HSL-GR Heavy duty anchor, stainless steel

Anchor version		Benefits
	HSL-GR	- suitable for non-cracked C 20/25 to C 50/60 - high loading capacity - force-controlled expansion - reliable pull-down of the part fastened - no rotation in hole when tightening bolt

Concrete

PROFIS Anchor design software

Basic loading data (for a single anchor)

All data in this section applies to

For details see Simplified design method

- Correct setting (See setting instruction)
- No edge distance and spacing influence
- Concrete as specified in the table
- *Steel* failure
- Minimum base material thickness
- Concrete C 20/25, $f_{ck,cube}$ = 25 N/mm²

Mean ultimate resistance

		Hilti technical data for non-cracked concrete				
Anchor size		**M8**	**M10**	**M12**	**M16**	**M20**
Tensile $N_{Ru,m}$	[kN]	*26,9*	39,2	47,9	66,9	93,5
Shear $V_{Ru,m}$	[kN]	*26,3*	*42,0*	*57,8*	*84,0*	*115,5*

Characteristic resistance

		Hilti technical data for non-cracked concrete				
Anchor size		**M8**	**M10**	**M12**	**M16**	**M20**
Tensile N_{Rk}	[kN]	23,4	29,5	36,1	50,4	70,4
Shear V_{Rk}	[kN]	*25,0*	*40,0*	*55,0*	*80,0*	*110,0*

Design resistance

		Hilti technical data for non-cracked concrete				
Anchor size		**M8**	**M10**	**M12**	**M16**	**M20**
Tensile N_{Rd}	[kN]	13,0	16,4	20,1	28,1	39,2
Shear V_{Rd}	[kN]	16,0	25,6	35,3	51,3	70,5

Recommended loads a)

		Hilti technical data for non-cracked concrete				
Anchor size		**M8**	**M10**	**M12**	**M16**	**M20**
Tensile N_{rec}	[kN]	9,3	11,7	14,3	20,0	28,0
Shear V_{rec}	[kN]	11,4	18,3	25,2	36,6	50,4

a) With overall partial safety factor for action γ = 1,4. The partial safety factors for action depend on the type of loading and shall be taken from national regulations.

Materials

Mechanical properties of HSL-GR

Anchor size		**M8**	**M10**	**M12**	**M16**	**M20**
Nominal tensile strength f_{uk}	[N/mm²]	700	700	700	700	700
Yield strength f_{yk}	[N/mm²]	450	450	450	450	450
Stressed cross-section A_s	[mm²]	36,6	58,0	84,3	157	245
Moment of resistance W	[mm³]	31,2	62,3	109,2	277,5	540,9
Design bending resistance without sleeve $M_{Rd,s}$	[Nm]	16,8	33,5	58,8	149,4	291,3

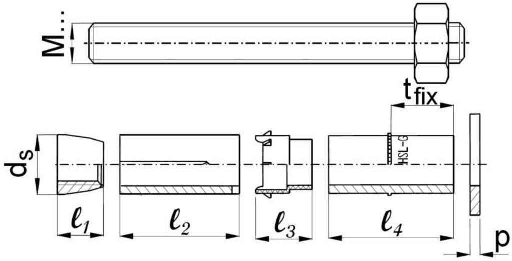
Material quality

Part	**Material**
Bolt, threaded rod	steel grade A4

Anchor dimensions

Dimensions of HSL-GR

Thread size	t_{fix} [mm]		d_s [mm]	ℓ_1 [mm]	ℓ_2 [mm]	ℓ_3 [mm]	ℓ_4 [mm]		p [mm]
	min	max					min	max	
M8	5	200	11,8	8,5	26	15,2	26	221	3
M10	5	200	14,8	10,8	30	17,2	29	224	4
M12	5	200	17,6	12	32	20	32	227	5
M16	10	200	23,6	18	46	24,4	43	233	5
M20	10	200	27,6	22	57	31,5	51	241	6

