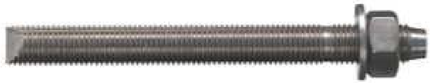
HVA adhesive system (HVU with HAS anchor rod)

Mortar system		Benefits
	Hilti HVU foil capsule	- suitable for non-cracked concrete - high loading capacity - suitable for dry and water saturated concrete - large diameter applications - high corrosion resistant
	HAS-E HAS-E R HAS-E HCR rod	

Concrete | Small edge distance and spacing | Fire resistance | Corrosion resistance | High corrosion resistance | European Technical Approval | CE conformity | PROFIS Anchor design software

Approvals / certificates

Description	Authority / Laboratory	No. / date of issue
European technical approval [a)]	DIBt, Berlin	ETA-05/0255 / 2011-06-23
Fire test report	IBMB, Braunschweig	UB-3333/0891-1 / 2004-03-26
Fire test report ZTV-Tunnel	IBMB, Braunschweig	UB 3333/0891-2 / 2003-08-12
Assessment report (fire)	warringtonfire	WF 166402 / 2007-10-26

a) All data given in this section according ETA-05/0255, issue 2011-06-23

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
- *Steel* failure
- Base material thickness, as specified in the table
- One typical embedment depth, as specified in the table
- One anchor material, as specified in the tables
- Concrete C 20/25, $f_{ck,cube}$ = 25 N/mm²
- Temperate range I
  (min. base material temperature -40°C, max. long term/short term base material temperature: +24°C/40°C)
- Installation temperature range -5°C to +40°C

Mean ultimate resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm², anchor HAS

			Data according ETA-05/0255, issue 2011-06-23							
Anchor size			M8	M10	M12	M16	M20	M24	M27	M30
Tensile $N_{Ru,m}$	HAS-E[a)]	[kN]	*17,9*	*27,3*	*39,9*	*75,6*	*117,6*	*168*	250,3	298,7
Shear $V_{Ru,m}$	HAS-E [a)]	[kN]	*8,9*	*13,7*	*20*	*37,8*	*58,8*	*84*	*182,7*	*221,6*
Tensile $N_{Ru,m}$	HAS-ER (A4)	[kN]	*24,8*	*39,6*	*57,8*	*109,1*	*170,3*	*244,4*	*230,7*	*280,2*
Shear $V_{Ru,m}$	HAS-ER (A4)	[kN]	*14,8*	*23,8*	*34,5*	*65,4*	*102,1*	*146,9*	*138,5*	*168,3*

Characteristic resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm², anchor HAS

			Data according ETA-05/0255, issue 2011-06-23							
Anchor size			M8	M10	M12	M16	M20	M24	M27	M30
Tensile N_{Rk}	HAS-E[a)]	[kN]	*17,0*	*26,0*	*38,0*	60	111,9	140	187,8	224
Shear V_{Rk}	HAS-E [a)]	[kN]	*8,5*	*13,0*	*19,0*	*36,0*	*56,0*	*80,0*	*174,0*	*211,0*
Tensile N_{Rk}	HAS-ER (A4)	[kN]	*23,0*	*36,7*	*53,5*	60	111,9	140	187,8	224
Shear V_{Rk}	HAS-ER (A4)	[kN]	*13,7*	*22,0*	*32,0*	*60,5*	*94,5*	*136,0*	*128,2*	*155,8*

Design resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm², anchor HAS

			Data according ETA-05/0255, issue 2011-06-23							
Anchor size			M8	M10	M12	M16	M20	M24	M27	M30
Tensile N_{Rd}	HAS-E[a)]	[kN]	11,3	17,3	25,3	40	74,6	93,3	125,2	149,4
Shear V_{Rd}	HAS-E [a)]	[kN]	6,8	10,4	15,2	28,8	44,8	64	139,2	168,8
Tensile N_{Rd}	HAS-ER (A4)	[kN]	12,4	19,8	28,6	40	74,6	93,3	75,9	92,2
Shear V_{Rd}	HAS-ER (A4)	[kN]	7,7	12,2	17,3	32,7	50,6	71,8	45,8	55,5

Recommended loads [b)]: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm², anchor HAS

			Data according ETA-05/0255, issue 2011-06-23							
Anchor size			M8	M10	M12	M16	M20	M24	M27	M30
Tensile N_{rec}	HAS-E[a)]	[kN]	5,7	8,7	12,7	20	37,3	46,7	62,6	74,7
Shear V_{rec}	HAS-E [a)]	[kN]	2,8	4,3	6,3	12,0	18,7	26,7	58,0	70,3
Tensile N_{rec}	HAS-ER (A4)	[kN]	7,6	12,2	17,8	20	37,3	46,7	62,6	74,7
Shear V_{rec}	HAS-ER (A4)	[kN]	4,6	7,3	10,7	20,2	31,5	45,3	42,7	51,9

a) The standard delivery program for HAS-E anchor rod: Grade 5.8 for HAS-E M8-M24, Grade 8.8 for M27-M39.
b) With overall global safety factor γ = 3. The recommended loads vary according to the safety factor requirement from national regulations.

