HILTI HIT HY200 Injection adhesive

The enclosed pages are taken from the
Hilti Fastening Technology Manual
Edition September 2012

For further details including details of product European Technical Approvals, Guidance on product selection and detailed design assistance please contact Hilti (Gt Britain) Ltd Technical Advisory Service.

Hilti (Gt Britain) Ltd

TECHNICAL ADVISORY SERVICE

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Quality Management Approvals

ISO 9001: 2008 Quality Management System
Certified by: The Swiss Association for Quality and Management Systems.
Registration No: 12455 Valid until 30th June 2013
Scope No: 18, Machinery and Equipment.
Note: Under our accreditation with SQS the scope of accreditation is not contained within an appendix but is stated as Scope 18 on the SQS Certificate. Scope No. 18 is Machinery and Equipment."

Important notice

1. Construction materials and conditions vary on different sites. If it is suspected that the base material has insufficient strength to achieve a suitable fastening, contact the Hilti Technical Advisory Service.
2. The information and recommendations given herein are based on the principles, formulae and safety factors set out in the Hilti technical instructions, the operating manuals, the setting instructions, the installation manuals and other data sheets that are believed to be correct at the time of writing. The data and values are based on the respective average values obtained from tests under laboratory or other controlled conditions. It is the users responsibility to use the data given in the light of conditions on site and taking into account the intended use of the products concerned. The user has to check the listed prerequisites and criteria conform with the conditions actually existing on the job-site. Whilst Hilti can give general guidance and advice, the nature of Hilti products means that the ultimate responsibility for selecting the right product for a particular application must lie with the customer.
3. All products must be used, handled and applied strictly in accordance with all current instructions for use published by Hilti, i.e. technical instructions, operating manuals, setting instructions, installation manuals and others.
4. All products are supplied and advice is given subject to the Hilti terms of business.
5. Hilti´s policy is one of continuous development. We therefore reserve the right to alter specifications, etc. without notice.
6. The given mean ultimate loads and characteristic data in the Anchor Fastening Technology Manual reflect actual test results and are thus valid only for the indicated test conditions.
Due to variations in local base materials, on-site testing is required to determine performance at any specific site.
7. Hilti is not obligated for direct, indirect, incidental or consequential damages, losses or expenses in connection with, or by reason of, the use of, or inability to use the products for any purpose. Implied warranties of merchantability or fitness for a particular purpose are specifically excluded.

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Visit our web site at www.Hilti.co.uk/technical to access our comprehensive technical support services

Design and Specification	Profis Anchor Software	Technical Library
		
Access our **comprehensive engineering support**, including the **Anchor Design and Firestop Design Centres**	Profis Anchor 2.1 is the latest Hilti software, designed to assist planners and specifiers to select the required anchors for your applications.	Download the **latest technical documents** (approvals, test reports, etc.) and **software** (PROFIS Anchor).

CONSTRUCTION FIXINGS association

Hilti (Gt. Britain) Ltd is a member of the Construction Fixings Association.

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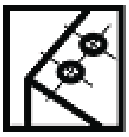
Hilti HIT-HY 200 with rebar

Injection mortar system		Benefits
	Hilti HIT-HY 200-A 500 ml foil pack (also available as 330 ml)	- suitable for cracked and non-cracked concrete C 20/25 to C 50/60. - suitable for dry and water saturated concrete - high loading capacity, excellent handling - HY 200-R version with extended curing time for rebar applications - small edge distance and anchor spacing possible - large diameter applications - in service temperature range up to 120℃ short term/72℃ long term - manual cleaning for anchor size Ø8 to Ø16 and embedment depth $h_{ef} \leq$ 10d for non-cracked concrete - embedment depth range: from 60 ... 160 mm for Ø8 to 128 ... 640 mm for Ø32 - two mortar (A and R) versions available with different curing times and same performance
	Hilti HIT-HY 200-R 500 ml foil pack (also available as 330 ml)	
	Static mixer	
	rebar BSt 500 S	

Concrete

Tensile zone



Small edge distance and spacing

Variable embedment depth

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-11/0493 / 2012-08-08 (Hilti HIT-HY 200-A) ETA-12/0084 / 2012-08-08 (Hilti HIT-HY 200-R)

a) All data given in this section according ETA-11/0493 and ETA-12/0084, issue 2012-08-08.

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℃, max. long ter m/short term base material temperature: +24℃/40℃)
- Installation temperature range +5℃ to +40℃

Embedment depth a) and base material thickness for the basic loading data.

Mean ultimate resistance, characteristic resistance, design resistance, recommended loads.

	Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size	**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
Typical embedment depth [mm]	80	90	110	125	145	170	210	270	300
Base material thickness [mm]	110	120	145	165	185	220	275	340	380

a) The allowed range of embedment depth is shown in the setting details. The corresponding load values can be calculated according to the simplified design method.

Mean ultimate resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm², anchor rebar BSt 500S

			Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size			**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
Non cracked concrete											
Tensile $N_{Ru,m}$	BSt 500 S	[kN]	*29,4*	45,0	*65,1*	87,6	116,1	148,6	204,0	297,4	348,4
Shear $V_{Ru,m}$	BSt 500 S	[kN]	*14,7*	*23,1*	*32,6*	*44,1*	*57,8*	*90,3*	*141,8*	*177,5*	*232,1*
Cracked concrete											
Tensile $N_{Ru,m}$	BSt 500 S	[kN]	-	18,8	38,5	51,1	67,7	99,3	145,4	212,0	248,3
Shear $V_{Ru,m}$	BSt 500 S	[kN]	-	*23,1*	*32,6*	*44,1*	*57,8*	*90,3*	*141,8*	*177,5*	*232,1*

Characteristic resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm², anchor rebar BSt 500 S

			Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size			**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
Non cracked concrete											
Tensile N_{Rk}	BSt 500 S	[kN]	24,1	33,9	49,8	66,0	87,5	111,9	153,7	224,0	262,4
Shear V_{Rk}	BSt 500 S	[kN]	*14,0*	*22,0*	*31,0*	*42,0*	*55,0*	*86,0*	*135,0*	*169,0*	*221,0*
Cracked concrete											
Tensile N_{Rk}	BSt 500 S	[kN]	-	14,1	29,0	38,5	51,0	74,8	109,6	159,7	187,1
Shear V_{Rk}	BSt 500 S	[kN]	-	*22,0*	*31,0*	*42,0*	*55,0*	*86,0*	*135,0*	*169,0*	*221,0*

Design resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm², anchor rebar BSt 500 S

			Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size			**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
Non cracked concrete											
Tensile N_{Rd}	BSt 500 S	[kN]	16,1	22,6	33,2	44,0	58,3	74,6	102,5	149,4	174,9
Shear V_{Rd}	BSt 500 S	[kN]	9,3	14,7	20,7	28,0	36,7	57,3	90,0	112,7	147,3
Cracked concrete											
Tensile N_{Rd}	BSt 500 S	[kN]	-	9,4	19,4	25,7	34,0	49,8	73,0	106,5	124,7
Shear V_{Rd}	BSt 500 S	[kN]	-	14,7	20,7	28,0	36,7	57,3	90,0	112,7	147,3

Recommended loads [a)]: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm², anchor rebar BSt 500 S

			Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size			**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
Non cracked concrete											
Tensile N_{rec}	BSt 500 S	[kN]	11,5	16,2	23,7	31,4	41,6	53,3	73,2	106,7	125,0
Shear V_{rec}	BSt 500 S	[kN]	6,7	10,5	14,8	20,0	26,2	41,0	64,3	80,5	105,2
Cracked concrete											
Tensile N_{rec}	BSt 500 S	[kN]	-	6,7	13,8	18,3	24,3	35,6	52,2	76,1	89,1
Shear V_{rec}	BSt 500 S	[kN]	-	10,5	14,8	20,0	26,2	41,0	64,3	80,5	105,2

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 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 rebar BSt 500S

			Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size			**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
Nominal tensile strength f_{uk}	BSt 500 S	[N/mm²]	550	550	550	550	550	550	550	550	550
Yield strength f_{yk}	BSt 500 S	[N/mm²]	500	500	500	500	500	500	500	500	500
Stressed cross-section A_s	BSt 500 S	[mm²]	50,3	78,5	113,1	153,9	201,1	314,2	490,9	615,8	804,2
Moment of resistance W	BSt 500 S	[mm³]	50,3	98,2	169,6	269,4	402,1	785,4	1534	2155	3217

Material quality

Part	Material
rebar BSt 500 S	Geometry and mechanical properties according to DIN 488-2:1986 or E DIN 488-2:2006

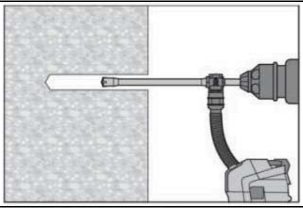
Setting

Installation equipment

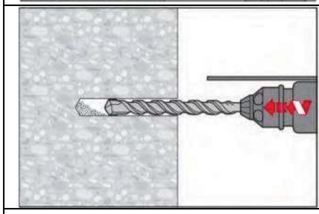
Anchor size	Ø8	Ø10	Ø12	Ø14	Ø16	Ø20	Ø25	Ø28	Ø32
Rotary hammer	TE 2 – TE 16					TE 40 – TE 70			
Other tools	compressed air gun or blow out pump, set of cleaning brushes, dispenser								