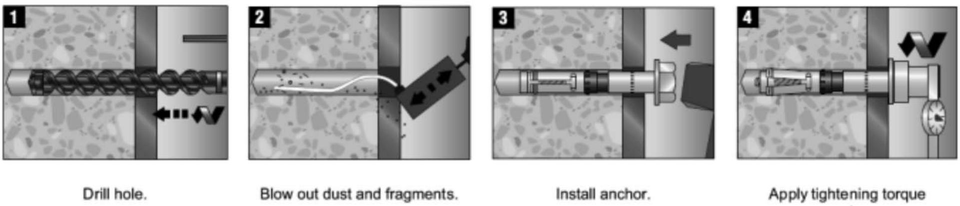


Setting

installation equipment

Anchor size	M8	M10	M12	M16	M20
Rotary hammer	TE2 – TE16			TE40 – TE70	
Other tools	hammer, torque wrench, blow out pump				

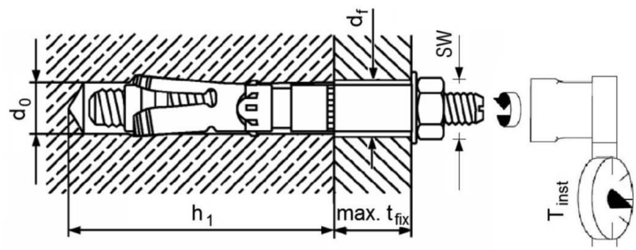
Setting instruction



For detailed information on installation see instruction for use given with the package of the product.

For technical data for anchors in diamond drilled holes please contact the Hilti Technical advisory service.

Setting details: depth of drill hole h_1 and effective anchorage depth h_{ef}

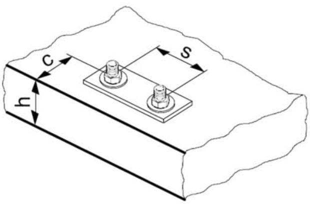


Setting details

Anchor size			M8	M10	M12	M16	M20
Nominal diameter of drill bit	d_o	[mm]	12	15	18	24	26
Cutting diameter of drill bit	$d_{cut} \leq$	[mm]	12,5	15,5	18,5	24,55	28,55
Depth of drill hole	$h_1 \geq$	[mm]	80	90	105	125	155
Diameter of clearance hole in the fixture	$d_f \leq$	[mm]	14	17	20	26	31
Effective anchorage depth	h_{ef}	[mm]	60	70	80	100	125
Torque moment	T_{inst}	[Nm]	25	50	80	120	200
Width across	SW	[mm]	13	17	19	24	30

Setting parameters

Anchor size			M8	M10	M12	M16	M20
Minimum base material thickness	h_{min}	[mm]	120	140	160	200	250
Minimum spacing	s_{min}	[mm]	100	160	240	240	300
Minimum edge distance	c_{min}	[mm]	60	70	80	100	150
Critical spacing for splitting failure	$s_{cr,sp}$	[mm]	270	300	330	380	480
Critical edge distance for splitting failure	$c_{cr,sp}$	[mm]	135	150	165	190	240
Critical spacing for concrete cone failure	$s_{cr,N}$	[mm]	180	210	240	300	375
Critical edge distance for concrete cone failure	$c_{cr,N}$	[mm]	90	105	120	150	187,5



For spacing (edge distance) smaller than critical spacing (critical edge distance) the design loads have to be reduced.

Critical spacing and critical edge distance for splitting failure apply only for non-cracked concrete. For cracked concrete only the critical spacing and critical edge distance for concrete cone failure are decisive.

Simplified design method

Simplified version of the design method according ETAG 001, Annex C.

- Influence of concrete strength
- Influence of edge distance
- Influence of spacing
- Valid for a group of two anchors. (The method may also be applied for anchor groups with more than two anchors or more than one edge. The influencing factors must then be considered for each edge distance

and spacing. The calculated design loads are then on the save side: They will be lower than the exact values according ETAG 001, Annex C.)

The design method is based on the following simplification:

- No different loads are acting on individual anchors (no eccentricity)

The values are valid for one anchor.