Service temperature range

Hilti HVU adhesive may be applied in the temperature ranges given below. An elevated base material temperature may lead to a reduction of the design bond resistance.

Temperature range	Base material temperature	Maximum long term base material temperature	Maximum short term base material temperature
Temperature range I	-40 °C to +40 °C	+24 °C	+40 °C
Temperature range II	-40 °C to +80 °C	+50 °C	+80 °C
Temperature range III	-40 °C to +120 °C	+72 °C	+120 °C

Max short term base material temperature
Short-term elevated base material temperatures are those that occur over brief intervals, e.g. as a result of diurnal cycling.

Max long term base material temperature
Long-term elevated base material temperatures are roughly constant over significant periods of time.

Materials

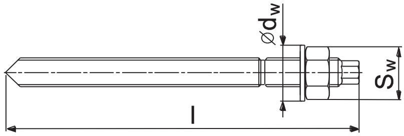
Mechanical properties of HAS

			Data according ETA-05/0255/0256/0257, issue 2011-06-23							
Anchor size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Nominal tensile strength f_{uk}	HAS-(E)	[N/mm²]	500	500	500	500	500	500	800	800
	HAS-(E)F	[N/mm²]	800	800	800	800	800	800	800	800
	HAS –(E)R	[N/mm²]	700	700	700	700	700	700	500	500
	HAS –(E)HCR	[N/mm²]	800	800	800	800	800	700	-	-
Yield strength f_{yk}	HAS-(E)	[N/mm²]	400	400	400	400	400	400	640	640
	HAS-(E)F	[N/mm²]	640	640	640	640	640	640	640	640
	HAS –(E)R	[N/mm²]	450	450	450	450	450	450	210	210
	HAS –(E)HCR	[N/mm²]	600	600	600	600	600	400	-	-
Stressed cross-section A_s	HAS	[mm²]	32,8	52,3	76,2	144	225	324	427	519
Moment of resistance W	HAS	[mm³]	27,0	54,1	93,8	244	474	809	1274	1706

Material quality

Part	Material
Threaded rod HAS-(E) M8-M24 HAS-(E) M27+M30	Strength class 5.8, EN ISO 898-1, A_5 > 8% ductile steel galvanized ≥ 5 µm, EN ISO 4042 (F) hot dipped galvanized ≥ 45 µm, EN ISO 10684
Threaded rod HAS-(E)F M8-M30 HAS-(E) M27+M30	Strength class 8.8, EN ISO 898-1, A_5 > 8% ductile steel galvanized ≥ 5 µm, EN ISO 4042 (F) hot dipped galvanized ≥ 45 µm, EN ISO 10684
Threaded rod HAS-(E)R	Stainless steel grade A4, A_5 > 8% ductile strength class 70 for ≤ M24 and class 50 for M27 to M30, EN ISO 3506-1, EN 10088: 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362
Threaded rod HAS-(E)HCR	High corrosion resistant steel, EN ISO 3506-1, EN 10088: 1.4529; 1.4565 strength ≤ M20: R_m = 800 N/mm², $R_{p\,0.2}$ = 640 N/mm², A_5 > 8% ductile M24: R_m = 700 N/mm², $R_{p\,0.2}$ = 400 N/mm², A_5 > 8% ductile
Washer ISO 7089	Steel galvanized, EN ISO 4042; hot dipped galvanized, EN ISO 10684
	Stainless steel, EN 10088: 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362
	High corrosion resistant steel, EN 10088: 1.4529; 1.4565
Nut EN ISO 4032	Strength class 8, ISO 898-2 steel galvanized ≥ 5 µm, EN ISO 4042 hot dipped galvanized ≥ 45 µm, EN ISO 10684
	Strength class 70, EN ISO 3506-2, stainless steel grade A4, EN 10088: 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362
	Strength class 70, EN ISO 3506-2, high corrosion resistant steel, EN 10088: 1.4529; 1.4565

Anchor dimensions



Anchor size		M8	M10	M12	M16	M20	M24	M27	M30
Anchor rod HAS-E, HAS-R, HAS-ER HAS-HCR		M8x80	M10x90	M12x110	M16x125	M20x170	M24x210	M27x240	M30x270
Anchor embedment depth	[mm]	80	90	110	125	170	210	240	270
Anchor length $_l$	[mm]	110	130	160	190	240	290	340	380
Width across flats $_{sw}$	[mm]	13	17	19	24	30	36	41	46
Washer diameter $_{dw}$	[mm]	16	20	24	30	37	44	50	56

