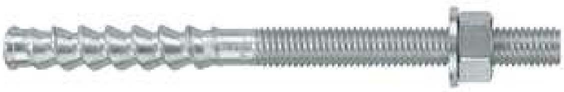
Hilti HIT-HY 200 with HIT-Z

Injection mortar system		Benefits
	Hilti HIT-HY 200-A 500 ml foil pack (also available as 330 ml foil pack)	- No cleaning required: Zero succeptability to borehole cleaning conditions with dry and water saturated concrete base material - Maximum load performance in cracked concrete and uncracked concrete - Suitable for cracked and non-cracked concrete C 20/25 to C 50/60 - Suitable for use with diamond cored holes in non-cracked or cracked concrete with no load reductions - Two mortar (Hilti HIT-HY 200-A and Hilti HIT-HY 200-R) versions available with different curing times and same performance
	Hilti HIT-HY 200-R 500 ml foil pack (also available as 330 ml foil pack)	
	Static mixer	
	HIT-Z HIT-Z-R rod	

Concrete | Tensile zone | Corrosion resistance | European Technical Approval | CE conformity | PROFIS Anchor design software | No cleaning required for approved loads

Approvals / certificates

Description	Authority / Laboratory	No. / date of issue
European technical approval [a)]	DIBt, Berlin	ETA-12/0006 / 2012-04-04 (HIT-HY 200-A) ETA-12/0028 / 2012-04-04 (HIT-HY 200-R)
Fire test report	IBMB, Brunswick	3501/676/13 / 2012-08-03

a) All data given in this section according ETA-12/0006 and ETA-12/0028, issue 2012-04-04.

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
- Embedment depth, as specified in the table
- <u>One</u> 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℃, max. long ter m/short term base material temperature: +24℃/40℃)
- Installation temperature range +5℃ to +40℃

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

Anchor size	M8	M10	M12	M16	M20
Typical embedment depth [mm]	70	90	110	145	180
Base material thickness [mm]	130	150	170	245	280

Mean ultimate resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm², element HIT-Z

Anchor size			M8	M10	M12	M16	M20
Non-cracked concrete							
Tensile $N_{Ru,m}$	HIT-Z	[kN]	*25,2*	*39,9*	*57,8*	*100,8*	*153,3*
Shear $V_{Ru,m}$	HIT-Z	[kN]	*12,6*	*20,0*	*28,4*	*50,4*	*76,7*
Cracked concrete							
Tensile $N_{Ru,m}$	HIT-Z	[kN]	*25,2*	*39,9*	55,1	83,4	115,4
Shear $V_{Ru,m}$	HIT-Z	[kN]	*12,6*	*20,0*	*28,4*	*50,4*	*76,7*

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

Anchor size			M8	M10	M12	M16	M20
Non-cracked concrete							
Tensile N_{Rk}	HIT-Z	[kN]	*24,0*	*38,0*	54,3	88,2	122,0
Shear V_{Rk}	HIT-Z	[kN]	*12,0*	*19,0*	*27,0*	*48,0*	*73,0*
Cracked concrete							
Tensile N_{Rk}	HIT-Z	[kN]	21,1	30,7	41,5	62,9	86,9
Shear V_{Rk}	HIT-Z	[kN]	*12,0*	*19,0*	*27,0*	*48,0*	*73,0*

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

Anchor size			M8	M10	M12	M16	M20
Non-cracked concrete							
Tensile N_{Rd}	HIT-Z	[kN]	16,0	25,3	36,2	58,8	81,3
Shear V_{Rd}	HIT-Z	[kN]	9,6	15,2	21,6	38,4	58,4
Cracked concrete							
Tensile N_{Rd}	HIT-Z	[kN]	14,1	20,5	27,7	41,9	58,0
Shear V_{Rd}	HIT-Z	[kN]	9,6	15,2	21,6	38,4	58,4

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

Anchor size			M8	M10	M12	M16	M20
Non-cracked concrete							
Tensile N_{rec}	HIT-Z	[kN]	11,4	18,1	25,9	42,0	58,1
Shear V_{rec}	HIT-Z	[kN]	6,9	10,9	15,4	27,4	41,7
Cracked concrete							
Tensile N_{rec}	HIT-Z	[kN]	10,0	14,6	19,8	29,9	41,4
Shear V_{rec}	HIT-Z	[kN]	6,9	10,9	15,4	27,4	41,7

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.

Service temperature range

Hilti HIT-HY 200 injection mortar with anchor rod HIT-Z may be applied in the temperature ranges given below. An elevated base material temperature leads 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	+40 °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 HIT-Z and HIT-Z-R

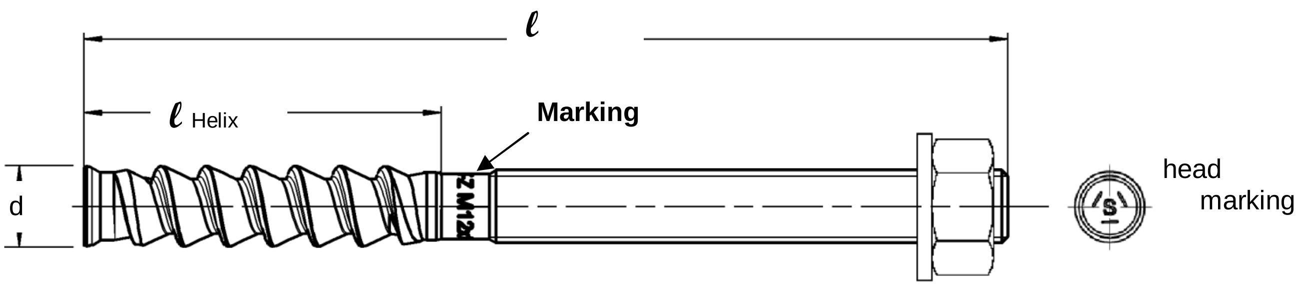
Anchor size			M8	M10	M12	M16	M20
Nominal tensile strength f_{uk}	HIT-Z / HIT-Z-R	[N/mm²]	650	650	650	610	595
Yield strength f_{yk}	HIT-Z / HIT-Z-R	[N/mm²]	520	520	520	490	480
Stressed cross-section of thread A_s	HIT-Z	[mm²]	36,6	58,0	84,3	157	245
Moment of resistance W	HIT-Z	[mm³]	31,9	62,5	109,7	278	542