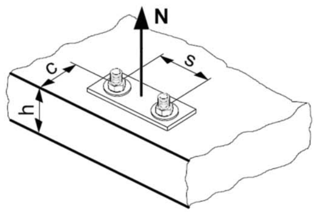
For more complex fastening applications please use the anchor design software PROFIS Anchor.

Tension loading

The design tensile resistance is the lower value of

- Steel resistance: $N_{Rd,s}$
- Concrete pull-out resistance: $N_{Rd,p} = N^0_{Rd,p} \cdot f_B$
- Concrete cone resistance: $N_{Rd,c} = N^0_{Rd,c} \cdot f_B \cdot f_{1,N} \cdot f_{2,N} \cdot f_{3,N} \cdot f_{re,N}$
- Concrete splitting resistance (only non-cracked concrete):

$$N_{Rd,sp} = N^0_{Rd,c} \cdot f_B \cdot f_{1,sp} \cdot f_{2,sp} \cdot f_{3,sp} \cdot f_{h,sp} \cdot f_{re,N}$$



Basic design tensile resistance

Design steel resistance $N_{Rd,s}$

Anchor size		M8	M10	M12	M16	M20
$N_{Rd,s}$	[kN]	13,7	21,7	31,6	58,8	91,7

Design pull-out resistance $N_{Rd,p} = N^0_{Rd,p} \cdot f_B$

Anchor size		M8	M10	M12	M16	M20
$N^0_{Rd,p}$	[kN]	No pull-out failure				

Design concrete cone resistance $N_{Rd,c} = N^0_{Rd,c} \cdot f_B \cdot f_{1,N} \cdot f_{2,N} \cdot f_{3,N} \cdot f_{re,N}$
Design splitting resistance $N_{Rd,sp} = N^0_{Rd,c} \cdot f_B \cdot f_{1,sp} \cdot f_{2,sp} \cdot f_{3,sp} \cdot f_{h,sp} \cdot f_{re,N}$

Anchor size		M8	M10	M12	M16	M20
$N^0_{Rd,c}$	[kN]	13,0	16,4	20,1	28,1	39,2

Influencing factors

Influence of concrete strength

Concrete strength designation (ENV 206)	C 20/25	C 25/30	C 30/37	C 35/45	C 40/50	C 45/55	C 50/60
$f_B = (f_{ck,cube}/25N/mm^2)^{1/2}$ a)	1	1,1	1,22	1,34	1,41	1,48	1,55

a) $f_{ck,cube}$ = concrete compressive strength, measured on cubes with 150 mm side length

Influence of edge distance a)

$c/c_{cr,N}$ $c/c_{cr,sp}$	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1
$f_{1,N} = 0{,}7 + 0{,}3 \cdot c/c_{cr,N} \leq 1$ $f_{1,sp} = 0{,}7 + 0{,}3 \cdot c/c_{cr,sp} \leq 1$	0,73	0,76	0,79	0,82	0,85	0,88	0,91	0,94	0,97	1
$f_{2,N} = 0{,}5 \cdot (1 + c/c_{cr,N}) \leq 1$ $f_{2,sp} = 0{,}5 \cdot (1 + c/c_{cr,sp}) \leq 1$	0,55	0,60	0,65	0,70	0,75	0,80	0,85	0,90	0,95	1

a) The edge distance shall not be smaller than the minimum edge distance c_{min} given in the table with the setting details. These influencing factors must be considered for every edge distance.

Influence of anchor spacing a)

$s/s_{cr,N}$ $s/s_{cr,sp}$	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1
$f_{3,N} = 0{,}5 \cdot (1 + s/s_{cr,N}) \leq 1$ $f_{3,sp} = 0{,}5 \cdot (1 + s/s_{cr,sp}) \leq 1$	0,55	0,60	0,65	0,70	0,75	0,80	0,85	0,90	0,95	1

a) The anchor spacing shall not be smaller than the minimum anchor spacing s_{min} given in the table with the setting details. This influencing factor must be considered for every anchor spacing.