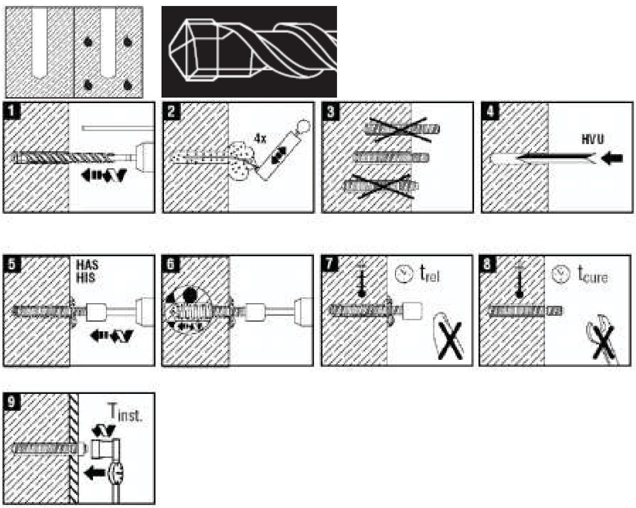
Setting

installation equipment

Anchor size	M8	M10	M12	M16	M20	M24	M27	M30
Rotary hammer	TE 2 – TE 16				TE 40 – TE 70			
Other tools	blow out pump or compressed air gun, setting tools							

Setting instruction

Dry and water-saturated concrete, hammer drilling



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

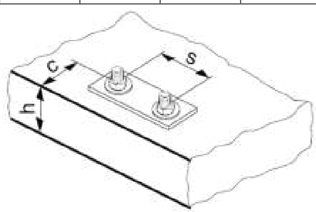
For technical data for anchors in diamond drilled holes please contact the Hilti Technical advisory service.

Curing time for general conditions

Data according ETA-05/0255/0256/0257, issue 2010-03-01 / 2006-01-20	
Temperature of the base material	**Curing time before anchor can be fully loaded t_{cure}**
20 °C to 40 °C	20 min
10 °C to 19 °C	30 min
0 °C to 9 °C	1 h
-5 °C to - 1 °C	5 h

Setting details

			Data according ETA-05/0255/0256/0257, issue 2011-06-23							
Anchor size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Nominal diameter of drill bit	d_0	[mm]	10	12	14	18	24	28	30	35
Effective anchorage and drill hole depth	h_{ef}	[mm]	80	90	110	125	170	210	240	270
Diameter of clearance hole in the fixture	d_f	[mm]	9	12	14	18	22	26	30	33
Minimum spacing	s_{min}	[mm]	40	45	55	65	90	120	130	135
Minimum edge distance	c_{min}	[mm]	40	45	55	65	90	120	130	135
Critical spacing for splitting failure	$s_{cr,sp}$		$2\ c_{cr,sp}$							
Critical edge distance for splitting failure Temperature range I										
Optimized for minimum base material thickness	h_{min} a)	[mm]	140	160	210	210	340	370	480	540
	$c_{cr,sp}$	[mm]	160	180	220	250	340	420	480	540
Optimized for minimum spacing	h_{min} a)	[mm]	160	180	220	250	340	420	480	540
	$c_{cr,sp}$	[mm]	100	130	180	180	340	340	480	540
Critical edge distance for splitting failure Temperature range II										
Optimized for minimum base material thickness	h_{min} a)	[mm]	110	120	170	170	220	300	340	380
	$c_{cr,sp}$	[mm]	130	150	220	250	340	420	480	540
Optimized for minimum spacing	h_{min} a)	[mm]	160	180	220	250	340	420	480	540
	$c_{cr,sp}$	[mm]	80	90	110	125	170	210	240	270
Critical edge distance for splitting failure Temperature range III										
	h_{min} a)	[mm]	110	120	140	170	220	270	300	340
	$c_{cr,sp}$	[mm]	80	90	110	125	170	210	240	270
Critical spacing for concrete cone failure	$s_{cr,N}$		$2\ c_{cr,N}$							
Critical edge distance for concrete cone failure	$c_{cr,N}$		$1{,}5\ h_{ef}$							
Torque moment b)	T_{max}	[Nm]	10	20	40	80	150	200	270	300



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

a) h: base material thickness ($h \geq h_{min}$)

b) This is the maximum recommended torque moment to avoid splitting failure during installation for anchors with minimum spacing and/or edge distance.

Simplified design method

Simplified version of the design method according ETAG 001, Annex C. Design resistance according data given in ETA-05/0255/0256/0257, issue 2011-06-23.

- 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 distance. 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. To avoid this, it is recommended to use the anchor design software PROFIS anchor)

The design method is based on the following simplification:

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

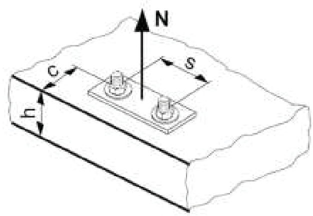
The values are valid for one anchor.