Material quality

Part	Material
HIT-Z	C-steel cold formed, steel galvanized ≥ 5µm
HIT-Z-R	stainless steel cold formed, A4

Anchor dimensions

Anchor size			M8	M10	M12	M16	M20
Length of anchor	min ℓ	[mm]	80	95	105	155	215
	max ℓ	[mm]	120	160	196	240	250
Helix length	ℓ_{Helix}	[mm]	50	60	60	96	100



Installation equipment

Anchor size	M8	M10	M12	M16	M20
Rotary hammer	TE 2 – TE 40			TE 40 - TE 70	

Curing and working time

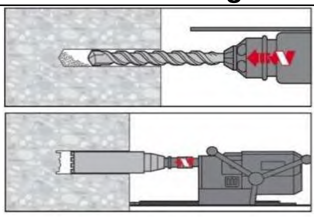
Temperature of the base material	HIT-HY 200-R	
	Working time in which anchor can be inserted and adjusted t_{work}	Curing time before anchor can be loaded t_{cure}
5 ℃	1 hour	3 hour
6 ℃ to 10 ℃	40 min	2 hour
11 ℃ to 20 ℃	15 min	1 hour
21 ℃ to 30 ℃	9 min	1 hour
31 ℃ to 40 ℃	6 min	1 hour

Curing and working time

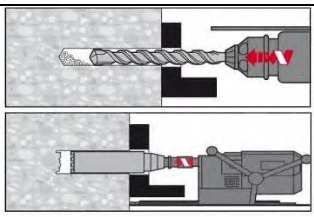
Temperature of the base material	HIT-HY 200-A	
	Working time in which anchor can be inserted and adjusted t_{work}	Curing time before anchor can be loaded t_{cure}
5 ℃	25 min	2 hour
6 ℃ to 10 ℃	15 min	1 hour
11 ℃ to 20 ℃	7 min	30 min
21 ℃ to 30 ℃	4 min	30 min
31 ℃ to 40 ℃	3 min	30 min

Setting instruction

Bore hole drilling



Pre-setting: Drill hole to the required drilling depth with a hammer drill set in rotation-hammer mode using an appropriately sized carbide drill bit.
Diamond coring is permissible when diamond core drilling machine and the corresponding core bit are used.

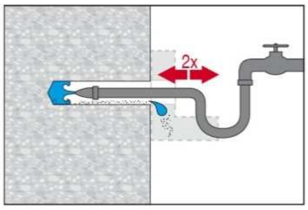


Through-setting: Drill hole through the clearance hole in the fixture to the required drilling depth with a hammer drill set in rotation-hammer mode using an appropriately sized carbide drill bit.
Diamond coring is permissible when diamond core drilling machine and the corresponding core bit are used.

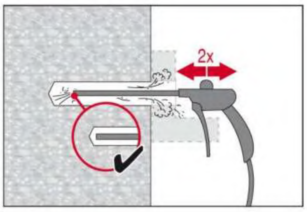
Bore hole cleaning[a)]

a) No cleaning required for hammer drilled boreholes

b) Hole flushing and evacuation for wet-drilled diamond cored holes or flooded holes

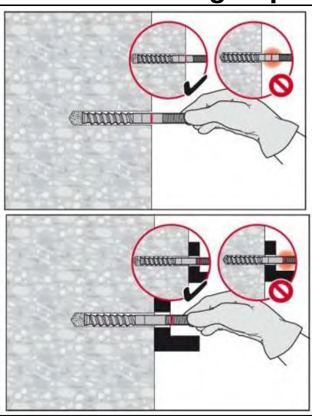


Flush 2 times from the back of the hole over the hole length.



Blow 2 times the hole with oil-free compressed air (min. 6 bar at 6 m³/h) to evacuate the water

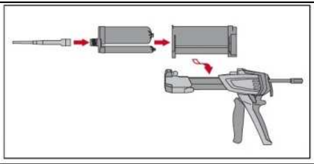
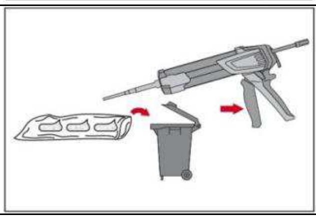
Check of setting depth and compress of the drilling dust



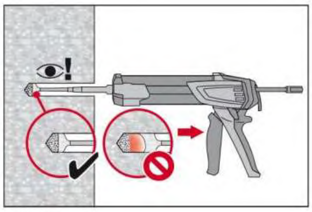
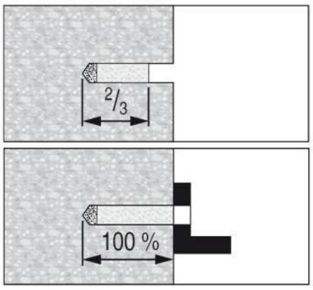
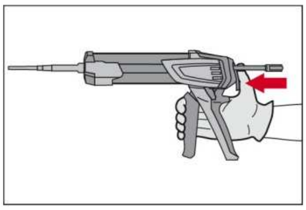
Mark the element and check the setting depth and compress the drilling dust. The element has to fit in the hole until the required embedment depth.
If it is not possible to compress the dust, remove the dust in the drill hole or drill deeper.

a) When drilling downward with non-cleaning the required drilling depths can vary due to accumulation of dust in the hole.