Setting instruction

Bore hole drilling



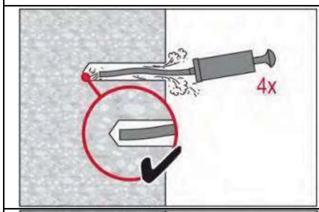
Drill hole to the required embedment depth with an appropriately sized Hilti TE-CD or TE-YD hollow drill bit with Hilti vacuum attachment. This drilling method properly cleans the borehole and removes dust while drilling. After drilling is complete, proceed to the “injection preparation” step in the instructions for use.



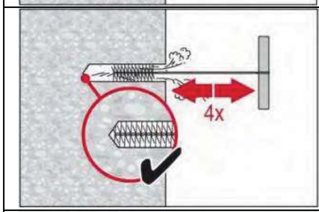
Drill Hole to the required embedment depth with a hammer drill set in rotation-hammer mode using an appropriately sized carbide drill bit.

Bore hole cleaning Just before setting an anchor, the bore hole must be free of dust and debris.

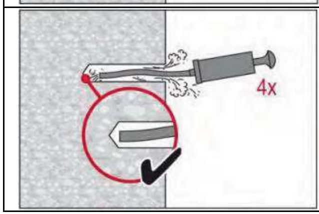
a) Manual Cleaning (MC) non-cracked concrete only
for bore hole diameters $d_0 \leq$ 20mm and bore hole depth $h_0 \leq$ 10d



The Hilti manual pump may be used for blowing out bore holes up to diameters $d_0 \leq$ 20 mm and embedment depths up to $h_{ef} \leq$ 10d.
Blow out at least 4 times from the back of the bore hole until return air stream is free of noticeable dust

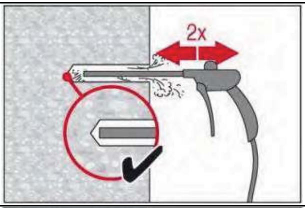


Brush 4 times with the specified brush size by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a twisting motion and removing it.
The brush must produce natural resistance as it enters the bore hole -- if not the brush is too small and must be replaced with the proper brush diameter.

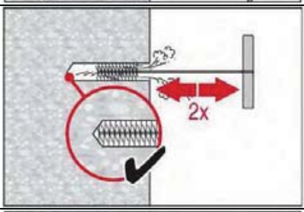


Blow out again with manual pump at least 4 times until return air stream is free of noticeable dust.

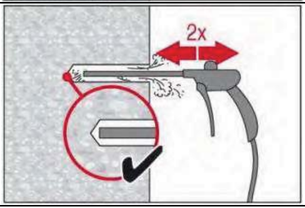
b) Compressed air cleaning (CAC)
for all bore hole diameters d_0 and all bore hole depth h_0



Blow 2 times from the back of the hole (if needed with nozzle extension) over the hole length with oil-free compressed air (min. 6 bar at 6 m³/h) until return air stream is free of noticeable dust. Bore hole diameter ≥ 32 mm the compressor must supply a minimum air flow of 140 m³/hour.

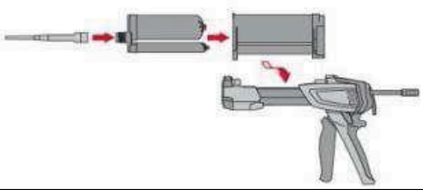


Brush 2 times with the specified brush size by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a twisting motion and removing it.
The brush must produce natural resistance as it enters the bore hole -- if not the brush is too small and must be replaced with the proper brush diameter.

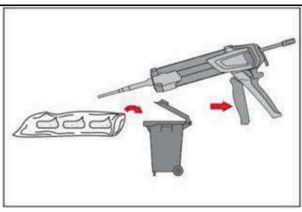


Blow again with compressed air 2 times until return air stream is free of noticeable dust.

Injection preparation

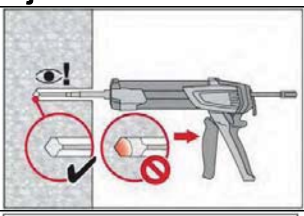


Tightly attach new Hilti mixing nozzle HIT-RE-M to foil pack manifold (snug fit). Do not modify the mixing nozzle. Observe the instruction for use of the dispenser. Check foil pack holder for proper function. Do not use damaged foil packs / holders. Swing foil pack holder with foil pack into HIT-dispenser.