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: $N_{Rd,s}$
- Combined pull-out and concrete cone resistance:
  $N_{Rd,p} = N^0_{Rd,p} \cdot f_{B,p} \cdot f_{h,p}$
- Concrete cone resistance: $N_{Rd,c} = N^0_{Rd,c} \cdot f_B \cdot f_{1,N} \cdot f_{2,N} \cdot f_{3,N} \cdot f_{h,N} \cdot f_{re,N}$
- 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 $N_{Rd,s}$

γ_{Ms} = 1.5 (HAS-E) 1.87 (HAS-ER)

			Data according ETA-05/0255/0256/0257, issue 2011-06-23							
Anchor size			M8	M10	M12	M16	M20	M24	M27	M30
$N_{Rd,s}$	HAS -(E)	[kN]	11,1	17,6	25,4	48,1	74,8	106,8	231,3	281,0
	HAS -(E)F	[kN]	17,7	28,2	40,6	76,9	119,6	170,9	231,3	281,0
	HAS (-E)-R	[kN]	12,4	19,8	28,6	54,1	84,1	120,2	75,9	92,2
	HAS (-E)-HCR	[kN]	17,7	28,2	40,6	76,9	119,6	106,8	-	-

Design combined pull-out and concrete cone resistance $N_{Rd,p} = N^0_{Rd,p} \cdot f_{B,p} \cdot f_{h,p}$ $\gamma_{Mp} = 1.5$

			Data according ETA-05/0255/0256/0257, issue 2011-06-23							
Anchor size			M8	M10	M12	M16	M20	M24	M27	M30
Typical embedment depth $h_{ef,typ}$ [mm]			80	90	110	125	170	200	210	270
$N^0_{Rd,p}$	Temperature range I	[kN]	16,7	23,3	33,3	40,0	76,7	93,3	133,3	166,7
$N^0_{Rd,p}$	Temperature range II	[kN]	13,3	16,7	26,7	33,3	50,0	76,7	93,3	113,3
$N^0_{Rd,p}$	Temperature range III	[kN]	6,0	8,0	10,7	16,7	26,7	40,0	50,0	50,0

Design concrete cone resistance $N_{Rd,c} = N^0_{Rd,c} \cdot f_B \cdot f_{1,N} \cdot f_{2,N} \cdot f_{3,N} \cdot f_{h,N} \cdot f_{re,N}$
Design splitting resistance a) $N_{Rd,sp} = N^0_{Rd,c} \cdot f_B \cdot f_{h,N} \cdot f_{1,sp} \cdot f_{2,sp} \cdot f_{3,sp} \cdot f_{re,N}$ $\gamma_{Mc} = 1.5$

		Data according ETA-05/0255/0256/0257, issue 2011-06-23							
Anchor size		M8	M10	M12	M16	M20	M24	M27	M30
$N^0_{Rd,c}$	[kN]	24,1	28,7	38,8	47,1	74,6	102,5	125,2	149,4

a) Splitting resistance must only be considered for non-cracked concrete

Influencing factors

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

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
$f_{B,p} = (f_{ck,cube}/25N/mm^2)^{0,1}$ a) b)	1	1,02	1,04	1,06	1,07	1,08	1,09

a) $f_{ck,cube}$ = concrete compressive strength, measured on cubes with 150 mm side length
b) For design data for $f_{ck,cube}$ = 15 and 20, please contact Hilti Technical Advisory Service

Influence of embedment depth on combined pull-out and concrete cone resistance

$$f_{h,p} = 1$$

Influence of concrete strength on concrete cone resistance

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
b) For design data of $f_{ck,cube}$ = 15 and 20, please contact Hilti technical advisory service

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

a) The 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 smaller than the critical 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
$f_{3,N} = 0{,}5\cdot(1 + s/s_{cr,N})$ $f_{3,sp} = 0{,}5\cdot(1 + s/s_{cr,sp})$	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 embedment depth on concrete cone resistance

$$f_{h,N} = 1$$

Influence of reinforcement

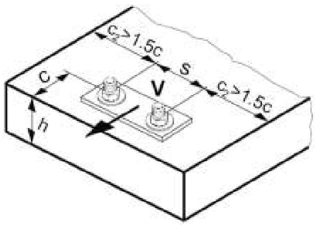
h_{ef} [mm]	40	50	60	70	80	90	≥ 100
$f_{re,N} = 0{,}5 + h_{ef}/200mm \le 1$	0,7 [a)]	0,75 [a)]	0,8 [a)]	0,85 [a)]	0,9 [a)]	0,95 [a)]	1

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 $f_{re} = 1$ may be applied.