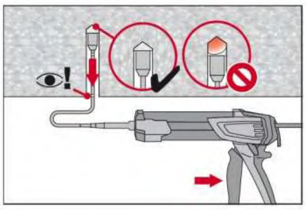
Injection preparation

	Tightly attach new Hilti mixing nozzle HIT-RE-M to foil pack manifold (snug fit). Do not modify the mixing nozzle. Observe the instruction for use of the dispenser. Check foil pack holder for proper function. Do not use damaged foil packs / holders. Swing foil pack holder with foil pack into HIT-dispenser.
	Discard initial adhesive. The foil pack opens automatically as dispensing is initiated. Depending on the size of the foil pack an initial amount of adhesive has to be discarded. Discard quantities are 2 strokes for 330 ml foil pack 3 strokes for 500 ml foil pack

Inject adhesive from the back of the borehole without forming air voids

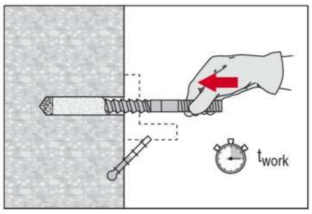
	Inject the adhesive starting at the back of the hole, slowly withdrawing the mixer with each trigger pull.
	Fill holes approximately 2/3 full for Pre-setting and 100% full for through-setting, or as required to ensure that the annular gap between the anchor and the concrete is completely filled with adhesive along the embedment length.
	After injection is completed, depressurize the dispenser by pressing the release trigger. This will prevent further adhesive discharge from the mixer.

Overhead installation

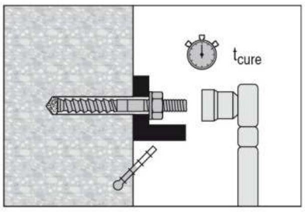


For overhead installation the injection is only possible with the aid of extensions and piston plugs. Assemble HIT-RE-M mixer, extension(s) and appropriately piston plug HIT-SZ. Insert piston plug to back of the hole and inject adhesive. During injection the piston plug will be naturally extruded out of the bore hole by the adhesive pressure

Setting the element



Before use, verify that the element is dry and free of oil and other contaminants. Set element to the required embedment depth until working time t_{work} has elapsed.
After setting the element the annular gap between the anchor and the fixture (through-setting) or concrete (pre-setting) has to be completely filled with mortar.



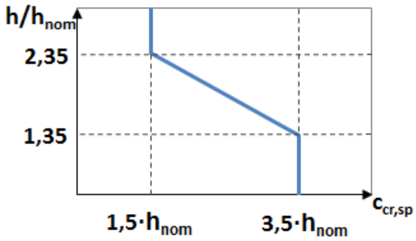
After required curing time t_{cure} remove excess mortar.
Apply indicated torque moment to activate anchor functioning principles.
The anchor can be loaded.

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

Setting details

Anchor size			M8	M10	M12	M16	M20
Nominal diameter of drill bit	d_0	[mm]	10	12	14	18	22
Effective embedment depth range	$h_{nom,min}$	[mm]	60	60	60	96	100
	$h_{nom,max}$	[mm]	100	120	150	200	220
Minimum base material thickness	h_{min}	[mm]	h_{nom} + 60 mm			h_{nom} + 100 mm	
Pre-setting: Diameter of clearance hole in the fixture	$d_f \leq$	[mm]	9	12	14	18	22
Through-setting: Diameter of clearance hole in the fixture	$d_f \leq$	[mm]	11	14	16	20	24
Torque moment	T_{inst}	[Nm]	10	25	40	80	150