Influence of base material thickness

h/h_{ef}	2,0	2,2	2,4	2,6	2,8	3,0	3,2	3,4	3,6	≥ 3,68
$f_{h,sp} = [h/(2 \cdot h_{ef})]^{2/3}$	1	1,07	1,13	1,19	1,25	1,31	1,37	1,42	1,48	1,5

Influence of reinforcement

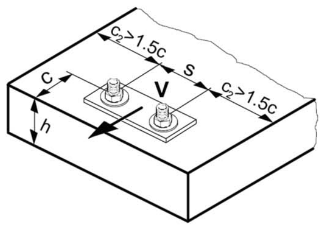
Anchor size	M8	M10	M12	M16	M20
$f_{re,N} = 0{,}5 + h_{ef}/200mm \leq 1$	0,8 a)	0,85 a)	0,9 a)	1	1

a) This factor applies only for dense reinforcement. If in the area of anchorage there is reinforcement with a spacing ≥ 150 mm (any diameter) or with a diameter ≤ 10 mm and a spacing ≥ 100 mm, then a factor $f_{re,N} = 1$ may be applied.

Shear loading

The design shear resistance is the lower value of

- Steel resistance: $V_{Rd,s}$
- Concrete pryout resistance: $V_{Rd,cp} = k \cdot N_{Rd,c}$
- Concrete edge resistance: $V_{Rd,c} = V^0_{Rd,c} \cdot f_B \cdot f_ß \cdot f_h \cdot f_4 \cdot f_{hef} \cdot f_c$



Basic design shear resistance

Design steel resistance $V_{Rd,s}$

Anchor size	M8	M10	M12	M16	M20
$V_{Rd,s}$ [kN]	16,0	25,6	35,3	51,3	70,5

Design concrete pryout resistance $V_{Rd,cp} = k \cdot N_{Rd,c}$ [a)]

Anchor size	M8	M10	M12	M16	M20
k	1,8	2,0			

a) $N_{Rd,c}$: Design concrete cone resistance

Design concrete edge resistance [a)] $V_{Rd,c} = V^0_{Rd,c} \cdot f_B \cdot f_ß \cdot f_h \cdot f_4 \cdot f_{hef} \cdot f_c$

Anchor size	M8	M10	M12	M16	M20
$V^0_{Rd,c}$ [kN]	11,4	16,5	22,4	36,2	46,9

a) For anchor groups only the anchors close to the edge must be considered.

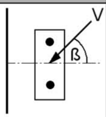
Influencing factors

Influence of concrete strength

Concrete strength designation (ENV 206)	C 20/25	C 25/30	C 30/37	C 35/45	C 40/50	C 45/55	C 50/60
$f_B = (f_{ck,cube}/25N/mm^2)^{1/2}$ [a)]	1	1,1	1,22	1,34	1,41	1,48	1,55

a) $f_{ck,cube}$ = concrete compressive strength, measured on cubes with 150 mm side length

Influence of angle between load applied and the direction perpendicular to the free edge

Angle ß	0°	10°	20°	30°	40°	50°	60°	70°	80°	≥ 90°
$f_\beta = \sqrt{\frac{1}{(\cos\alpha_V)^2 + \left(\frac{\sin\alpha_V}{2,5}\right)^2}}$ 	1	1,01	1,05	1,13	1,24	1,40	1,64	1,97	2,32	2,50

Influence of base material thickness

h/c	0,15	0,3	0,45	0,6	0,75	0,9	1,05	1,2	1,35	≥ 1,5
$f_h = \{h/(1,5 \cdot c)\}^{1/2} \leq 1$	0,32	0,45	0,55	0,63	0,71	0,77	0,84	0,89	0,95	1,00

Influence of anchor spacing and edge distance a) for concrete edge resistance: f_4