Shear loading

The design shear resistance is the lower value of

- Steel resistance: $V_{Rd,s}$
- Concrete pryout resistance: $V_{Rd,cp} = k \cdot$ lower value of $N_{Rd,p}$ and $N_{Rd,c}$
- Concrete edge resistance: $V_{Rd,c} = V^0_{Rd,c} \cdot f_B \cdot f_ß \cdot f_h \cdot f_4$



Basic design shear resistance

Design steel resistance $V_{Rd,s}$

γ_{Ms} = 1.25 (HAS-E) 1.56 (HAS-ER)

			Data according ETA-05/0255/0256/0257, issue 2011-06-23							
Anchor size			M8	M10	M12	M16	M20	M24	M27	M30
$V_{Rd,s}$	HAS -(E)	[kN]	6,6	10,6	15,2	28,8	44,9	64,1	138,8	168,6
	HAS -(E)F	[kN]	10,6	16,9	24,4	46,1	71,8	102,6	138,8	168,6
	HAS (-E)-R	[kN]	7,5	11,9	17,1	32,4	50,5	72,1	45,5	55,3
	HAS (-E)-HCR	[kN]	10,6	16,9	24,4	46,1	71,8	64,1	-	-

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

$$k = 1 \text{ for } h_{ef} < 60 \text{ mm}$$
$$k = 2 \text{ for } h_{ef} \ge 60 \text{ mm}$$

a) $N_{Rd,p}$: Design combined pull-out and concrete cone resistance
$N_{Rd,c}$: Design concrete cone resistance

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

$\gamma_{Mc} = 1.5$

Anchor size	M8	M10	M12	M16	M20	M24	M27	M30
$V^0_{Rd,c}$ [kN]	6,7	8,8	13,1	17,7	31,9	48,3	62,8	79,2

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

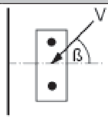
Influencing factors

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
b) For design data of $f_{ck,cube}$ = 15 and 20, please contact Hilti technical advisory service

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

Angle ß	0° - 55°	60°	65°	70°	75°	80°	85°	90° - 180°
$f_ß$ 	1	1,07	1,14	1,23	1,35	1,50	1,71	2

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
$f_h = \{h/(1,5 \cdot c)\}^{2/3} \leq 1$	0,22	0,34	0,45	0,54	0,63	0,71	0,79	0,86	0,93	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}.

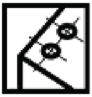
Combined tension and shear loading

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

HVA adhesive system (HVU with HIS-(R)N)

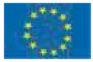
Mortar system		Benefits
	Hilti HVU foil capsule	- suitable for non-cracked concrete - high loading capacity - suitable for dry and water saturated concrete
	HIS-(R)N sleeve	


Concrete

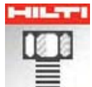

Small edge distance and spacing


Fire resistance

A4
316
Corrosion resistance


European Technical Approval

CE
CE conformity


PROFIS Anchor design software

Approvals / certificates

Description	Authority / Laboratory	No. / date of issue
European technical approval [a]	DIBt, Berlin	ETA-05/0255 / 2011-06-23
Fire test report	IBMB, Braunschweig	UB-3333/0891-1 / 2004-03-26
Assessment report (fire)	warringtonfire	WF 166402 / 2007-10-26

a) All data given in this section according ETA-05/0255, issue 2011-06-23.

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
- *Steel* failure
- Screw strength class 8.8 (HIS-N) or A4-70 (HIS-RN)
- Base material thickness, as specified in the table
- One typical embedment depth, as specified in the table
- One anchor material, as specified in the tables
- Concrete C 20/25, $f_{ck,cube}$ = 25 N/mm²
- Temperate range I
  (min. base material temperature -40°C, max. long term/short term base material temperature: +24°C/40°C)
- Installation temperature range -5°C to +40°C

Embedment depth and base material thickness for the basic loading data.
Characteristic resistance, design resistance, recommended loads.

Anchor size	M8	M10	M12	M16	M20
Embedment depth [mm]	90	110	125	170	205
Base material thickness [mm]	120	150	180	250	350

Characteristic resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm², anchor HIS-N

			Data according ETA-05/0255, issue 2011-06-23				
Anchor size			**M8**	**M10**	**M12**	**M16**	**M20**
Tensile N_{Rk}	HIS-N	[kN]	*25,0*	40,0	60,0	95,0	*109,0*
Shear V_{Rk}	HIS-N	[kN]	*13,0*	*23,0*	*39,0*	*59,0*	*55,0*
Tensile N_{Rk}	HIS-RN (A4)	[kN]	25,0	40,0	*59,0*	95,0	140,0
Shear V_{Rk}	HIS-RN (A4)	[kN]	*13,0*	*20,0*	*30,0*	*55,0*	*83,0*