Critical edge distance and critical spacing

<table>
<tr><td>Critical spacing
for splitting failure</td><td>$s_{cr,sp}$</td><td>[mm]</td><td colspan="3">$2\ c_{cr,sp}$</td></tr>
<tr><td rowspan="3">Critical edge distance
for splitting failure</td><td rowspan="3">$c_{cr,sp}$</td><td rowspan="3">[mm]</td><td>$1,5 \cdot h_{nom}$</td><td>for $h / h_{nom} \geq 2,35$</td><td rowspan="3">
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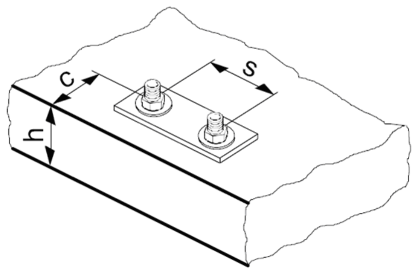
<tr><td colspan="2">$6,2\ h_{nom} - 2,0\ h$
for $2,35 > h / h_{nom} > 1,35$</td></tr>
<tr><td>$3,5\ h_{nom}$</td><td>for $h / h_{nom} \leq 1,35$</td></tr>
<tr><td>Critical spacing for
concrete cone failure</td><td>$s_{cr,N}$</td><td>[mm]</td><td colspan="3">$2\ c_{cr,N}$</td></tr>
<tr><td>Critical edge distance
for concrete cone
failure</td><td>$c_{cr,N}$</td><td>[mm]</td><td colspan="3">$1,5\ h_{nom}$</td></tr>
<tr><td colspan="6">
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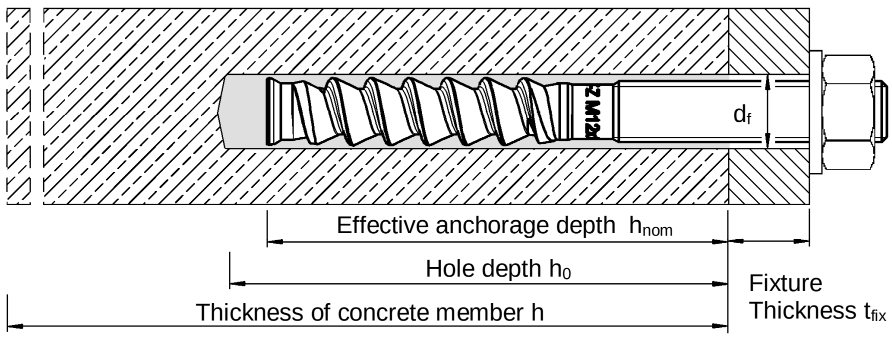
</table>

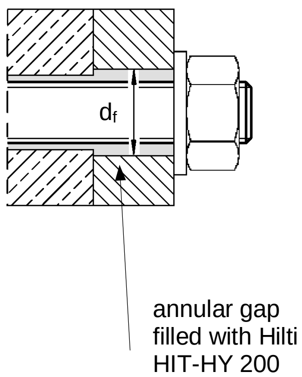
For spacing (or edge distance) smaller than critical spacing (or critical edge distance) the design loads have to be reduced.

a) Embedment depth range: $h_{nom,min} \leq h_{nom} \leq h_{nom,max}$

Pre-setting:
Install anchor before positioning fixture

Through-setting:
Install anchor through positioned fixture





Minimum edge distance and spacing

For the calculation of minimum spacing and minimum edge distance of anchors in combination with different embedment depth and thickness of concrete member the following equation shall be fulfilled:

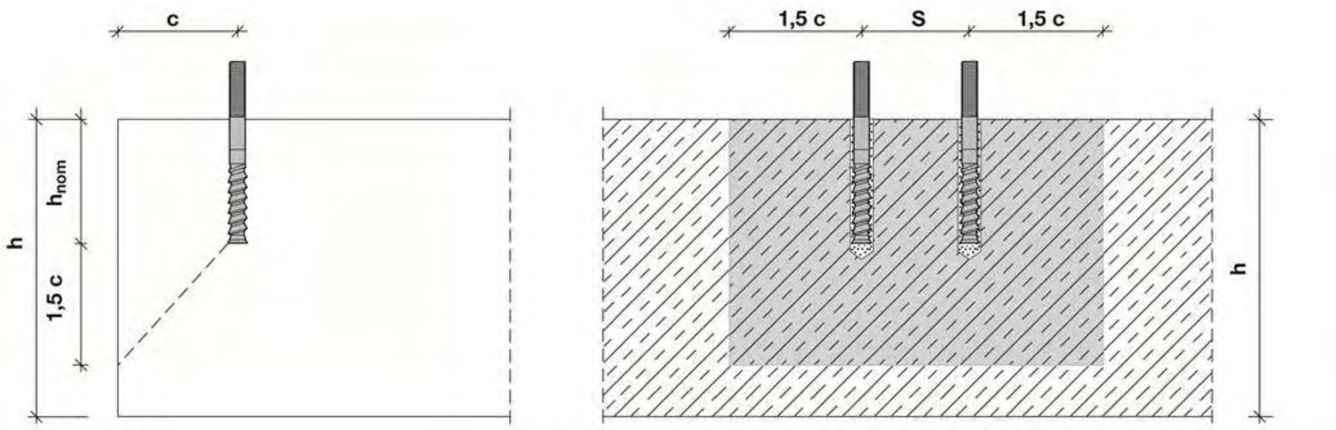
$$A_{i,req} < A_{i,cal}$$

Required interaction area $A_{i,req}$

Anchor size		M8	M10	M12	M16	M20
Cracked concrete	[mm²]	19200	40800	58800	94700	148000
Uncracked concrete	[mm²]	22200	57400	80800	128000	198000

