225	0.97	0.73	0.94	0.69	0.93	0.69	0.84	0.65	0.77	0.66	0.75	0.63	0.72	0.60
250	1.00	0.75	0.97	0.71	0.98	0.72	0.88	0.66	0.80	0.67	0.78	0.64	0.74	0.62
280	-	0.78	1.00	0.73	1.00	0.74	0.92	0.68	0.84	0.69	0.81	0.66	0.77	0.63
320	-	0.82	-	0.77	-	0.78	0.98	0.71	0.89	0.72	0.86	0.68	0.81	0.65
400	-	0.90	-	0.83	-	0.84	1.00	0.76	0.98	0.78	0.95	0.73	0.89	0.69
450	-	0.95	-	0.88	-	0.89	-	0.80	1.00	0.81	1.00	0.76	0.94	0.71
500	-	1.00	-	0.92	-	0.93	-	0.83	-	0.85	-	0.79	0.99	0.73
550	-	-	-	0.96	-	0.97	-	0.86	-	0.88	-	0.82	1.00	0.75
630	-	-	-	1.00	-	1.00	-	0.91	-	0.94	-	0.86	-	0.79
760	-	-	-	-	-	-	-	1.00	-	1.00	-	0.94	-	0.85
950	-	-	-	-	-	-	-	-	-	-	-	1.00	-	0.94
1100	-	-	-	-	-	-	-	-	-	-	-	-	-	1.00

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Design performance data for group of anchors

Size				M8	M10	M12	M16	M20	M24	M30
TENSION LOAD										
STEEL FAILURE (TR 029, 5.2.2.2)										
Steel class 5.8 Characteristic resistance		N_{Rks}	[kN]	18.0	29.0	42.0	78.0	122.0	176.0	280.0
Partial safety factor		γ_{Ms}	-	1.5						
Steel class 8.8 Characteristic resistance		N_{Rks}	[kN]	29.0	46.0	67.0	126.0	196.0	282.0	449.0
Partial safety factor		γ_{Ms}	-	1.5						
Steel class A4-70 Characteristic resistance		N_{Rks}	[kN]	26.0	41.0	59.0	110.0	171.0	247.0	393.0
Partial safety factor		γ_{Ms}	-	1.87						
PULL-OUT FAILURE (acc.TR 029, 5.2.2.3)										
NON-CRACKED CONCRETE C20/25 (CHARACTERISTIC RESISTANCE ACC. 5.2a $N^0_{Rk,p} = \pi \cdot d \cdot h_{ef} \cdot \tau_{Rk}$										
Characteristic bond resistance (Temp range I 40°C/24°C)		$\tau_{Rk.ucr}$	[N/mm²]	9.5	9.5	9.0	8.0	8.0	6.5	5.5
Characteristic bond resistance (Temp range II 80°C/50°C)		$\tau_{Rk.ucr}$	[N/mm²]	8.0	8.0	7.5	7.0	6.5	5.0	4.5
Partial safety factor for use category 1 + 2		γ_{Mp}	-	2.1	1.8					
Increasing factors for τ_{ucr}	C30/37	Ψ_c	-	1.04	1.04	1.04	1.04	1.00	1.00	1.00
	C40/50	Ψ_c	-	1.07	1.07	1.07	1.07	1.00	1.00	1.00
	C50/60	Ψ_c	-	1.09	1.09	1.09	1.09	1.00	1.00	1.00
CONCRETE CONE FAILURE (acc.TR 029, 5.2.2.4)										
Effective embedment depth		Min h_{ef}	[mm]	60	70	80	100	120	140	165
		Max h_{ef}	[mm]	100	120	145	190	240	290	360
Partial safety factor for use category 1 + 2*		γ_{Mc}	-	2.1	1.8					
CONCRETE SPLITTING FAILURE (acc.TR 029, 5.2.2.6)										
Effective embedment depth		Min h_{ef}	[mm]	60	70	80	100	120	140	165
		Max h_{ef}	[mm]	100	120	145	190	240	290	360
Edge distance	$h = h_{min}$	$c_{cr,sp}$	[mm]	$2.5 \cdot h_{ef}$		$2.0 \cdot h_{ef}$		$1.5 \cdot h_{ef}$		
	$h_{min} < h < 2 \cdot h_{ef}$	$c_{cr,sp}$	[mm]	From linear interpolation (drawing 1)						
	$h \geq 2 \cdot h_{ef}$	$c_{cr,sp}$	[mm]	$c_{cr,Np}$						
Spacing		$s_{cr,sp}$	[mm]	$2.0 \cdot c_{cr,sp}$						
Partial safety factor for use category 1 + 2*		γ_{Mc}	-	2.1	1.8					

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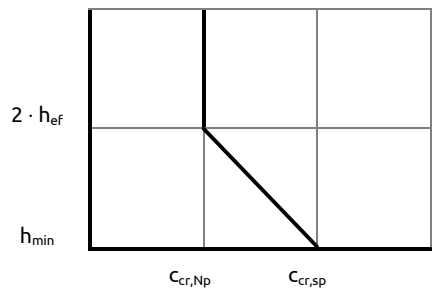
Design performance data for group of anchors

Size			M8	M10	M12	M16	M20	M24	M30
SHEAR LOAD									
STEEL FAILURE (TR 029, 5.2.3.2)									
Steel class 5.8 Characteristic resistance without lever arm	V_{Rks}	[kN]	9.0	14.0	21.0	39.0	61.0	88.0	140.0
Steel class 5.8 Characteristic resistance with lever arm	$M^0_{Rk,s}$	[Nm]	19.0	37.0	65.0	166.0	324.0	561.0	1124.0
Partial safety factor	γ_{Ms}	-				1.25			
Steel class 8.8 Characteristic resistance without lever arm	V_{Rks}	[kN]	15.0	23.0	34.0	63.0	98.0	141.0	224.0
Steel class 8.8 Characteristic resistance with lever arm	$M^0_{Rk,s}$	[Nm]	30.0	60.0	105.0	266.0	519.0	898.0	1799.0
Partial safety factor	γ_{Ms}	-				1.25			
Steel class A4-70 Characteristic resistance without lever arm	V_{Rks}	[kN]	13.0	20.0	29.0	55.0	86.0	124.0	196.0
Steel class A4-70 Characteristic resistance with lever arm	$M^0_{Rk,s}$	[Nm]	26.0	52.0	92.0	233.0	454.0	786.0	1574.0
Partial safety factor	γ_{Ms}	-				1.56			
PRYOUT FAILURE (TR 029 5.2.3.3)									
Factor	k	-	2	2	2	2	2	2	2
Partial safety factor	γ_{Ms}	-				1.5			
CONCRETE EDGE FAILURE (TR 029 5.2.3.4)									
Diameter	d	[kN]	8	10	12	16	20	24	30
Effective embedment depth	Min h_{ef}	[mm]	60	70	80	100	120	140	165
	Max h_{ef}	[mm]	100	120	145	190	240	290	360
Partial safety factor	γ_{Mc}	-				1.5			

* Use category: 1 – dry or wet concrete; 2 – flooded holes



Drawing 1. Curve to determination of $c_{cr,sp}$ in case when $h_{min} < h < 2 \cdot h_{ef}$

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