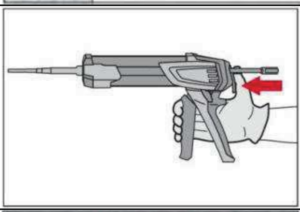


Discard initial adhesive. The foil pack opens automatically as dispensing is initiated. Depending on the size of the foil pack an initial amount of adhesive has to be discarded.
Discard quantities are
- 2 strokes for 330 ml foil pack,
- 3 strokes for 500 ml foil pack,
- 4 strokes for 500 ml foil pack ≤ 5°C.

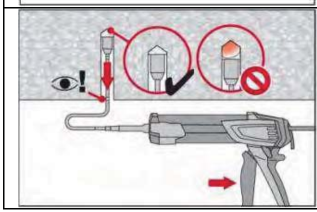
Inject adhesive from the back of the borehole without forming air voids



Inject the adhesive starting at the back of the hole, slowly withdrawing the mixer with each trigger pull. Fill holes approximately 2/3 full, or as required to ensure that the annular gap between the anchor and the concrete is completely filled with adhesive along the embedment length.

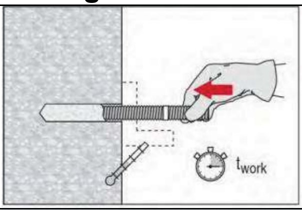
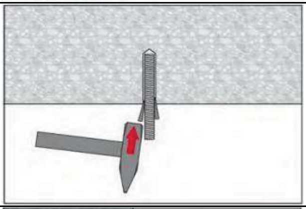
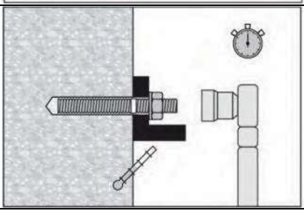


After injection is completed, depressurize the dispenser by pressing the release trigger. This will prevent further adhesive discharge from the mixer.



Overhead installation and installation with embedment depth h_{ef} > 250mm. 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 sized piston plug. 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. Mark and set element to the required embedment depth untill working time t_{work} has elapsed.
	For overhead installation use piston plugs and fix embedded parts with e.g. wedges
	Loading the anchor: After required curing time t_{cure} the anchor can be loaded.

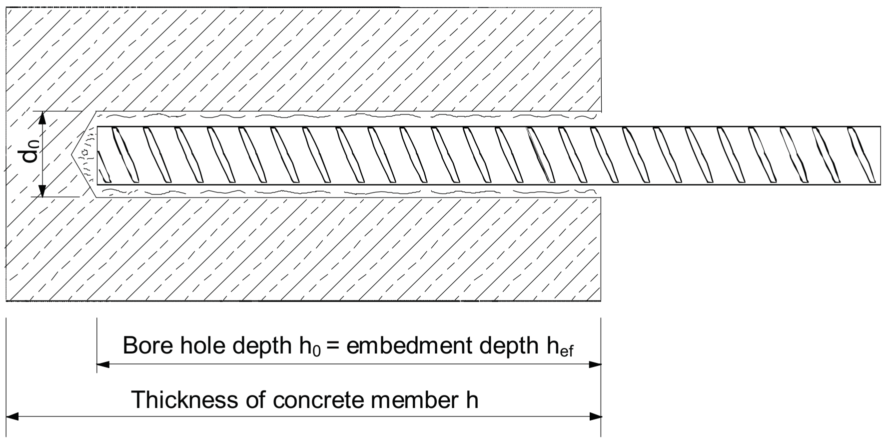
For detailed information on installation see instruction for use given with the package of the product.

Working time, curing time

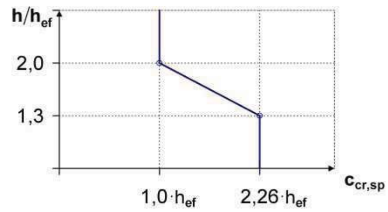
Temperature of the base material	Hilti HIT-HY 200-R	
	Working time in which anchor can be inserted and adjusted t_{work}	Curing time before anchor can be loaded t_{cure}
-10 °C to -5 °C	3 hour	20 hour
-4 °C to 0 °C	2 hour	7 hour
1 °C to 5 °C	1 hour	3 hour
6 °C to 10 °C	40 min	2 hour
11 °C to 20 °C	15 min	1 hour
21 °C to 30 °C	9 min	1 hour
31 °C to 40 °C	6 min	1 hour