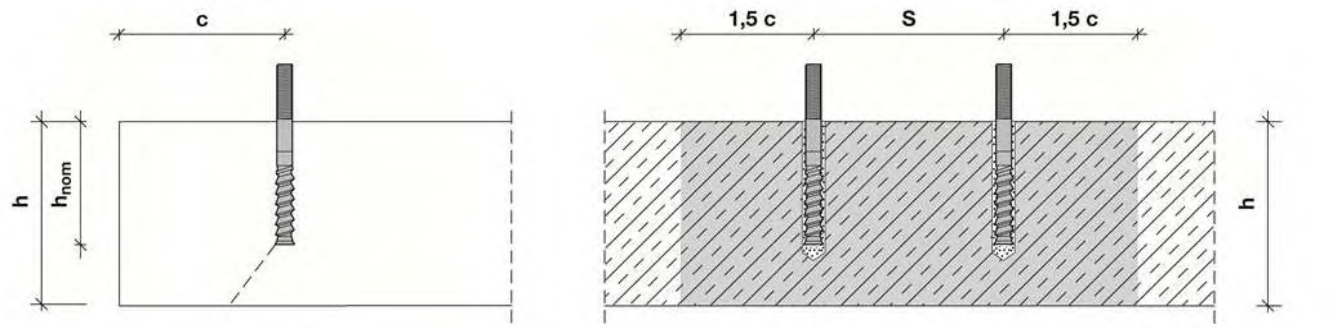
Calculate interaction area $A_{i,cal}$

Member thickness $h \geq h_{nom} + 1{,}5 \cdot c$



Single anchor and group of anchors with s > 3·c	[mm²]	$A_{i,cal} = (6 \cdot c) \cdot (h_{nom} + 1{,}5 \cdot c)$	with $c \geq 5 \cdot d$
Group of anchors with s ≤ 3·c	[mm²]	$A_{i,cal} = (3 \cdot c + s) \cdot (h_{nom} + 1{,}5 \cdot c)$	with $c \geq 5 \cdot d$ and $s \geq 5 \cdot d$

Member thickness $h \leq h_{nom} + 1{,}5 \cdot c$



Single anchor and group of anchors with s > 3·c	[mm²]	$A_{i,cal} = (6 \cdot c) \cdot h$	with $c \geq 5 \cdot d$
Group of anchors with s ≤ 3·c	[mm²]	$A_{i,cal} = (3 \cdot c + s) \cdot h$	with $c \geq 5 \cdot d$ and $s \geq 5 \cdot d$

Best case minimum edge distance and spacing with required member thickness and embedment depth

Anchor size			M8	M10	M12	M16	M20
Cracked concrete							
Member thickness	h ≥	[mm]	140	200	240	300	370
Embedment depth	h_{nom} ≥	[mm]	80	120	150	200	220
Minimum spacing	s_{min}	[mm]	40	50	60	80	100
Corresponding edge distance	c ≥	[mm]	40	55	65	80	100
Minimum edge distance	c_{min} =	[mm]	40	50	60	80	100
Corresponding spacing	s ≥	[mm]	40	60	65	80	100
Non cracked concrete							
Member thickness	h ≥	[mm]	140	230	270	340	410
Embedment depth	h_{nom} ≥	[mm]	80	120	150	200	220
Minimum spacing	s_{min}	[mm]	40	50	60	80	100
Corresponding edge distance	c ≥	[mm]	40	70	80	100	130
Minimum edge distance	c_{min}	[mm]	40	50	60	80	100
Corresponding spacing	s ≥	[mm]	40	145	160	160	235

Best case minimum member thickness and embedment depth with required minimum edge distance and spacing

Anchor size			M8	M10	M12	M16	M20
Cracked concrete							
Member thickness	h_{min}	[mm]	120	120	120	196	200
Embedment depth	$h_{nom,min}$	[mm]	60	60	60	96	100
Minimum spacing	s_{min}	[mm]	40	50	60	80	100
Corresponding edge distance	c ≥	[mm]	40	100	140	135	215
Minimum edge distance	c_{min} =	[mm]	40	60	90	80	125
Corresponding spacing	s ≥	[mm]	40	160	220	235	365
Non cracked concrete							
Member thickness	h_{min}	[mm]	120	120	120	196	200
Embedment depth	$h_{nom,min}$	[mm]	60	60	60	96	100
Minimum spacing	s_{min}	[mm]	40	50	60	80	100
Corresponding edge distance	c ≥	[mm]	50	145	200	190	300
Minimum edge distance	c_{min}	[mm]	40	80	115	110	165
Corresponding spacing	s ≥	[mm]	65	240	330	310	495

Minimum edge distance and spacing – Explanation

Minimum edge and spacing geometrical requirements are determined by testing the installation conditions in which two anchors with a given spacing can be set close to an edge without forming a crack in the concrete due to tightening torque.

The HIT-Z boundary conditions for edge and spacing geometry can be found in the tables to the left. If the embedment depth and slab thickness are equal to or greater than the values in the table, then the edge and spacing values may be utilized.

PROFIS Anchor software is programmed to calculate the referenced equations in order to determine the optimized related minimum edge and spacing based on the following variables:

Cracked or uncracked concrete	For cracked concrete it is assumed that a reinforcement is present which limits the crack width to 0,3 mm, allowing smaller values for minimum edge distance and minimum spacing
Anchor diameter	For smaller anchor diameter a smaller installation torque is required, allowing smaller values for minimum edge distance and minimum spacing
Slab thickness and embedment depth	Increasing these values allows smaller values for minimum edge distance and minimum spacing

Simplified design method

Simplified version of the design method according ETAG 001, TR 029. Design resistance according data given in ETA-12/0006 (HIT-HY 200-A) and ETA-12/0028 (HIT-HY 200-R) issued on 2012-04-04

- 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 simplified calculated design loads take a conservative approach: They will be lower than the exact values according to ETAG 001, TR 029. For an optimized design, anchor calculation can be performed using PROFIS anchor design software.

The design method is based on the following simplification:

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

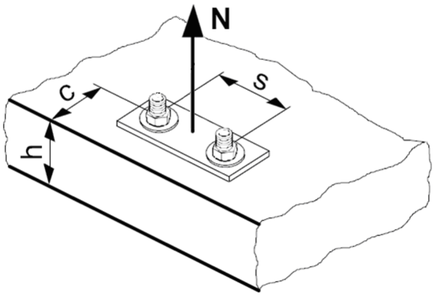
The values are valid for one anchor.