$f_4 = (c/h_{ef})^{1,5} \cdot (1 + s / [3 \cdot c]) \cdot 0,5$

c/h_{ef}	Single anchor	Group of two anchors s/h_{ef}														
		0,75	1,50	2,25	3,00	3,75	4,50	5,25	6,00	6,75	7,50	8,25	9,00	9,75	10,50	11,25
0,50	0,35	0,27	0,35	0,35	0,35	0,35	0,35	0,35	0,35	0,35	0,35	0,35	0,35	0,35	0,35	0,35
0,75	0,65	0,43	0,54	0,65	0,65	0,65	0,65	0,65	0,65	0,65	0,65	0,65	0,65	0,65	0,65	0,65
1,00	1,00	0,63	0,75	0,88	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
1,25	1,40	0,84	0,98	1,12	1,26	1,40	1,40	1,40	1,40	1,40	1,40	1,40	1,40	1,40	1,40	1,40
1,50	1,84	1,07	1,22	1,38	1,53	1,68	1,84	1,84	1,84	1,84	1,84	1,84	1,84	1,84	1,84	1,84
1,75	2,32	1,32	1,49	1,65	1,82	1,98	2,15	2,32	2,32	2,32	2,32	2,32	2,32	2,32	2,32	2,32
2,00	2,83	1,59	1,77	1,94	2,12	2,30	2,47	2,65	2,83	2,83	2,83	2,83	2,83	2,83	2,83	2,83
2,25	3,38	1,88	2,06	2,25	2,44	2,63	2,81	3,00	3,19	3,38	3,38	3,38	3,38	3,38	3,38	3,38
2,50	3,95	2,17	2,37	2,57	2,77	2,96	3,16	3,36	3,56	3,76	3,95	3,95	3,95	3,95	3,95	3,95
2,75	4,56	2,49	2,69	2,90	3,11	3,32	3,52	3,73	3,94	4,15	4,35	4,56	4,56	4,56	4,56	4,56
3,00	5,20	2,81	3,03	3,25	3,46	3,68	3,90	4,11	4,33	4,55	4,76	4,98	5,20	5,20	5,20	5,20
3,25	5,86	3,15	3,38	3,61	3,83	4,06	4,28	4,51	4,73	4,96	5,18	5,41	5,63	5,86	5,86	5,86
3,50	6,55	3,51	3,74	3,98	4,21	4,44	4,68	4,91	5,14	5,38	5,61	5,85	6,08	6,31	6,55	6,55
3,75	7,26	3,87	4,12	4,36	4,60	4,84	5,08	5,33	5,57	5,81	6,05	6,29	6,54	6,78	7,02	7,26
4,00	8,00	4,25	4,50	4,75	5,00	5,25	5,50	5,75	6,00	6,25	6,50	6,75	7,00	7,25	7,50	7,75
4,25	8,76	4,64	4,90	5,15	5,41	5,67	5,93	6,18	6,44	6,70	6,96	7,22	7,47	7,73	7,99	8,25
4,50	9,55	5,04	5,30	5,57	5,83	6,10	6,36	6,63	6,89	7,16	7,42	7,69	7,95	8,22	8,49	8,75
4,75	10,35	5,45	5,72	5,99	6,27	6,54	6,81	7,08	7,36	7,63	7,90	8,17	8,45	8,72	8,99	9,26
5,00	11,18	5,87	6,15	6,43	6,71	6,99	7,27	7,55	7,83	8,11	8,39	8,66	8,94	9,22	9,50	9,78
5,25	12,03	6,30	6,59	6,87	7,16	7,45	7,73	8,02	8,31	8,59	8,88	9,17	9,45	9,74	10,02	10,31
5,50	12,90	6,74	7,04	7,33	7,62	7,92	8,21	8,50	8,79	9,09	9,38	9,67	9,97	10,26	10,55	10,85

a) The anchor spacing and the edge distance shall not be smaller than the minimum anchor spacing s_{min} and the minimum edge distance c_{min}.

Influence of embedment depth

Anchor size	M8	M10	M12	M16	M20
$f_{hef} = 0,05 \cdot (h_{ef} / d)^{1,68}$	0,75	0,67	0,61	0,55	0,62

Influence of edge distance a)

c/d	4	6	8	10	15	20	30	40
$f_c = (d / c)^{0,19}$	0,77	0,71	0,67	0,65	0,60	0,57	0,52	0,50

a) The edge distance shall not be smaller than the minimum edge distance c_{min}.

Combined tension and shear loading

For combined tension and shear loading see section “Anchor Design”.