Design resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm², anchor HIS-N

			Data according ETA-05/0255, issue 2011-06-23				
Anchor size			**M8**	**M10**	**M12**	**M16**	**M20**
Tensile N_{Rd}	HIS-N	[kN]	16,7	26,7	40,0	63,3	74,1
Shear V_{Rd}	HIS-N	[kN]	10,4	18,4	26,0	39,3	36,7
Tensile N_{Rk}	HIS-RN (A4)	[kN]	16,7	26,7	31,6	63,3	69,1
Shear V_{Rk}	HIS-RN (A4)	[kN]	8,3	12,8	19,2	35,3	41,5

Recommended loads [a)]: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm², anchor HIS-N

			Data according ETA-05/0255, issue 2011-06-23				
Anchor size			**M8**	**M10**	**M12**	**M16**	**M20**
Tensile N_{rec}	HIS-N	[kN]	8,3	13,3	20,0	31,7	36,3
Shear V_{rec}	HIS-N	[kN]	4,3	7,7	13,0	19,7	18,3
Tensile N_{Rk}	HIS-RN (A4)	[kN]	8,3	13,3	19,7	31,7	46,7
Shear V_{Rk}	HIS-RN (A4)	[kN]	4,3	6,7	10,0	18,3	27,7

a) With overall global safety factor γ = 3. The recommended loads vary according to the safety factor requirement from national regulations.

Service temperature range

Hilti HVU adhesive may be applied in the temperature ranges given below. An elevated base material temperature may lead to a reduction of the design bond resistance.

Temperature range	Base material temperature	Maximum long term base material temperature	Maximum short term base material temperature
Temperature range I	-40 °C to +40 °C	+24 °C	+40 °C
Temperature range II	-40 °C to +80 °C	+50 °C	+80 °C
Temperature range III	-40 °C to +120 °C	+72 °C	+120 °C

Max short term base material temperature
Short-term elevated base material temperatures are those that occur over brief intervals, e.g. as a result of diurnal cycling.

Max long term base material temperature
Long-term elevated base material temperatures are roughly constant over significant periods of time.

Materials

Mechanical properties of HIS-(R)N

			Data according ETA-05/0255/0256, issue 2011-06-23				
Anchor size			**M8**	**M10**	**M12**	**M16**	**M20**
Nominal tensile strength f_{uk}	HIS-N	[N/mm²]	490	490	460	460	460
	Screw 8.8	[N/mm²]	800	800	800	800	800
	HIS-RN	[N/mm²]	700	700	700	700	700
	Screw A4-70	[N/mm²]	700	700	700	700	700
Yield strength f_{yk}	HIS-N	[N/mm²]	410	410	375	375	375
	Screw 8.8	[N/mm²]	640	640	640	640	640
	HIS-RN	[N/mm²]	350	350	350	350	350
	Screw A4-70	[N/mm²]	450	450	450	450	450
Stressed cross-section A_s	HIS-(R)N	[mm²]	51,5	108,0	169,1	256,1	237,6
	Screw	[mm²]	36,6	58	84,3	157	245
Moment of resistance W	HIS-(R)N	[mm³]	145	430	840	1595	1543
	Screw	[mm³]	31,2	62,3	109	277	541

Material quality

Part	Material
internally threaded sleeves [a)] HIS-N	C-steel 1.0718, EN 10277-3 steel galvanized ≥ 5µm EN ISO 4042
internally threaded sleeves [b)] HIS-RN	stainless steel 1.4401 and 1.4571 EN 10088

a) related fastening screw: strength class 8.8 EN ISO 898-1, A5 > 8% Ductile
steel galvanized ≥ 5µm EN ISO 4042

b) related fastening screw: strength class 70 EN ISO 3506-1, A5 > 8% Ductile
stainless steel 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362 EN 10088

Anchor dimensions

Anchor size		M8	M10	M12	M16	M20
Internal sleeve HIS-(R)N		M8x90	M10x110	M12x125	M16x170	M20x205
Anchor embedment depth	[mm]	90	110	125	170	205

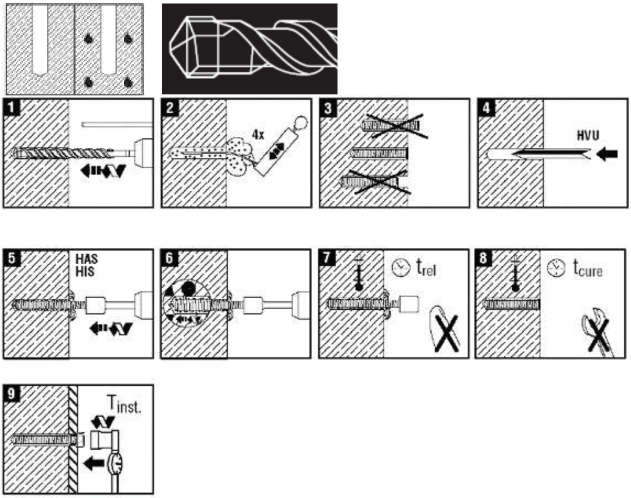
Setting

installation equipment

Anchor size	M8	M10	M12	M16	M20
Rotary hammer	TE2 – TE16		TE40 – TE70		
Other tools	blow out pump or compressed air gun, setting tools				