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



Basic design tensile resistance

Design steel resistance $N_{Rd,s}$

Anchor size			M8	M10	M12	M16	M20
$N_{Rd,s}$	HIT-Z / HIT-Z-R	[kN]	16,0	25,3	36,7	64,0	97,3

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

Anchor size			M8	M10	M12	M16	M20
Non-cracked concrete							
$N^0_{Rd,p}$	Temperature range I	[kN]	20,1	30,2	36,2	77,2	100,5
$N^0_{Rd,p}$	Temperature range II	[kN]	18,4	27,6	33,2	70,8	92,2
$N^0_{Rd,p}$	Temperature range III	[kN]	16,8	25,1	30,2	64,3	83,8
Cracked concrete							
$N^0_{Rd,p}$	Temperature range I	[kN]	18,4	27,6	33,2	70,8	92,2
$N^0_{Rd,p}$	Temperature range II	[kN]	16,8	25,1	30,2	64,3	83,8
$N^0_{Rd,p}$	Temperature range III	[kN]	15,1	22,6	27,1	57,9	75,4

a) The combined pull-out and concrete cone resistance is independent from the embedment depth.

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

Anchor size			M8	M10	M12	M16	M20
$h_{nom,typ}$		[mm]	70	90	110	145	180
$N^0_{Rd,c}$	Non cracked concrete	[kN]	19,7	28,7	38,8	58,8	81,3
$N^0_{Rd,c}$	Cracked concrete	[kN]	14,1	20,5	27,7	41,9	58,0

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
$f_{B,p}$ =	1,00	1,00	1,00	1,00	1,00	1,00	1,00

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
$f_B = (f_{ck,cube}/25N/mm^2)^{0,5}$ 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}. 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
$f_{3,N} = 0{,}5 \cdot (1 + s/s_{cr,N}) \leq 1$ $f_{3,sp} = 0{,}5 \cdot (1 + s/s_{cr,sp}) \leq 1$	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}. This influencing factor must be considered for every anchor spacing.

Influence of embedment depth on concrete cone resistance

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

Influence of reinforcement

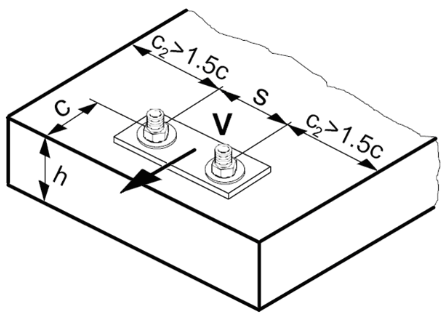
h_{nom} [mm]	60	70	80	90	≥ 100
$f_{re,N} = 0{,}5 + h_{nom}/200mm \leq 1$	0,8 [a)]	0,85 [a)]	0,9 [a)]	0,95 [a)]	1

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

SHEAR loading

The design shear resistance is the lower value of

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



Basic design shear resistance

Design steel resistance $V_{Rd,s}$

Anchor size			M8	M10	M12	M16	M20
$V_{Rd,s}$	HIT-Z	[kN]	9,6	15,2	21,6	38,4	58,4
$V_{Rd,s}$	HIT-Z-R	[kN]	11,2	18,4	26,4	45,6	70,4

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

$$k = 2 \text{ for } h_{ef} \geq 60 \text{ mm}$$

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

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

		Non-cracked concrete					Cracked concrete				
Anchor size		M8	M10	M12	M16	M20	M8	M10	M12	M16	M20
$V^0_{Rd,c}$	[kN]	5,8	8,6	11,6	18,9	27,4	4,1	6,0	8,2	13,3	19,4

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

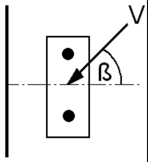
Influencing factors

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

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°
$f_\beta = \frac{1}{\sqrt{(\cos\alpha_V)^2 + \left(\frac{\sin\alpha_V}{2,5}\right)^2}}$ 	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

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

c/h_{nom}	Single anchor	Group of two anchors s/h_{nom}														
		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

h_{nom}/d	4	4,5	5	6	7	8	9	10	11
$f_{hef} = 0{,}05 \cdot (h_{nom} / d)^{1{,}68}$	0,51	0,63	0,75	1,01	1,31	1,64	2,00	2,39	2,81
h_{ef}/d	12	13	14	15	16	17	18	19	20
$f_{hef} = 0{,}05 \cdot (h_{nom} / d)^{1{,}68}$	3,25	3,72	4,21	4,73	5,27	5,84	6,42	7,04	7,67

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

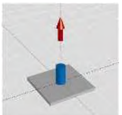
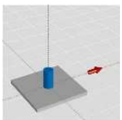
For combined tension and shear loading see section "Anchor Design".

Precalculated values – design resistance values

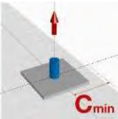
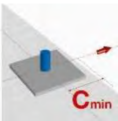
All data applies to:
- temperature range I (see service temperature range)
- no effects of dense reinforcement

Recommended loads can be calculated by dividing the design resistance by an 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.