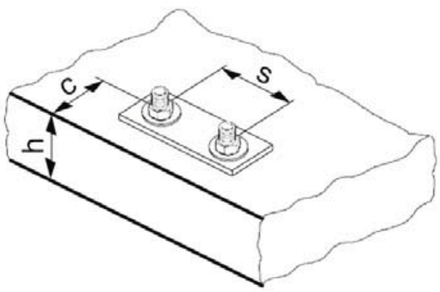
Temperature of the base material	Hilti HIT-HY 200-A	
	Working time in which anchor can be inserted and adjusted t_{work}	Curing time before anchor can be loaded t_{cure}
-10 °C to -5 °C	1,5 hour	7 hour
-4 °C to 0 °C	50 min	4 hour
1 °C to 5 °C	25 min	2 hour
6 °C to 10 °C	15 min	1 hour
11 °C to 20 °C	7 min	30 min
21 °C to 30 °C	4 min	30 min
31 °C to 40 °C	3 min	30 min

Setting details



Setting details

			Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size			**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
Nominal diameter of drill bit	d_0	[mm]	12 (10)[a)]	14 (12)[a)]	16 (14)[a)]	18	20	25	32	35	40
Effective anchorage and drill hole depth range [b)]	$h_{ef,min}$	[mm]	60	60	70	75	80	90	100	112	128
	$h_{ef,max}$	[mm]	160	200	240	280	320	400	500	560	640
Minimum base material thickness	h_{min}	[mm]	h_{ef} + 30 mm			$h_{ef} + 2\ d_0$					
Minimum spacing	s_{min}	[mm]	40	50	60	70	80	100	125	140	160
Minimum edge distance	c_{min}	[mm]	40	50	60	70	80	100	125	140	160
Critical spacing for splitting failure	$s_{cr,sp}$		$2\ c_{cr,sp}$								
Critical edge distance for splitting failure [c)]	$c_{cr,sp}$	[mm]	**$1{,}0 \cdot h_{ef}$**	for $h / h_{ef} \geq 2{,}0$							
			$4{,}6\ h_{ef} - 1{,}8\ h$	for $2{,}0 > h / h_{ef} > 1{,}3$							
			$2{,}26\ h_{ef}$	for $h / h_{ef} \leq 1{,}3$							
Critical spacing for concrete cone failure	$s_{cr,N}$		$2\ c_{cr,N}$								
Critical edge distance for concrete cone failure [d)]	$c_{cr,N}$		$1{,}5\ h_{ef}$								



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

a) both given values for drill bit diameter can be used

b) $h_{ef,min} \leq h_{ef} \leq h_{ef,max}$ (h_{ef}: embedment depth)

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

d) The critical edge distance for concrete cone failure depends on the embedment depth h_{ef} and the design bond resistance. The simplified formula given in this table is on the save side.

Simplified design method

Simplified version of the design method according ETAG 001, TR 029. Design resistance according data given in ETA-11/0493 issued 2012-08-08 for HIT-HY 200-A and ETA-12/0084 issued 2012-08-08 for HIT-HY 200-R. Both mortars possess identical technical load performance.

- 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)

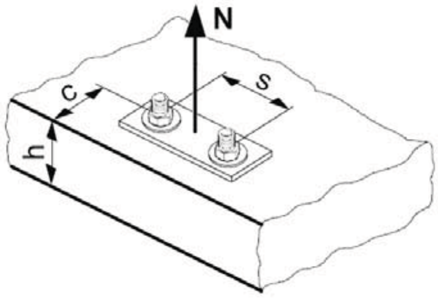
The values are valid for one anchor.

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:
  $N_{Rd,p} = N^0_{Rd,p} \cdot f_{B,p} \cdot f_{1,N} \cdot f_{2,N} \cdot f_{3,N} \cdot f_{h,p} \cdot f_{re,N}$
- 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 $N_{Rd,s}$

	Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size	**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
$N_{Rd,s}$ BSt 500 S [kN]	20,0	30,7	44,3	60,7	79,3	123,6	192,9	242,1	315,7

Design combined pull-out and concrete cone resistance

$N_{Rd,p} = N^0_{Rd,p} \cdot f_{B,p} \cdot f_{1,N} \cdot f_{2,N} \cdot f_{3,N} \cdot f_{h,p} \cdot f_{re,N}$

	Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size	**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
Typical embedment depth $h_{ef,typ}$ [mm]	**80**	**90**	**110**	**125**	**145**	**170**	**210**	**270**	**300**
Non cracked concrete									
$N^0_{Rd,p}$ Temperature range I [kN]	16,1	22,6	33,2	44,0	58,3	85,5	131,9	190,0	241,3
$N^0_{Rd,p}$ Temperature range II [kN]	13,4	18,8	27,6	36,7	48,6	71,2	110,0	158,3	201,1
$N^0_{Rd,p}$ Temperature range III [kN]	11,4	16,0	23,5	31,2	41,3	60,5	93,5	134,6	170,9
Cracked concrete									
$N^0_{Rd,p}$ Temperature range I [kN]	-	9,4	19,4	25,7	34,0	49,8	77,0	110,8	140,7
$N^0_{Rd,p}$ Temperature range II [kN]	-	7,5	15,2	20,2	26,7	39,2	60,5	87,1	110,6
$N^0_{Rd,p}$ Temperature range III [kN]	-	6,6	13,8	18,3	24,3	35,6	55,0	79,2	100,5

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

	Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size	**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
$N^0_{Rd,c}$ Non cracked concrete [kN]	24,1	28,7	38,8	47,1	58,8	74,6	102,5	149,4	174,9
$N^0_{Rd,c}$ Cracked concrete [kN]	-	20,5	27,7	33,5	41,9	53,2	73,0	106,5	124,7

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						

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

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

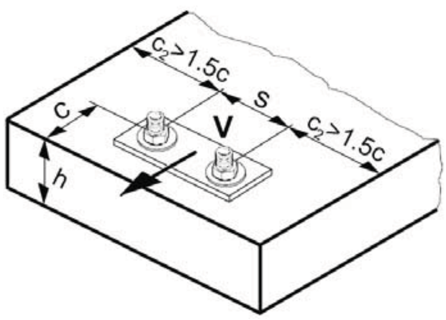
h_{ef} [mm]	60	70	80	90	≥ 100
$f_{re,N} = 0{,}5 + h_{ef}/200\text{mm} \leq 1$	0,8 a)	0,85 a)	0,9 a)	0,95 a)	1

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 $f_{re} = 1$ 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 $V_{Rd,s}$

	Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size	Ø8	Ø10	Ø12	Ø14	Ø16	Ø20	Ø25	Ø28	Ø32
$V_{Rd,s}$ BSt 500 S [kN]	9,3	14,7	20,7	28,0	36,7	57,3	90,0	112,7	147,3

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

k = 2

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

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

		Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size		**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
Non-cracked concrete										
$V^0_{Rd,c}$	[kN]	5,9	8,6	11,6	15,0	18,7	27,0	39,2	47,3	59,0
Cracked concrete										
$V^0_{Rd,c}$	[kN]	-	6,1	8,2	10,6	13,2	19,2	27,7	33,5	41,8

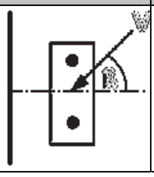
Influencing factors

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

h_{ef}/d	4	4,5	5	6	7	8	9	10	11
$f_{hef} = 0,05 \cdot (h_{ef} / d)^{1,68}$	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**
$f_{hef} = 0,05 \cdot (h_{ef} / d)^{1,68}$	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}.

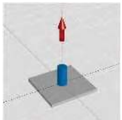
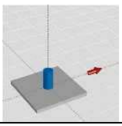
Combined tension and shear loading

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

Precalculated values

Recommended loads can be calculated by dividing the design resistance by an overall partial safety factor for action $\gamma = 1,4$. The partial safety factors for action depend on the type of loading and shall be taken from national regulations.

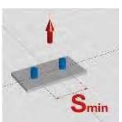
Design resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm², Temperature range I

		Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size		**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
Embedment depth $h_{ef,1}$ = [mm]		60	60	72	84	96	120	150	168	192
Base material thickness h_{min}= [mm]		90	90	104	120	136	170	214	238	272
	**Tensile N_{Rd}: single anchor, no edge effects**									
	Non cracked concrete									
	BSt 500 S [kN]	12,1	15,1	20,6	25,9	31,7	44,3	61,8	73,3	89,6
	Cracked concrete									
	BSt 500 S [kN]	-	6,3	12,7	17,2	22,5	31,5	44,1	52,3	63,9
	**Shear V_{Rd}: single anchor, no edge effects, without lever arm**									
	Non cracked concrete									
	BSt 500 S [kN]	9,3	14,7	20,7	28,0	36,7	57,3	90,0	112,7	147,3
	Cracked concrete									
	BSt 500 S [kN]	-	12,6	20,7	28,0	36,7	57,3	88,2	104,5	127,7

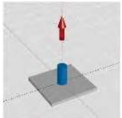
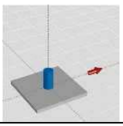
Design resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm², Temperature range I

		Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size		**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
Embedment depth $h_{ef,1}$ = [mm]		60	60	72	84	96	120	150	168	192
Base material thickness h_{min}= [mm]		90	90	104	120	136	170	214	238	272
Edge distance $c = c_{min}$= [mm]		40	50	60	80	100	120	135	150	150
	**Tensile N_{Rd}: single anchor, min. edge distance ($c = c_{min}$)**									
	Non cracked concrete									
	BSt 500 S [kN]	7,3	9,4	12,0	16,0	20,4	27,9	37,2	43,7	50,4
	Cracked concrete									
	BSt 500 S [kN]	-	4,2	8,5	12,6	17,3	23,7	31,0	36,6	41,6
	**Shear V_{Rd}: single anchor, min. edge distance ($c = c_{min}$) , without lever arm**									
	Non cracked concrete									
	BSt 500 S [kN]	3,5	4,9	6,7	10,3	13,7	19,3	25,2	30,2	32,0
	Cracked concrete									
	BSt 500 S [kN]	-	3,5	4,7	7,3	9,7	13,6	17,8	21,4	22,7

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

		Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size		**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
Embedment depth $h_{ef,1}$ = [mm]		60	60	72	84	96	120	150	168	192
Base material thickness h_{min}= [mm]		90	90	104	120	136	170	214	238	272
Spacing $s = s_{min}$= [mm]		40	50	60	80	100	120	135	150	150
	**Tensile N_{Rd}: double anchor, no edge effects, min. spacing ($s = s_{min}$)**									
	Non cracked concrete									
	BSt 500 S [kN]	7,9	9,5	12,4	16,0	19,9	27,5	37,8	44,6	53,3
	Cracked concrete									
	BSt 500 S [kN]	-	4,5	8,4	11,6	15,2	21,0	28,7	33,9	40,2
	**Shear V_{Rd}: double anchor, no edge effects, min. spacing ($s = s_{min}$) , without lever arm**									
	Non cracked concrete									
	BSt 500 S [kN]	9,3	14,7	20,7	28,0	36,7	57,3	80,4	95,1	112,9
	Cracked concrete									
	BSt 500 S [kN]	-	8,0	16,2	22,7	30,3	42,1	57,3	67,8	80,5

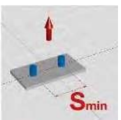
Design resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm², Temperature range I

			Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size			**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
Embedment depth	$h_{ef,typ}$ =	[mm]	80	90	110	125	145	170	210	270	300
Base material thickness	h_{min}=	[mm]	110	120	142	161	185	220	274	340	380
	**Tensile N_{Rd}: single anchor, no edge effects**										
	Non cracked concrete										
	BSt 500 S	[kN]	16,1	22,6	33,2	44,0	58,3	74,6	102,5	149,4	174,9
	Cracked concrete										
	BSt 500 S	[kN]	-	9,4	19,4	25,7	34,0	49,8	73,0	106,5	124,7
	**Shear V_{Rd}: single anchor, no edge effects, without lever arm**										
	Non cracked concrete										
	BSt 500 S	[kN]	9,3	14,7	20,7	28,0	36,7	57,3	90,0	112,7	147,3
	cracked concrete										
	BSt 500 S	[kN]	-	14,7	20,7	28,0	36,7	57,3	90,0	112,7	147,3

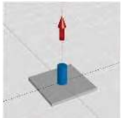
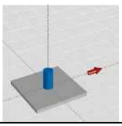
Design resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm², Temperature range I

			Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size			**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
Embedment depth	$h_{ef,typ}$ =	[mm]	80	90	110	125	145	170	210	270	300
Base material thickness	h_{min}=	[mm]	110	120	142	161	185	220	274	340	380
Edge distance	$c = c_{min}$=	[mm]	40	50	60	80	100	120	135	150	150
	**Tensile N_{Rd}: single anchor, min. edge distance ($c = c_{min}$)**										
	Non cracked concrete										
	BSt 500 S	[kN]	9,2	12,9	18,6	23,7	30,4	38,9	51,7	72,0	81,9
	Cracked concrete										
	BSt 500 S	[kN]	-	5,4	11,1	15,6	21,6	31,0	43,2	59,2	66,5
	**Shear V_{Rd}: single anchor, min. edge distance ($c = c_{min}$) , without lever arm**										
	Non cracked concrete										
	BSt 500 S	[kN]	3,7	5,3	7,3	11,2	15,8	21,5	27,5	34,3	36,5
	Cracked concrete										
	BSt 500 S	[kN]	-	3,8	5,2	7,9	11,2	15,2	19,5	24,3	25,8