Setting instruction

Dry and water-saturated concrete, hammer drilling



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

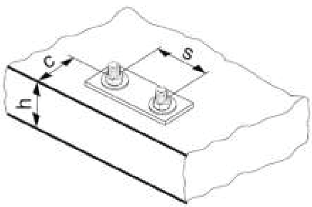
For technical data for anchors in diamond drilled holes please contact the Hilti Technical advisory service.

Curing time for general conditions

Data according ETA-05/0255/0256, issue 2011-06-23	
Temperature of the base material	**Curing time before anchor can be fully loaded t_{cure}**
20 °C to 40 °C	20 min
10 °C to 19 °C	30 min
0 °C to 9 °C	1 h
-5 °C to - 1 °C	5 h

Setting details

			Data according ETA-05/0255/0256, issue 2011-06-23				
Anchor size	**Sleeve HIS-(R)N foil capsule**		**M8x90 M10x90**	**M10x110 M12x110**	**M12x125 M16x125**	**M16x170 M20x170**	**M20x205 M24x210**
Nominal diameter of drill bit	d_0	[mm]	14	18	22	28	32
Diameter of element	d	[mm]	12,5	16,5	20,5	25,4	27,6
Effective anchorage and drill hole depth	h_{ef}	[mm]	90	110	125	170	205
Diameter of clearance hole in the fixture	d_f	[mm]	9	12	14	18	22
Thread engagement length; min - max	h_s	[mm]	8-20	10-25	12-30	16-40	20-50
Minimum spacing	s_{min}	[mm]	40	45	60	80	125
Minimum edge distance	c_{min}	[mm]	40	45	60	80	125
Critical spacing for splitting failure	$s_{cr,sp}$		2 $c_{cr,sp}$				
Critical edge distance for splitting failure Temperature range I							
Optimized for minimum base material thickness	h_{min} a)	[mm]	120	150	180	250	350
	$c_{cr,sp}$	[mm]	90	150	250	340	410
Optimized for minimum spacing	h_{min} a)	[mm]	-	220	250	340	410
	$c_{cr,sp}$	[mm]	-	110	125	170	250
Critical edge distance for splitting failure Temperature range II							
	h_{min} a)	[mm]	120	150	170	230	270
	$c_{cr,sp}$	[mm]	90	110	150	170	220
Critical edge distance for splitting failure Temperature range III							
	h_{min} a)	[mm]	120	150	170	230	270
	$c_{cr,sp}$	[mm]	90	110	125	170	205
Critical spacing for concrete cone failure	$s_{cr,N}$		2 $c_{cr,N}$				
Critical edge distance for concrete cone failure	$c_{cr,N}$		1,5 h_{ef}				
Torque moment b)	T_{max}	[Nm]	10	20	40	80	150



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

a) h: base material thickness ($h \geq h_{min}$)

b) This is the maximum recommended torque moment to avoid splitting failure during installation for anchors with minimum spacing and/or edge distance.

Simplified design method

Simplified version of the design method according ETAG 001, Annex C. Design resistance according data given in ETA-05/0255/0256, issue 2011-06-23.

- 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 distance. 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. To avoid this, it is recommended to use the anchor design software PROFIS anchor)

The design method is based on the following simplification:

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

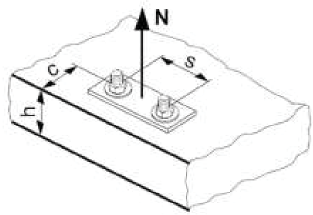
The values are valid for one anchor.

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: $N_{Rd,s}$
- Combined pull-out and concrete cone resistance:
  $N_{Rd,p} = N^0_{Rd,p} \cdot f_{B,p} \cdot f_{h,p}$
- Concrete cone resistance: $N_{Rd,c} = N^0_{Rd,c} \cdot f_B \cdot f_{1,N} \cdot f_{2,N} \cdot f_{3,N} \cdot f_{h,N} \cdot f_{re,N}$
- 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 $N_{Rd,s}$

$\gamma_{Mc} \geq 1.47$

			Data according ETA-05/0255/0256, issue 2011-06-23				
Anchor size			M8	M10	M12	M16	M20
$N_{Rd,s}$	HIS-N	[kN]	16,8	30,7	44,7	80,3	74,1
	HIS-RN	[kN]	13,9	21,9	31,6	58,8	69,2