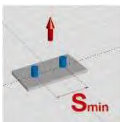
Design resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm²

Anchor size		M8	M10	M12	M16	M20
Embedment depth $h_{nom,min}$ = [mm]		60	60	60	96	100
Base material thickness h_{min}= [mm]		120	120	120	196	200
	Tensile N_{Rd}: single anchor, no edge effects					
	Non-cracked concrete					
	HIT-Z / HIT-Z-R [kN]	15,6	15,6	15,6	31,7	33,7
	Cracked concrete					
	HIT-Z / HIT-Z-R [kN]	11,2	11,2	11,2	22,6	24,0
	Shear V_{Rd}: single anchor, no edge effects, without lever arm					
	Non-cracked concrete					
	HIT-Z [kN]	9,6	15,2	21,6	38,4	58,4
	HIT-Z-R [kN]	11,2	18,4	26,4	45,6	67,3
	Cracked concrete					
	HIT-Z [kN]	9,6	15,2	21,6	38,4	48,0
	HIT-Z-R [kN]	11,2	18,4	22,3	45,1	48,0

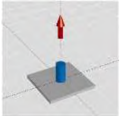
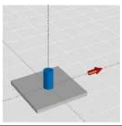
Design resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm²

Anchor size		M8	M10	M12	M16	M20
Embedment depth $h_{nom,min}$ = [mm]		60	60	60	96	100
Base material thickness h_{min}= [mm]		120	120	120	196	200
	Tensile N_{Rd}: single anchor, min. edge distance (c = c_{min})					
	Non-cracked concrete					
	c_{min} [mm]	40	80	115	110	165
	HIT-Z / HIT-Z-R [kN]	7,8	10,5	13,2	20,1	25,7
	Cracked concrete					
	c_{min} [mm]	40	80	115	110	165
	HIT-Z / HIT-Z-R [kN]	6,7	10,2	11,2	18,5	24,0
	Shear V_{Rd}: single anchor, min. edge distance (c = c_{min}) , without lever arm					
	Non-cracked concrete					
	c_{min} [mm]	40	80	115	110	165
	HIT-Z [kN]	3,5	9,2	12,8	16,3	26,0
	HIT-Z-R [kN]	3,5	9,2	12,8	16,3	26,0
	Cracked concrete					
	c_{min} [mm]	40	80	115	110	165
	HIT-Z [kN]	2,5	6,5	9,1	11,6	18,4
	HIT-Z-R [kN]	2,5	6,5	9,1	11,6	18,4

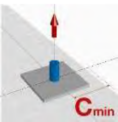
Design resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm²
(load values are valid for single anchor)

Anchor size		M8	M10	M12	M16	M20
Embedment depth $h_{nom,min}$ = [mm]		60	60	60	96	100
Base material thickness h_{min}= [mm]		120	120	120	196	200
	Tensile N_{Rd}: double anchor, no edge effects, min. spacing (s = s_{min})					
	Non-cracked concrete					
	s_{min} [mm]	40	50	60	80	100
	HIT-Z / HIT-Z-R [kN]	8,9	9,2	9,5	18,7	20,3
	Cracked concrete					
	s_{min} [mm]	40	50	60	80	100
	HIT-Z / HIT-Z-R [kN]	6,8	7,1	7,4	14,4	16,0
	Shear V_{Rd}: double anchor, no edge effects, min. spacing (s = s_{min}) , without lever arm					
	Non-cracked concrete					
	s_{min} [mm]	40	50	60	80	100
	HIT-Z [kN]	9,6	15,2	20,9	38,4	44,9
	HIT-Z-R [kN]	11,2	18,4	20,9	40,5	44,9
	Cracked concrete					
	s_{min} [mm]	40	50	60	80	100
	HIT-Z [kN]	9,6	14,3	14,9	28,8	32,0
	HIT-Z-R [kN]	11,2	14,3	14,9	28,8	32,0

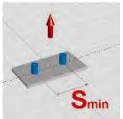
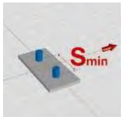
Design resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm²

Anchor size		**M8**	**M10**	**M12**	**M16**	**M20**
Embedment depth $h_{nom,typ}$ =	[mm]	70	90	110	145	180
Base material thickness h_{min}=	[mm]	130	150	170	245	280
 **Tensile N_{Rd}: single anchor, no edge effects**						
Non-cracked concrete						
HIT-Z / HIT-Z-R	[kN]	16,0	25,3	36,2	58,8	81,3
Cracked concrete						
HIT-Z / HIT-Z-R	[kN]	14,1	20,5	27,7	41,9	58,0
 **Shear V_{Rd}: single anchor, no edge effects, without lever arm**						
Non-cracked concrete						
HIT-Z	[kN]	9,6	15,2	21,6	38,4	58,4
HIT-Z-R	[kN]	11,2	18,4	26,4	45,6	70,4
Cracked concrete						
HIT-Z	[kN]	9,6	15,2	21,6	38,4	58,4
HIT-Z-R	[kN]	11,2	18,4	26,4	45,6	70,4

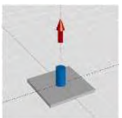
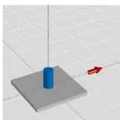
Design resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm²

Anchor size		**M8**	**M10**	**M12**	**M16**	**M20**
Embedment depth $h_{nom,typ}$ =	[mm]	70	90	110	145	180
Base material thickness h_{min}=	[mm]	130	150	170	245	280
 **Tensile N_{Rd}: single anchor, min. edge distance ($c = c_{min}$)**						
Non-cracked concrete						
c_{min}	[mm]	40	65	80	90	120
HIT-Z / HIT-Z-R	[kN]	9,1	13,7	18,1	27,0	37,2
Cracked concrete						
c_{min}	[mm]	40	65	80	90	120
HIT-Z / HIT-Z-R	[kN]	7,9	12,8	17,4	24,4	34,9
 **Shear V_{Rd}: single anchor, min. edge distance ($c = c_{min}$) , without lever arm**						
Non-cracked concrete						
c_{min}	[mm]	40	65	80	90	120
HIT-Z	[kN]	3,6	7,5	10,6	13,8	21,8
HIT-Z-R	[kN]	3,6	7,5	10,6	13,8	21,8
Cracked concrete						
c_{min}	[mm]	40	65	80	90	120
HIT-Z	[kN]	2,6	5,3	7,5	9,8	15,5
HIT-Z-R	[kN]	2,6	5,3	7,5	9,8	15,5