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

			Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size			**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
Embedment depth	$h_{ef,typ}$ =	[mm]	80	90	110	125	145	170	210	270	300
Base material thickness	h_{min}=	[mm]	110	120	142	161	185	220	274	340	380
Spacing	$s = s_{min}$=	[mm]	40	50	60	80	100	120	135	150	150
	**Tensile N_{Rd}: double anchor, no edge effects, min. spacing ($s = s_{min}$)**										
	Non cracked concrete										
	BSt 500 S	[kN]	10,6	14,5	20,8	26,9	33,9	43,1	58,5	83,9	97,1
	Cracked concrete										
	BSt 500 S	[kN]	-	6,5	12,7	16,9	22,4	31,5	44,3	63,1	72,7
	**Shear V_{Rd}: double anchor, no edge effects, min. spacing ($s = s_{min}$) , without lever arm**										
	Non cracked concrete										
	BSt 500 S	[kN]	9,3	14,7	20,7	28,0	36,7	57,3	90,0	112,7	147,3
	Cracked concrete										
	BSt 500 S	[kN]	-	14,7	20,7	28,0	36,7	57,3	88,7	112,7	145,5

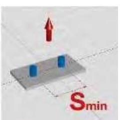
Design resistance: concrete C 20/25 – $f_{ck,cube}$ = 25 N/mm², Temperature range I

		Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size		**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
Embedment depth $h_{ef,2}$ = [mm]		96	120	144	168	192	240	300	336	384
Base material thickness h_{min}= [mm]		126	150	176	204	232	290	364	406	464
	**Tensile N_{Rd}: single anchor, no edge effects**									
	Non cracked concrete									
	BSt 500 S [kN]	19,3	30,2	43,4	59,1	77,2	120,6	174,9	207,4	253,3
	Cracked concrete									
	BSt 500 S [kN]	-	12,6	25,3	34,5	45,0	70,4	110,0	137,9	180,2
	**Shear V_{Rd}: single anchor, no edge effects, without lever arm**									
	Non cracked									
	BSt 500 S [kN]	9,3	14,7	20,7	28,0	36,7	57,3	90,0	112,7	147,3
	Cracked concrete									
	BSt 500 S [kN]	-	14,7	20,7	28,0	36,7	57,3	90,0	112,7	147,3

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

		Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size		**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
Embedment depth $h_{ef,2}$ = [mm]		96	120	144	168	192	240	300	336	384
Base material thickness h_{min}= [mm]		126	150	176	204	232	290	364	406	464
Edge distance $c = c_{min}$= [mm]		40	50	60	80	100	120	135	150	150
	**Tensile N_{Rd}: single anchor, min. edge distance ($c = c_{min}$)**									
	Non cracked concrete									
	BSt 500 S [kN]	11,0	17,2	24,8	33,9	42,4	58,6	79,7	94,3	111,7
	Cracked concrete									
	BSt 500 S [kN]	-	7,2	14,5	20,9	28,5	43,7	64,0	75,7	88,6
	**Shear V_{Rd}: single anchor, min. edge distance ($c = c_{min}$) , without lever arm**									
	Non cracked and cracked concrete									
	BSt 500 S [kN]	3,9	5,7	7,8	12,0	16,9	23,6	30,5	36,7	39,6
	Cracked concrete									
	BSt 500 S [kN]	-	4,0	5,5	8,5	12,0	16,7	21,6	26,0	28,1

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

		Data according ETA-11/0493 and ETA-12/0084, issue 2012-02-06								
Anchor size		**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø25**	**Ø28**	**Ø32**
Embedment depth $h_{ef,2}$ = [mm]		96	120	144	168	192	240	300	336	384
Base material thickness h_{min}= [mm]		126	150	176	204	232	290	364	406	464
Spacing $s = s_{min}$= [mm]		40	50	60	80	100	120	135	150	150
	**Tensile N_{Rd}: double anchor, no edge effects, min. spacing ($s = s_{min}$)**									
	Non cracked concrete									
	BSt 500 S [kN]	12,9	19,9	28,1	38,4	49,9	69,5	96,2	113,9	137,6
	Cracked concrete									
	BSt 500 S [kN]	-	8,8	17,0	23,3	30,5	46,3	69,3	84,9	102,1
	**Shear V_{Rd}: double anchor, no edge effects, min. spacing ($s = s_{min}$) , without lever arm**									
	Non cracked concrete									
	BSt 500 S [kN]	9,3	14,7	20,7	28,0	36,7	57,3	90,0	112,7	147,3
	Cracked concrete									
	BSt 500 S [kN]	-	14,3	20,7	28,0	36,7	57,3	90,0	112,7	147,3