Design combined pull-out and concrete cone resistance $N_{Rd,p} = N^0_{Rd,p} \cdot f_{B,p} \cdot f_{h,p}$

$\gamma_{Mp} = 1.5$

			Data according ETA-05/0255/0256, issue 2011-06-23				
Anchor size			M8	M10	M12	M16	M20
Embedment depth h_{ef} [mm]			90	110	125	170	205
$N^0_{Rd,p}$	Temperature range I	[kN]	16,7	26,7	40,0	63,3	93,3
$N^0_{Rd,p}$	Temperature range II	[kN]	13,3	23,3	33,3	50,0	63,3
$N^0_{Rd,p}$	Temperature range III	[kN]	6,0	10,7	13,3	26,7	33,3

Design concrete cone resistance $N_{Rd,c} = N^0_{Rd,c} \cdot f_B \cdot f_{1,N} \cdot f_{2,N} \cdot f_{3,N} \cdot f_{h,N} \cdot f_{re,N}$
Design splitting resistance [a] $N_{Rd,sp} = N^0_{Rd,c} \cdot f_B \cdot f_{h,N} \cdot f_{1,sp} \cdot f_{2,sp} \cdot f_{3,sp} \cdot f_{re,N}$ $\gamma_{Mc} = 1.5$

	Data according ETA-05/0255/0256, issue 2011-06-23				
Anchor size	**M8**	**M10**	**M12**	**M16**	**M20**
$N^0_{Rd,c}$ [kN]	28,7	38,8	47,1	74,6	98,8

a) Splitting resistance must only be considered for non-cracked concrete

Influencing factors

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

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
$f_{B,p} = (f_{ck,cube}/25N/mm^2)^{0,1}$ [a]	1	1,02	1,04	1,06	1,07	1,08	1,09

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

Influence of embedment depth on combined pull-out and concrete cone resistance

$$f_{h,p} = h_{ef}/h_{ef,typ}$$

Influence of concrete strength on concrete cone resistance

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
b) For design data of $f_{ck,cube}$ = 15 and 20, please contact Hilti technical advisory service

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

a) The 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 smaller than the critical 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
$f_{3,N} = 0,5 \cdot (1 + s/s_{cr,N})$ / $f_{3,sp} = 0,5 \cdot (1 + s/s_{cr,sp})$	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 embedment depth on concrete cone resistance

$$f_{h,N} = (h_{ef}/h_{ef,typ})^{1,5}$$

Influence of reinforcement

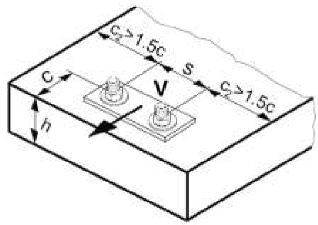
h_{ef} [mm]	80	90	≥ 100
$f_{re,N}$ = 0,5 + h_{ef}/200mm ≤ 1	0,9 a)	0,95 a)	1

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} = 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 · lower value of $N_{Rd,p}$ and $N_{Rd,c}$
- Concrete edge resistance: $V_{Rd,c} = V^0_{Rd,c} \cdot f_B \cdot f_ß \cdot f_h \cdot f_4$



Basic design shear resistance

Design steel resistance $V_{Rd,s}$

γ_{Ms} = vary according to ETA

		Data according ETA-05/0255/0256, issue 2011-06-23				
Anchor size		M8	M10	M12	M16	M20
$V_{Rd,s}$	HIS-N [kN]	10,4	18,4	26,0	39,3	36,7
	HIS-RN [kN]	8,3	12,8	19,2	35,3	41,5

Design concrete pryout resistance $V_{Rd,cp}$ = lower value[a)] of k · $N_{Rd,p}$ and k · $N_{Rd,c}$

k = 1 for h_{ef} < 60 mm
k = 2 for h_{ef} ≥ 60 mm

a) $N_{Rd,p}$: Design combined pull-out and concrete cone resistance
$N_{Rd,c}$: Design concrete cone resistance

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

γ_{Mc} = 1.5

Anchor size	M8	M10	M12	M16	M20
$V^0_{Rd,c}$ [kN]	9,4	14,4	19,1	34,3	48,4

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

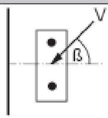
Influencing factors

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
b) For design data of $f_{ck,cube}$ = 15 and 20, please contact Hilti technical advisory service

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

Angle ß	0° - 55°	60°	65°	70°	75°	80°	85°	90° - 180°
$f_ß$ 	1	1,07	1,14	1,23	1,35	1,50	1,71	2

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
$f_h = \{h/(1,5 \cdot c)\}^{2/3} \le 1$	0,22	0,34	0,45	0,54	0,63	0,71	0,79	0,86	0,93	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}.

Combined tension and shear loading

For combined tension and shear loading see section "Anchor Design".