Design resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm²
(load values are valid for single anchor)

Anchor size		M8	M10	M12	M16	M20
Embedment depth	$h_{nom,typ}$ = [mm]	70	90	110	145	180
Base material thickness	h_{min}= [mm]	130	150	170	245	280
	Tensile N_{Rd}: double anchor, no edge effects, min. spacing (s = s_{min})					
	Non-cracked concrete					
	s_{min} [mm]	40	50	60	80	100
	HIT-Z / HIT-Z-R [kN]	10,9	15,7	21,0	32,1	44,1
	Cracked concrete					
	s_{min} [mm]	40	50	60	80	100
	HIT-Z / HIT-Z-R [kN]	8,4	12,1	16,4	24,8	34,3
	Shear V_{Rd}: double anchor, no edge effects, min. spacing (s = s_{min}) , without lever arm					
	Non-cracked concrete					
	s_{min} [mm]	40	50	60	80	100
	HIT-Z [kN]	9,6	15,2	21,6	38,4	58,4
	HIT-Z-R [kN]	11,2	18,4	26,4	45,6	70,4
	Cracked concrete					
	s_{min} [mm]	40	50	60	80	100
	HIT-Z [kN]	9,6	15,2	21,6	38,4	58,4
	HIT-Z-R [kN]	11,2	18,4	26,4	45,6	68,7

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

Anchor size		M8	M10	M12	M16	M20
Embedment depth	$h_{nom,max}$ = [mm]	100	120	150	200	220
Base material thickness	h_{min}= [mm]	160	180	210	300	320
	Tensile N_{Rd}: single anchor, no edge effects					
	Non-cracked concrete					
	HIT-Z / HIT-Z-R [kN]	16,0	25,3	36,2	64,0	97,3
	Cracked concrete					
	HIT-Z / HIT-Z-R [kN]	16,0	25,3	33,2	64,0	78,3
	Shear V_{Rd}: single anchor, no edge effects, without lever arm					
	Non-cracked concrete					
	HIT-Z [kN]	9,6	15,2	21,6	38,4	58,4
	HIT-Z-R [kN]	11,2	18,4	26,4	45,6	70,4
	Cracked concrete					
	HIT-Z [kN]	9,6	15,2	21,6	38,4	58,4
	HIT-Z-R [kN]	11,2	18,4	26,4	45,6	70,4

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

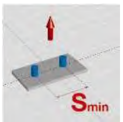
Anchor size		M8	M10	M12	M16	M20
Embedment depth $h_{nom,max}$ =	[mm]	100	120	150	200	220
Base material thickness h_{min}=	[mm]	160	180	210	300	320

Tensile N_{Rd}: single anchor, min. edge distance ($c = c_{min}$)						
Non-cracked concrete						
c_{min}	[mm]	40	55	65	80	105
HIT-Z / HIT-Z-R	[kN]	10,1	15,6	18,6	38,7	46,3
Cracked concrete						
c_{min}	[mm]	40	55	65	80	105
HIT-Z / HIT-Z-R	[kN]	9,2	14,3	17,1	33,5	41,1

Shear V_{Rd}: single anchor, min. edge distance ($c = c_{min}$) , without lever arm						
Non-cracked concrete						
c_{min}	[mm]	40	55	65	80	105
HIT-Z	[kN]	3,9	6,4	8,7	13,0	19,6
HIT-Z-R	[kN]	3,9	6,4	8,7	13,0	19,6
Cracked concrete						
c_{min}	[mm]	40	55	65	80	105
HIT-Z	[kN]	2,8	4,6	6,2	9,2	13,9
HIT-Z-R	[kN]	2,8	4,6	6,2	9,2	13,9

Design resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm²
(load values are valid for single anchor)

Anchor size		M8	M10	M12	M16	M20
Embedment depth $h_{nom,max}$ =	[mm]	100	120	150	200	220
Base material thickness h_{min}=	[mm]	160	180	210	300	320



Tensile N_{Rd}: double anchor, no edge effects, min. spacing ($s = s_{min}$)						
Non-cracked concrete						
s_{min}	[mm]	40	50	60	80	100
HIT-Z / HIT-Z-R	[kN]	11,5	17,2	20,6	44,0	57,9
Cracked concrete						
s_{min}	[mm]	40	50	60	80	100
HIT-Z / HIT-Z-R	[kN]	10,5	15,8	18,9	38,5	45,1

Shear V_{Rd}: double anchor, no edge effects, min. spacing ($s = s_{min}$) , without lever arm						
Non-cracked concrete						
s_{min}	[mm]	40	50	60	80	100
HIT-Z	[kN]	9,6	15,2	21,6	38,4	58,4
HIT-Z-R	[kN]	11,2	18,4	26,4	45,6	70,4
Cracked concrete						
s_{min}	[mm]	40	50	60	80	100
HIT-Z	[kN]	9,6	15,2	21,6	38,4	58,4
HIT-Z-R	[kN]	11,2	18,4	26,4	45,6	70,4